

# Manufactured exports from Brazil: determinants and consequences\*

Analice Amazonas\*\*  
Alexandre Rands Barros\*\*\*

Summary: 1. Introduction; 2. Determinants of manufactured export growth in Brazil; 3. General comments on the determinants of Brazilian manufactured exports; 4. Summary and conclusions.

Key words: manufactured exports; export equation.

This paper presents a supply and demand model for the determinants of exports of manufactures from Brazil, which encompasses most of the other models found in the related literature. In the process of specifying the model, many of these studies are critically reviewed.

Este artigo apresenta um modelo de oferta e demanda para os determinantes da exportação de produtos manufaturados pelo Brasil, englobando a maioria dos outros modelos encontrados na literatura correlata. No processo de se especificar o modelo, muitos desses estudos foram examinados criticamente.

## 1. Introduction

This paper presents a demand and supply model of the determinants of manufactured exports from Brazil, for the period 1965-88.<sup>1</sup> Previous studies are reviewed and the model proposed is built on the basis of this review. The model which in the end is estimated is distinguished from the previous ones not only by the method of estimation but also by the inclusion of certain variables which shed some light on the role which domestic costs and productivity growth may have had in the development of the Brazilian manufactured exports.

The paper is organized as follows. Next section specifies the model, borrowing largely from previous models estimated in the literature, and estimates it. Section 3 comments on these results and discusses some simulation exercises developed on the basis of the equations estimated in section 2. Section 4 concludes the paper.

\* Paper received in Jan. and approved in Apr. 1995.

\*\* St. Antony's College, University of Oxford.

\*\*\* Visiting professor, Pimes/UFPe. This paper was written while this author was a Senior Associate member in St. Antony's College, Oxford.

---

<sup>1</sup> The data set used is for 1964-88, but the period included in the estimations spans from 1965 to 1988, due to the inclusion of one lag in the dependent variable.

## 2. Determinants of manufactured export growth in Brazil

Manufactured exports of a country are considered a sectorial export in the literature and as such are determined by supply and demand, as for all goods. Thus, we have:

$$X_t^s = f\left(\frac{E_t p w_t}{p d_t}(1 + S_t), C_t, W_t, P_t, o_i, YP_t, X_{t-1}^s\right) + u_t \quad f_1, f_4, f_6 > 0; f_2, f_3, f_5 < 0 \quad (1)$$

$$X_t^d = g(p w_t, p c_t, Y_t, X_{t-1}^d) + v_t \quad g_1 < 0, g_2, g_3 > 0 \quad (2)$$

where:

$X_t^s$  is the export supply;

$X_t^d$  is the export demand;

$Y_t$  is the real GDP in the rest of the world;

$p d_t$  is an index of domestic prices for manufactures;

$p w_t$  is the world price of the country's exports, measured in foreign currency;

$E_t$  is the nominal exchange rate measured in local currency by foreign currency;

$S_t$  is the rate of subsidies to a monetary unit exported;

$W_t$  is the domestic real wages;

$p c_t$  is a vector of world price of the competing products, measured in foreign currency;

$YP_t$  is the domestic potential production of the sector;

$C_t$  is an index of cyclical activity, normally measured by the capacity utilization;

$P_t$  is the productivity of the sector;

$u_t$  and  $v_t$  are stochastic errors with constant zero mean, which will be specified later.

Equations (1) and (2) encompass most of the models found in the literature on supply and demand for manufactured exports in Brazil.<sup>2</sup> An additional identity of supply and demand is also included in most models, which is represented by:

$$X_t^s = X_t^d$$

Equation (1) defines the supply of manufactured exports as a function of: their prices in the world market as perceived by domestic producers; the domestic costs of the sector, represented by domestic real wages and oil prices; and the optimal production decision of the sector, which is represented by the installed capacity and the index of cyclical activity. The first relation is common to all supply functions and is normally justified by the profit maxi-

<sup>2</sup> Surveys of these models may be found in Zini Jr. (1988) and in Braga and Markwald (1983).

mizing behavior of firms. The world price of the commodity is transformed into domestic currency through the exchange rate and is corrected for the subsidies. This price is then deflated by a domestic price index to obtain the price of exports at constant prices. The price taken into account by domestic producers to make decisions is the relative domestic effective price, which is the world price converted to domestic currency through the exchange rate plus the subsidies received to export, all deflated by the wholesale price index in industry.<sup>3</sup>

The second relation in equation (1) is justified on the grounds that real wages are a proxy for domestic costs (Pinto, 1980 and 1981). Others have chosen the domestic price index, also included in equation (1), as a proxy for domestic costs (Zini Jr., 1988). In this case, the nominal prices of goods in the foreign market  $E_t p w_t (1 + S_t)$  are taken as the decision variable by agents. However, this assumption violates the microeconomic principle of no monetary illusion and, consequently, is not used in the estimations below.

The dependence of exports on productive capacity utilization, which is measured as a share of total capacity or as a deviation of a long-run trend of total production, is attributed to the marginal role of exports in the total industrial market (Cardoso & Dornbusch, 1980). It is argued that the position of the Brazilian industry differs from that of many other manufactured exporters, in the sense that its dynamism is determined by the domestic market. Under this argument, export activity has been regarded by agents as a residual use for excess production capacity,<sup>4</sup> because of the lack of international competitiveness of the Brazilian industry and the situation of selling to a protected market. Many studies have indicated a negative correlation of export growth with the rate of capacity utilization, based on the premise that exports will increase when internal demand shrinks (see Cardoso & Dornbusch, 1980; Pinto, 1984; Braga & Markwald, 1983; Rios, 1987; Zini Jr., 1988).

According to this argument, the simple change in relative prices, expressed by changes in  $((E_t P w_t)(1 + S_t) / P d_t)$ , is not sufficient to reflect the relative changes in market availability. Therefore, the inclusion of capacity utilization in equation (1) brings in the hypothesis that there are sticky prices in the Brazilian industry. This is normally attributed to a mark-up price settlement policy, under the assumption that most firms operate domestically in oligopolist markets, although they are subject to perfect competition in the international market. The negative effect of capacity utilization on exports also represents the intertemporal strategy of oligopolistic companies of giving priority to clients whose relation with the firm is more strongly associated with its brand.

Installed capacity is yet another variable sometimes included as an important determinant of manufactured exports in Brazil. More than justifying its inclusion through any solid theoretical foundation, most studies have relied on this variable with the intention of capturing the existing secular trend in manufactured exports, which does not have a counterpart in the other independent variables included in their equations (Braga & Markwald, 1983). Since often the only independent variable included in the models which also has a clear secular trend is installed capacity (Carvalho & Haddad, 1978; Pinto, 1980; Reis, 1979; Markwald, 1981; and Braga & Markwald, 1983, for instance), the significance of this relationship in export equations may be strongly affected by the so-called spurious regression phenomenon, which has been such an important concern in econometrics (Granger & Newbold, 1974; and

<sup>3</sup> It should be noted that  $((E_t p w_t (1 + S_t)) / p d_t)$  measures the change in relative prices between foreign and domestic markets. Therefore, the dependency of exports on this variable embodies the notion of an alternative use for scarce resources.

<sup>4</sup> See, for example, Braga and Markwald (1983).

Phillips, 1986). We turn to this subject later, discussing in more detail the inclusion of installed capacity in the manufactured exports supply equations and the various forms which have been resorted to measure this variable.

When installed capacity is introduced as an independent variable, researchers often associate the value of its elasticity with the trade bias of the country. If its elasticity is greater (smaller) than one, there is a pro-trade (anti-trade) bias. An elasticity of one would mean that the industrial development of the country is trade neutral (Johnson, 1959). Zini Jr. (1988) found evidence in support of the anti-trade bias in the short-term, although the hypothesis of trade neutrality was not rejected at standard significance levels. His long-term elasticity, however, indicated that there is trade neutrality in the development of the Brazilian industry.

The inclusion of productivity (measured as the value of manufactured production divided by the average number of workers in manufacturing) as an independent variable in equation (1) is a consequence of the obvious theoretical argument that, given everything else constant, an increase in productivity increases the supply of products which companies are able to sell abroad. Some products which could not be sold in the international market because they were not cost competitive may become competitive when there is a rise in productivity. To our knowledge, however, no study has included productivity as a relevant variable to determine manufactured exports in Brazil. Studies for other countries, such as the one of Muscatelli, Srinivasan and Vines (1992), include productivity jointly with wages. We opted to include it separately in equation (1).

An additional component of costs included in equation (1) is oil price. Energy costs have been highly influenced by oil prices not only in Brazil but all around the world, and they often represent a reasonable share of the costs of manufactures, especially when their role in the costs of all inputs is taken into account.

Equation (2) is a standard demand function with the assumptions of quasi-concave utility for consumers and that they are subject to a budget constraint. Since consumers of exported goods live abroad, no exchange rate was included in that equation, although a weighed average of the exchange rates of those countries which trade with Brazil should be included.<sup>5</sup> These weights, however, are very difficult to calculate because they should be considered for all countries according to their potential share in the market for Brazilian exports. In practice, no study calculates this weight, and it will not be done here either.

The impressive export performance of Newly Industrialized Countries (NICs) has raised a debate on the income and price elasticities of their demands, i.e. whether they fall in the small country case, to which the income elasticity of demand is high and the price elasticity is infinite, indicating that there is not much need to estimate the demand for their exports, or whether they were subject to low income and price elasticities of demand, as taken to be the case for the majority of developing countries by the early development economists (Prebisch, 1951; Singer, 1950; and Lewis, 1954). Supporters of the outward-oriented model of development have been arguing that these elasticities are high enough not to consist in a problem for developing countries wishing to embark in their proposed development strategy (Balassa, 1971; Krueger, 1978; Bhagwati, 1978; and Riedel, 1984).

---

<sup>5</sup> If the currency used to measure the variables in foreign currency included in the model is the US dollar, then the exchange rates in question should be in relation to the US dollar.

Some recent empirical studies,<sup>6</sup> mainly for Asian countries, have found support to the hypothesis that there are high price and income elasticities of demand for exports of NICs. A study by Muscatelli, Srinivasan and Vines (1992) for Hong Kong found support for the hypothesis that there is a high income elasticity of demand. However, their estimated price elasticity is low, despite the small size of Hong Kong in the world market.

