

“Temporal Causality between the Exchange Rate And the Trade Balance : The Case of Brazil”

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Exchange Rate Management and Foreign Trade: The Brazilian Experience

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Abstract

The paper assesses the impact of international relative prices and domestic expenditure variables on Brazil's foreign trade performance in the first half of the 1990s. It has been argued that the appreciation of the Real since 1994 has had a detrimental impact of the country's trade balance. However, using temporal precedence analysis, our results do not indicate that the trade balance is strongly affected by international relative prices, such as the exchange rate. Instead, domestic expenditure variables appear to be more powerful determinant of the country's trade performance in recent years. Granger and error correction causality techniques are used to determine temporal precedence between the trade balance and the exchange rate in the period under examination. Our findings shed light on the debate over the sustainability of recent exchange rate-anchored macroeconomic stabilisation programmes, which is a topic that has encouraged a lot of debate among academics and practitioners.

Keywords: foreign trade, stabilisation, Granger causality.

JEL Classification Numbers: F41, F31, O54.

1 Introduction

It has been claimed in recent years that the deterioration of Brazil's trade balance after 1995 has been associated with the appreciation of the domestic currency subsequently to the launching of the 'Real' Plan in June 1994. Recent macroeconomic stabilisation plans in the developing world, such as the 'Real' Plan in Brazil, have stressed the need for tight monetary policy, together with fiscal discipline, to reduce inflation and promote self-sustained growth in the long run [e.g. Bruno (1989), Bruno and Fischer (1990), Sachs

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² University of Kent, UK. Corresponding author. Mailing Address: Department of Economics, Keynes College, University of Kent, Canterbury, Kent, CT2 7NP. Tel.: (44-1227) 764000 ext. 7471, Fax: (44-1227) 827850, e-mail: L.R.De-Mello@ukc.ac.uk, and OECD Development Centre, 94, rue Chardon Lagache, 75016 Paris France. Tel.: (33-1) 45 24 96 21, Fax: (33-1) 45 24 79 43, e-mail: 100734-2545@compuserve.com.

(1994)]. Additional policy instruments in high-inflation countries, such as price and exchange rate freezes, are also common to stabilisation programmes and serve the purpose of tackling inertial inflation and stabilising the price-wage dynamics in environments of persistent high inflation [Calvo *et al.* (1995), Krueger (1997)].

An undesirable outcome of exchange rate anchor-based stabilisation, or tight monetary policy to induce disinflation with delayed fiscal adjustment, is the likely overvaluation of the domestic currency, which is deemed to have a detrimental impact on the country's trade performance. Real appreciations are expected, at least in the short run, because prices in the sectors producing tradables and non-tradables do not often adjust at the same speed after the fixing (or pegging) of the exchange rate. Excess public spending and/or monetary laxity increase the demand for non-traded goods and labour [Obstfeld and Rogoff (1996)], which pushes real wages up, depresses competitiveness and increases imports. Trade and fiscal imbalances may subsequently force a policy reversal and the collapse of the exchange rate [Dornbusch (1989)]. As analysed by Dornbusch *et al.* (1990), a further problem related to the management of the exchange rate in stabilisation programmes is that fiscal deficits may worsen through changes in the revenue of export and import taxes, the composition of the government's foreign currency-denominated assets and liabilities, and the difference between buying and selling rates in multiple exchange rate regimes [see also Cardoso (1992)].

In this paper, we use a standard open-economy capital accumulation model to examine the impact of both international relative prices and domestic expenditure variables on the trade balance. The conventional intertemporal model of current account determination provides the basic theoretical framework within which the analysis is carried out [e.g. Obstfeld (1993), Turnovsky (1995), Obstfeld and Rogoff (1994, 1996)]. While it is believed that a depreciation of the domestic currency might improve the trade balance, evidence in support of this view tends to be derived from structural models of import demand and supply [for a survey, see Goldstein and Khan (1985)]. From the perspective of this paper, although theory points to an association between the exchange rate and the trade balance, such association

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does not prove temporal causality. This is because trade balances, and exports and imports separately, may have a stronger association with other macroeconomic variables, such as industrial production, sales and the level of economic activity, than with international relative prices, such as the exchange rate. In this case, this paper contends that policy instruments that boost aggregate demand or domestic absorption may generate trade deficits, such that the causality may well run from the trade balance to the exchange rate. In this case, changes in domestic expenditure may swamp the price effects associated with exchange rate changes [Knoester (1995)].

Because the question of whether price or expenditure effects predominate in explaining trade imbalances is essentially empirical, this paper tests the hypothesis that the trade balance is more responsive to domestic expenditure than the exchange rate in Brazil in the first half of the 1990s. It has often been suggested that the trade deficits observed in Brazil since 1995 have been caused by the appreciation of the domestic currency after the implementation of the macroeconomic stabilisation programme in July 1994. However, little effort has been made to take account of the role played by domestic expenditure variables in the relationship between the exchange rate and foreign trade. In this respect, we also investigate temporal causality relationships between imports and exports separately and other domestic demand-related macroeconomic variables in order to assess the impact of domestic expenditure on the performance of Brazilian foreign trade.

