TEXTO PARA DISCUSSÃO Nº 523

THE POST 1990 BRAZILIAN TRADE LIBERALIZATION AND THE PERFORMANCE OF LARGE MANUFACTURING FIRMS: PRODUCTIVITY, MARKET SHARE AND PROFITS*

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Rio de Janeiro, outubro de 1997

* Acknowledgements. In respect of the data used in this study, thanks are due to: the team at IBGE with responsibility for the **Pesquisa Industrial Anual**, especially for giving access to the data for 1994; to Kepler Mauro de M. Magalhães, for rapid and efficient programming; to Maurício Mesquita Moreira of BNDES for making available his estimates of dollar values of gross outputs and trade by sector since 1989; to Honório Kume for supplying his estimates of nominal and effective protection by sector; and to Flavio Borges Barros for excellent research assistance. In respect of the content of the research, the intellectual debts to the published works of Regis Bonelli and Honório Kume are considerable, and their encouragement and advice has been greatly appreciated. Roberto Iglesias has contributed enormously with his detailed knowledge of data sources and Brazilian industry: without his help this research would certainly have taken much longer to complete. IPEA in Rio de Janeiro provided an excellent research environment, graciously arranged by the Director, Claudio Monteiro Considera. ANPEC provided a generous grant to enable my stay in Brazil for a year to undertake this study.

** Bolsista da Anpec/PNPE na Direitoria de Pesquisa do IPEA.

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ISSN 1415-4765

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SUMÁRIO

ABSTRACT

This paper analyses the effects of the 1990 Brazilian trade liberalization on the total factor productivity, market share and profits of a sample of 349 large manufacturing firms. A panel data production function analysis for the period 1986/94 indicates very large total factor productivity gains in the period to 1994, which were accompanied by large falls in market shares and profits. The explanation advanced is that the shock of trade liberalization to profits was so great that firms were stimulated to improve their efficiency dramatically.

1- INTRODUCTION

In the period since the mid 1980s Brazilian manufacturing firms certainly came to appreciate the irony of the traditional Chinese curse: "May you live in interesting times". Much of the 'interest' stemmed from the vicissitudes of macroeconomic policy and performance in the period. [The key developments are summarized in Table 1: detailed discussion is available in Silva (1991), Silva and Velloso (1987), Oliveira **et alii** (1994) and Levy and Hahn (1996)]. There was a pronounced cycle in aggregate economic activity with a boom in the period 1984/87, followed by a recession which lasted for five years (with a slight reversal in 1989). The recession included the policy induced slump of 1990, which extended into 1991/92. A renewed period of expansion began in 1993. This cycle was even more accentuated in manufacturing activity. But the major preoccupation of policy was inflation. From a fairly stable rate of 100% p.a. in the early 1980s, as measured by the GDP deflator, inflation accelerated for most of the decade reaching a peak of 2574% p.a. in 1990. Policy measures and recession reduced the rate somewhat in 1991/92, but it accelerated again in 1993 and 1994, and was only finally brought under control by the Plano Real in 1994, falling to just under 10% by 1996. The policy responses to the inflation included no less than five separate Plans between 1986 and 1994, seeking to contain inflation with a mixture of price controls (or freezes) and attempts to break indexation.

Table 1
Macroeconomic performance and policy summary

Year	GDP % change	Industrial output % change	GDP deflator % change	Stage of cycle	Macroeconomic policies
1980	9.2	7.30		Recovery	Growth with external debt
1981	-4.3	-10.38	101	Recession	Oil price plus high international interest rates: measures to restrict domestic demand.
1982	0.8	-0.18	101	Recession	Same continued
1983	-2.9	-5.84	131	Recession	IMF stabilization programme: maxidevaluation
1984	5.4	6.17	202	Recovery	Growth -exportled
1985	7.9	8.34	249	Recovery	Growth -consumer led
1986	7.5	11.30	149	Recovery	Plano Cruzado
1987	3.5	0.95	206	Recovery	Plano Bresser
1988	-0.1	-3.41	628	Recession	
1989	3.2	2.88	1304	?	Plano Verão
1990	-4.4	-9.46	2574	Recession	Collor emergency measures: fear of hyperinflation
1991	0.3	-2.36	423	Recession	Plano Collor II
1992	-0.8	-4.08	995	Recession	Impeachment
1993	4.2	8.08	2072	Recovery	Why recovery?
1994	5.7	7.74	2295	Recovery	Plano Real

Source: **A Economia Brasileira em Perspectiva 1996**, Rio de Janeiro, IPEA, 1996: Parte 5 Estatísticas e Indicadores Econômicos: Séries Anuais: Tabelas 5 e 7, and studies citied in the Introduction.

As if macroeconomic instability was not sufficient to complicate the operations of firms and the lives of their managers, the period also witnessed a complete transformation in trade and industrial policies. Prior to 1990, the Brazilian economy was highly protected by a variety of tariff and non-tariff barriers to trade, and industrial policy was interventionist, with a variety of incentives, credit subsidies and price controls. Some minor cracks began to appear in this edifice in 1988, but after 1990 the whole structure was more or less demolished. Since the effects of this policy change on the performance of large manufacturing firms is the primary focus of the analysis in this paper, a more detailed discussion will be presented in Section 2.

Anticipating the results of the analysis which follows, we may identify the main effects of trade liberalization as a reduction of market shares in the domestic market, a sharp fall in profits, and a marked increase in the efficiency of large Brazilian manufacturing firms. In other words, the shock of import competition (actual or potential) stimulated the firms to improve their efficiency. How these elements link together is the subject of Section 3, in which we present an illustrative model based on the Cournot oligopoly model.

This theoretical discussion provides the framework for the empirical work which follows in Sections 5 and 6. In Section 5 we analyse the degree to which changes in sales productivity (that is, sales per worker) can be explained by changes in the level of protection across different sectors after 1990. This analysis also has to control for the effects of the macroeconomic cycle on productivity. In Section 6 we relate the market shares and profits of the firms to their efficiency, and to the degree of protection of their markets. These analyses are based on the data of the **Pesquisa Industrial Anual** (PIA), which is described in Section 4. This panel data set comprises detailed accounting and cost information for 650 leading industrial firms in each year 1986/94, except for 1991.

The conclusion of the study is that trade liberalization had a profound effect on these Brazilian firms. There is, of course, a large literature on the effects of trade liberalization [see for example, Papageorgiou, Michaely and Choksi (1992)]; but for comparative purposes, studies with similar panel data in other Latin American economies are of most interest [for examples: Tybout and Westbrook (1995) for Mexico, Roberts and Tybout (1991) for Colombia and Bolivia, Tybout, Melo and Corbo (1991) for Chile, and Barrera (1995) for Colombia]. Although there are differences in both methodology and data used in these studies — for example, the authors use panels relating to plants rather than firms, and in some cases are able to track the process of exit and entry of plants — the impacts of trade liberalization appear to be greater in the Brazilian case, as least in respect of impacts on the larger manufacturing firms that make up the PIA sample.

2 - TRADE LIBERALIZATION AND INDUSTRIAL POLICY

2.1 - Tariffs and Non-Tariff Barriers Prior to 1988

The pattern of protection in Brazilian manufacturing prior to 1988 has been carefully analysed by Kume (1989). The set of protectionist measures had accumulated over the years, with the result that there were many measures which were simply redundant. The structure of tariffs had remained virtually unchanged since the introduction of **ad valorem** tariffs in 1957. By 1988 there were generalized redundant tariffs in all sectors except for Pharmaceuticals, Clothing, Footwear and Other Manufacturing. That is, the tariff exceeded the difference between the world price and the domestic price, which is the implicit tariff. For the whole of Industry of Transformation the actual tariff was 56% while the implicit tariff was only 16%. Moreover there were additional taxes on imports: IOF (on foreign exchange transactions), TMP (a hypothecated tax for investment in port facilities), and AFRMM (a tax to provide subsidies for the domestic merchant fleet). According to Kume these together added on average 28% to the cost of imports, and taken together with tariffs implied redundancy in every sector of manufacturing.

However in practice the tariff structure was completely irrelevant. The same reforms in 1957 which had established the **ad valorem** tariffs had also created the **Comissão de Política Aduaneira (CPA)**, given discretionary powers to the **Carteira de Comércio Exterior do Banco do Brasil (Cacex)** to control the level of imports (and the conditions under which goods might be imported), and had activated the **Lei do Similar Nacional**. This last introduced, as a criterion for judging whether a particular import should be permitted, the question of whether a similar product was already produced in Brazil. In the 1980s, these entities operated a variety of non-tariff barriers. First, there was a list of 1300 products that in practice were not permitted to be imported — the so-called Anexo C. Second, all firms had to submit in advance annual plans for their imports. A third implicit non-tariff barrier affected imports of capital goods: access to fiscal subsidies and subsidized credit was made dependent on the domestic content of an investment project. Finally, by 1988 there were 42 Special Regimes which accounted for 70% of all imports, excluding oil. Within these Regimes the tariffs were either zero or greatly reduced, but were subject to the **Lei do Similar Nacional**. Under the law a product could only be imported with exemption or reduction in import taxes if it could be shown that a similar product was not available domestically. Given the high tariffs prior to 1990, the law effectively applied to the great majority of imports. In the case of machinery and equipment, the association of domestic producers of machinery was consulted to determine the existence of a similar product, which only served to strengthen the protectionist nature of the measure. The products included in the Regimes either arose from international agreements, or were essential supplies to the domestic market, or were selected to give incentives to firms which planned to export a substantial fraction of their output.

Pinheiro and Almeida (1994) analysed the sectoral distribution of nominal tariffs, effective protection and non-tariff barriers (as measured by the proportion of goods in a sector affected). They found that all three had the same relative structure in 1980 and in 1988: consumer goods, especially durables, had the highest levels of protection, with capital goods and intermediate goods less protected. In particular, they found that prior to 1988 high protection was generally associated with: low capital/output ratios and low productivity, low wages, low scale economies and low concentration. It was also associated with a dominance of Brazilian firms in a sector.