Some studies for the Brazilian economy have incorporated the small country assumption without a previous estimation of a demand function for Brazilian manufactured exports. They simply estimate the supply function and assume that the demand is infinitely elastic when they draw conclusions on the results of the supply equations (examples of which are Doelinger et alii, 1971; Carvalho & Haddad, 1978; Lopes & Resende, 1981; Musalem, 1981; and Markwald, 1981). The estimations in this paper will be able to clarify this hypothesis and also shed some light on the discussions on the income and price elasticities of demand for the NICs, assuming that Brazil can be considered a NIC. These findings could be of particular relevance because the demand function estimated is for manufactured exports, which are considered to be non-traditional exports for developing countries, and is often placed as an alternative to overcome the problem of low demand elasticity for exports of developing countries pointed by the early development economists. The suggestion of export oriented models of development has been based on the success of the NICs, which have promoted mainly exports of manufactured goods.

Before proceeding with the discussion of the functions to be estimated, one more comment on the discussions about the price and income elasticities of the demand function for exports of NICs. The fact that exports of some individual countries have faced elastic demand does not mean that the group of all developing countries could follow a similar strategy and still face equally high income and price elasticities, or at least not while they have a negative capital account in their balance of payment, since, in this case, they must have a surplus in their trade balance and, consequently, cannot rely on the growing market in developing countries to keep their exports growing at levels that do not damage their terms of trade. Cline (1982) discusses this point as he analyzes the possibility of generalization of the East Asian model.

Some dynamics are normally introduced in the static functions presented in equations (1) and (2), usually through the inclusion of lagged values of the dependent variable. The major arguments for this change in the functions are the existence of partial adjustment because of the time needed to fully adjust to any change in the exogenous variables (Zini Jr., 1988; Cardoso & Dornbusch, 1980; and Braga & Markwald, 1983). In the case of demand, the persistence of habits in the demand curve and the existence of durability of the goods purchased could also justify the intertemporal dependence (see Muellbauer & Parchades, 1988). The incurring of fixed costs in entering foreign markets may also justify the partial adjustments in the supply function.

Most of the estimates for equations (1) and (2) use a log-linear function. This will also be done here. The functional forms normally chosen for supply and demand are:

$$x_t^s = \alpha_0 + \alpha_1 ep_t + \alpha_2 c_t + \alpha_3 w_t + \alpha_4 p_t + \alpha_5 o_t + \alpha_6 yp_t + \alpha_7 x_{t-1}^s + u_t \quad (4)$$

$$x_t^d = \beta_0 + \beta_1 x_{t-1}^d + \beta_2 pw_t + \beta_3 pc_t + \beta_4 y_t + v_t \quad (5)$$

---

<sup>6</sup> Examples of which are: Goldstein and Khan, 1982; Dornbusch, 1985; Bond, 1985; Riedel, 1988; Athukorala and Riedel, 1990.

where small letters represent the natural logarithm of the same variables with a capital letter in equations (1) and (2) and  $ep_t$  represents the natural logarithm of effective price ( $Epw(1+S_t)/pd_t$ ). Before discussing the final form used in the estimations, alternative approaches to deal with the trend in these two equations are reviewed in the next section.

### *Alternative procedures to handle the long-term trend of exports*

In simple static supply and demand functions, as specified in microeconomic textbooks, supply depends only on the price faced by producers. When transported to the real world, these simple specifications fail to capture some important aspects of reality. The main source of failure is the fact that reality is dynamic, while these simple functions are designed to capture the major aspects of a static world. As regards supply, an obvious consequence of this problem is the failure of functions based on price and cost of factors to only reproduce the observed supplies, which clearly have a secular trend as the economies grow, even when costs and prices only fluctuate around a fixed mean. In the case of demand, similar problems may appear despite the inclusion of income, which in itself can account for at least some of the long term positive trend of exports.

In microeconomics and in the theory of economic growth, production functions are commonly assumed to be homogeneous of degree one. Thus, if all factors of production increase in a given proportion, so will the total product, even if all prices and costs remain constant. This assumption implies that long-run supply functions, for given prices and costs, have a growth rate that is equal to the growth of the factors of production. It follows, then, that a crucial factor determining the secular growth of supply is the installed capacity and, consequently, that prices and costs are not the only factors behind the long-term behavior of supply. This argument is the major justification for the inclusion of installed capacity in equation (4).

Still, as can be seen from the estimation of equation (4) in the next section, we have replaced  $yp_t$  by the natural logarithm of industrial production, instead of using a measure of potential production. The rationale for this is simple. As  $c_t = y_i_t - yp_t$ , where  $y_i_t$  is the natural logarithm of industrial production,  $yp_t$  may be replaced in the equation by  $y_i_t - c_t$ , and  $\alpha_2$  can be redefined as  $(\alpha_2' + \alpha_6')$ , where  $\alpha_6'$  and  $\alpha_2'$  are the structural parameters for  $yp_t$  and  $c_t$ , respectively. In this case,  $\alpha_6' = \alpha_6$ . This transformation approximates our model to those found in the literature and specifies it with more reliable variables.

The inclusion of industrial production in the supply function also serves one more purpose. In addition to installed capacity and costs — represented in equation (4) by real wages and oil prices — as variables with a long term trend affecting the development of exports, there are also the productivities in other sectors, such as transport, communications, and banking, which also affect the competitiveness of domestic manufacturing in foreign markets and may also have a secular trend. Since these sectors are often subjected to increasing returns to scale, their productivities are strongly influenced by the size of the industrial production of the country, or, in other words, by the industrial concentration in a given territory. Thus, the inclusion of industrial production in equation (4), replacing installed capacity, also allows the model to partially incorporate the result of these additional relevant cost effects, if they are really relevant.

Although most of the models found in the literature on Brazilian manufactured exports are encompassed by the specifications in equations (3), (4) and (5), the specific structures of

the models differ. A difference of particular interest is the definition of the dependent variable. Cardoso and Dornbusch (1980) used the share of exports in total manufactured production. Several other studies incorporated this idea (Rios, 1987; and Lopes & Resende, 1981, for example). Another option is to use exports directly, in which case they could appear in value, deflated by an appropriate price index, or in a quantum index.

In the first case, i.e. exports as a share of total production, the secular trend of exports is partially captured by the long-term trend of industrial production. In equation (4), this would be represented by  $\alpha_6 = 1$ . The inclusion of only industrial production and effective prices in an export supply function, however, is not sufficient to properly represent the secular trend of exports, as other variables included in equation (4), such as wages and productivity, may also affect the trend of exports. Even effective prices, capacity utilization and oil prices, which one could argue are trendless, may also affect the trend of exports in this particular case, as all these variables are clearly not stationary in the period under analysis (see figure 1). Figure 2 shows the behavior of the share of exports in total industrial production in Brazil in the period 1964-88. As may be seen, this share was not stationary. This gives some intuitive indication that the long-term trend of exports is not fully explained by industrial production alone, even if the assumption that the coefficient of  $y_i$  is 1 is relaxed, as in Doellinger et alii (1971). Still, a more formal proof is given by the co-integration test presented in table 1. The results were obtained from the Stock and Watson (1988) test for common trend, which tests the null hypothesis that there is only one common trend between manufactured exports and production in Brazil (i.e. there is co-integration). This test does not reject the hypothesis that there are two common trends, which means that there is no co-integration. This gives support to the hypothesis that industrial production is not the only determinant of the trend in manufactured exports in Brazil.

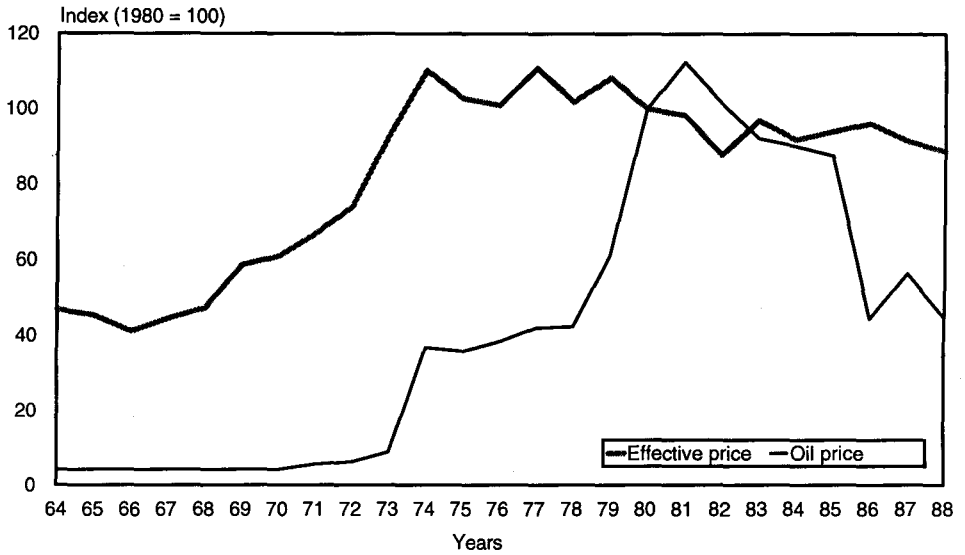
Table 1  
Stock and Watson co-integration test for the natural logarithm of manufactured exports and industrial production

Truncation parameter	L = 1	L = 2	15%	50%
Statistics	-23.75	-22.96	-24.2	-15.1

Note: This test is for the null hypothesis that there is not co-integration, against the alternative hypothesis that there is a common trend in the two variables involved. Statistics under 5 and 10% are for the critical values at these significance levels. *L* is the truncation parameter. More details on this test may be found in Stock and Watson (1988).

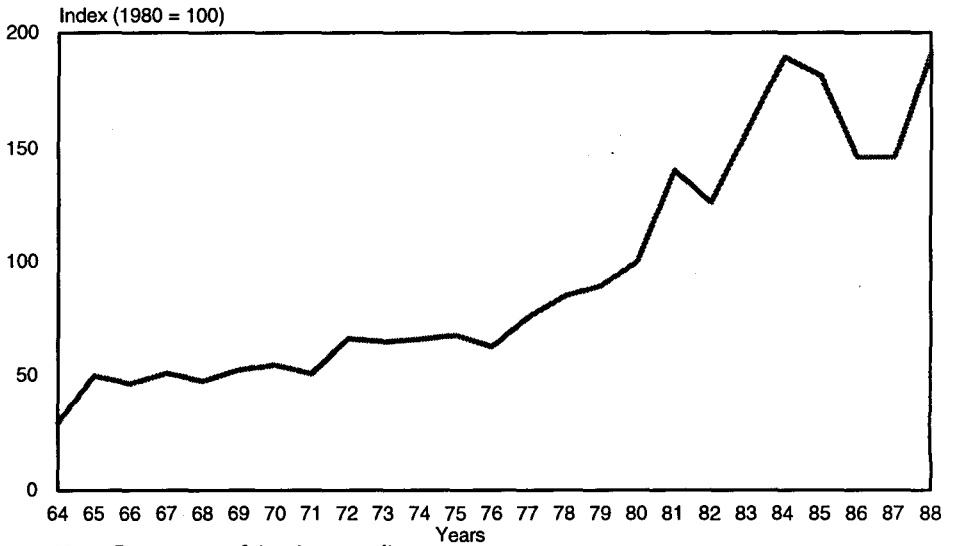
Incidentally, the fact that there are other elements accounting for the behavior of the trend of the share of manufactured exports in industrial production suggests the need for correction of auto-correlation of the errors in models such as those presented by Cardoso and Dornbusch (1980), Musalem (1981), Lopes and Resende (1981), Markwald (1981), and Rios (1987), which did not include variables such as real wages or productivity. As the stochastic trend of these variables are relevant to explain the trend of the share of exports in industrial production, these models are likely to present the problem of spurious regression (Granger & Newbold, 1974; and Phillips, 1986). In these cases, the Durbin-Watson statistics tend to have very low value, which may explain their conclusion that a correction for first order auto-correlation of the errors was necessary.