With regard to previous research in the area, Ferreira (1993) presents Granger-causality tests for the Brazilian trade balance using quarterly data for the period 1972:2/1989:1. His results do not indicate that changes in the exchange rate affected the trade balance in the period analysed. In general, usual explanations for the results above rest on low responsiveness of exports and imports to changes in relative prices [Thirlwall (1988)], such that the Marshall-Lerner condition fails, and/or relatively stable real exchange rates. The former does not seem to be the case in Brazil, whereas the latter is true for most of the 1980-92 period. A similar methodology is used to perform causality tests for Colombian

foreign trade in Kamas (1995), suggesting that changes in domestic credit affect the trade balance but not the exchange rate.

The paper is organised as follows. Section 2 presents the theoretical model. Section 3 briefly describes the methodology for causality testing and discusses our main findings. Because causality testing remains an unsettled topic in the applied econometrics literature, two methods are used here: a usual short-run or Granger causality method, and a long-run error-correction-based method (ECM), which allows for the analysis of causation when the variables are cointegrated. Causality tests are accompanied by unit root testing, in order to establish the order of integration of each relevant variable, and cointegration testing. For cointegration testing, we use Johansen's (1988) maximum likelihood method. Temporal causality testing is complemented by forecast error variance decomposition analysis in Section 4. The paper closes with concluding remarks in Section 5.

2 *Theoretical Considerations*

This section is aimed at providing a bird's-eye view of the standard intertemporal model used in open-economy macroeconomics [e.g. Turnovsky (1995)]. Let a representative agent consume two composite goods: a tradable good (x) and a non-tradable good (m). The exchange rate (e) is the relative price of non-tradables to tradables, such that domestic absorption, defined as $Q = x + em$, is a weighted average of consumption of tradables and non-tradables. Labour is mobile across sectors but not internationally. The representative agent maximises lifetime utility discounted at rate ρ . Capital is mobile internationally such that aggregate production in the domestic economy is carried out using domestic capital and foreign capital, defined respectively as k and b . Total investment is defined as $\frac{dk}{dt}$ plus $\frac{db}{dt}$, and f and g are, respectively, the production functions in the traded and non-traded sectors.

Omitting the time indices for simplicity and abstracting from government consumption, let the utility maximisation problem of the representative agent be defined as:

$$\begin{aligned}
(1) \quad & \max \int_0^{\infty} u(x, m) e^{-\rho t} dt \\
& \text{s.t. } \frac{dk}{dt} + \frac{db}{dt} = f(k, b) + g(k, b) - x - em, \\
& k(0) \geq 0, \quad b(0) \geq 0.
\end{aligned}$$

Let aggregate production exhibit constant returns to scale such that $f_i > 0$ and $f_{ii} < 0$, for $i = k, b$, where the subscript denotes partial derivatives. Let $g_k > 0$, $g_b > 0$, and $g_{ii} < 0$, for $i = k, b$. The first-order conditions for utility maximisation are:

$$(2) \quad \frac{u_m}{u_x} = e \frac{v}{\mu}, \text{ where } u_i \text{ is the marginal utility of } i, \text{ and } v \text{ and } \mu \text{ are the co-state variables associated with } b \text{ and } k, \text{ respectively.}$$

$$(3) \quad (\rho - f_k)(\rho - g_b) = g_k f_b.$$

$$(4) \quad f(k, b) = x.$$

$$(5) \quad g(k, b) = em.$$

For the steady-state solution to problem (1) compatible with saddle point stability (Appendix), the growth rates of consumption of non-tradables and tradables determine the evolution of domestic absorption. Since non-tradables, by definition, are not traded internationally, the trade balance is defined as the difference between output and consumption of tradables: $T = f(k, b) - x$. Assume, for simplicity, that $u(x) = \ln x$, $u(m) = \ln m$, $f(k, b) = Ak^\alpha b^{1-\alpha}$, and $g(k, b) = Bk^\beta b^{1-\beta}$. Given the dynamics of problem (1):

$$(6a) \quad \gamma_T = \gamma_A + \alpha\gamma_k + (1-\alpha)\gamma_b - \gamma_x = \gamma_A + \gamma_b + [\gamma_k - \gamma_b - A(\frac{k}{b})^{\alpha-1}] \alpha + B \frac{\beta}{\xi} (\frac{k}{b})^{\beta-1} - \rho,$$

and

$$(6b) \quad \gamma_Q = \gamma_x + e\gamma_m = A\alpha\left(\frac{k}{b}\right)^{\alpha-1} + B\frac{\beta}{\xi}\left(\frac{k}{b}\right)^{\beta-1} - \rho,$$

where γ_i denotes the growth rate of i , and ξ denotes the relative price of domestic to foreign capital [see equation (A3), in the Appendix].

The standard conclusions on the impact of exchange rate movements on the rate of growth of foreign trade and domestic absorption can be inferred from equation (6). An appreciation of the domestic currency is expected to encourage a shift in consumption towards tradables, which, in turn, raises domestic absorption and worsens the trade balance. This follows directly from equations (6a) and (6b), since $\frac{\partial \gamma_Q}{\partial \gamma_x} > 0$ and $\frac{\partial \gamma_T}{\partial \gamma_x} < 0$. For a given rate of time preference, an appreciation of the domestic currency pushes up the price (opportunity cost) of domestic relative to foreign capital, captured by ξ , and induces a shift in the composition of the capital stock away from domestic capital towards foreign capital (a fall in k/b). Also, total factor productivity growth (γ_A) increases the rate of growth of the trade balance unequivocally, such that the trade balance may be unaffected by the appreciation of the domestic currency if this appreciation is matched by productivity gains. The accumulation of foreign capital (γ_b) has an ambiguous impact on the evolution of the trade balance.