2.2 - The New Industrial Policy 1988

The policies introduced in 1988 by the Sarney administration had limited objectives. One was the removal of redundancy in the tariff structure: new tariffs were established approximately at the differential between internal and external prices.[1] Two of the import taxes (IOF and TPM) were suppressed. However Kume (1989) shows that tariffs plus taxes continued to provide redundant protection in virtually all sectors. Implicit tariffs were respectively 21%, 21% and 3% in capital, intermediate and consumer goods sectors: the actual tariffs including taxes were 50%, 31% and 50%. Exceptions to the general rule of redundancy were the Furniture, Rubber, Pharmaceuticals, Clothing and Footwear sectors: but non-tariff barriers covered at least 80% of the products in all these sectors except Pharmaceuticals. Some Special Regimes were also abolished, but Kume shows that these covered only 15% of total imports (excluding crude oil). He concludes that the reforms were nothing like as radical as originally envisaged, mainly due to strong opposition from producer interest groups. However Pinheiro and Almeida (1994) identify some significant changes in the sectoral pattern of protection in 1989 (as well as definite reductions in non-tariff barriers). There was relatively more protection for high technology sectors, and decline in protection for the low productivity, low scale sectors that had previously enjoyed high protection.

2.3 - Trade Liberalization: The Programme After 1990

By contrast with the tidying up of tariffs in 1988/89, the programme of reforms introduced by the Collor administration in 1990 constituted a major break with the protectionism of the past, and a decision to pursue **abertura comercial** (trade liberalization) as a long term strategy for Brazilian development. The reforms covered three areas. First, Anexo C, the list of 1300 products with imports prohibited, was abolished. Second, virtually all the Special Regimes were abolished: the exceptions were drawback, the Zona Franca of Manaus, and the information technology sector. Third, a tariff reform programme was announced, with some immediate adjustments, and a four year programme of reductions to

[1] This was by no means a straightforward exercise. For a description of some of the difficulties [see Tyler (1980) or Braga, Santiago and Ferro (1980)]. The estimates of the **Comissão de Política Aduaneira** in 1987 were never formally released.

bring all tariffs into the range 0%-40% by 1994 with a modal value of 20% (see Table 2).

Table 2
The tariff reform programme announced in June 1990: tariffs to be introduced by 1994

Tariff	Products
0%	Orange juice, iron ore, cellulose, cement.
5%	Maize flour, rice.
10% or 15%	Products which utilize basic inputs with zero tariffs e.g. cellulose 0%, paper 10%, paper products 15%, cotton 0%, yarn 10%, clothes 15%. Most intermediate products.
20%	Most manufactured products.
30%	Fine chemicals, wheat and derivatives, consumer electronics (TV, sound, video).
35%	Cars, lorries, motorcycles.
40%	Information tecnology.

Horta, Piani and Kume (1991) show that the immediate adjustments in tariffs reflected a variety of objectives:

a) products previously in Anexo C. Despite the fact that tariffs were already at a level sufficient to protect the domestic market, tariffs on electroelectronics and vehicles were raised to 85%, and on toys to 105% (in May 1990). The idea was that 'repressed demand' existed, and the additional tariffs provided additional 'security'.

b) textile products. At the end of June 1990, partial reductions in tariffs were brought in immediately to counter a rapid rise in the price of clothing. This anticipated plans for restructuring the sector drawn up by the **Programa Setorial Integrado (PSI)** as part of the industrial policy of the previous Administration. The difference was that no resources were forthcoming for the complementary measures aimed at restructuring.

c) in August 1990, there was a reduction in tariffs for agriculture machinery imports, as part of a series of measures for the agricultural sector.

d) tariffs for machinery and equipment not manufactured in Brazil were reduced immediately to zero.

e) tariff reductions as a method of price control were also tried in some producer sectors in 1990 — cement, aluminium, stainless steel, chemicals and petrochemicals — on the suspicion that the monopolistic/oligopolistic structures

of these sectors were particularly conducive to price increases in an inflationary period.

While these tariff changes were significant in themselves, Horta, Piani and Kume (1991) are probably correct to see their main impact as signalling in an unmistakable way that the long years of protectionism were coming to an end. The four year programme of tariff reductions was going to become a reality.

In fact the tariff reduction programme was completed in three years, with the four steps being taken in February 91, January 92, October 92 and July 93. The two initial steps emphasized reductions in tariffs on capital and intermediate goods, with the main reductions in consumer goods coming later. By international standards the tariff reductions were neither radical nor rapid, but together with the removal of the apparatus of non-tariff barriers, they were sufficient to signal a complete change of direction, and to shock the manufacturing sector into taking defensive action. This was exactly what the proponents of the liberalization had hoped would happen.

For completeness we should note two subsequent developments. The first was the additional liberalizing measures associated with the **Plano Real** in the second half of 1994. Reductions in tariffs and import taxes were used selectively to discipline sectors which were thought to be increasing prices without justification. More generally, in September 1994 the government anticipated the Mercosul external tariff programmed for the beginning of the next year. The second development came in 1995, with a resurgence of protectionist lobbies. In response the government made use of the Mercosul list of exceptions to raise tariffs (in some cases to 70%) on cars, consumer electronics, consumer electricals, and ten textile products. There was even a reincidence of non-tariff barriers with a licensing arrangement for imports of toys.

2.4 - Studies of the Impact of Trade Liberalization

There has only been one detailed study of the impact of trade liberalization at the industry level, that of Moreira and Correa (1996). Before turning to that, it is worth noting the annual studies by the **Confederação Nacional da Indústria (CNI)** based on a questionnaire survey addressed to industrial managers. In each year, starting in 1991, the respondents were asked to evaluate the effects of the trade liberalization on their firm, and to indicate how they were planning to meet the expected increases in import competition. These responses were then analysed in aggregate, and distinguishing between different sectors. The sequence of the studies is interesting in that it tracks the increasing awareness of the effects of trade liberalization, and therefore of the need to act effectively to confront the increased competition. Initially, most concerns about increased competition came from the intermediate and capital goods sectors, which were the first to experience significant tariff reductions, and regarded the rate of trade liberalization as rapid. By 1994 the consumer goods sectors were also beginning to feel the effects of

liberalization, but these were not judged to be strong until 1995. And despite the increased competition, 90% of the respondents in 1994 still regarded trade liberalization favourably — though the percentages were much lower in textiles, and somewhat lower in mechanical engineering and chemicals. In 1995 many more respondents were concerned about the exchange rate than about the tariff reductions.

Responses to questions about reactions to trade liberalization suggest that the primary instinct of Brazilian industry was to meet competition by increasing productivity of existing plants, by improving product quality and by investment in new technologies. The weak competitive position of the capital goods sector was signalled as early as 1992 with some firms in the relevant sectors reporting that they were abandoning investment plans. By 1994 they were also reporting plant closures. By 1995 the phenomenon of abandonment of investment by some firms had spread to other sectors. Even so, the vast majority of respondents remained confident of their ability to compete successfully, and reported that they had already achieved major gains in productivity and improvements in quality as a result of measures they had taken.

Moreira and Correa (1996) analysed the impact of trade liberalization at the sectoral level.[2] The study made estimates of the gross output of industrial production measured in dollars in 45 sectors in the period 1989/95, and of sectoral international trade flows. These estimates were then used to calculate indices of import penetration and of the share of exports in production. These showed a generalized increase in import penetration in all sectors to levels last observed in 1968/73, and in particular in machine tools, electronics, textiles (natural and artificial fibres), cars and lorries, tractors, and heavy electrical equipment. On the export side, there was a general increase in the share of exports in all sectors with particular emphasis in wood products, non ferrous metals, cellulose, orange juice, shoes, and iron and steel.

In a further analysis of the data, Moreira and Correa attempted to attribute the growth (or decline) in output in each sector to three elements — changes in domestic demand, changes in exports, and changes in imports. Gaining sectors were drinks, cellulose and pharmaceuticals, with all three elements favourable to growth. Major losses were registered by electronics/telecommunications equipment, synthetic fibres, iron and steel, and some textiles — though the relative weights of the three elements were different in each case. Broadly speaking, capital goods sectors lost out to imports, and intermediate goods sectors due to lower domestic demand. A key finding was that gains and losses in the period owed as much to the domestic economy as to the impact of trade liberalization. The authors then looked for explanations of the revealed comparative advantage (sectoral gains and losses) emerging after trade

[2] The IBGE classification of industries used in the study — Nível Cem — is one developed for use in constructing input-output tables: it lies between the 2 — and 3 — digit classifications of the Standard Industrial Classification.

liberalization, in terms of standard theories of international specialization. First they analysed factor intensity, finding that technology and resource intensive sectors lost out (but mainly due to domestic demand and exports rather than import competition). There were however no apparent relationships between revealed comparative advantage and other indicators such as economies of scale or R&D intensity.

One other study of the impact of trade liberalization by Fonseca (1996) is worthy of note here. In a careful econometric study of product quality in the Brazilian car industry, he showed that a positive effect of increasing openness to trade was a marked improvement in the quality of cars produced and supplied to the Brazilian domestic market.

3 - AN ILLUSTRATIVE MODEL

In this section we explore the effect of trade liberalization on firms in imperfectly competitive industries to provide an analytic framework for the subsequent empirical work. The analysis is intended only to be illustrative,so we will use the simplest model of oligopolistic competition, which is the Cournot model of an industry producing a homogeneous good. Our assumption is that imports and domestic production are perfect substitutes. Costs are assumed to vary between firms, and are partly endogenous, determined by the efforts of the managers.

The inverse market demand curve is given by $p = f(Q)$, where p is the market price, and Q is the total quantity put onto the market by all the firms that are present in the market at a given time (that is $Q = \Sigma_i\, q_i$ where q_i are the outputs of each of the firms i = 1, 2, 3,...). Each firm has constant marginal costs, c_i, and fixed costs, F_i. The profit of each firm is given by:

$$\pi_i = (f(Q) - c_i)\, q_i - F_i \tag{3.1}$$

The f.o.c. condition can be written as:

$$\frac{p - c_i}{p} = \frac{s_i}{E}\left(1 + \lambda_i\right) \tag{3.2}$$

which is the expression for the price cost margin. E is the elasticity of demand, s_i is the market share of firm i. λ_i is the conjectural variation parameter, which is a convenient means of indicating the degree of competition in the market. The parameter can take on a range of values: $\lambda_i = \frac{1 - s_i}{s_i}$ for full collusion, $\lambda_i = 0$ for Nash Cournot competition, and $\lambda_i < 0$ for competitive behaviour. Summing 3.2 across all firms j yields:

$$p = \frac{\bar{c}}{1 - \frac{1 + \sum s_j \lambda_j}{nE}} \tag{3.3}$$

where $\bar{c} = \frac{\sum c_j}{n}$, the simple average of the costs of all the firms.