Figure 1  
 Effective price of Brazilian manufactured exports  
 and a world oil price index, 1964-88



Note: See appendix for sources of series.

Figure 2  
 Index of the share of Brazilian manufactured exports  
 on industrial production, 1964-88



Note: See sources of data in appendix.



The inclusion of one lag of the dependent variable in these studies will not be sufficient to eliminate the mis-specification of their equations if productivity and real wages are: (a) relevant variables to explain the dynamics of Brazilian manufactured exports; (b) non-stationary; and (c) excluded from the estimated equation. In this case, the true parameter for the lagged dependent variable should converge to one, but it does not do so with ordinary least square procedures. The low Durbin-Watson statistics, normally found in these studies and interpreted as an indication of the need for correction of first order auto-correlation of the errors, may be a consequence of the exclusion of these non-stationary variables which are relevant to explain the dependent variable. The fact that a first order auto-correlation of the error terms only arises under very particular combinations of parameter values, which implies the existence of common factors (Hendry, 1989:10-11), strengthens our hypothesis of the importance of such variables.

If manufactured exports have a long-term equilibrium relationship with industrial production, effective export prices, real wages, productivity, and oil prices, the trend of this variable will not comprise a problem for the estimation of equation (4). As these other variables included in equation (4) represent the accumulation of factors of production, costs, and prices, they could account for the long-run trend in manufactured exports. Thus, an empirical test to check if these variables are co-integrated in the Engle and Granger (1987) sense was applied. These tests are presented in table 2.<sup>7</sup> They indicate that the null hypothesis of non co-integration may be rejected, meaning that the use of manufactured exports, with the specification in equation (4), overcomes the problem of specification for the long-run trend, even if the lag of the dependent variable is left out of the model.

Table 2  
Stock and Watson co-integration test for variables in the supply equation

Truncation parameter	L = 1	L = 2	10%	5%
Statistics	-26.65	-18.22	-27.8	-25.2

Note: This test is for the null hypothesis that there is no co-integration, against the alternative hypothesis that there is a common trend in the six variables involved, namely real wages, manufactured exports, total industrial production, labor productivity, world oil prices, and effective prices for producers. Statistics under 5 and 10% are for the critical values at these significance levels. *L* is the truncation parameter. More details of this test may be found in Stock and Watson (1988).

An alternative solution given by other studies included a linear trend to estimate the supply equation (see, for example, Zini Jr., 1988). Supposedly, such a trend would represent the increase of installed capacity, which is not explicitly included in the model.<sup>8</sup> As shown by Cochrane (1991),<sup>9</sup> all stochastic processes with a unit root may be approximated by a trend stationary representation and vice-versa. However, the trend stationarity assumption is a simplification, which excludes a more thorough specification of the determinants of manufac-

<sup>7</sup> The tests made exclude capacity utilization because Stock and Watson (1988) only tabulated the quantiles for systems with at most six variables. Nonetheless, if the other six variables are co-integrated, the system with seven variables will also be; therefore, this exclusion does not change the results as long as the existence of co-integration is supported by the tests.

<sup>8</sup> This device is also found in supply functions for other countries. See, for instance, Riedel (1988), as an example of such procedure applied to Hong Kong.

<sup>9</sup> See also Campbell & Perron (1991).

tured exports. Therefore, studies such as those by Zini Jr. (1988) and others which use "potential product", determined as a time trend, to capture the secular trend of manufactured exports are only unnecessarily simplifying the specification of equation (4).

Having said that, it is possible that despite the existence of co-integration among the variables in equation (4), a trend is still necessary to correctly represent the dynamics of manufactured export supply, since there may be other cost variables not included in the model, which probably also have a unit root. This may be seen from the following representation:

$$\Delta X_t = \delta_1 + \delta_2 \Delta Z_t + e'_t$$

In this equation, if  $E(\Delta Z_t) = 0$ , but other elements are affecting the rate of growth of  $X_t$ , then  $\Delta X_t$  could still have a mean different from zero. In this case,  $\delta_1 \neq 0$ . This could be justified by reductions in other costs, which are not captured by the cost or any other variable included in equation (4). If  $e'_t = e_t - e_{t-1}$ , a simple integration of this equation gives:

$$X_t = \delta_0 + \delta_1 T + \delta_2 \Delta Z_t + e_t$$

Therefore, a specification of equation (4) with the inclusion of a time trend should be tried, since the time trend may be an empirical need to overcome the difficulties raised by the exclusion of some integrated series.

With respect to the demand function as specified in equation (5), although it is less subject to contentions due to the inclusion of income, at least as regards the representation of its secular trend, there may still be some relevant variables which are excluded from this equation. Of particular relevance are the changes in the structure of world demand in terms of different rates of growth for different types of goods, and the change in the market structure as far as countries composition is concerned. These structural changes could force the secular trend of Brazilian manufactured exports to depart from the trend of world imports of manufactures. On these grounds, we have decided to include a secular trend in the demand function.

Another concept of potential product used in some studies of manufactured export determinants is defined by the construction of a variable which incorporates all the peaks in industrial product and smoothes the dynamics from one peak to the other (see, for example, Pinto, 1980). This method is based on the idea that the capacity of the economy is built smoothly and only in peaks is it fully used. Recent emphasis on productivity shocks as a major source of business cycles fluctuations (Prescott, 1986) and its reasonable share in short term fluctuations (Blanchard & Quah, 1989; and Shapiro & Watson, 1989) suggests that this idea of smooth development of capacity is misleading. Therefore, the recent developments in macroeconomics discourage the use of such method.

The discussion of these alternative methods to handle the secular trend of exports suggests that the estimation of an equation such as (4), perhaps with an additional time trend, is the best method available, if the variables included in the equation are co-integrated. We shall follow a similar procedure in the estimation of equation (5), although a co-integration test has indicated that if the lagged dependent variable is excluded, the remaining variables included in equation (5) will not be co-integrated (table 3). In this case, however, we will rely on the

introduction of a lag for exports to assure that  $v_t$  is stationary. A model with a time trend will also be estimated.

Table 3  
Stock and Watson co-integration test for variables in the demand equation

Truncation parameter	L = 1	L = 2	15%	50%
Statistics	-21.27	-21.45	-31.8	-21.4

Note: This test is for the null hypothesis that there is not co-integration, against the alternative hypothesis that there is one co-integrating vector for the natural logarithm of the four variables: Brazilian manufactured exports, world manufactured imports, a price index of Brazilian manufactured exports and an index of the unit value of manufactured exports of developed countries. Statistics under 15 and 50% are for the critical values at these significance levels.  $L$  is the truncation parameter. More details on this test may be found in Stock and Watson (1988).

### Estimation procedures

Equation (4) was not estimated as previously specified. In addition to the substitution of industrial production for installed capacity, productivity was decomposed in employment and industrial production to avoid multicollinearity among regressors. More precisely, the logarithm of labor productivity  $p_t$  was decomposed as  $p_t = y_{it} - L$ , where  $L$  is the natural logarithm of the employment in industry. This decomposition follows directly from its definition. Substituting it back in equation (4) yields:

$$x_t^s = \alpha_0 + \alpha_1 e p_t + \alpha_2 c_t + \alpha_3 w_t - \alpha_4 L_t + \alpha_5 o_i t + (\alpha_4 + \alpha_6) y_{it} + \alpha_7 x_{t-1}^s + u_t \quad (4a)$$

Still in order to avoid multicollinearity, labor supply was also transformed before its introduction in equation (4a). It was decomposed as:

$$L_t = \delta'_0 T + \delta'_1 y_{it} - \delta'_1 y_{i0} + \sum_{i=0}^{t-1} m_{t-i} + L_0$$

Substituting this back in equation (4a) yields:

$$x_t^s = \alpha_0 + \alpha_4 (\delta'_1 Y_{i0} - L_0) + \alpha_1 e p_t + \alpha_2 c_t + \alpha_3 w_t - \alpha_4 L'_t + \alpha_5 o_i t + (\alpha_4 + \alpha_6 - \alpha_4 \delta'_1) y_{it} + \alpha_7 x_{t-1}^s + u_t \quad (4b)$$

where

$$L'_t = \delta'_0 T + \sum_{i=0}^{t-1} m_{t-i}$$

To obtain  $L'_t$  in order to include it as a regressor in equation (4b), we first estimated:

$$\Delta L_t = \delta'_0 + \delta'_1 \Delta y_{it} + m_t \quad (6)$$

where  $m_t$  was taken to be a random term with mean zero. An instrumental variable procedure was applied in this estimation, with the instruments being the same as those defined for equation (7) below, except for the exclusion of the time trend. If  $y_{it}$  and  $L_t$  are integrated of order one ( $I(1)$ ), the estimation of an equation in first difference as in (6) yields consistent estimators. The results found for this regression are:

$$\Delta L_t = -0.0158 + 0.756 \Delta y_{it} \quad (6a)$$

(-1.57)      (5.9)

$$R^2 = 0.75; \bar{R}^2 = 0.74; DW = 2.26; Q(12) = 15.84; \alpha_Q = 0.2$$

Where  $DW$ ,  $Q$  and  $\alpha_Q$  are the Durbin-Watson statistics, the Ljung-Box statistics, and its  $p$ -value, respectively.