It is therefore clear that the simple intertemporal model above shows that there is a long-run analytical relationship between the trade balance and domestic absorption, on the one hand, and international relative prices, on the other. Exchange rate changes are therefore expected to affect foreign trade and domestic absorption patterns, but the actual behaviour of these variables over time depends on initial conditions, the transitional dynamics to the steady state, the composition of the stock of capital in each sector, and the speed of adjustment of the capital stock between sectors. In this case, the trade balance may be more responsive to changes in domestic absorption, than in the relative value of the domestic currency.

However, assessing the relative magnitude of price and absorption effects in foreign trade is nevertheless an empirical question, which requires a more thorough investigation than the casual observation of trade and exchange rate patterns over time. Rather than assessing these effects by estimating foreign trade elasticities, in what follows, causality is estimated in the temporal sense. The major question to be asked is whether foreign trade patterns track domestic demand/expenditure or the exchange rate.

3 Temporal Ordering Tests and Empirical Analysis

3.1 Theoretical Considerations

Although by equation (6) there is an association between the exchange rate, domestic absorption, and foreign trade, such association does not prove temporal causality, as suggested above. The relationship between the trade balance and the exchange rate can be estimated using the following reduced-form vector autoregressive (VAR) representation of expression (6a):

$$(7) \quad [I - \Omega(L)] \begin{bmatrix} \Delta \xi_t \\ \Delta T_t \end{bmatrix} + \Pi \begin{bmatrix} \xi_{t-1} \\ T_{t-1} \end{bmatrix} = \psi \begin{bmatrix} u_{1t} \\ u_{2t} \end{bmatrix},$$

where u_i , for $i = 1, 2$, are white noise disturbance terms.

If ξ and T have unit roots, temporal causality analysis follows directly from equation (7) [Granger (1969), Sims (1980), Geweke *et al.* (1983)]. In principle, T Granger-causes ξ strongly if forecasts of ξ can be improved by adding some lagged value of T , or alternatively, if $\frac{\partial \xi_{t+i}}{\partial T_t} \neq 0$, for all $i \neq 0$. In other words, in bivariate VAR models, a stationary time series T is said to Granger-cause a stationary series ξ if statistically significantly better predictions of ξ can be made by including lagged values of T in the conditioned information set in addition to lagged values of ξ . In more formal terms, temporal causality between ξ and T can be estimated using the following equations:

$$(8a) \quad \Delta \xi_t = \alpha_0 + \alpha_1 \Delta T_t + \sum_{i=1}^n c_i \Delta \xi_{t-i} + \sum_{i=1}^n F_i \Delta T_{t-i} + u_t,$$

and

$$(8b) \quad \Delta T_t = b_0 + b_1 \Delta \xi_t + \sum_{i=1}^m d_i \Delta \xi_{t-i} + \sum_{i=1}^m G_i \Delta T_{t-i} + v_t,$$

where n and m denote the number of lags in the VAR so that u and v are white noise disturbance terms.

By equation (8a), T Granger causes ξ if $\alpha_1 = 0$ and $F_i \neq 0$, and, by equation (8b), ξ Granger causes T , or alternatively, there is temporal precedence of ξ with respect to T , if $b_1 = 0$ and $G_i \neq 0$. Conventional F-tests are used to test the hypotheses above. Bi-directional Granger causality is obtained if $\alpha_1 = b_1 = 0$ and $F_i \neq 0$ and $G_i \neq 0$, for some i . Note that Granger causality is a weaker condition than exogeneity. A necessary condition for the latter is that $\alpha_i = c_i = 0$, in equation (8a), and $b_i = d_i = 0$, in equation (8b) [Enders (1995)].

More intuitively, temporal causality analysis allows for the examination of the lagged responses of a given variable to changes in another variable, when the theory suggests an analytical link between both variables. In other words, if foreign trade is expected to be affected by relative prices, temporal causality analysis tests whether the trade balance responds to lagged changes in the exchange rate. If the measured response passes conventional statistical tests, the trade balance is said to be caused by the exchange rate, since changes in the trade balance trail behind changes in the exchange rate. By the same token, the trade balance is caused by domestic expenditure variables in the temporal sense if its response to lagged changes in these domestic variables is statistically significant. In this case, given the lag structure of these responses - which is another empirical question to be investigated below -, a deterioration of the trade balance can be attributed to increases in domestic expenditure.

3.2 *Data and Results*

The rudiments of Brazilian exchange rate management can be summarised as follows. The Brazilian exchange rate regime has not changed dramatically over the years and across different macroeconomic stabilisation programmes [see Calvo *et al.* (1995) and de Mello and Carneiro (1997), for further details of the Brazilian exchange rate regime]. During most of the 1980s, the Brazilian policy was to target the real exchange rate, so that nominal adjustments to the exchange rate were made in line with inflation, thereby preserving the real exchange rate from drastic swings. Major policy reversals occurred in 1979, in response to the second oil shock, and in 1983, due to the deterioration of the current account at the beginning of the debt crisis. A maxi-devaluation was implemented at the time in a policy reversal aimed at correcting the country's external imbalances. The exchange rate was allowed to rise to give the country the competitive edge needed to generate successive trade surpluses capable of offsetting the deterioration of the current account⁴ in a standard debt transfer situation.

