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**EXCHANGE RATE POLICY AND TRADE BALANCE. A  
COINTEGRATION ANALYSIS OF THE ARGENTINE EXPERIENCE  
SINCE 1962.**

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**Abstract:** Using multivariate cointegration tests for non-stationary data and vector error correction models, this paper examines the determinants of trade balance for Argentina over the last forty to fifty years. Our investigation confirms the existence of long-run relationships among trade balance, Real Exchange Rate (RER) and foreign and domestic incomes for Argentina during different real exchange rate management policies. Based on the estimations, the Marshall-Lerner condition is examined and, by means of impulse response functions, we trace the effect of a one-time shock to the RER on the trade balance checking the J-curve pattern.

**Keywords:** Argentina, Marshall-Lerner, J-Curve, cointegration and impulse response analysis.

**JEL Classification:** C22, C32, F31, F43

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## **I. Introduction.**

The management of the Exchange Rate has been a critical issue for the economic policy, especially in developing countries. In defining an exchange rate policy, one of the most important considerations is the responsiveness of Trade Balance (TB) to changes in terms of trade or, more generally, in Real Exchange Rate (RER). The effects of currency depreciation on a country's trade balance have centred an important and on-going debate in the international economic literature. Precisely, this issue has been traditionally studied in the Marshall-Lerner condition (ML) and the so called J-curve framework. According to the ML condition, currency devaluation improves the trade balance in the long run only if the sum of the absolute values of imports and exports demand price elasticities exceeds unit. However, due to the lag dynamics structure, TB can worsen in the short-run because of the inelastic demand for imports and exports in the immediate aftermath of an exchange rate change. In this case, TB is said to follow the J-curve pattern.

A wide number of papers have tested the ML condition and J-curve. Bahamani-Oskooee and Ratha (2004) is a good survey on ML and J-curve showing non conclusive results on this issue. In Bahamani-Oskooee and Niroomand (1998) the ML condition is addressed for almost thirty developed and developing countries over the period 1960-92. Gomes and Paz (2005) and Tsen (2006) demonstrate the existence of a long run relationship among TB, real exchange rate, foreign and domestic income for Brazil in the nineties and for Malaysia during 1965-2002 respectively. Mahmud et al. (2004) suggest that, though during fixed exchange rates periods ML condition is supported, it is less probable in flexible exchange periods. Almost all these papers find support for the existence of the J-curve pattern except Narayan (2004) who does not confirm the ML condition in New Zealand.

As far as we know, there is only one paper that deals with ML condition in Argentina, namely Lopez y Cruz (2000). This study supports the relationship among TB, real exchange rate, foreign and domestic income for the Argentine economy during the period 1965-1995, but it does not analyse the short-run adjustment through the J-curve phenomenon. In this paper, we test not only the validity of ML condition but also the existence of a J-curve pattern for the Argentine economy from 1962 up to nowadays discerning three cut-off points due to different periods of exchange and trade policies implemented in Argentina: 1990 reveals a clear change in Argentine exchange rate regime when the Convertibility Plan in April 1991 fixed the Argentine peso to US dollar in a currency board system; 2000 evidences a slowdown triggering the sharp crises in 2002

and the end of the fixed exchange rate regime period after an intense devaluation of the currency in the first days of 2002. Finally, we have analysed 1978-05 period to capture relationships during the change in Argentina's trade policy making towards a liberalization phase, away from the import substitution protectionism period in 1978. We note that three of the periods we have tested, 1962-2005, 1962-2000 and 1978-05, include the Convertibility Plan stage which implied a fixed exchange rate policy with US dollar. The other one, 1962-1990, showed more flexible options on the currency.

Hence, the aim of the paper consists on empirically verify the ML condition and the J-curve pattern for Argentina. To this purpose, we exploit some econometric techniques using time series unit root tests to examine the stationary properties of the data and the Johansen and Juselius procedure (1991) to search for multivariate cointegrating relationships from a robust and stable vector autoregressive (VAR) modelling specification. Based on a vector error-correction (VECM) formulation and generalized impulse response function, we analyze the long and short term trade balance dynamic model for Argentina.

Taking into account the slow long run balance of payments constrained economic growth of Argentina suggested in several papers (see, for instance, López and Cruz (2000) and Perraton (2003) and the key role of the exchange rate rule on the Argentine development during the last decades, specially since 1991, we highlight the importance of this paper for policy-making decisions on exchange rate regime in the Argentine economic development. The contributions of the paper are twofold. The first is to test ML and J-curve phenomenon for Argentina in different periods. The second is to provide new insights on the effects of fixed and flexible exchange rate regimes in the TB and, therefore, in the relationships between RER and long term economic growth.

The rest of the paper is organized as follows. Section 2 sets our model specification. In Section 3 we present the econometric methodology and our empirical results for Argentina. Finally, Section 4 concludes the paper.

## **II. Theoretical framework**

Following the straightforward modelling introduced by Rose and Yellen (1989) and Rose (1991), a country's trade balance behaviour is built into a reduced form function directly depending on the real exchange rate and the real domestic and foreign incomes.

We begin with a standard model specification for export and import demand functions

$$X_t = \left( \frac{P}{P^* \cdot E} \right)_t^\eta \cdot (Y_t^*)^\varepsilon \quad (1)$$

$$M_t = \left( \frac{P^* \cdot E}{P} \right)_t^\gamma \cdot (Y_t)^\pi \quad (2)$$

where  $X$  and  $M$  are the volume of exports and imports,  $E$  is the nominal exchange rate and  $P, P^*$  and  $Y, Y^*$  denote the domestic and foreign price levels and incomes respectively;  $\eta$  and  $\gamma$  are the real exchange rate elasticities for exports and imports and  $\varepsilon$  and  $\pi$  are the income elasticities for imports and exports.