$L'_t$  was reconstructed from this first step using the estimated parameters. Finally, we obtained the supply equation to be estimated in a reduced form, which can be defined as:

$$x_t^s = \alpha'_0 + \alpha_1 ep_t + \alpha_2 c_t + \alpha_3 w_t - \alpha_4 L'_t + \alpha_5 o_t + \alpha'_6 y_{it} + \alpha_7 x_{t-1}^s + u_t \quad (7)$$

where  $\alpha'_0 = \alpha_0 + \alpha_4(\delta'_1 y_{i0} - L_0)$  and  $\alpha'_6 = \alpha_4 + \alpha_6 - \alpha_4 \delta'_1$ .

Equations (5) and (7) were estimated separately, with annual data for the period 1964 to 1988. Their sources and detailed specifications are discussed in the appendix. All the variables which appear in equation (7) were considered as integrated of at most first order ( $I(i)$ , where  $0 \leq i \leq 1$ ). No unit root tests were made, since none of the series are stationary, as can be easily seen from their graphs, and the available tests do not have sufficient power to differentiate a series with a unit root and a drift from one with a deterministic trend (Campbell & Perron, 1991).

Lagged exports is the only variable in equation (7) which may be claimed to be independent of  $u_t$ . The inclusion of equation (3) assures that the necessary independence of effective price from the error terms is not satisfied. It would also be incorrect to assume that domestic wages, labor productivity and capacity utilization are not dependent of autonomous changes in exports of manufactured goods. According to Teitel and Thoumi (1986), who emphasize the role of exports in increasing the import capacity and the consequent impact on productivity because of its effects on the ability to import raw materials and intermediary goods, this is not true for productivity. Moreover, if supply and demand play some role on real wages determination, this would not be true for wages either. Assuming that the Brazilian industry does not operate at full capacity, this will also not be true for capacity utilization and industrial production. Fasano Filho (1988), in particular, has shown how manufactured exports have a positive effect on GDP in Brazil. This effect can certainly be easily extended to the case of industrial production alone. Thus, simple ordinary least square procedures would not be appropriate to estimate the coefficients appearing in that equation, since they would present second order bias, which may imply a substantial bias in finite sample estimations (Phillips & Hansen, 1990). Procedures using an appropriate set of instrumental variables (Phillips & Hansen, 1990) or a canonical cointegrating regression method (Park, 1992) would solve this bias problem.

We have chosen the instrumental variable method suggested by Phillips and Hansen (1990). If the selected instruments are completely independent of the error terms in equations (5) and (7), a standard instrumental variable procedure would not require any correction to

assure that the estimators are free of first and second order bias, and the standard hypotheses test statistics will have the standard distributions used for such tests. The independence mentioned above is not only for time  $t$ , it also implies that  $E(u_t Z_{t-i}) = 0$ , for any  $i$  belonging to the set of integers, where  $Z_t$  and  $u_t$  are the regressors and the error terms of the estimated equation, respectively. Thus, these instruments have to be very carefully chosen.

The instruments used in the estimations for equation (7) were the US GDP deflator, the import unit value of developed countries, a world oil price index, world total imports of manufactured goods, a time trend and a constant. For the demand equation (equation 5), the instruments were US GDP deflator, import unit value of developed countries, unit value of manufactured exports of developed countries, and world total imports of manufactured goods. All these variables were introduced in their natural logarithms, at the current period, and with one lag, with the obvious exception of the constant and the time trend. The idea that these variables are fully independent of the autonomous changes in the Brazilian manufactured exports relies on the small country assumption made for Brazil, as regards the ability of Brazilian exports to affect the world variables included in the set of instruments. This assumption is a good approximation for a country with such a low share of the world markets as Brazil.

The error terms in equations (5) and (7) were assumed to have a zero mean, but not to be independently identically distributed. In fact, there was an estimation of a variance-covariance matrix of the errors through the method proposed by Newey and West (1987), with a truncation parameter allowing for a one year lag. Such a procedure was carried out in order to introduce more generality to the results, as the Ljung and Box statistics did not show any sign of autocorrelation of the error terms. Tables 4 and 5 present the results of the estimations for equations (7) and (5), respectively.

Table 4  
Estimation results for equation (7)

Parameter	Estimated value	$t$ -statistics	Lowest $p$ -value
$\alpha'_0$	14.23	3.56	0.003
$\alpha_1$	0.64	2.09	0.05
$\alpha_2$	-5.19	-3.88	0.001
$\alpha_3$	-0.83	-3.68	0.002
$\alpha'_6$	1.93	3.68	0.002
$\alpha_5$	-0.23	-2.34	0.03
$-\alpha_4$	-0.25	-0.30	0.77
$\alpha_7$	0.36	2.18	0.05
$R^2$	0.99	$\overline{R}^2$	0.98
Durbin-Watson	1.88		
Ljung-Box	13.81	11	0.24

Note: Coefficients are as specified in equation (7).  $t$ -statistics are for the null hypothesis that coefficients are zero. The value under the  $t$ -statistics for Ljung-Box statistics is the degree of freedom.

As may be seen in table 4, all the parameters for equation 7 have the expected signs and are all significantly different from zero at standard significance levels (10%), with the exception of the coefficient for employment, which represents the coefficient for productivity. These results lend support to the theoretical arguments previously forwarded, including the

relevance of variables such as real wages and oil prices, which have been persistently left out of previous estimations of models for the supply of Brazilian manufactured exports. The coefficient for productivity, which appears in the equation as the negative value of the coefficient for employment, was not significantly different from zero, although it has the theoretically expected sign. This may be lending some support to the hypothesis that productivity increase was not targeted as an important element by Brazilian entrepreneurs to improve the competitiveness of their products in the world market.

Table 5  
Estimation results for equation (5)

Parameter	Estimated value	<i>t</i> -statistics	Lowest <i>p</i> -value
$\beta_0$	0.43	1.26	0.22
$\beta_1$	0.64	6.14	0.00001
$\beta_2$	-0.19	-2.30	0.03
$\beta_3$	0.16	0.98	0.33
$\beta_4$	0.73	3.80	0.001
$R^2$	0.99	$\bar{R}^2$	0.99
Durbin-Watson	2.06		
Ljung-Box	7.27	11	0.78

Note: Coefficients are as specified in equation (5). *t*-statistics are for the null hypothesis that coefficients are zero. The value under the *t*-statistics for Ljung-Box statistics is the degree of freedom.

According to the definition of  $\alpha'_6$ , the elasticity of manufactured exports with respect to industrial production is  $\alpha_6 = 1.87$ , which is well above 1.0. However, a chi-square of the hypothesis that this coefficient is one was not rejected at standard significance levels.<sup>10</sup> Thus, although the hypothesis of constant returns to scale in the Brazilian industry is not refuted by the data, the estimated  $\alpha_6$  constitutes strong evidence of the existence of increasing returns to scale in industry. In addition to this direct effect, the elasticity found for industrial production may be resulting from externalities originated from increasing returns to scale in sectors related to those industries (e.g., transportation, communication, ports), or from productivity gains in the related sectors. The confirmation of the hypothesis of co-integration of the variables in equation (7), as revealed by the test in table 2, is further strong evidence in support of this hypothesis.

The estimated parameters for the demand equation (5), reported in table 5, also conform to the theoretical expectations and are not significantly different from zero only for the constant and for the manufacturing unit value index of developed countries, included in the equation as a proxy for the price of substitutes. Its non-significance does not necessarily imply that the price of competitive products is not relevant to determining the demand for Brazilian manufactured products; it may simply be that the price index used is not appropriate to represent the substitutes for the Brazilian manufactures exported.

As suggested before, there is no *a priori* reason to exclude the possibility of equations (5) and (7) having the time trend as an additional regressor. In fact, there are reasons to believe that such a time trend may be relevant in these equations. Therefore, we also estimated equations (5) and (7) with a time trend. The results obtained are presented in tables 6 and 7.

<sup>10</sup> A minimum *p*-value equal to 0.185 was obtained.

Table 6  
Estimation results for equation (7) with a time trend

Parameter	Estimated value	<i>t</i> -statistics	Lowest <i>p</i> -value
$\alpha'_0$	14.04	3.16	0.007
$\alpha_1$	0.78	2.35	0.03
$\alpha_2$	-4.75	-2.88	0.01
$\alpha_3$	-0.62	-1.87	0.08
$\alpha'_4$	1.40	1.51	0.15
$\alpha_5$	-0.19	-1.80	0.09
$\alpha_6$	-0.27	-0.29	0.78
$\alpha_7$	0.17	0.73	0.48
$\alpha_8$	0.04	1.00	0.34
$R^2$	0.99	$\bar{R}^2$	0.98
Durbin-Watson	1.76		
Ljung-Box	15.56	11	0.16

Note: Coefficients are as specified in equation (7), plus  $\alpha_8$  to the time trend. *t*-statistics are for the null hypothesis that coefficients are zero. The value under the *t*-statistics for Ljung-Box statistics is the degree of freedom.

Table 7  
Estimation results for equation (5) with a trend

Parameter	Estimated value	<i>t</i> -statistics	Lowest <i>p</i> -value
$\beta_0$	-0.60	-1.14	0.27
$\beta_1$	0.83	3.83	0.001
$\beta_2$	-0.51	-2.30	0.03
$\beta_3$	0.53	2.98	0.008
$\beta_4$	1.07	3.13	0.006
$\beta_5$	-0.05	-1.50	0.152
$R^2$	0.99	$\bar{R}^2$	0.98
Durbin-Watson	2.28		
Ljung-Box	9.34	11	0.59

Note: Coefficients are as specified in equation (5) plus  $\beta_5$  to the time trend. *t*-statistics are for the null hypothesis that coefficients are zero. The value under the *t*-statistics for Ljung-Box statistics is the degree of freedom.

The major changes for equation (7) are that  $\alpha'_6$  is no longer significantly different from zero for standard, significance levels and that the elasticity of industrial production falls to 1.33. As before, it is not significantly different from one. This implies that  $y_{it}$  in this estimation is barely representing any additional cost variables which were left out of equation (7). Therefore, the results in table 7 give support to the initial hypothesis that industrial production is also capturing the effect of other relevant variables excluded from the first estimations of equation (7), presented in table 4. The inclusion of the time trend, which is not statistically significant as an explanatory variable, is done at the expense of the explanatory power of industrial production. It becomes difficult to choose between the two models only from the estimation results. Nevertheless, if we rely on Hendry's methodology (see Gilbert, 1986), the

time trend should be excluded, and the results presented in table 4 given priority as the appropriate model. Furthermore, the co-integration tests in table 2<sup>11</sup> indicate that the secular effect of the variables excluded from equation (7) are adequately captured by the variables included in that equation, when the time trend is excluded. Therefore, the model presented in table 4 is taken as the more appropriate here and will be the one used in the general comments presented in the next section.