3.1 - Market Share

Substituting 3.3 in 3.2 gives an expression for the market share s_i of each firm:

$$s_i = \frac{E}{1+\lambda_i} - \frac{E}{1+\lambda_i}\left[1 - \frac{1+\sum \lambda_j s_j}{nE}\right]\frac{c_i}{\bar{c}} \tag{3.4}$$

Note that $1 - \frac{1 + \sum \lambda_j s_j}{nE}$ determines the mark up of price over the average costs of firms: so it can be interpreted as an index of competition in the market.

However it is apparent that 3.4 is actually a system of j simultaneous equations, which can in principle be solved [see Hay and Liu (1997)] to give:

$$s_i = \frac{E}{1+\lambda_i} - \frac{c_i(nE-1)}{\bar{c}n(1+\lambda_i)} + \frac{1}{1-\mu}\frac{c_i}{\bar{c}}\frac{1}{n(1+\lambda_i)}\sum_{j=1}^{n}\frac{\lambda_j}{1+\lambda_j}\left[E - \frac{c_j}{\bar{c}}(nE-1)\right] \tag{3.5}$$

where

$$\mu \equiv \sum_{j=1}^{n} \frac{c_j \lambda_j}{n\bar{c}(1+\lambda_j)}$$

If all the λs are the same, this expression simplifies to:

$$s_i = \frac{E}{1+\lambda} - \frac{E}{1+\lambda}\left[1 - \frac{1+\lambda}{nE}\right]\frac{c_i}{\bar{c}} \tag{3.6}$$

and for λ = 0

$$s_i = E - E\left[1 - \frac{1}{nE}\right]\frac{c_i}{\bar{c}} \tag{3.7}$$

For the collusive case, $\lambda = \frac{1 - s_j}{s_j}$, the expression for s_i is not defined, presumably because in collusion all output should be produced by the most efficient firm.

The conclusion is that the market share is determined by the cost of the firm relative to the average costs of all suppliers in the market. More efficient firms naturally have larger market share.

3.2 - Profits

Gross profits, ignoring F_i, are:

$\pi_i = (p_i - c_i)\, q_i$

which, if the λs are the same for all firms, is given by:

$$\pi_i = \frac{E}{1+\lambda} \frac{\bar{c}}{1-\frac{1+\lambda}{nE}} \left[1 - \left(1 - \frac{1+\lambda}{nE} \right) \frac{c_i}{\bar{c}} \right]^2 Q \qquad (3.8)$$

Recalling that the expression for price is:

$$p = \frac{\bar{c}}{1-\frac{1+\lambda}{nE}}$$

and substituting gives:

$$\pi_i = -\frac{1}{1+\lambda} \frac{dQ}{dp} \left(\frac{\bar{c}}{1-\frac{1+\lambda}{nE}} - c_i \right)^2 \qquad (3.9)$$

Evidently π_i is diminishing in c_i: lower cost (more efficient) firms generate higher profits.

3.3 - Endogenous Costs

Next we consider the case where costs are endogenous. Let the costs of each firm be $c_i + c\,(e_i)$ where c_i depends on the physical and R&D capital stock of the firm, and $c\,(e_i)$ depends on the effort e_i of the manager. We will assume[3] that $c\,(e_i) = -e_i$. Let the managerial utility function be $\beta\,(\pi_i) - e_i^2$ i.e. positive linear in the share of profits and negative quadratic in effort. Writing it out in full gives:

$\beta\,(p(Q) - c_i - c\,(e_i))\, q_i - e_i^2$ (3.10)

[3] Note that the linear assumption is not necessarily a good one in this model: one would expect diminishing returns to effort. But the linear assumption greatly simplifies the mathematics of the illustrative model.

The manager's problem is solved in two stages: first we write profit as a function of effort, and then maximize utility with respect to effort. Using 3.9,

$$\pi_i = -\frac{1}{1+\lambda}\frac{dQ}{dp}\left(\frac{\bar{c}}{1-\frac{1+\lambda}{nE}} - c_i + e_i\right)^2$$

with a first derivative with respect to managerial effort[4]

$$\frac{\partial \pi_i}{\partial e_i} = -\frac{2}{1+\lambda}\frac{dQ}{dp}\left(\frac{\bar{c}}{1-\frac{1+\lambda}{nE}} - c_i + e_i\right)$$

where $\bar{c} = \frac{\sum c_{i-e_i}}{n}$.

The managerial optimum is therefore given by:

$$-\frac{2\beta}{1+\lambda}\frac{dQ}{dp}\left(\frac{\bar{c}}{1-\frac{1+\lambda}{nE}} - c_i + e_i\right) - 2e_i = 0$$

$$e_i = -\frac{\frac{\beta}{1+\lambda}\frac{dQ}{dp}\left(\frac{\bar{c}}{1-\frac{1+\lambda}{nE}} - c_i\right)}{1+\frac{\beta}{1+\lambda}\frac{dQ}{dp}} \qquad (3.11)$$

The implication is that higher c_i (i.e. the cost not affected by effort), implies less effort by the manager, presumably because the marginal gain from a decrease in costs is spread across a smaller output and so is less worthwhile.

[4] This neglects a second order effect which is that a change in e_i also effects the average costs $\bar{c}$ for the whole industry and hence (slightly) reduces the incentives for managerial effort.

3.4 - The Effects of Trade Liberalization on Market Share, Profits and Efficiency

In principle, trade liberalization can have three separate effects on competition in the market:

a) particularly in the case of removal of non tariff barriers, an effect is that import suppliers can now compete in the domestic market. Even if the new suppliers are no more efficient on average than the domestic firms, they will be able to enter and establish a market share. In terms of the model, the number of competitors, *n*, increases;

b) alternatively we may assume no change in the number of firms, but that changes in tariffs and exchange rates have an impact on the costs of foreign firms supplying the domestic market. Suppose there are *j* domestic firms and *k* foreign suppliers, so average costs of total supply are:

$$\bar{c} = \frac{\sum c_j + \sum c_k}{j+k} \tag{3.12}$$

$$= \sigma\, \bar{c}_j + (1-\sigma)\bar{c}_k \tag{3.13}$$

where $\sigma = \frac{j}{j+k}$.

Note that:

$$\bar{c}_k = (1+\tau) ER \bar{c}_k^* \tag{3.14}$$

where $\bar{c}_k^*$ is the average costs of foreign suppliers in foreign currency, *ER* is the exchange rate, and τ is the tariff. Evidently, the effect of a tariff reduction is to reduce $\bar{c}$; and

c) a third possible effect of trade liberalization is that implicit (or explicit) collusion may be broken. In particular, import suppliers may no longer be willing to accept price leadership from domestic firms, given that their ability to supply the market is no longer constrained. This effect is modelled by a change in the value of λ.

In a companion paper to this one [Hay (1997)], we analyse the effects of marginal changes in *n*, τ and λ on market share, profits and efficiency. The analysis contains few surprises, at least in terms of market shares and profits. Marginal increases in *n*, reductions in τ, and decreases in λ all reduce profits as intuition would suggest. The same holds for market share, with the exception of the effects

of decreases in λ. **Ceteris paribus**, a decrease in collusion increases the market share of the more efficient firms, and decreases that of the less efficient.

But the effect of these marginal changes is generally to reduce managerial effort and hence efficiency. This rather counterintuitive result has a straightforward explanation: if the marginal utility of profit to the manager is a constant (β), then anything that reduces the profitability of the firm will also reduce the incentives to reduce costs. Suppose however that the effect of import competition on the profits of incumbent firms is not marginal: that is there is a discrete change in the state of competition in the market such that the incumbents lose out substantially in terms of market share and profits. Then it is no longer the case that the marginal utility of profit will remain unaltered: instead one might expect it to increase substantially (as measured for example by the slope of the profits-utility relationship). In what follows, we explore this possibility informally, as a full analysis proves intractable. The general expression for profits (compare 3.8) is:

$$\pi_i = -\frac{1}{1+\lambda}\frac{dQ}{dp}\left(\frac{\bar{c}}{1-\frac{1+\lambda}{nE}} - c_i + e_i\right)^2$$

Using $p = \dfrac{\bar{c}}{1-\dfrac{1+\lambda}{nE}}$, and setting $-\dfrac{1}{1+\lambda}\dfrac{\partial Q}{\partial p} = k$ (linear demand), gives:

$$\pi_i = k\,(p - c_i + e_i)^2$$

Proceeding as before, we derive:

$$e_i = \frac{\beta' k\left(p - c_i\right)}{1 - \beta' k\left(p - 1\right)} \tag{3.15}$$

where β' is the marginal utility of profit to the firm.

Total differentiation yields:

$$\Delta e_i = \frac{\beta' k(1+\beta' k(1+c_i))}{\left(1-\beta' k\left(p-1\right)\right)^2}\Delta p + \frac{k\left(p-c_i\right)}{\left(1-\beta' k\left(p-1\right)\right)^2}\Delta\beta_i'$$

Focussing first on the term in Δp, we note that the coefficient is positive and increasing in both β' and c_i. The interpretation is that if prices fall, all firms reduce their effort, but high cost, high β' firms reduce it the most. But that is offset by an increase in effort, if $\Delta\beta_i' > 0$; and the increase is greater the more efficient the firm is initially, and the lower is the initial β'. In the empirical analysis which follows

we assume that the shocks of trade liberalization and recession in Brazil in the early 90s were such that the effects were quite definitely non-marginal, and hence $\Delta\beta$' was positive and sufficiently large to offset the reduced incentive for effort from lower marginal profits.

4 - THE "PESQUISA INDUSTRIAL ANUAL" AND OTHER DATA SOURCES

4.1 - Firm Data

The basic source of information for the study is the excellent **Pesquisa Industrial Anual (PIA)** of leading industrial firms in the Brazilian economy. The purpose and methodology of the survey are described in detail in a series of publications [IBGE (1994, 1995**a**, 1995**b**, 1996)]. The original data set includes nearly 500 firms with information in every year of the survey. Firms were dropped from the analysis for a number of reasons: **a**) in sectors[5] which lacked complementary data series e.g. price indices (publishing and printing), measures of effective protection (soaps and perfume); **b**) in sectors with special non-market arrangements (e.g. oil refining, alcohol); **c**) in some sectors involved in primary processing of raw materials e.g. wood products, cellulose, leather; and **d**) apparent data 'errors' in one or more years for a particular firm e.g. due to mergers, or changes in accounting practices. The final sample for the analysis in the paper comprised 349 firms, from which we drew two overlapping pooled samples. The first subsample of 275 firms was all the firms in seven industry groups. The second sample comprised 293 firms in 21 sectors. All the industry groups, and some of the sectors, contained sufficient observations to permit individual analysis.