In the non-orthodox post-1985 era, crawling peg slow-downs often characterised the aftermath of adjustment plans, which were short-lived, given that the underlying fiscal imbalances were never satisfactorily eliminated. Domestic expenditure surges were not uncommon, as a result of the sudden fall in inflation and constant recourse to price and wage freezes, on the one hand, and lack of credibility, on the other. In the 1990s, a real appreciation of the domestic currency was the product of a less accommodating exchange rate policy, given the removal of the liquidity constraints of the 1980s and renewed access to international capital markets and offshore funds⁵.

In what follows, we use Brazilian data to test for temporal precedence between the trade balance and the exchange rate, and between exports and imports separately and domestic

⁴ See Edwards (1989) for further details on exchange rate management and adjustment in Latin America in response to the Debt Crisis of the 1980s.

⁵ See Cardoso (1997) for further details.

expenditure variables. The data used in this paper spans 1989:1 through 1995:8 and includes the first 13 months of the latest stabilisation programme implemented in Brazil in July 1994. The post-1995:8 period is excluded from our sample given that turmoil in international financial markets after the 1994 Mexican crisis led to an acceleration in the rate of nominal devaluation implicit in the country's pegged exchange rate regime. Nominal devaluations thereafter have reduced the rate of real appreciation that characterised the initial phase of adjustment (Figure 2). More recently, since early 1997, nominal devaluations have outpaced consumer price inflation, leading to a real depreciation of the domestic currency. The variables used here are measured in logarithmic form, except for the trade balance. Foreign trade and international relative price variables (the exchange rate, exports and imports) are available from the Central Bank of Brazil while economic activity variables (industrial production, domestic sales and capacity utilisation) are obtainable from the Federation of Industries of the State of São Paulo (FIESP).

For a preliminary grasp of the data, Figures 1 and 2 show the patterns of domestic expenditure and foreign trade variables in the period under consideration. Visual inspection of the series in Figure 2 reveals that there was an increase in the volume of *both* imports and exports after mid-1994, simultaneously to the sharp appreciation of the domestic currency. Also, in Figure 1, domestic expenditure variables show an increase, coupled with less volatility and seasonal variation, after January 1995, which reflects a more stable macroeconomic environment after the implementation of the stabilisation programme. Although the series (with the possible exception of the exchange rate) seem stationary for most of the period, a more rigorous test of stationarity was carried out using unit root tests. The results of the unit root tests are reported in Table 1. In general, we cannot reject non-stationarity for the levels of the variables. In contrast, when the data are differenced, non-stationarity is rejected.

We first conducted conventional short-run Granger causality tests for the foreign trade balance and, in line with earlier findings in the literature, found no temporal causation between the nominal exchange rate and the trade balance [Rose (1990), Ferreira (1993)].

The results are reported in Table 2. However, if the foreign trade balance is used as the dependent variable in equation (8b), industrial production, capacity utilisation and sales are shown to Granger cause the trade balance, but the reverse is not true. The performance of foreign trade in Brazil therefore seems to be conditional on domestic demand or expenditure factors, reflecting changes in the level of economic activity and domestic absorption, rather than international relative prices, such as the exchange rate. To test the robustness of the results, we also used the real, rather than the nominal, exchange rate. The conclusions above nevertheless hold, which reflects the nominal adjustments of the exchange rate in line with inflation during most of the period under examination.

Subsequently, given the dynamics of foreign trade, we opted for a disaggregated analysis in which Granger causality is tested for exports and imports separately. In this case, rather than looking at net trade flows, a more careful analysis of export and import performance may shed more light on the relationship between foreign trade and the exchange rate. The results are reported in the second panel of Table 2 and reveal that exports Granger cause the exchange rate, which in turn Granger causes imports. This finding reflects the import repression that characterised the Brazilian foreign trade policy in the 1980s and early 1990s. Exchange rate determination in the period was aimed at ensuring sizeable trade surpluses, by encouraging exports in a standard debt transfer situation, as suggested above. Imports were then contingent on the export-maximising level of the exchange rate. As for the domestic demand variables there is bi-directional causation between sales and exports, and between industrial production and exports. As for imports, there seems to be unidirectional causation running from sales, industrial production, economic activity, and capacity utilisation to imports. This finding is in line with the fact that, in exchange rate-based stabilisation programmes, an initial expansion of private consumption, and hence domestic absorption, is expected due to the wealth effect due to the fall in inflation and if agents believe the exchange rate regime to be unsustainable in the long run [Reinhart and Vegh (1995)].

3.3 Further Investigation on Causality Relations

For the cases in which we have found two-way causation, we have applied a more comprehensive test of causality which specifically allows for a causal linkage between two variables stemming from a common trend [Hendry *et al.* (1984)]. If the variables in the VAR have unit roots, the model can be re-parameterised in an error-correction (ECM) form. This method examines whether lagged values of a variable T may help explain the current change in another variable ξ , even if past changes in ξ do not, assuming that both T and ξ are stationary. The intuition is that, if the two variables are cointegrated, then part of the current change in T results from ξ moving into alignment with the trend value of T . As long as T and ξ have a common trend, causality must exist at least in one direction [see Enders (1995)].