Table 7 indicates that the time trend is not significantly different from zero in the demand equation either, which could suggest (by Hendry's methodology) that the model without the trend should be given preference. However, the relevance of the trend in this case is more appealing because the co-integration test in table 3 does not reject the non-cointegration hypothesis. The inclusion of the trend also improves the estimation for the price of substitutes, at least with regard to its precision. The price elasticity, however, decreases considerably, while the elasticity of the price of substitutes increases. These estimated elasticities may be considered excessively low (high) even by those who advocate the existence of a limited market for manufactured exports for the NICs. The income elasticity, on the other hand, increases, which is welcomed theoretically, especially because it approaches one. Therefore, the choice of the best model in this case is particularly complicated, as the additional possible criteria for selection do not point in the same direction.

One conclusion we may draw from the estimations of the demand equation, with and without the trend, is that the income elasticity of the Brazilian manufactured exports is not as high as assumed by those who support the outward oriented model. Even the highest of the two estimated income elasticities is still not as high as often suggested by these studies. However, when it approaches one, as in the case with the trend, it indicates that this elasticity does not comprise a problem for Brazilian manufactured exports to expand at the pace of international trade in manufacturing, which has been growing fast lately.

### **3. General comments on the determinants of Brazilian manufactured exports<sup>12</sup>**

An important result from previous estimations is that the employment level in manufacturing, when netted out of industrial production, does not have a significant effect on exports. The negative sign of the estimated coefficient for this variable captures the effect of labor productivity growth in exports. To better appraise the effect of productivity on manufactured exports during the period covered by estimations (1965-88), two simulated series for manufactured exports were created, with labor productivity fixed at its 1965 level and everything else behaving as it did in reality.<sup>13</sup> The difference between these manufactured export series

---

<sup>11</sup> Similar tests were also applied to the variables that are included in equation (7). The results are exactly the same as those for the tests presented in equation 3.

<sup>12</sup> In this section we combine results obtained from formal hypothesis testing with suggestions extracted from point estimators. The latter, however, are presented as indicators of possibilities, as they should be understood in econometrics. This distinction is important and throughout this section we make it clear by the power attributed to the two different types of conclusion.

<sup>13</sup> To create this series we decomposed the manufactured exports in components defined by the independent variables of the model formed by equations (3)-(5) and the error terms obtained in estimations. The estimated coefficients were used in this decomposition. All the independent variables were allowed to behave as they did in reality, with the exception of productivity, which was used to define the employment level from the industrial production. The error terms were also taken to be exactly as they were, according to the estimations made in the last section.



and the actual one represents the effect of productivity changes after 1965 on exports, according to the estimations from the last section. The simulated series are displayed in figure 3, together with the actual quantum index for manufactured exports of Brazil. The two simulated series with productivity fixed at the 1965 level are for the two estimated demand functions, presented in tables 5 and 7. The estimated supply which appears in table 4 was used for the calculation of both series.

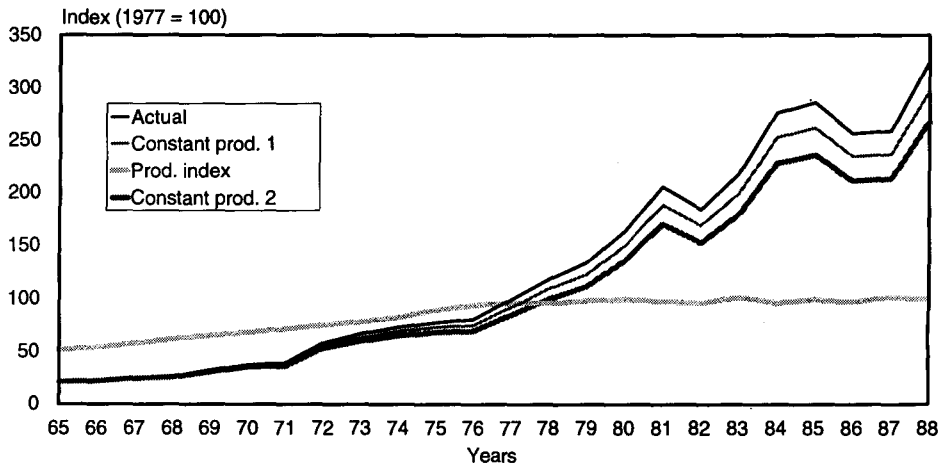
The data displayed in figure 3 shows that the effect of productivity in the growth of Brazilian manufactured exports is not very high, despite the reasonable growth of productivity in Brazilian manufacturing, which grew at an average annual rate of 2.80%. Productivity almost doubled in the period which spans from 1965 to 1988 (increased by 93.8%), while the productivity of the non-farm sector in the United States, for example, only increased by 33.3% in the same period at an average annual growth of 1.21%. This simple comparison shows that the growth of productivity in the Brazilian industry was not marginal. Thus, whilst the overall productivity growth in the Brazilian manufacturing sector has been high, this productivity growth seems to have had only a minor effect on manufactured exports. This result may be an indication that manufactured exports have not been originating very much from those sectors experiencing the high rates of productivity growth. In terms of factor intensity of the country's exports, this would mean that manufactured exports from Brazil are probably composed more of products characterized by the extensive use of factors of production and with little technological effort.

We have found an elasticity coefficient for industrial production above 1 (although not significantly different from zero). As we have argued before, there are three possible explanations for this, although any combination of them could also justify the estimated value of the coefficient. They are: (a) the spillovers to the competitiveness of exports caused by the overall increase in the productivity of the economy (which includes the manufacturing sectors and sectors related to them such as banking, communications, transport etc.); (b) the increasing returns to scale in the exporting sectors themselves; and (c) the increasing returns to scale in sectors related to the exporting sector.

A similar exercise to the one made above for productivity was repeated with industrial production held constant at its 1965 level. Two effects are captured by this exercise: (a) the externalities and effects of other sectors which were represented by industrial production in the supply equation; and (b) the effect of available capacity in the industry. The results of the exercise are presented in figure 4. They show that these two effects combined are responsible for a large share of the growth of exports in the period under analysis. Figure 5 shows a similar exercise, but forcing the elasticity of industrial production to be 1.0 and leaving the industrial production to change as it did in reality. This figure shows that most of the effect of industrial production found in equation (4) is actually a consequence of the external effect of the growth of industrial production, not of the capacity increase. The combination of these two graphs indicates that, while the internal productivity growth of industry contributed only slightly to the growth of competitiveness in the Brazilian manufactured exports, the external productivity growth, generated in other sectors of the economy, such as services and communications, had a strong impact in the performance of manufactured exports.

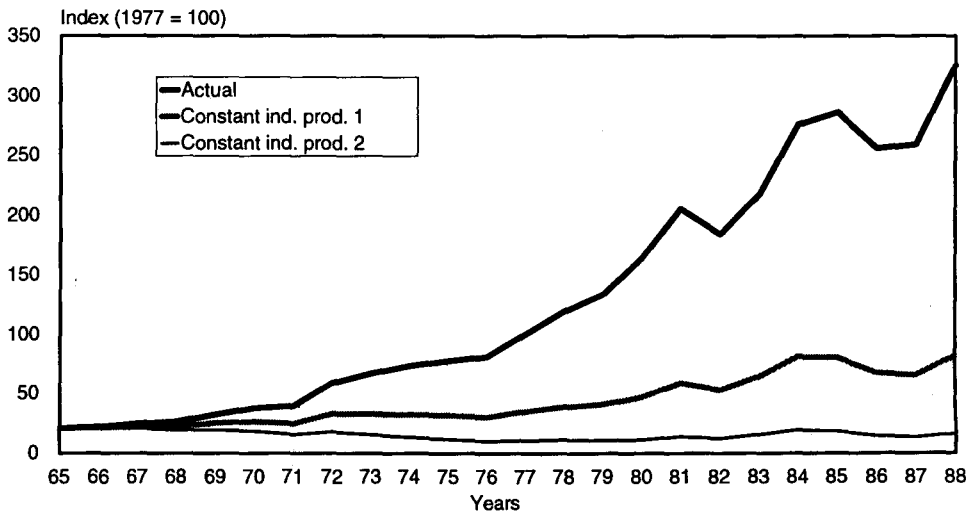
The role of the growth of external productivity on manufactured exports in Brazil reveals the importance of the previous phase of import substitution to the performance of Brazilian manufacturing exports during the period in analysis. According to our estimations, had the manufacturing sector not been able to enjoy those external productivity effects, the competitiveness of manufactured exports would have been hampered. As it is known, the develop-

**Figure 3**  
**Brazilian manufactured exports, 1965-88**  
**Actual value and with labor productivity in industry at constant 1965 level**



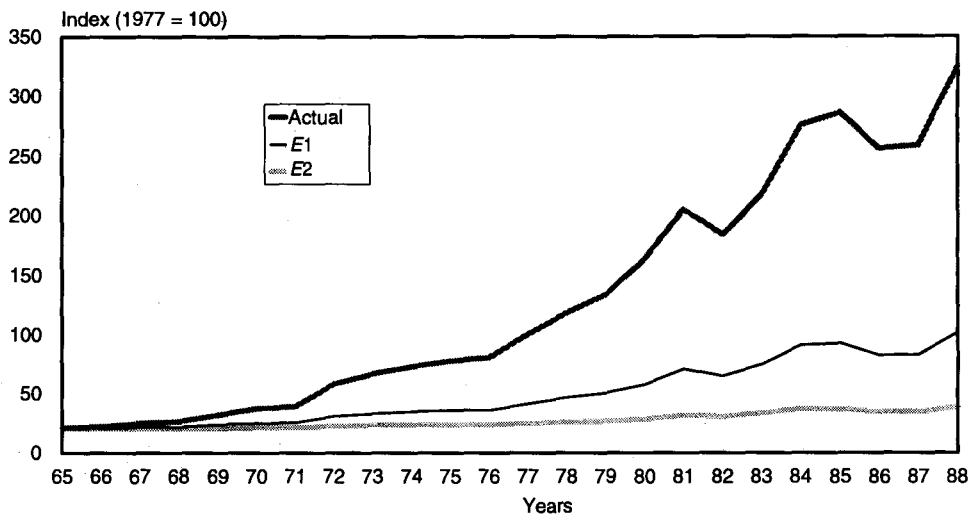
Note: The indexes are such that 1977 = 100 only for the actual series. The transformed export series have their 1965 values equal to the one of the actual series. The productivity index included has 1980 = 100. The series labelled constant prod. 1 and constant prod. 2 are for the exports when productivity is kept at its 1965 level, when the demand equations are as estimated in tables 5 and 7, respectively.