The PIA contains a wealth of information about the firms. It combines accounting balance sheet data with data on employment, sales and costs. For the purposes of the analysis in this paper we used only three variables: net sales, capital stock, and employees involved in production.

a) **net sales**. Net sales, deflated by the average of the sectoral wholesale price index (FGV-IPA) for each year, was our measure of output. Obviously we would have preferred to use an estimate of value added, but there are two problems with the data. The first is that the inquiry includes a catch-all category: 'Other costs and outgoings (including purchases of raw materials)', in which 'costs' and 'outgoings' are distinguished. Unfortunately, this item under the heading 'outgoings' is often extremely large, and deducting it sometimes gave a negative value added. The second problem is the valuation of changes in stocks of raw materials and work in progress, which is given simply as the change in value over the year, which is not very informative in a period of high inflation. Evidently a

[5] The Brazilian industrial classification of sectors is Nível Cem, designed specifically to facilitate the construction of an input-output matrix. It corresponds (roughly) to the 3-digit ISIC. Industry groups (Gêneros) are the next level of aggregation, corresponding to 2-digit ISIC.

proper measure of value added should be adjusted for these changes in real terms, which is not possible with the data as they are;

b) **capital stock**. Our measure of capital stock is drawn from the balance sheet. Fortunately, for these leading firms, stringent inflation accounting rules were applied over the period. The rules provided for indexation of values during the year, including acquisition of new capital assets, disposals of assets, and depreciation, so as to give an inflation adjusted value as of 31 December in each year. In principle then, these reported values, deflated by the same index as was used in their construction, should give an indicator of the real assets of the firm;[6]

c) **labour**. The only measure of labour input available for firms in the PIA is the end-of-year workforce.[7] There are no data on variations in the labour force over the year, of quality e.g. educational level.

4.2 - Measures of Protection

Indices of nominal and effective protection at sector level were made available by Honório Kume. As explained in Section 2 above, before 1988 non-tariff barriers implied that most tariffs were redundant, that is the tariffs exceeded the differential between internal and external prices. The 1988 tariff reform sought to remove this redundancy. On this basis, the 1989 nominal tariffs may be used as an approximate index of the degree of protection in different sectors during the second half of the 1980s. From 1990, tariffs had a renewed economic significance and, as already noted, they were progressively reduced under a planned programme. For this period then, an appropriate measure of protection is given by Kume's indices of effective protection, calculated on the basis of the 1985 input-output table. The changes in tariffs did not conform precisely to calendar years. So we have chosen the effective tariff measures that were in place for the greater part of a particular year:

1990 - September 89 to September 90
1991 - February 91 to January 92
1992 - January 92 to October 92
1993 - October 92 to July 93, and July 93 to December 94 (average of the two)
1994 - July 93 to December 94.

[6] However, two caveats are in order here. First, these values suggested that the average growth of the real capital stock in 1992/93 was very low, which does not accord with information on aggregate investment in manufacturing in this period. Second, the shock of trade liberalization after 1990 certainly reduced the effective stock of capital, as productive units were partially or completely closed down. It is not clear how such partial or complete scrapping was accounted for by the firms. But it is quite likely that the post 1990 asset values exagerate the stock of capital available to the firm.

[7] Note that this is only a problem for that part of the PIA which deals with firms. The PIA data for establishments include monthly totals.

4.3 - Market Size

Estimates of gross output and trade flows in current dollar values, 1989/95, for sectors have been made by Moreira and Correa (1996). While the trade flows are based directly on primary data, the measures of gross output have to be indirect estimates, in the absence of any industrial census after 1985. The basis of their estimates was the data from the PIA for 1989, 1990 and 1992, extrapolated for other years by indices of physical output produced by IBGE [the **Pesquisa Industrial Mensal - Produção Física (PIM-PF)]**. Our measure of the market in each sector is given by gross output plus imports. It would have been helpful to exclude exports, but the PIA data do not distinguish domestic and export sales by each firm.

5 - THE DETERMINANTS OF FIRM EFFICIENCY

The illustrative model of Section 3 has shown that if the adverse shocks experienced by a firm due to trade liberalization or a sudden recession are large enough, it may make an effort to increase its efficiency. In this section we explore the impacts of trade liberalization and recessionary shocks on the efficiency of the firms in our data set in the period 1986/94. Although the theoretical model is developed in terms of costs, it is more convenient empirically to work in terms of productive efficiency, following Nickell (1996). Evidently more efficient firms will have lower costs.

The analysis contributes to a wider debate about productivity growth in Brazil [Bonelli (1996), Salm, Saboia and Carvalho (1996)].The key fact to be explained is that labour productivity in the Brazilian manufacturing sector, which had scarcely changed in the period 1985/90, suddenly began to grow at a rate of 7.35% p.a. in the period 1991/95 (see Figure 1). This period of productivity growth included two different phases. In the first, up to 1992, there was a deep recession with output falling, but employment falling even faster. In the second phase, after 1992, productivity and output grew: but the former grew faster so employment continued to fall, though at a lesser rate than in 1990/92. A further characteristic of labour productivity growth in the period 1985/95, which is emphasized by Bonelli (1996), is that exactly the same pattern is present in different industrial sectors. He calculated productivity[8] in seven sectors (metals, mechanical engineering, electrical, transport equipment, chemicals, textiles and food), which in 1985 produced jointly 70% of the value added in the industrial sector. With some variation, all seven sectors demonstrate the same behaviour. Using 1985 =100 as the base, productivity in 1990 was a virtually the same level as in 1985; but by 1995 it had grown to anything between 120 (transport equipment, textiles) and 180 (electrical), with a weighted average of 145.

[8] Sectoral real output indices divided by an index of paid hours worked.

The debate between rival explanations of this phenomenon has been ably summarized by Bonelli (1996):

a) an early study by Silva et alii (1993) looked at productivity change in 1990/92, and concluded that it could best be explained by the deep recession (picking up a parallel with the early 1980s). They further noted that there was no clear evidence of change in firm behaviour with respect to efficiency — either investment in new technologies, or change in management techniques. Bonelli noted that this conclusion was overtaken by events, since productivity continued to grow **after** growth in output was resumed in 1992/95. However, that does not allow for the possibility that the 'shock' of recession continued to have an effect on managerial behaviour long after the recession had ended [see, for example, the discussion in Nickell, Wadhwani and Wall (1992)].

b) Feijó and Carvalho (1994) argue that productivity growth in this period was due to technical progress and a managerial revolution, stimulated by the **abertura comercial** and the general liberalization of the economy. In respect of technical progress, they point to a rapid growth in imports of capital goods, presumably incorporating the best technologies, in the period after 1990. In respect of managerial techniques, a subsequent study by Salm, Saboia and Carvalho (1996) did show strong rank correlations between productivity growth in 12 industrial sectors, and the degree of adoption of various managerial techniques as revealed in a survey of firms. Indeed, the authors argue that these results can explain how productivity gains were achieved without an appreciable increase in the level of investment.

c) Considera (1995) argued that substantial gains in productivity had come from the closing down of inefficient producers in the face of competitive pressures from imports and from new foreign-owned producers in the Brazilian domestic market. He also suggested that 'tercerization' — the contracting out of industrial and other services — might have had substantial effects, though this would be difficult to measure accurately.

d) Amadeo and Gonzaga (1996), while giving due weight to managerial improvements and tercerization, also suggested a role for imported inputs. If firms substitute imported inputs for components they previously supplied themselves, the relationship between value of output and value added changes. For example, more sectoral output could in fact represent less value added. The evidence for substitution of domestic production by imported parts is strong in some sectors (electronics, automobiles): but in the absence of industrial census information the changes in the ratio of value added to value of output cannot be observed.

Our analysis is not able to address all these issues. The data do not permit exploration of the hypothesis of productivity gains via the closing down of inefficient producers, as the PIA includes only leading firms. Nor can we examine the hypothesis of tercerization/imported inputs as the only reliable indicator of

output is sales rather than value added. But we should be able to establish the relative importance of trade liberalization, and recession and recovery.

The basic empirical model is a Cobb-Douglas production function in log linear form:

$$y_{it} - n_{it} = \gamma\,(y_{it-1} - n_{it-1}) + (1-\gamma)\,\alpha\,(k_{it} - n_{it}) + (1-\gamma)\,(\alpha+\beta-1)\,n_{it} + \phi_1\,(\textit{protection}) + \phi_2\,(\textit{real exchange rate}) + \theta_i + \theta_t + \varepsilon_{it} \qquad (5.1)$$

where y_{it} is log real output, n_{it} is log employment, k_{it} is log capital stock, α and β are the exponents on capital and labour in the Cobb-Douglas production function, ϕ_1 and ϕ_2 are the coefficients on measures of protection and real exchange rates (to be defined below), and θ_i and θ_t are firm and time fixed effects. θ_i captures all firm specific factors affecting the level of productivity. θ_t captures time specific shocks common to all firms, for example the general level of activity in the economy. ε_{it} picks up all other shocks to firm productivity and is assumed to be serially uncorrelated. Note that returns to scale are indicated by $(\alpha + \beta - 1)$. Simple dynamics, reflecting lags in adjustment of outputs to inputs, are captured by including the lagged dependent variable.

A number of econometric issues have to be considered.[9] The first is that the capital/labour ratio and the number of workers are certainly endogenous, and therefore have to be instrumented. It is also likely that the lagged dependent variable and the error term are correlated, so the former should be instrumented. For instruments we have utilized all available lagged values of the variables. The second issue is whether to estimate the equation in levels or in first differences. The latter has the advantage that it eliminates the firm fixed effects, and concentrates attention on the explanatory variables and the dynamics of adjustment. However implementation proved difficult with the current data set. The absence of data for 1991 either implied losing a lot of data points as appropriate lagged values were not available, or required some procedure to interpolate 1991 values. Moreover it proved difficult to obtain meaningful results: given the chaotic economic environment of Brazil in this period and the difficulties of measuring variables accurately in a period of high inflation, it is perhaps unwise to expect economic rationality to show up in year on year changes. We therefore opted for estimations in levels with a full set of firm dummies.[10] This has the advantage of obtaining direct estimates of the fixed factors associated with each firm, which can be interpreted as an index of their total factor productivity, and are used subsequently in the analysis.