In more formal terms, to test for causality when variables are cointegrated, one uses the following error-correction (ECM) equations:

$$(9a) \quad \Delta \xi_t = a_0 + a_1 \varepsilon_{t-1} + \sum_{i=1}^n c_i \Delta \xi_{t-i} + \sum_{i=1}^n F_i \Delta T_{t-i} + u_t,$$

and

$$(9b) \quad \Delta T_t = b_0 + b_1 \eta_{t-1} + \sum_{i=1}^m d_i \Delta \xi_{t-i} + \sum_{i=1}^m G_i \Delta T_{t-i} + v_t,$$

where ε_{t-1} and η_{t-1} are the lagged values of the residuals from cointegration vectors such as, respectively, $\xi_t = \phi_1 T_t + \varepsilon_t$ and $T_t = \phi_2 \xi_t + \eta_t$, n and m denote the number of lags, and u and v are white noise disturbance terms.

From (9a), the null hypothesis that T does not Granger cause ξ is rejected either if the coefficient on ε_{t-1} is significant or the F_i 's are joint significant. In other words, the value of ε in one period represents the error to be corrected in the next period. If ξ and T are positively related, then a_1 would be negative, which means that an extremely high value of T

relatively to ξ leads to a reduction in T . The same reasoning applies in the case of η in equation (10), for the null hypothesis that ξ does not Granger cause T ⁶.

We carry out cointegration tests based on the Johansen (1988) maximum likelihood method [see Johansen and Juselius (1990)]. The results of the cointegration tests are nevertheless not reported. It is also interesting to note that the cointegration-based method tests for the existence of a stable long-run relationship between the exchange rate and the trade balance, which provides *prima facie* evidence of the sustainability of the exchange rate regime. In addition, the Johansen-type ECM-based approach to causality testing is known to supersede the conventional short-run Granger causality method [Toda and Phillips (1993)]. Hence, when the results obtained using the two causality methods are contradictory, preference is given to the ECM-based results.

The ECM-based approach reported in Table 3 suggests that long-run or ECM-based causation most likely runs from exports to sales, capacity utilisation and industrial production. The bi-directional causality relationships between sales and exports, and industrial production and exports, found in the conventional Granger causality tests in the preceding section seem to be confined to the short run. The remaining findings of unidirectional causation however remain valid and, therefore, are not reported. Overall, there seems to be little contradiction between the results of the two methods used for causality testing, which is suggestive of limited discrepancy between the short-run dynamics and the long-run patterns of the variables under examination.

4 Variance Decomposition Analysis

Because the relationship between foreign trade, the exchange rate and domestic expenditure variables is complex, we further investigate the data using a multivariate common trends VAR representation [Sims (1980)] of the following type:

⁶ Note that the same cointegration residual ε_t or η_t can be used in both VECM equations.

$$(10) \quad \Delta\Omega_t = A(L)e_t,$$

where Ω_t is a vector of endogenous variables, $A(L)$ is a square matrix of lag polynomials and the number of lags is chosen such that e_t is white noise.

Equation (10) is subsequently used to perform variance decomposition analysis, which assesses the relative impact of changes in each of the macroeconomic variables included in the VAR on the dependent variables. The technique consists of orthogonalising the VAR residuals, by decomposing them into as many orthogonal times series as endogenous variables in vector Ω_t . In our analysis, vector Ω_t comprises all the demand-related and foreign trade variables considered in the previous sections (economic activity, capacity utilisation, sales, exports, imports) and the exchange rate. The analysis is carried out with two lags for each variable (the lag structure was chosen according to the Schwartz criterion) and the VAR was estimated with a constant and a time trend.

The corresponding covariance matrix of the VAR residuals is reported in Table 4. Innovations or exogenous shocks to the exchange rate are positively related to innovations in all variables in the VAR, with the exception of sales. Innovations to imports are also positively related to innovations in all variables in the VAR, with the exception of capacity utilisation. Surprisingly, exchange rate shocks are positively correlated with innovations in both exports and imports, which suggests an important association between foreign trade and domestic expenditure variables in Brazil. This association is in accordance with the results of the temporal causality tests above.

As for variance decomposition analysis, the impact of changes in economic activity, capacity utilisation, sales, exports, and imports on the exchange rate in the period spanning 1989:1 to 1985:8 is reported in Table 5. Conversely, Table 6 presents the results of the variance decomposition analysis for the impact of the exchange rate of the demand-related variables. In line with the findings of the temporal precedence analysis, when the exchange rate is

taken as the dependent variable, variance decomposition confirms that the impact of changes in demand-related variables on the exchange rate is stronger than the converse.

By Table 5, changes in capacity utilisation explain more than 8% of changes in the exchange rate after 9 months, against 2.7% and 4.9% in the case of changes in imports and exports, respectively. Economic activity is a poorer predictor, as expected in the light of the temporal precedence results in Tables 2 and 3. In the case of exports, the magnitude of the impact on exchange rate fluctuations is relatively stable throughout the simulation period, whereas in the very short run, the impact of sales on exchange rate fluctuations is relatively strong, despite being a poor predictor in the longer term. Conversely, by Table 6, the impact of changes in the exchange rate on the demand variables suggests a rapid adjustment to its longer term magnitude within the first three months. The longer term impact of exchange rate fluctuations on economic activity, capacity utilisation and sales is much stronger than on exports or imports, which confirms previous findings. The results are robust to changes in the ordering of the endogenous variables in the VAR.