**Figure 4**  
**Brazilian manufactured exports, 1965-88**  
**Actual and with domestic industrial production at constant 1965 level**



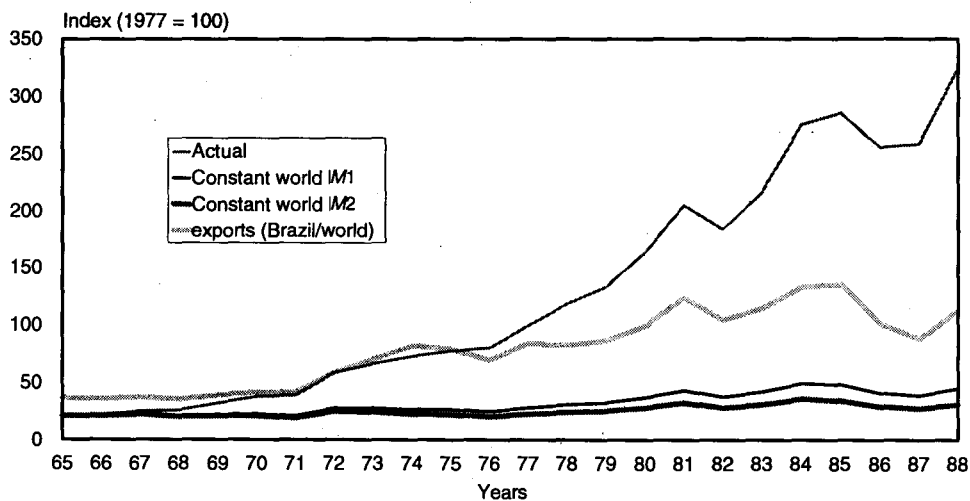
Note: The indexes are such that 1977 = 100 for the actual series only. The transformed series has its value equal to the actual one at 1965. Constant ind. prod. 1 and 2 were calculated using demands presented in tables 5 and 7, respectively.

Figure 5  
 Brazilian manufactured exports, 1965-88  
 Actual and industrial production elasticity equal to one



Note: The indexes are such that 1977 = 100 for the actual series only.  $E1$  and  $E2$  were calculated using demands from tables 5 and 7, respectively.  $E1$  and  $E2$  were normalized to be equal to the actual series in 1965.

Figure 6  
 Brazilian manufactured exports and its share in the world total, 1965-88  
 Actual and with world manufactured imports at constant 1965 level



Note: The export indexes are such that 1977 = 100 for actual series only. The index for share of manufactured export has 1980 = 100. The transformed series has its value equal to the actual one in 1965. Constant world  $M1$  and  $M2$  where calculated using demands from tables 5 and 7, respectively.

ment of services and infrastructure was greatly fostered by the industrial development which took place in Brazil prior to 1963. The impact of such external effects favors the hypotheses that the development in other areas of the economy is extremely important for the good performance in the exporting sector due to the interdependence among sectors.

Figure 6 shows that competitiveness had some role to play in the expansion of manufactured exports in Brazil, aside the effect of the increase of world imports itself. In an exercise similar to that done for labor productivity in figure 3, we keep world imports constant at its 1965 level and allow everything else to change. The constructed series estimated shows still a small long term increase. Figure 6 also shows the long term trend of the index of the share of manufactured exports in the world total, which has clearly increased. Thus, although the actual series shows a much more impressive increase than can be accounted by competitiveness alone, it cannot be neglected.

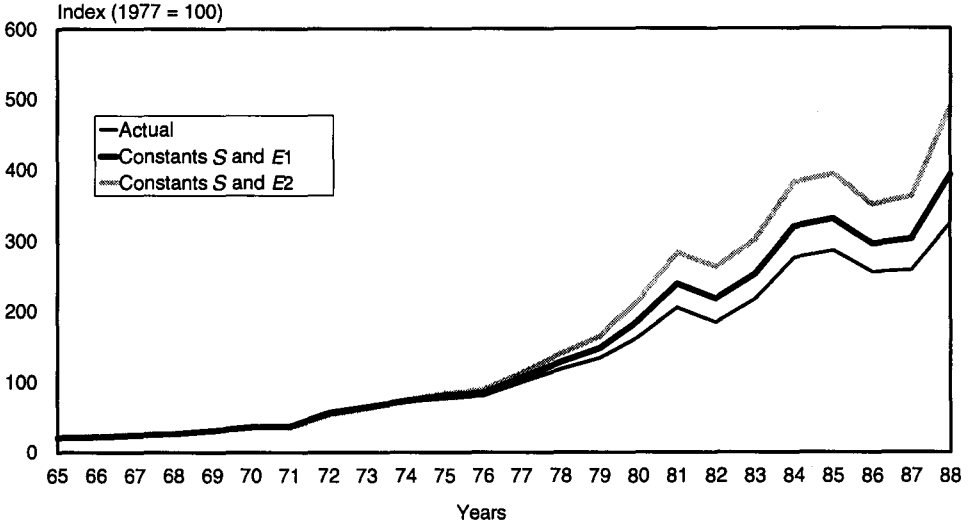
It is important to note that the effect of world imports of manufactured goods shows that the income elasticity of demand for Brazilian manufactured exports is not high. Using world imports instead of world income may certainly have contributed to bring down the coefficient which represents the role of the world income in Brazilian exports, but this value is still very low, in comparison, for example, with the results found for Hong Kong by Muscatelli, Srinivasan and Vines (1992).

As regards the price received by producers, we have seen that it has a positive effect on manufactured exports, as expected on the basis of the initial theoretical discussion, which is significantly different from zero at standard significance levels. In the same way, the effect of the price of Brazilian manufactures is also significantly different from zero on the demand for Brazilian manufactures, although in this case its effect is negative, also as theoretically expected. It certainly indicates that the Brazilian exports are subject to substitution, even if the effect of the unit value of manufactured exports of developed countries included in equation (5) was not significantly different from zero in one of the alternative estimated demands. In contrast with the estimations for other NICs, our estimated demand function has a low price elasticity. In the most optimistic case, a 1% reduction in prices will only bring a 0.51% increase in the quantity sold. This is well below what should be expected if the country was subject to very competitive markets with low differentiation of products. Zini Jr. (1988) has suggested that this result, which he also obtained in his estimations, may lead to a deterioration in the terms of trade of manufactured exports in the same fashion observed with primary exports in the 1930s, which at the time stimulated policy discussions leading to the eventual industrialization effort launched by Latin American countries.

The estimation results allow us to speculate on the effect of exchange rate and subsidies to the development of Brazilian manufactured exports since the mid-sixties as well. In figure 7 we have carried a similar exercise as the one previously formulated for labor productivity. Only the real exchange rate and the subsidy rates (as a percentage of the final price received by producers) were kept constant at 1965 levels. Everything else was free to change as it did in reality and all autonomous innovations were considered to be of the same magnitude as they were found in the estimations. The series shown in figure 7 indicate that the combined policy of real exchange rate and subsidy determinations was not beneficial to manufactured exports. The results found actually indicate that they were prejudicial, although only to a small extent. If both the real exchange rate and the subsidy rates were kept at their 1965 level, manufactured exports would have been higher in the last decade.

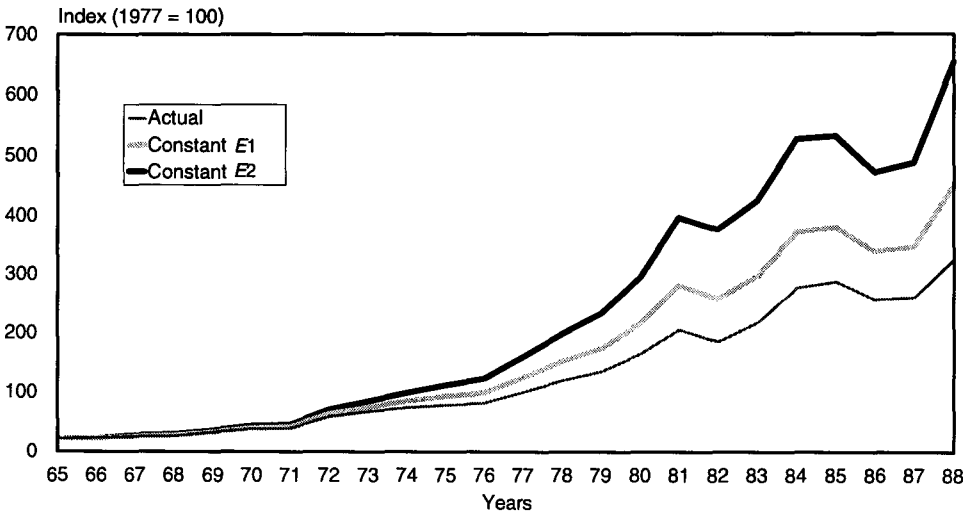
This rather intriguing result was further investigated in estimations shown in figures 8 and 9. While the subsidy policy had a positive effect on the development of manufactured

**Figure 7**  
**Brazilian manufactured exports, 1965-88**  
**Actual and with subsidy and real exchange rates at 1965 levels**



Note: The indexes are such that 1977 = 100 for the actual series only. The transformed series has its value equal to the actual one at 1965. Constants S and E1 and E2 were estimated using demands from tables 5 and 7, respectively.

**Figure 8**  
**Brazilian manufactured exports, 1965-88**  
**Actual and with real exchange rates at constant 1965 level**



Note: The indexes are such that 1977 = 100 for actual series only. The transformed series have their values equal to the actual one at 1965. Constants E1 and E2 were calculated using demands from tables 5 and 7, respectively.

exports, the exchange rate policy had a negative impact (see figures 8 and 9). Thus, the final result seen in figure 7 is a consequence of the fact that the subsidies were not sufficient to compensate for the negative impact of the adverse exchange rate developments.

The findings discussed in the paragraph above may lead to the conclusion that the policy of creating special incentives for manufactured exports was not necessarily positive to the Brazilian development, especially considering that incentives through subsidies can be less efficient than the market forces in the selection of sectors to be fostered. One may be tempted to conclude that rather than creating special market distorting incentives, the government could have practised a more realistic exchange rate policy, which would have had the same effect, without distorting market signals, as in a policy of subsidies.