The productivity equation, in addition to year dummies, includes variables for protection and the real exchange rate. As explained in the data section, for the

[9] This is a preliminary version of the paper, and a number of issues of econometric testing remain to be addressed.
[10] Implemented with the PANEL programme in TSP.

years prior to 1990 we used the (log of) nominal protection in 1989 (PN)[11] as a proxy for protection, on the grounds that the tariffs were set in that year to approximate the differential between internal and external prices. From 1990 onwards, we use the (log of the) effective protection rates (PE) calculated by Kume. These pre-1990 and post-1990 variables have to be inserted separately in the equation, as they are not directly comparable. The real exchange rate (ERR) is calculated as the ratio of a general world price index for industrial goods multiplied by an index of the average exchange rates of a basket of currencies of Brazil's major trading partners, to the domestic wholesale price index. An increase in the value of the index indicates a rise in competitiveness for Brazilian industry, a decrease indicates a fall in competitiveness. Taking 1990 = 100, the index had a value of 82 in 1986, increased sharply to 107 in 1989, increased sharply again in 1991/93 with a high of 125 in 1991, and then fell back in 1994 and 1995. Our expectation is that this index will be negatively correlated with efficiency. A devaluation 'protects' domestic industry; a revaluation 'exposes' it to imports, requiring it to become more efficient. Note that in the empirical work, we distinguish the effects of the real exchange rate before 1990 (ERR1), when import controls were in place, and after 1990 (ERR2), when imports were liberalized.

Results are tabulated in Tables 3-5: in Table 3 for pooled data, and Tables 4 and 5 for some industry groups (Gêneros) and for some sectors. Considering first the pooled data equations, it is evident that the results differ very little between the two samples described in Section 3. So for discussion we focus on the second sample (pooled data from the sectors). Looking first at the variables common to all specifications (A to D), we note that there is a generalized lag in adjustment, with apparently only two thirds of adjustment in the current year. The coefficient on the capital labour ratio is implausibly low — even adjusting for lags, it is generally less that 0.18. This probably reflects the poor measurement of this variable. The negative coefficient on labour suggests diminishing returns to scale, which may be partly a result of using pooled data.

In column A, year dummies are included in the equation. (Note that 1989 is the reference year, and 1992 is dropped because of the lack of 1991 data to provide lagged values.) Assuming that the coefficient captures total factor productivity, a strong cyclical pattern emerges. Productivity was stable 1986/88, fell in 1989 and especially in 1990, with a very strong recovery to 1993/94. The scale of the latter gains is impressive: the coefficients imply an increase of more than 58% in total factor productivity from the low of 1990 to the high of 1994. The empirical challenge is to distinguish in this pattern the effects of the economic cycle and the effects of protection/real exchange rates. In column C, measures of protection and real exchange rates are introduced: the year dummies are dropped as they are collinear with ERR1 and ERR2. The coefficients on the (log) measures of protection (LPN and LPE) are negative, as expected, and significant. Note that LPN is picking up both a time series effect and a cross section effect. The cross

[11] Note that this is defined as (1 + τ) where τ is the tariff, in line with the theoretical model of Section 3.

Table 3 no arquivo td0523t

Table 3
Sales per worker equations (pooled data)

Gêneros (resultados gerais)					Setores (resultados gerais)				
	A	B	C	D		A	B	C	D
LSANT (-1)*	0.27	0.38	0.38	0.28	LSANT (-1)*	0.28	0.39	0.39	0.29
	5.76	7.99	8.03	5.91		6.38	9.01	9.00	6.55
LKNT*	0.08	0.13	0.16	0.07	LKNT*	0.06	0.09	0.11	0.05
	3.36	7.14	7.9	3.16		3.34	5.05	5.25	3.02
LNT*	-0.07	-0.06	-0.05	-0.06	LNT*	-0.08	-0.10	-0.10	-0.08
	-1.86	-1.62	-1.4	-1.76		-2.44	-2.92	-2.74	-2.37
YR86	0.03			0.03	YR86	0.06			0.06
	1.24			1.13		2.52			2.38
YR87	0.12			0.12	YR87	0.16			0.16
	5.55			5.46		7.62			7.49
YR88	0.04			0.04	YR88	0.06			0.06
	1.83			1.78		2.89			2.82
YR90	-0.16			-0.23	YR90	-0.08			-0.16
	-7.04			-6.02		-3.62			-4.26
YR93	0.16			0.06	YR93	0.20			0.09
	5.08			1.39		6.97			2.29
YR94	0.32			0.21	YR94	0.38			0.27
	9.65			4.7		11.00			5.91
LPN		-0.69	-1.04	-0.45	LPN		-0.77	-0.92	-0.48
		-6.87	-7.62	-3.44			-8.58	-7.65	-4.12
LPE		-0.64	-0.64	-0.12	LPE		-0.62	-0.64	-0.15
		-11.92	-11.88	-2.13			-11.46	-11.43	-2.75
LERR1			-0.12		LERR1			-0.21	
			-2.15					-3.58	
LERR2			-0.15		LERR2			-0.22	
			-2.66					-3.76	
Standard error	0.27	0.28	0.28	0.27	Standard error	0.30	0.32	0.32	0.30
Adj.R^2	0.88	0.86	0.86	0.88	Adj.R^2	0.87	0.85	0.85	0.87
F	3.81	3.27	3.33	3.83	F	3.20	2.80	2.83	3.23
d.o.f.	(274,1641)	(274,1645)	(274,1643)	(274,1639)	d.o.f.	(292,1749)	(292,1753)	(292,1751)	(292,1747)
P-Value	0.0000	0.0000	0.0000	0.0000	P-Value	0.0000	0.0000	0.0000	0.0000
Nob.	1925	1925	1925	1925	Nob.	2051	2051	2051	2051

*These variables are instrumented.

Table 4
Sales per worker equations (gêneros)

	Metalurgia (11)		Mecânica (12)		Material elétrico (13)		Material de transporte (14)		Química (20)		Têxtil (24)		Produtos Alimentares (26)	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
LSANT (-1)*	0.17	0.32	0.21	0.37	0.26	0.26	0.00	0.00	0.40	0.42	0.25	0.39	0.06	0.02
	1.44	2.74	1.37	2.96	2.00	2.28	0.03	-0.05	4.49	4.52	2.28	3.76	0.52	0.12
LKNT*	0.08	0.17	0.13	-0.02	0.11	0.12	0.09	0.24	0.08	0.21	0.08	0.10	-0.01	0.14
	1.89	4.55	1.33	-0.21	2.39	2.56	1.86	5.43	1.78	4.83	1.50	2.03	-0.16	2.13
LNT*	-0.06	-0.03	0.09	0.10	0.13	0.09	-0.13	-0.12	-0.02	-0.08	0.01	-0.01	-0.07	-0.01
	-0.66	-0.37	0.68	0.79	1.11	0.75	-1.28	-1.13	-0.19	-0.76	0.16	-0.09	-0.74	-0.15
YR86	-0.11		0.44		-0.10		-0.07		0.05		0.18		-0.07	
	-1.93		4.86		-1.33		-1.34		0.83		3.19		-1.07	
YR87	0.01		0.32		0.10		0.05		0.06		0.34		-0.01	
	0.23		3.85		1.63		1.08		1.25		8.08		-0.15	
YR88	0.07		0.09		-0.09		0.00		0.15		0.13		-0.02	
	1.61		1.37		-1.51		-0.13		3.18		2.79		-0.43	
YR90	-0.12		-0.16		-0.25		-0.31		-0.18		0.06		-0.13	
	-2.72		-1.63		-3.86		-7.13		-3.39		1.37		-2.25	
YR93	0.12		0.29		0.59		-0.04		0.08		0.30		0.03	
	1.85		2.20		6.12		-0.63		1.07		4.87		0.36	
YR94	0.32		0.43		0.68		0.07		0.27		0.53		0.24	
	5.10		3.57		5.37		0.97		3.54		8.23		2.12	
LERR1		-0.20		-0.53		0.10		0.03		-0.25		-0.58		0.05
		-1.50		-2.45		0.64		0.23		-1.98		-4.69		0.35
LPE		-1.14		-3.75		-4.60		-0.07		-0.16		-0.38		-0.17
		-5.23		-8.57		-9.64		-0.59		-1.88		-5.16		-0.53
LERR2		-0.14		-0.26		0.45		-0.02		-0.26		-0.50		0.04
		-1.07		-1.21		3.08		-0.21		-2.12		-4.14		0.31
Standard error	0.22	0.23	0.28	0.30	0.30	0.30	0.21	0.23	0.21	0.24	0.22	0.25	0.24	0.25
Adj.R^2	0.89	0.87	0.83	0.81	0.87	0.86	0.85	0.82	0.91	0.88	0.84	0.79	0.87	0.86
F	3.52	2.88	3.04	2.49	3.67	3.51	6.38	6.09	3.90	3.31	3.86	2.66	3.85	3.63
d.o.f.	(51,302)	(51,306)	(27,158)	(27,162)	(32,188)	(32,192)	(40,236)	(40,240)	(32,188)	(32,192)	(45,266)	(45,270)	(35,206)	(35,210)
P-Value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Nob.	364	364	196	196	231	231	287	287	231	231	322	322	252	252

*These variables are instrumented.