5 *Conclusions*

This paper used a standard intertemporal optimisation model to examine the relationship between foreign trade, domestic demand/expenditure and the exchange rate. It is shown that the appreciation of the domestic currency may not have devastating effects on the trade balance if compensated by productivity gains, in a standard Balassa/Samuelson scenario. Because the association between the exchange rate, the trade balance (or imports and exports separately), and domestic expenditure variables implied by the theoretical model does not prove temporal causality, we proceeded to test for temporal causality using two different approaches. The first is the usual short-run Granger causality, when the variables in the VAR are defined in first differences. The second is a long-run or ECM-based causality, when the variables in the VAR cointegrate.

Three basic conclusions can be inferred from the above. First, if the Brazilian experience can be extrapolated to economies implementing macroeconomic stabilisation programmes with emphasis on an exchange rate anchor, our results do not indicate that the trade balance is strongly affected by the exchange rate. Our findings are suggestive of a more sluggish response of trade flows to changes in international relative prices than in domestic expenditure variables. In fact, our results show that the latter tend to swamp price effects. Second, the examination of the relationship between the exchange rate and imports and exports seems to reveal more about the behaviour of foreign trade variables than in the case of the trade balance. The basic findings of the paper are reinforced by the variance decomposition analysis. Third, and more generally, our findings cast doubt on the critique of the sustainability of exchange rate anchors in macroeconomic stabilisation programmes, given the alleged overvaluation of the exchange rate.

The strength of the conclusions above needs some attention. In the case of Brazil, important factors that could be singled out as obscuring the role of the exchange rate in explaining the performance of foreign trade during most of the 1980s were the policy of real exchange targeting coupled with lack of fiscal and monetary discipline, important wage rigidities due to extensive formal and informal indexation, and import repression. In addition, Brazil is a large, relatively closed economy. A stylised fact in international macroeconomics is that large economies tend to be more closed than their smaller counterparts, in which the GDP share of exports and imports tends to be much larger. Being naturally less open to foreign trade, larger economies also tend to be less exposed to external price and demand shocks, and their trade patterns tend to be more responsive to changes in domestic, rather than external, price and absorption effects.

Our results suggest that a deterioration of the trade balance is more likely to arise due to factors which may boost aggregate demand and hence put mounting pressure on the sustainability of exchange rate regime. Should a fixed exchange rate be maintained, fiscal discipline and export promotion, which pulls resources into exportable production and reduce the bias against exports, would avoid policy reversals and reduce the exposure of the

domestic currency to speculative attacks. The deterioration of Brazil's external position in recent years is more closely associated with delayed fiscal adjustment than the country's trade performance in response to a less accommodating exchange rate policy. Import-export imbalances may also be attributed to unilateral trade liberalisation in the 1990s, with the removal of quantity controls over imports and the reduction of protection for import-competing goods. In this respect, an undesirable aspect of trade and investment liberalisation is that the repressed demand for imports manifests itself before production is shifted from import-competing to exportable goods and services. Brazilian exports had been discouraged in the 1970s and early 1980s by import substitution, with high prices for domestically-produced intermediate inputs relative to the international prices received for exports, and excessive tariff protection for import-competing sectors/activities. Export growth in the 1980s was due more to the exchange rate regime, characterised by nominal devaluations in line with inflation, than investment in exploring foreign markets, developing distribution networks, and upgrading the country's export base.

Finally, the analytical links between trade and current account imbalances, on the one hand, and the sustainability of macroeconomic policy, on the other, has been the object of intense research in recent months. Due to the Mexican exchange rate crisis of 1994 and the ongoing Asian currency meltdown, there has been a burst of research into currency crises and exchange rate management in developing countries. Sizeable current account imbalances have been deemed unsustainable when accompanied by weak fundamentals, in which case policy reversals and exchange rate re-alignments are mandatory. A new generation of currency crisis models has nevertheless suggested that macroeconomic probity alone may not be a sufficient condition for tranquillity in foreign exchange markets, and that currencies may suffer speculative attacks even if the fundamentals are strong. In either case, the literature on the impact of exchange rate changes on trade flows, as surveyed by Obstfeld (1995), remains largely inconclusive. In this respect, this paper sheds some more light on the relative importance of exchange rate and expenditure variables in explaining the behaviour of foreign trade balances.

Appendix

Let μ and η be the multipliers associated with the state variables k and b , in problem (1), such that:

$$(A1) \quad -\frac{d\mu}{dt} = \mu f_k + \eta g_k.$$

$$(A2) \quad -\frac{d\eta}{dt} = \mu f_b + \eta g_b.$$

Let $\xi = \mu/\eta$, such that:

$$(A3) \quad \frac{d\xi}{dt} = f_b \xi^2 + (g_b - f_k)\xi - g_k.$$

Because equation (A3) is a quadratic function of ξ , at the steady state ($\frac{d\xi}{dt} = 0$), it yields two equilibrium solutions. Let $\Delta = (g_b - f_k)^2 + 4f_b g_k > 0$ and let $-\sqrt{\Delta} < g_b - f_k < \sqrt{\Delta}$, such that the roots of equation (A3) are real, unequal and of opposite signs. The stability properties of the solutions to problem (1) can be evaluated by linearising the system formed by equation (A3) and the $\frac{dk}{dt}$ constraint of problem (1) around a steady state $(\tilde{k}, \tilde{\xi})$.