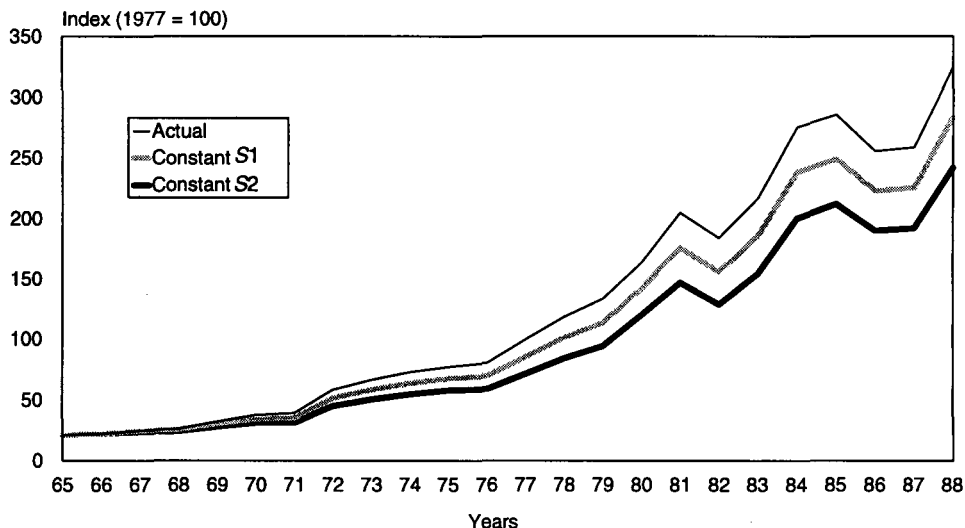
Nevertheless, such conclusions are premature. First, because many of these subsidies are introduced to correct the negative impact of market failures and to offset the negative effect of protection measures which created an anti-export bias. In addition to this, manufactured exports may have a positive effect on the productivity development of other sectors in the economy, a result which does not necessarily emerge from agricultural exports. Therefore, the subsidies to manufactured exports, which are similar to introducing a different exchange rate for those sectors subject to incentives, may have introduced an industrial bias in the Brazilian GDP, which had a positive impact through its externalities and dynamic effects on technological absorption. Only in a world of similarly decreasing returns to scale in all sectors and no dynamic effect on technology absorption would the conclusions in the paragraph above be applicable. In any case, a much more thorough study than the one offered by the estimations above is necessary to assess the hypothesis of negative effect of the subsidy policy for manufactured exports, as these externalities and dynamic effects have to be appropriately specified and measured in order to fully explore the two alternative hypotheses put forth. It should, however, be emphasized that recent developments in growth theory have found theoretical and empirical support for the existence of increasing returns to scale (see, for example, Romer, 1990; and Caballero & Lyons, 1992). A simple exchange rate policy which perpetuated specialization in agricultural production would inhibit gains from economies of scale in industry, which most likely exists in the Brazilian industry.

Finally, let us look at an interesting exercise shown in figure 10. In a way similar to the exercise developed for previous variables, we have examined the effect of real wages by holding the value of that variable at its 1965 level. It can be seen that real wages had a negative impact on exports, which would have grown much more had there been no change in that variable since 1965. The estimated elasticity of real wages in the supply equation is high in absolute terms (-0.83) and the impact of real wages may have been substantial, if the demand with a time trend is the correct specification. These findings are particularly revealing because real wages in Brazil are notoriously low and, thus, would be unlikely to make such difference were it not for the high intensity in the use of this factor of production in those industries engaged in exports.

#### **4. Summary and conclusions**

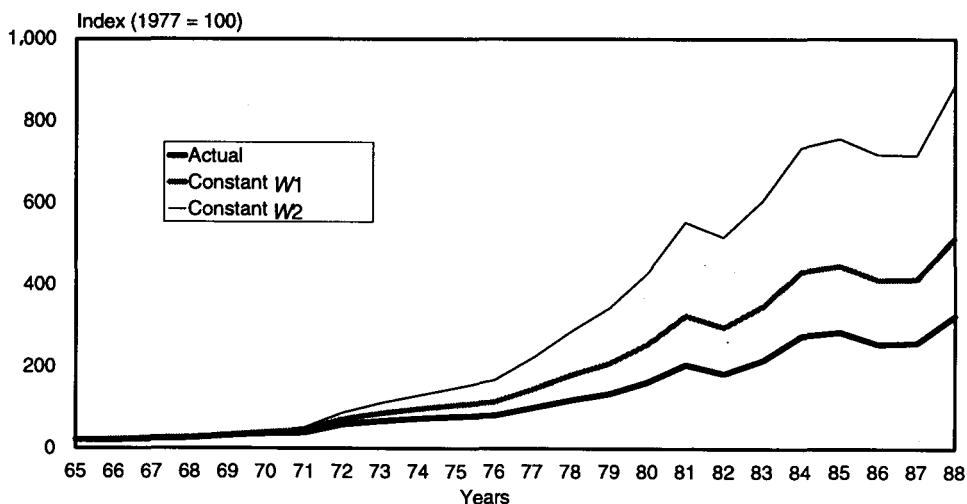
In this paper we have presented a supply and demand model for the determinants of exports of manufactures from Brazil, which encompasses most of the other models found in the related literature. In the process of specifying the model, we have critically reviewed many of these studies.

Figure 9  
 Brazilian manufactured exports, 1965-88  
 Actual and with subsidy rate at constant 1965 levels



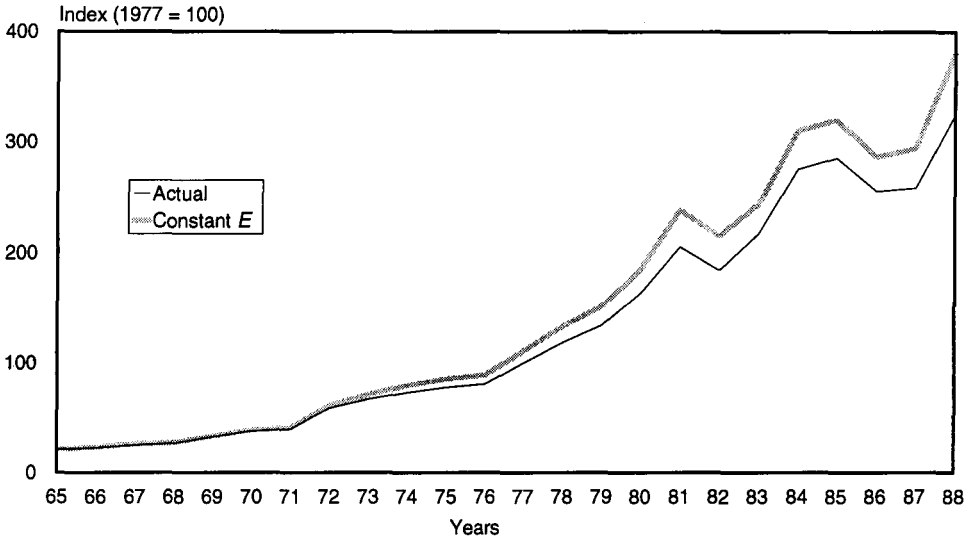
Note: The indexes are such that 1977 = 100 for actual series only. The transformed series have their values equal to the actual one at 1965. Constants S1 and S2 were calculated using demands from tables 5 and 7, respectively.

Figure 10  
 Brazilian manufactured exports, 1965-88  
 Actual and with real wages in industry at constant 1965 levels



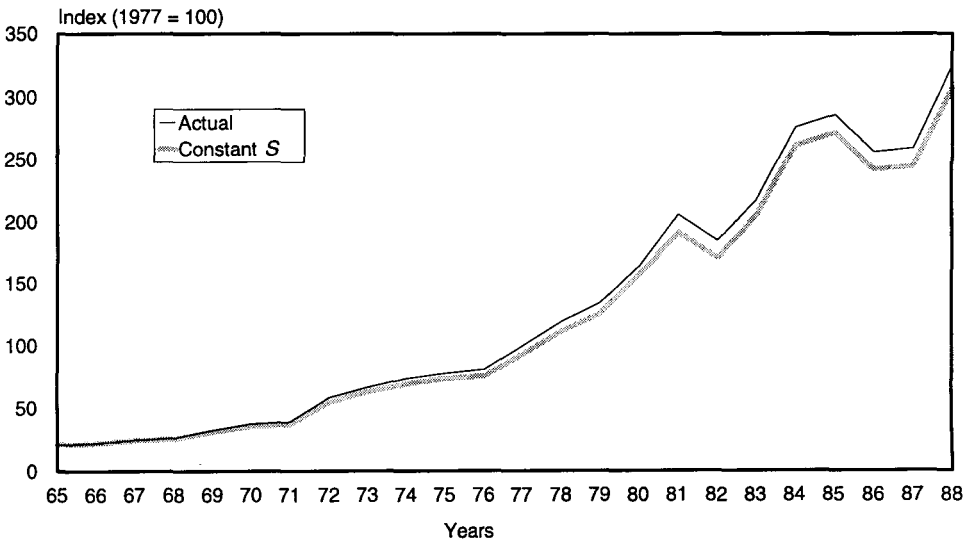
Note: The indexes are such that 1977 = 100 for actual series only. The transformed series have their values equal to the actual one at 1965. Constants W1 and W2 were calculated using demands from tables 5 and 7, respectively.

Figure 11  
 Brazilian manufactured exports, 1965-88  
 Actual and with real subsidy rate constant 1965 levels



Note: The indexes are such that 1977 = 100 for the actual series only. The transformed series has its value equal to the actual one at 1965.

Figure 12  
 Brazilian manufactured exports, 1965-88  
 Actual and with subsidy rate constant 1965 levels



Note: The indexes are such that 1977 = 100 for the actual series only. The transformed series has its value equal to the actual one at 1965.



One of the most serious problems found in these models has been the treatment given to the long term stochastic trend of the dependent variable. We have carefully examined the relations of co-integration among the variables and found a model which accounts for this trend in a more satisfying way. An additional contribution of the model presented here is the direct consideration given to domestic costs and labor productivity. In the case of domestic costs, the model includes energy and labor costs as proxies for the costs which are not a result of productivity change. The model also allows further discussion on the relevance of the various components of effective price, international demand and productivity for the behavior of Brazilian exports from 1965 to 1988.

The estimated income elasticity of demand obtained is not high, confirming the importance of the estimation of a demand function and the invalidity of the small country assumption in the case of Brazil, as some studies have previously done. Therefore, the success of Brazil as a manufacturing exporter could not rely only on the growth of the world market, but had to build also on competitiveness increases. The estimated price elasticity indicates that the Brazilian manufactured exports are subject to substitution and that the effort to increase exports has had to rely on price reductions.

As far as the various components of effective price are concerned, we have found that while the subsidies had a positive effect on the development of manufactured exports, the exchange rate policy had a negative impact on it. The final effect of these two conflicting policies was a marginal negative effect. Therefore, we found support for the hypothesis that the subsidies to export in Brazil were not enough even to compensate for the adverse evolution of the exchange rate. The adverse effect of the exchange rate policy has been discussed before in the literature (see, for example, Pinto, 1980; Rios, 1987; Bontempo, 1989).