Table 5
Sales per worker equations (setores)

	Siderurgia 510		Máquinas e Equipamentos 810		Motores e Peças 1310		Fab. Papel 1520		Fiaç. Tec. Fib. Nat. 2210		Vestuário 2310		Sapatos 2420	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
LSANT(-1)*	0.15	0.32	0.21	0.34	0.10	0.12	-0.07	0.09	0.20	0.09	0.59	0.45	-0.15	-0.17
	0.86	1.91	1.37	2.38	1.13	1.44	-0.44	0.58	1.25	0.56	2.36	1.89	-0.78	-0.97
LKNT*	0.00	0.04	0.00	-0.14	0.13	0.15	0.00	0.03	-0.03	0.00	0.14	0.15	0.49	0.49
	0.06	0.61	-0.04	-1.78	2.39	3.00	0.05	0.37	-0.44	-0.06	2.62	2.85	2.13	2.14
LNT*	-0.29	-0.25	0.14	0.19	-0.29	-0.30	-0.32	-0.33	-0.20	-0.19	-0.07	-0.09	-0.13	-0.14
	-3.02	-2.53	1.14	1.54	-2.85	-3.02	-2.73	-2.31	-1.37	-1.20	-0.63	-0.76	-1.18	-1.50
YRR86	-0.11		0.39		-0.05		-0.03		0.08		-0.02		0.35	
	-1.58		3.64		-0.89		-0.49		1.27		-0.21		2.91	
YR87	-0.04		0.28		0.02		0.17		0.27		0.18		0.49	
	-0.66		2.83		0.49		3.58		5.93		1.97		5.73	
YR88	0.13		0.04		-0.02		-0.05		0.08		-0.08		0.41	
	1.65		0.47		-0.58		-0.77		1.36		-1.24		4.26	
YR90	-0.14		-0.05		-0.35		-0.11		0.01		-0.03		0.02	
	-1.71		-0.49		-7.58		-1.54		0.11		-0.42		0.12	
YR93	0.23		0.35		-0.17		0.22		0.28		-0.02		0.30	
	2.07		3.07		2.13		1.55		2.97		-0.18		1.49	
YR94	0.44		0.53		-0.09		0.53		0.57		0.21		0.49	
	4.26		4.22		-1.23		4.11		6.60		2.10		3.35	
LERR1		-0.29		-0.42		-0.03		-0.21		-0.66		-0.24		-1.39
		-1.50		-1.61		-0.22		-1.35		-4.58		-1.19		-4.80
LPE		-2.08		-3.80		-1.28		-3.50		-2.03		-0.48		-3.00
		-6.20		-6.71		-4.45		-5.31		-5.72		-2.66		-4.75
LERR2		-0.15		-0.13		0.00		-0.08		-0.53		-0.18		-1.20
		-0.79		-0.53		-0.01		-0.50		-3.82		-0.95		-4.01
Standard error	0.20	0.21	0.27	0.29	0.18	0.18	0.19	0.22	0.23	0.24	0.27	0.28	0.48	0.47
Adj.R^2	0.87	0.86	0.79	0.76	0.70	0.70	0.91	0.88	0.78	0.75	0.76	0.73	0.54	0.55
F	3.81	2.83	3.27	2.59	6.19	6.21	5.22	4.49	3.68	3.88	2.18	2.19	2.28	2.50
d.o.f.	(18,104)	(18,108)	(21,122)	(23,126)	(27,158)	(27,162)	(14,80)	(14,84)	(22,128)	(22,132)	(18,104)	(18,108)	(26,152)	(26,156)
P-value	0.0000	0.0005	0.0000	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0075	0.0070	0.0010	0.0003
Nob.	133	133	154	154	196	196	105	105	161	161	133	133	189	189

*These variables are instrumented.

Table 7

Market share equations (industry groups) Market share equations (sectors)

	Equaç.	Const.	LEFF6	LPE	LPERR2	R^2		Equaç.	Const.	LEFF6	LPE	LPERR2	R^2
11 Metalurgia*	1	-13.50	1.09	4.29		0.30	510 Siderurgia*	1	-23.92	1.65	3.55		0.66
		-9.71	8.68	5.86					-12.40	12.17	4.06		
	2	-25.85	1.01		2.87	0.24		2	-38.31	1.60		3.22	0.63
		-6.19	7.77		3.90				-5.79	11.21		2.80	
12 Mecânica*	1	-11.26	0.63	4.27		0.27	810 Máquinas e Equipamentos*	1	-11.26	0.63	4.27		0.27
		-8.92	5.43	4.03					-8.92	5.43	4.03		
	2	-15.48	0.49		1.35	0.15		2	-15.48	0.49		1.35	0.15
		-2.69	4.09		1.24				-2.69	4.09		1.24	
13 Material Elétrico*	1	-12.63	0.87	10.99		0.21	1310 Motores e Peças*	1	-29.93	2.27	7.77		0.85
		-4.78	3.53	5.47					-26.93	23.79	14.94		
	2	-24.89	0.12		4.42	0.07		2	-44.20	2.09		3.69	0.64
		-3.19	0.62		3.13				-10.15	13.95		5.06	
14 Material de Transporte*	1	-30.94	2.48	7.14		0.74	1520 Fab. de Papel	1	-14.86	1.01	4.13		0.60
		-20.65	18.67	9.72					-10.90	9.41	3.17		
	2	-44.36	2.30		3.45	0.61		2	-38.19	1.02		4.90	0.62
		-9.41	14.20		4.30				-5.70	9.83		3.80	
20 Química*	1	-9.28	0.68	0.13		0.21	2210 Fiaç. Tec. Frib. Nat.*	1	-35.86	1.48	9.35		0.67
		-6.98	5.69	0.63					-7.36	10.25	11.63		
	2	-9.66	0.69		0.06	0.21		2	-50.44	1.12		7.26	0.40
		-6.62	5.72		0.31				-8.20	6.01		7.04	
24 Têxtil*	1	-14.63	1.34	3.24		0.59	2310 Vestuário*	1	-14.99	1.30	2.59		0.35
		-11.86	9.85	15.32					-6.26	5.87	4.82		
	2	-29.92	1.26		3.37	0.57		2	-33.20	1.43		3.51	0.41
		-15.64	9.19		14.76				-7.36	6.61		5.76	
26 Produtos Alimentares*	1	-13.14	1.16	0.62		0.50	2420 Sapatos*	1	-9.97	1.18	4.67		0.19
		-11.32	11.13	1.04					-4.96	4.52	3.73		
	2	-22.37	1.21		1.78	0.53		2	-50.77	1.34		8.23	0.38
		-6.86	12.00		3.13				-7.85	5.99		7.05	

Table 9
Profit equations (log linear)-Dependent variable LRPROF-

Sector	510 Siderurgia		810 Máquinas e Equipamentos		1310 Motores e Peças		1520 Fab.de Papel		2210 Fia.Tec. Fibras Naturais		2310 Vestuário		2420 Sapatos	
C	-38.62	-0.71	-11.86	1.38	-32.81	-2.67	-16.86	0.54	-16.46	-0.79	-23.71	-0.35	-9.24	-2.93
	-1.31	-1.57	-0.96	3.72	-4.17	-8.27	-1.60	1.96	-1.23	-1.60	-2.56	-0.67	-2.22	-4.32
LREFF	2.25	2.25	0.72	0.71	2.84	2.84	1.67	1.67	1.74	1.73	1.69	1.69	2.24	2.23
	12.14	12.11	5.17	5.07	20.65	19.90	15.68	15.62	8.13	8.11	7.50	7.49	7.69	7.71
LMEFF	3.16		1.62		3.20		1.47		1.57		2.75		1.35	
	1.29		1.06		3.78		1.60		1.09		2.41		1.64	
PRE	1.19		0.78		0.38		0.57		1.15		-0.08		-0.72	
	1.34		1.14		1.40		1.87		3.56		-0.17		-1.15	
LPE	4.16		1.24		2.18		2.31		3.18		0.46		-1.72	
	0.95		0.46		1.93		0.93		2.72		0.63		-0.94	
PRE88		0.44		-0.05		-0.04		-0.29		0.36		-0.50		0.51
		1.43		-0.20		-0.27		-1.40		1.35		-1.72		1.65
YR90		-0.26		-0.60		-0.41		-0.60		-0.31		-0.40		0.15
		-067		-1.97		-2.10		-2.28		-0.94		-1.14		0.40
YR92		-0.12		-0.58		-0.40		-0.64		-0.76		-1.13		-0.22
		-031		-1.93		-2.03		-2.50		-2.30		-3.18		-0.58
POST93		-0.05		-0.43		-0.43		-0.46		-1.02		-0.82		0.35
		-0.14		-1.59		-2.50		-2.08		-3.53		-2.65		1.06
N	145	145	143	143	214	214	118	118	177	177	147	147	188	188
F	39.13	31.19	9.78	7.56	114.28	82.56	63.34	50.25	27.81	22.40	17.25	13.78	15.51	13.17
$\bar{R}^2$	0.51	0.51	0.20	0.19	0.68	0.66	0.68	0.68	0.38	0.38	0.31	0.30	0.24	0.25

Table 9 (continued)
Profit equations (long linear) - Dependent variable LRPROF-

Gêneros	11 Metalurgia		12 Mecânica		14 Material Elétrico		14 Material de Transporte		20 Química		24 Têxtil		26 Produtos Alimentares	
C	-13.30	0.07	-9.71	0.75	-10.43	1.40	-17.19	-0.56	-16.06	1.75	-14.58	-0.50	-5.80	0.74
	-1.34	0.26	-1.38	2.17	-1.31	4.69	-3.22	-2.25	-3.86	6.60	-2.60	-1.50	-0.83	2.66
LREFF	1.58	1.57	1.13	1.12	1.11	1.09	1.99	1.99	0.76	0.76	1.42	1.40	1.37	1.35
	13.79	13.82	8.80	8.71	9.39	9.47	18.62	19.12	6.92	7.24	9.90	9.84	12.61	12.54
LMEFF	1.50		1.44		1.66		1.80		1.90		2.05		0.69	
	1.33		1.44		1.53		3.08		4.31		2.42		0.88	
PRE	0.50		0.58		0.76		0.21		0.23		0.50		0.39	
	2.06		1.36		1.06		1.43		1.46		2.00		1.50	
LPE	1.13		1.53		1.68		0.04		0.06		0.73		1.02	
	0.95		0.79		0.78		0.14		0.21		2.56		1.09	
PRE88		0.33		0.01		0.17		0.05		0.51		0.63		0.08
		1.69		0.05		0.71		0.29		2.63		3.21		0.37
YR90		-0.26		-0.50		-0.25		-0.37		-0.47		0.11		-0.32
		-1.06		-1.71		-0.90		-1.74		-1.96		0.44		-1.26
YR92		-0.05		-0.51		0.15		-0.19		0.29		-0.31		-0.06
		-0.19		-1.80		0.53		-0.93		1.22		-1.28		-0.23
POST93		-0.23		-0.30		0.03		-0.22		0.22		-0.43		-0.10
		-1.09		-1.18		0.12		-1.19		1.08		-2.06		-0.46
N	398	398	187	187	253	253	312	312	259	259	353	353	325	325
F	51.22	41.48	22.41	17.56	23.39	18.60	99.12	75.17	19.88	16.14	35.23	29.67	40.65	32.43
$\bar{R}^2$	0.34	0.34	0.32	0.31	0.26	0.26	0.56	0.54	0.23	0.23	0.28	0.29	0.33	0.33