Linearisation yields the following:

$$\begin{pmatrix} \frac{dk}{dt} \\ \frac{d\xi}{dt} \end{pmatrix} = \begin{pmatrix} f_k & 0 \\ -f_{kk}\tilde{\xi} - g_{kk} & 2f_b\tilde{\xi} + g_b - f_k \end{pmatrix} \begin{pmatrix} k - \tilde{k} \\ \xi - \tilde{\xi} \end{pmatrix}$$

Saddle point stability is obtained if the determinant of the matrix of coefficients above is negative, for the equilibrium values of $\tilde{\xi}$. It is easy to see that the determinant of the matrix of coefficients is negative for $\tilde{\xi} < -(g_b - f_k)/2f_b$.

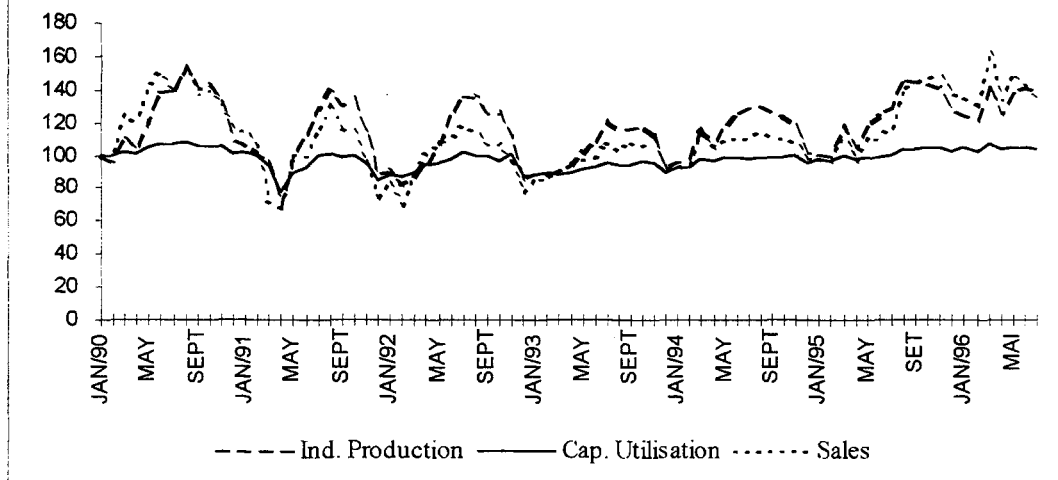
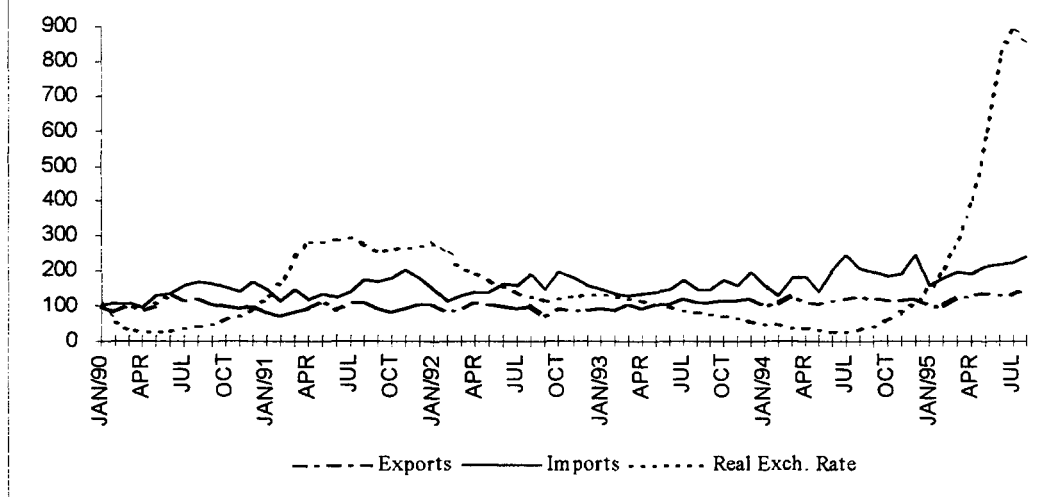
Figure 1: Domestic Expenditure Variables**Figure 2: Foreign Trade and the Exchange Rate**

Table 1: Unit Roots Tests

<i>Variables</i>	<i>Level</i>	<i>First Difference</i>
Exports	0.751	-8.048**
Imports	0.892	-8.555**
Trade Balance		-8.875**
Industrial Production	0.259	-5.757**
Capacity Utilisation	0.281	-4.722**
Exchange Rate	1.455	-2.322*
Sales	0.616	-6.134**

Note: The numbers reported are ADF(1) statistics. The critical values are -1.946 and -2.599 for 5% and 1% significance levels, respectively. The sample is 1989:1 to 1995:8.