Industrial production appears as an important determinant of manufactured exports. It is used in the model as a proxy for installed capacity, but also captures other effects which may have been the result of the spillover which productivity increases in the economy have on the competitiveness of exports and/or the result of increasing returns of scale in manufacturing and related sectors. Some light is shed on the possible relative magnitude of the effects of capacity utilization and the others just mentioned.

With respect to labor productivity, the results of estimations indicate that despite the significant growth of labor productivity in the Brazilian economy (93.8% between 1965 and 1988), its effect on manufactured exports has not been very significant. We suggest that this may be explained by the low reliance of Brazilian manufactured exports on sectors which experienced more productivity increases.

The impact of real wages on the supply of manufactured exports is another curious result. Despite the notoriously low level of real wages in Brazil, we have found them to have a significant negative impact on the supply of manufactures. This again complements the findings mentioned above in the sense that real wages in Brazil can only have such an impact because of the high intensity of exports in labor input.

## References

Athukorala, P. & Riedel, J. The short-run behaviour of prices and output in the exportable sector. *Journal of International Economics*, 12:83-93, 1990.

③ Balassa, B. *The structure of protection in developing countries*. Baltimore, Johns Hopkins University Press, 1971.

- Baumann, R. Ajuste externo — experiência recente e perspectivas para a próxima década. In: Ipea/Iplan (org.). *Prioridades e perspectivas de políticas públicas*, Brasília, Ipea, 1989.
- Bhagwati, J. *Anatomy and consequences of foreign exchange regimes*. Cambridge (MA), NBER, 1978.
- Blanchard, O. & Quah, D. The dynamic effects of aggregate demand and supply disturbances. *American Economic Review*, 79(4):155-73, 1989.
- Bond, M. Export demand and supply for groups of non-oil developing countries. *IMF Staff Papers*, 32:56-77, 1985.
- Bontempo, H. Política cambial e superávit comercial. *Pesquisa e Planejamento Econômico*, 19(1):45-64, 1989.
- Braga, H. & Markwald, R. Funções de oferta e de demanda das exportações de manufaturados no Brasil: estimação de um modelo simultâneo. *Pesquisa e Planejamento Econômico*, 13(3):707-44, 1983.
- Caballero, R. & Lyons, R. External effects in U.S. procyclical productivity. *Journal of Monetary Economics*, 29(2): 209-25, 1992.
- Campbell, J. & Perron, P. Pitfalls and opportunities: what macroeconomists should know about unit roots. *NBER Macroeconomics Annual 1991*, Cambridge (MA), MIT Press, 1991.
- Cardoso, E. & Dornbusch, R. Uma equação para as exportações brasileiras de manufaturados. *Revista Brasileira de Economia*, Rio de Janeiro, FGV, 34(3), 1980.
- Carvalho, J. & Haddad, C. Estratégias comerciais e absorção de mão-de-obra no Brasil. Rio de Janeiro, FGV, 1978. (Série Pesquisas EPGE, 1.)
- Cline, W. Can the East Asian model be generalized? *World Development*, 10(2):81-90, 1982.
- Cochrane, J. A critique of the application of unit root tests. *Journal of Economic Dynamics and Control*, 15:275-84, 1991.
- Doellinger, C. von et alii. Exportações dinâmicas brasileiras. Rio de Janeiro, Ipea/Inpes, 1971. (Coleção Relatórios de Pesquisa, 2.)
- Dornbusch, R. Policy performance links between LDC debtors and industrial nations. 1985. *Brookings Papers on Economic Activity*, v. 2, p. 303-86.
- Engle, R. & Granger, C. Cointegration and error-correction: representation, estimation and testing. *Econometrica*, 55:251-76, 1987.
- Fasano Filho, U. A expansão das exportações e o crescimento econômico: o caso do Brasil. *Revista Brasileira de Economia*, Rio de Janeiro, FGV, 42(1):73-81, 1988.
- Gilbert, C. Professor Hendry's methodology. *Oxford Bulletin of Economics and Statistics*, 48:283-307, 1986.
- Goldstein, M. & Khan, M. *Effects of slowdown in industrial countries on growth in non-oil developing countries*. International Monetary Fund, 1982. (Occasional Paper, 12.)
- Granger, C. & Newbold P. Spurious regressions in econometrics. *Journal of Econometrics*, 2:111-20, 1974.
- Hendry, D. *PC-Give. An interactive econometric modelling system*. Great Britain, Biddles Ltd., Guilford and King's Lynn, 1989.
- IBGE. *Estatísticas históricas do Brasil*. Rio de Janeiro, IBGE, 1990.
- Johnson, H. Economic development and international trade. *Nationalokonomisk Tidsskrift*, 97:252-72, 1959.
- Krueger, A. *Foreign trade regimes and economic development: liberalization attempts and consequences*. Cambridge (MA), NBER, 1978.

- Lall, S. *Building industrial competitiveness in developing countries*. Paris, OECD, 1990.
- Lewis, W. A. Economic development with unlimited supplies of labor. *The Manchester School*, p. 131-91, May 1954.
- Lopes, F. & Resende L. *A inflação e o balanço de pagamentos: uma análise quantitativa das opções de política econômica*. Rio de Janeiro, PUC/RJ, 1981. (Relatório de Pesquisa, 1.)
- Markwald R. *Estimação de equações de oferta desagregadas para o Brasil, 1960-80*. Rio de Janeiro, Ipea/Inpes, 1981.
- Meullbauer J. & Parchades, P. Tests of dynamic specification and homogeneity in a demand system. Oxford, Nuffield College, 1988. (manuscript.)
- Musalem, A. R. Política de subsídios e exportações de manufaturados no Brasil. *Revista Brasileira de Economia*, Rio de Janeiro, FGV, 35(1): 17-41, 1981.
- Muscattelli, V. Srinivasan T. & Vines, D. Demand and supply factors in the determination of NIE exports: a simultaneous error-correction model for Hong Kong. *The Economic Journal*, 102(415), 1992.
- Newey W. & West, K. A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. *Econometrica*, 55(3):703-8, 1987.
- Park, J. Canonical cointegration regressions. *Econometrica*, 60(1):119-43, 1992.
- Phillips, P. Understanding spurious regressions in econometrics. *Journal of Econometrics*, 33(3):311-40, 1986.
- & Hansen, B. Statistical inference in instrumental variables regression with I(1) processes. *Review of Economic Studies*, 57:99-125, 1990.
- Pinheiro, A. *Measuring and explaining total factor productivity growth: Brazilian manufactured in the 1970s*. Rio de Janeiro, Ipea/Inpes, 1990. (Texto para Discussão Interna, 189.)
- Pinto, M. B. O crescimento das exportações brasileiras de manufaturados, 1954-74. *Estudos Econômicos*, 10(3): 101-43, 1980.
- . Os efeitos dos incentivos sobre a estrutura das exportações brasileiras de manufaturados. *Estudos Econômicos*, 11(3):115-32, 1981.
- . Efeitos alocativos da política de promoção de exportações: uma reavaliação. *Pesquisa e Planejamento Econômico*, 14(2):547-60, 1984.
- Prebisch, R. Interpretação do processo de desenvolvimento econômico. *Revista Brasileira de Economia*, Rio de Janeiro, FGV, 1, 1951.
- Prescott, E. Theory ahead of business cycle measurement e *Carnegie-Rochester Conference Series on Public Policy*, 25:11-44, 1986.
- Reis, E. *Estimação de equações de exportações*. Rio de Janeiro, Ipea/Inpes, 1979. mimeog.
- Riedel, J. Trade as an engine of growth in developing countries. (revisited.) *Economic Journal*, 94:56-73, 1984.
- . The demand for LCD exports of manufactures: estimates for Hong Kong. *Economic Journal*, 98:138-48, 1988.
- Rios, S. Exportações brasileiras de produtos manufaturados: uma avaliação econométrica para o período 1964-84. *Pesquisa e Planejamento Econômico*, 17(2):299-332, 1987.
- Romer, P. Endogenous technological change. *Journal of Political Economy*, 98(5):S71-S102, part 2, 1990.

Shapiro, M. & Watson, M. Sources of business cycle fluctuations. *NBER Macroeconomics Annual 1989*, Cambridge (MA), MIT Press, 1989.

Singer, H. The distribution of gains between investing and borrowing countries. *American Economic Review*, 40: 473-85, 1950.

Stock & Watson, M. Testing for common trends. *Journal of the American Statistical Association*, 83(404):1.097-107, 1988.

Teitel, S. & Thoumi, F. E. Da substituição de importações às exportações: as experiências argentina e brasileira no campo das exportações de manufaturados. *Pesquisa e Planejamento Econômico*, 16(1):129-66, 1986.

Zini Jr., A. Funções de exportação e de importação para o Brasil. *Pesquisa e Planejamento Econômico*, 18(3), 1988.

## Appendix: data sources

$X_t$  (Brazilian manufacturing exports): UN, *International Trade Statistics*, various issues.

$ep_t$  (effective price): official exchange rate from Rios (1987), and *Conjuntura Econômica*, various issues. The deflator was the wholesale price index, from *Conjuntura Econômica*, various issues. Subsidies from Musalem (1981) and Baumann (1989).

$c_t$  (capacity utilization): Pinto (1980) and *Conjuntura Econômica*, various issues.

$w_t$  (manufactured real wages): Pinto (1980) and IBGE (1990), and for the wholesale price index, used as a deflator, *Conjuntura Econômica*, various issues.

$Y_i$  (industrial production index): extracted from IBGE (1990).

$oi_t$  (world oil price index): World Bank, deflated by the UN developed countries manufacturing export prices index.

$P_t$  (labor productivity): calculated as industrial production divided by the industrial employment. Both variables were obtained from IBGE (1990).

$pw_t$  (world price of Brazilian manufactured exports in US\$): UN, *International Trade Statistics Yearbook*, various issues.

$pc_t$  (unit value of manufactured exports of developed countries): Grilli and Yang (1988), updated with the UN unit value of developed countries manufactured exports, obtained from various issues of its *Monthly Statistical Bulletin*.

$y_t$  (index of world real GDP): IMF, *International Financial Statistics*, various issues.

### • Additional Instrumental variables.

US GDP deflator: IMF, *International Financial Statistics*, various issues.

Import unit value of developed countries: IMF, *International Financial Statistics*, various issues.

World total imports of manufactured goods: UN, *International Trade Statistics Yearbook*, various issues.