section effect arises from the variation in non-tariff protection across sectors prior to 1990. The time series effect is the removal of non-tariff barriers in 1990: presumably this effect is the greater, the higher the pre 1990 protection. The average value of nominal protection in 1988 was about 32%, and the coefficient implies that a one percent reduction in protection was accompanied by a 0.9% increase in efficiency. Assuming nominal protection in 1989 to be a reasonable indicator of non-tariff barriers, the implication is that efficiency increased on average by 22% due to their removal in 1990. To take an admittedly extreme example, the removal of the non-tariff barrier in the automobile industry, which was equivalent to a 65% nominal tariff, would have increased efficiency by 35%. The effects of reductions in protection after 1990 are only slightly smaller. According to Kume's calculations (1996), the average effective tariff fell from 45.5% in 1990 to 19.9% in 1994. The coefficient on LPE suggests that this on average increased efficiency by about 11%. The results in column C also suggest a minor role for the real exchange rate: a 'protective' devaluation of 10% reduces efficiency by 2%. In column D, we attempt to evaluate the relative contributions of the economic cycle and of protection to efficiency. There is no difference in the year coefficients prior to 1990, but from 1990 onwards the coefficients are much lower. The coefficients on PN, and especially on PE, are also much reduced. Unfortunately it is unlikely that these coefficients give an accurate indication of the separate effects: the removal of non-tariff barriers coincided precisely with the policy-induced recession of 1990, and the process of reducing effective tariffs after 1990 coincided with the rapid recovery of economic activity. A comparison with the period 1981/95 is instructive, if not conclusive. The pattern of decline and growth in manufacturing activity in that period was not dissimilar to that of 1990/94 (see Figure 1). In that period labour productivity increased by 5.2%. If that experience can be extrapolated to 1990/94, it would suggest that of the 58% growth in total factor productivity, only five percentage points can be accounted for by the cyclical effects, leaving some 53 percentage points to be explained by trade liberalization and privatization/deregulation of the economy. Of these 53 points, perhaps 22 were due to the abandonment of non-tariff barriers in 1990 and 11 were due to the progressive reduction of effective tariffs over the period; the remaining 20 points may be attributable to the general liberalization of the economy, including privatization/deregulation in some sectors e.g. the steel industry.

Tables 4 and 5 present results by industry groups (Gêneros) and by sectors, where the latter are more homogeneous than the former. In all cases the coefficients on the year dummies show the same distinct pattern of stable efficiency levels in 1986/88, a fall in 1989/90, and then efficiency gains to 1993/94. Two Industries warrant further comment. The first is **mecânica** [see also **máquinas e equipamentos** (810)], where the recovery in efficiency to 1994 only served to restore efficiency to the levels of 1986. The second is **material de transportes** [see also **motores e peças** (1310)], which is virtually exclusively the automobile industry in this sample. Once again, efficiency was more or less the same at the beginning and end of the period, but fell dramatically in the 1990 recession.

Table 4 no arquivo td0523t

Table 5 no arquivo td0523t

The alternative equations include the (logs of) ERR1, ERR2, and PE. (Note that these equations cannot include year dummies together with ERR1, ERR2 and PE because of collinearity: PN is excluded as it has only a single value in the period 1986/89.) The real exchange rate is evidently more important in some sectors — **química**, **têxtil**, **fibras naturais**, and **sapatos**: perhaps these sectors are more sensitive than other sectors to movements in world prices. Effective protection has the expected negative sign, and is significant at least the 10% level in all industry groups, with the exceptions of **material de transportes** and **produtos alimentares**. Some of the coefficients suggest very large efficiency effects from trade liberalization — especially **mecânica**, **material elétrico**, **siderurgia**, **papel**, **fibras naturais** and **sapatos**. For example, in **material elétrico**, the coefficient on PE suggests an 88% gain in efficiency since 1990 due to the reduction in protection: in **sapatos**, a 50% gain. However, the previous caveat applies; at least some of these gains should be attributed to the recovery in output after the deep recession of 1990/91.

To conclude, our results indicate very substantial efficiency losses associated with non-tariff protection prior to 1990. Post 1990, there have been very large efficiency gains arising jointly from the recovery after the 1990/91 recession, from the trade liberalization, and from liberalization of the economy in general. While it is not possible to distinguish these quantitatively, our equations and a comparison with 1981/85 suggest that the greater part of the gains should be attributed to trade liberalization.

Our next task is to probe a little more deeply into the mechanisms which induced firms to improve their efficiency so dramatically, in response to the shocks of recession and import competition. Specifically we investigate the effects on the market shares and profits of domestic firms.

6 - MARKET SHARE AND PROFITS

6.1 - Market Share

In Subsection 3.1, for the case where λ is the same for all firms, we showed that the market share of the firm is given by:

$$s_i = \frac{E}{1+\lambda} - \frac{E}{1+\lambda}\left[1 - \frac{1+\lambda}{nE}\right]\frac{c_i}{\bar{c}} \qquad (6.1)$$

In principle, as discussed in Subsection 3.4, trade liberalization could affect market share by affecting n, λ and $\bar{c}$. Our empirical work focusses on $\bar{c}$, assuming that changes in n and λ are small. In which case we can write the previous equation, distinguishing different time periods, as:

$$s_{it} = \varphi_1 - \varphi_2 \frac{c_{it}}{\bar{c}_t}$$

and substituting from 3.13 and 3.14,

$$s_{it} = \varphi_1 - \varphi_2 \frac{c_{it}}{\sigma \bar{c}_{jt} + (1-\sigma)(1+\tau_t) ER_t \bar{c}^*_{kt}} \qquad (6.2)$$

To interpret, market share is decreasing in the firm's own costs, and increasing with the average costs of domestic suppliers and of foreign suppliers in the domestic market taking into account tariffs and the exchange rate.

6.2 is highly non-linear and in any case arises from a very particular model. So for empirical purposes, we specify a general (log linear) relationship between c_{it}, $\bar{c}_{jt}$ and $(1+\tau_t) ER_t \bar{c}^*_{kt}$. In the place of measures of c_{it} and $\bar{c}_{jt}$, we use indices of firm efficiency constructed from the production function analysis of the previous section, noting that costs are inversely related to efficiency. So in place of c_{it}, the efficiency measure is the firm fixed effect, θ_i, plus the time fixed effect, θ_t, plus the efficiency effects of protection and the real exchange rate. In place of $\bar{c}_{jt}$, which is the average of the c_{it} for domestic firms, we use an average of the firm efficiency measures. The costs of foreign suppliers can be proxied by $(1 + \tau_t)\ ER_t$ in the absence of information on $\bar{c}^*_{kt}$. In practice things are not so straightforward.

First, as defined c_{it} and $\bar{c}_{jt}$ are collinear, and so are the corresponding efficiency measures, so only one can be included in the equation. We opt for the firm measure rather than the industry average measure as we are also interested in the effects of its cross-section variation on market share. Second, $(1 + \tau_t)\ ER_t$ enters in two places: indirectly via its effect on firm efficiency and indirectly through its effect on the cost of foreign suppliers. To exclude any possibility of collinearity over time between $(1 + \tau_t)\ ER_t$ and the firm efficiency measure, we opted for a definition which included only the firm fixed effect and the time fixed effect. The empirical counterparts (in logs) are LEFF for the firm efficiency measure, LPE for $(1 + \tau_t)$, LERR2 for ER_t and LPERR2 for $(1 + \tau_t)\ ER_t$. Our expectation is that (log) firm market share will be positively related to LEFF, and positively related to LPE, LERR2 and LPERR2. Note that the analysis captures a cross-section effect (more efficient domestic producers will have a higher market share), and a time series effect (changes in the relative costs of domestic and foreign suppliers).

Market shares are calculated as the ratio of firm sales to the estimates of market size of Moreira and Correa (1996) described in Section 4 before.[12] The latter are only available for 1989 onwards, so our analysis is for four years only, 1990 and 1992/94. Some sectors had to be excluded for lack of market size data. Results for pooled data are given in Table 6 (note that sectoral dummies were included in all these equations). As expected, protection has a big effect on market share: these equations suggest that a 1% fall in protection directly decreased the market share of domestic firms by 2.56%. Also as expected, more efficient firms have larger market shares: the elasticity is 1.16. Note that this is capturing mainly a cross-section effect. But it also has a time-series aspect: from the previous section we know that a 1% fall in protection stimulates domestic firm efficiency with an estimated elasticity of 0.64, which in turn increases market share by 0.74%. The net effect of a 1% decrease in protection is therefore of the order of a 1.8% loss in market share. Given Kume's estimate (1996) that on average protection fell by 17% between 1990 and 1994, a 30% fall in market share is implied if these elasticities are correct.[13] These are implausibly large effects: the suspicion is that the equations are overestimating the impact of trade liberalization. Equations for individual industry groups and sectors, in Table 7, compound the problem, since many of the elasticities of market share with respect to protection are even larger than for the pooled sample.

Table 6
Market share equation (pooled data)

	A	B	C
C	-13.67	-13.20	-13.17
	-8.64	-24.96	-24.91
LEFF	1.16	1.16	1.16
	22.58	22.64	22.64
LPE	2.56	-	2.52
	10.73	-	11.90
LERR2	0.11	-	-
	0.34	-	-
LPERR2	-	0.56	-
	-	11.96	-
N	1044	1044	1044
$\bar{R}^2$	0.73	0.73	0.73
F	104.11	108.40	108.21

Nota: **Dummies** setoriais são incluídas em todas as equações.

[12] This is not an ideal measure of market share, given that the gross value of output calculated by Moreira and Correa(1996) is exactly that — output, not sales, and hence excluding changes in stocks.

[13] Actual average import penetration was much less than this. See for example the estimates of Moreira and Correa (1996), Table 2, of how import shares increased in different sectors 1990/95. Note however that our sample probably includes more firms from sectors in which import competition was above average in this period.

Table 7 no arquivo td0523t

Whatever may be the explanation, one thing seems certain — trade liberalization had a dramatic effect on the market share of domestic producers in this period. While no doubt quite a number of firms simply closed down under the impact of import competition, those who remained in the market had to make a major effort to reduce costs in order to mitigate their losses.