Table 2: Conventional Granger Causality Tests

<i>Direction of Causality</i>	<i>Test</i>
Exchange Rate => Trade Balance	1.528
Trade Balance => Exchange Rate	1.840
Industrial Prod. => Trade Balance	2.840*
Trade Balance => Industrial Prod.	1.029
Trade Balance => Capacity Utilisation	1.946
Capacity Utilisation => Trade Balance	2.905*
Trade Balance => Sales	2.093
Sales => Trade Balance	3.797**
Exports => Exchange Rate	2.225*
Exchange Rate => Exports	1.386
Imports => Exchange Rate	1.388
Exchange Rate => Imports	3.239**
Sales => Exports	2.916*
Exports => Sales	3.496**
Sales => Imports	5.548**
Imports => Sales	1.193
Imports => Capacity Utilisation	1.877
Capacity Utilisation => Imports	4.667**
Exports => Industrial Prod.	3.000**
Industrial Prod. => Exports	2.716*
Capacity Utilisation => Exports	1.081
Exports => Capacity Utilisation	2.428*

Note: The Granger Causality tests reported are F-tests distributed as F(7,58). The sample is 1989:1 to 1995:8. (*) means significant at the 5% level and (**) means significant at the 1% level. The results were obtained using six lags for each variable; the number of lags was chosen by the Schwartz criterion.

Table 3: ECM Granger Causality Tests

<i>Direction of Causality</i>	<i>ECM</i>	<i>F Test</i>	<i>Residuals</i>
Sales => Exports	0.138 (1.104)	1.036	-3.7650**
Exports => Sales	-0.304* (-2.619)	1.472	-3.7527**
Exports => Industrial Production	-0.279* (-2.461)	2.379*	-2.1074*
Industrial Production => Exports	-0.011 (-0.072)	1.977	-2.1074*
Capacity Utilisation => Exports	-0.026 (-0.192)	1.252	-4.0272**
Exports => Capacity Utilisation	-0.105* (-2.303)	2.142	-4.0272**

Note: The Granger Causality tests reported are F-tests distributed as F(6,58). The sample is 1989:1 to 1995:8. The ECM column reports the coefficient of the ECM term obtained when estimation an equation of the form described by equation (4); the number in parenthesis is the t-statistic; the residuals test is the ADF(1) test for I(0) stationarity. (*) means significant at the 5% level and (**) means significant at the 1% level. For the number of lags used, see Table 2.

Table 4: Residual Covariance Matrix

	<i>Industrial Production</i>	<i>Capacity Utilisation</i>	<i>Sales</i>	<i>Exports</i>	<i>Imports</i>	<i>Exch. Rate</i>
Ind. Production	0.009					
Cap. Utilisation	0.003	0.001				
Sales	0.008	0.003	0.010			
Exports	0.003	0.000	0.003	0.011		
Imports	0.001	-0.001	0.000	0.008	0.019	
Exch. Rate	0.001	0.000	-0.0002	0.005	0.001	0.004

Note: The sample is 1989:1 to 1995:8.

**Table 5: Variance Decomposition
(Dependent Variable: Exchange Rate)**

<i>Lags</i>	<i>Standard Errors</i>	<i>Industrial Production</i>	<i>Capacity Utilisation</i>	<i>Sales</i>	<i>Exports</i>	<i>Imports</i>
1	0.062	0.781	0.046	3.985	1.716	1.802
3	0.112	1.006	4.194	1.795	0.951	5.302
5	0.127	0.825	7.956	1.848	1.575	5.087
7	0.130	0.785	8.171	1.946	2.438	4.999
9	0.131	0.879	8.132	1.954	2.705	4.950

Note: The sample is 1989:1 to 1995:8. Test Summary: Variance of Residuals: 0.004, Standard Error of Regression: 0.06, \bar{R}^2 : 0.77, DW: 2.06, Block Exogeneity Test: 1.00.

Table 6: Variance Decomposition
(due to changes in the exchange rate)

<i>Lags</i>	<i>Industrial Production</i>	<i>Capacity Utilisation</i>	<i>Sales</i>	<i>Exports</i>	<i>Imports</i>
1	0.000 (0.094)	0.00 (0.034)	0.00 (0.101)	0.00 (0.106)	0.00 (0.141)
3	9.209 (0.118)	12.535 (0.047)	11.639 (0.127)	1.635 (0.134)	1.871 (0.179)
5	8.850 (0.121)	12.101 (0.047)	11.416 (0.131)	2.159 (0.143)	3.365 (0.193)
7	9.952 (0.122)	12.123 (0.047)	11.740 (0.132)	2.296 (1.440)	3.471 (0.196)
9	9.349 (0.122)	12.141 (0.048)	11.765 (0.132)	2.402 (1.444)	3.534 (0.196)
Var. of Residuals	0.009	0.001	0.100	0.011	0.019
Std. Err. Regression	0.009	0.030	0.100	0.110	0.140
\bar{R}^2	0.30	0.39	0.30	0.62	0.37
Durbin-Watson	1.91	2.02	2.09	1.86	2.09
Block Exogeneity	4.120**	5.809**	4.120**	2.350*	3.480**

Note: Standard errors in parentheses. (*) means significant at the 5% level and (**) means significant at the 1% level.

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