6.2 - Profits

In Subsection 3.2 we derived the expression for the profits of each firm

$$\pi_i = -\frac{1}{1+\lambda}\frac{dQ}{dp}\left(\frac{\bar{c}}{1-\frac{1+\lambda}{nE}} - c_i\right)^2 \qquad (6.3)$$

Assuming, as in the case of market share, that the effects of trade liberalization on the number of competitors, *n*, and the degree of collusion, λ, are small, this expression can be written:

$$\log \pi_{it} = \psi_1 + 2\log\left(\psi_2 \bar{c}_t - c_{it}\right)$$

Substituting from 3.13 and 3.14 gives:

$$\log \pi_{it} = \psi_1 + 2\log\left(\psi_2 \sigma\, \bar{c}_{jt} + \psi_2(1-\sigma)(1+\tau_t)ER_t \bar{c}^*_{kt} - c_{it}\right)$$

or

$$\log \pi_{it} = \psi_1 + 2\log\left(\left(\psi_2\sigma - 1\right)\bar{c}_{jt} + \psi_2(1-\sigma)(1+\tau_t)ER_t \bar{c}^*_{kt} + (\bar{c}_{jt} - c_{it})\right) \qquad (6.4)$$

i.e. firm *i* profits are a non-linear function of three variables: the average costs of domestic firms $\bar{c}_{jt}$, the average costs of foreign suppliers $(1+\tau_t)ER_t\bar{c}^*_{kt}$, and the efficiency of firm *i* relative to its domestic competitors $(\bar{c}_{jt} - c_{it})$.

For empirical work we specify a general (log linear) relationship between log profits (LRPROF), log average efficiency of domestic firms (LMEFF) in a sector, derived from the production function analysis, the log relative efficiency of firm *i* (LREFF) measured as the difference between firm efficiency and sectoral average efficiency, and measures of protection (LPN prior to 1990, and LPE from 1990 onwards). For comparison we also ran equations with relative efficiency (LREFF) only, the other variables being substituted by four time dummies (PRE88 for 1986/88, YR90 for 1990, YR92 for 1992 and POST93 for 1993/94 — note that the coefficients on these dummies are relative to the base year of 1989).

The measure of profits is the closest approximation to the concept of gross profits which can be derived from the data of the PIA. From net sales are deducted identifiable costs of production — wages and related labour costs, and costs of inputs. As explained in Section 4 above, the precise nature of some other recorded expenditures is unclear, so these were not deducted. Nor is any adjustment made for changes in work in progress or in stocks of raw materials. Nominal profits are deflated by the average of the sectoral price index (IPA) to give a measure of real profits (RPROF).

The pooled data set (after deleting approximately 5% of the observations with negative profits) gave 2087 observations over eight years. Sectoral dummies were included in the equations to capture inter industry differences in capital intensity. The results are given in Table 8. In the specification with time dummies, the collapse of profits in 1990 relative to 1986/88 is very evident: the difference in coefficients is equivalent to a 42% decline in average profits. Although profits recovered somewhat thereafter, the 1993/94 level was still 35% lower than in 1986/88. In the specification which included the average efficiency of domestic firms (LMEFF) and measures of protection (LPN and LPE),[14] the signs of the coefficients were as expected, and with the exception of LPE, significant. That is, firm profits were higher the greater the efficiency of the firm relative to its domestic competitors, the higher the average efficiency of domestic producers, and the higher the level of protection. The coefficients suggest that a 1% improvement in average efficiency generated a 1% increase in profits, and a 1% increase in PN (which is a proxy for non-tariff protection prior to 1990) increased profits by 0.7%. The puzzle is the weak performance of the effective protection variable from 1990 (LPE). There are two possible explanations: **a**) from the production function analysis we know that the average efficiency of domestic firms has a negative relationship with LPE; it is possible therefore that LMEFF is picking up all the effects of the decline in protection after 1990; **b**) the movements in profits within the period 1990/94 were much smaller than in the preceding period.

The results for industry groups and sectors confirm the results of the pooled sample. The equations with time period dummies track some very large falls in profits from 1986/88 to 1993/94: for example, in **têxtil** the decline is 65%, with an even greater fall (79%) in **fibras naturais**. The alternative equations include average domestic firm efficiency, a dummy (PRE89) for the period 1986/89 to capture the effects of non-tariff barriers, and effective protection (LPE) for 1990 onwards. In most cases the coefficients on relative efficiency and average domestic firm efficiency are larger than in the pooled equation, indicating that efficiency gains by individual firms, or by all firms relative to foreign suppliers, generated expressive gains in terms of profits. As expected the PRE89 dummy reflects much higher profits in virtually all sectors in the period before trade

[14] We experimented with variables in which the measures of protection were interacted with real exchange rates, or with real exchange rates and an index of international manufacturing costs. Neither procedure improved the results.

Table 8
Profit equations (log linear)-POOLED DATA-

DEPENDENT VARIABLE LRPROF			
C	-7.65	C	0.06
	-18.08		0.33
LREFF	1.37	LREFF	1.38
	25.02		25.66
LMEFF	0.97	PRE88	0.29
	19.23		3.70
LPN	0.72	YR90	-025
	3.79		-2.63
LPE	0.05	YR92	-0.07
	0.33		-0.78
		POST93	-0.14
			-1.68
N	2087	N	2087
F	244.37	F	39.36
$\overline{R}^2$	0.32	$\overline{R}^2$	0.36

Nota : **Dummies** setoriais são incluídas em todas as equacões.

liberalization. The coefficient on protection after 1990 (LPE) is, in contrast with the pooled data, generally positive and large though seldom statistically significant.[15]

These results have two important implications for our study:

a) there is no doubt that the falls in profits arising from the recession in 1990/91, and from trade liberalization from 1990 onwards, were non-marginal. The argument of Subsection 3.4 that firms made more effort because the marginal utility of profits increased dramatically is clearly plausible, though not of course demonstrated.

b) the fall in profit was mitigated, to some extent, by the improved efficiency of domestic producers. For example, if the estimated elasticities from the pooled equations are correct, a 1% fall in protection stimulated a 0.6% improvement in efficiency pushing up profits by about the same amount. The direct impact on profits was -0.7% due to import competition. The net effect was a small decrease in profits of -0.1%.

[15] One reason for the lack of significance may be that the equation does not control for the fall in profits in 1990 provoked by the domestic recession, at a time when the effective protection rate was highest.

7 - CONCLUSIONS

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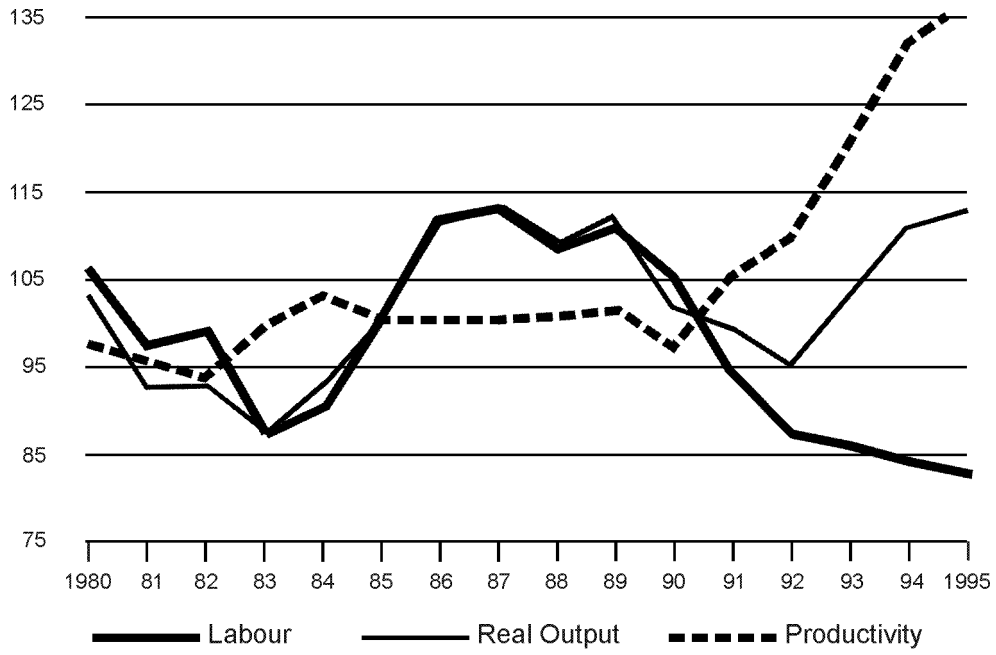
Proponents of trade liberalization have based their arguments on the presumption that import competition stimulates domestic producers to improve their X-efficiency and to catch up technologically [Tybout (1991)]. There are however more sceptical opinions [see for example, Rodrik (1992)], and the issue remains to be resolved by empirical studies. The experience of the post 1990 Brazilian trade liberalization is potentially very interesting, as it enables us to study the impact on a relatively large and well developed, and highly protected, industrial structure. The analysis of this paper suggests that the optimism of enthusiasts for trade liberalization is well founded. The leading Brazilian manufacturing firms responded to trade liberalization after 1990 with an impressive growth in productivity, though some of that growth also represented the effects of general liberalization of the economy and a recovery from the adverse effects of the policy induced recession of 1990/91. This growth was in total factor productivity, indicating a key role for improvements in X-efficiency and technological catch up. The remaining puzzle is the nature of the behavioural response by the firms. Since competition reduces profitability, why did the firms not respond by reducing their efforts, and accepting the inevitable reduction in profits and market share? The explanation suggested here is that the shocks to profits were so large that the marginal utility of profit with respect to effort actually increased, stimulating greater efficiency. While this mechanism is not observable directly, we have shown that the adverse shocks to profits were proportionately very large.

Table 9 no arquivo td0523t

Table 9 (cont.) no arquivo td0523t

Figure 1

Productivity in Manufacturing Industry (1980/95)



Data Sources: Real Output - Pesquisa Industrial Mensal - Produção Física (PIM-PF) IBGE.
Labour - 1985/95 - Pesquisa Industrial Mensal - Dados Gerais (PIM-DG) IBGE.
- 1983/84 - Variações de Pesquisa Mensal de Emprego (PME) IBGE.
- 1980/82 - Variações anuais do pessoal ocupado na Indústria - Anuário Estatístico do IBGE.

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