Using logarithms, equation (1) and (2) become

$$\ln X_t = \eta [\ln P_t - \ln P_t^* - \ln E_t] + \varepsilon \ln Y_t^* \quad (3)$$

$$\ln M_t = \gamma [\ln P_t^* + \ln E_t - \ln P_t] + \pi \ln Y_t \quad (4)$$

where  $\ln e_t = [\ln P_t^* + \ln E_t - \ln P_t]$  is the natural logarithm of real exchange rate. Let TB stand for the trade balance. Following common practice, TB is defined as the ratio between exports and imports so

$$\ln TB_t = \pi \ln Y_t + \varepsilon \ln Y_t^* + \mathcal{G} \ln e_t \quad (5)$$

where  $\mathcal{G} = -(\eta + \gamma)$ . Precisely, the coefficient of  $\ln e_t$  indicates whether the ML condition is fulfilled. Note that here  $\eta$  and  $\gamma$  are assumed to be negative and  $\varepsilon$  and  $\pi$  are positive so ML holds whenever  $\mathcal{G}$  is positive indicating that a higher real exchange rate, that is, a real depreciation, appears to improve the trade balance over time.

Our major concern is focused on the time-path dynamics of the trade balance analyzing both the long run and short term impact of changes in the exchange rate of the Argentina's currency checking, in selected periods over the sample 1962-2005, whether it induced an upgrading or a worsening of the country's trade position.

### III. Methodology, empirical results and discussion.

In this section we present the estimation techniques as well as the empirical results testing not only the long- and short-terms impacts of real exchange rate on the trade balance but also the validity of the ML condition for Argentina. In this fashion, we firstly examine whether there exists a long-run relationship between trade balance and real exchange rate, foreign income and domestic income for Argentina. Second, we test if a worsening of the RER results in a long-term improvement in the trade balance. Finally, we apply the impulse response analysis to determine whether shocks to RER induce the trade balance to follow a J-Curve.

Annual data from the International Financial Statistics published by the International Monetary Fund (IMF) are used in our analysis covering the whole period 1962-2005. National ( $Y$ ) and foreign income ( $Y^*$ ) are defined by GDP volume index numbers and the US GDP is taken as the proxy for world output. TB is constructed as the rate volume of exports and volume of imports and the real exchange rate ( $RER$ ) is computed as the ratio of foreign price proxied by US consumer price to domestic consumer price multiplied by the nominal exchange rate of the domestic currency with US dollar. All the variables are expressed in logarithmic forms.

In keeping with the trade balance evolution encapsulated in equation (5), we assume that the long-run cointegrating testable relationship takes the following log-linear form

$$\ln TB_t = \beta_0 + \beta_1 \ln Y_t + \beta_2 \ln Y_t^* + \beta_3 \ln RER_t + u_t \quad (6)$$

where  $u_t$  is the random error term. In this regard, likelihood-based inference in cointegrating vector autoregressive models is required in order to determine whether this linear combination of non-stationary data series of TB, real exchange rate and foreign and domestic incomes is stationary and, therefore, describes a stable and non-spurious regression.

In so doing, we run univariate Dickey-Fuller (DF) and the Augmented Dickey-Fuller (ADF) unit root tests for each variable that enters the multivariate model following the decision tree process proposed by Charemza and Deadman (1992) testing for the significance of trend and drift together with non-stationary and assuming that the choice of lags is based to guarantee non-residual autocorrelation. The results over the period

1962-2005 are reported in table (1) and indicate that  $\ln Y$  and  $\ln Y^*$  and  $\ln RER$  contain a unit root in their levels form but not in their first differences form so they are integrated of order one,  $I(1)$ , while  $\ln TB$  is also stationary in levels. In addition, we find that neither trends nor drifts should be entered in the cointegration space. Though not reported here, we have checked that all the variables are  $I(1)$  series for each of the short time spans considered. Note that, if the series have not contain a unit root, the cointegration test will lead to a number of cointegration vectors equal to four which is the number of endogenous variables.

Turning to cointegration analysis, we implement the cointegration test developed by Johansen (1988) and Johansen and Juselius (1990) which applies maximum likelihood to a VAR model assuming that the errors are Gaussian. Essentially, testing the existence of this long-run relationship requires a  $p$ th-order structural and dynamic VAR model on the variables under consideration which, in keeping with Granger representation theorem, can be written as an unrestricted VEC involving up to  $p$  lags

$$\Delta \ln TB_t = \delta_0 + \sum_{j=1}^p \theta_k \Delta \ln TB_{t-j} + \sum_{j=1}^p \gamma_k \Delta \ln Y_{t-j} + \sum_{j=1}^p \varphi_k \Delta \ln Y_{t-j}^* + \sum_{j=1}^p \phi_k \Delta \ln RER_{t-j} + \lambda [\ln TB_{t-1} - \hat{\beta}_0 - \hat{\beta}_1 \ln Y_{t-1} - \hat{\beta}_2 \ln Y_{t-1}^* - \hat{\beta}_3 \ln RER_{t-1}] + \varepsilon_t \quad (7)$$

where  $\Delta$  is the first difference operator,  $\lambda$  provides information on the speed-of-adjustment coefficient to long-run equilibrium and  $\varepsilon_t$  is a purely white noise term.

To this purpose, we firstly proceed by setting the appropriate lag-length in order to ensure the gaussian structure of the residuals in the VECM. We note that when the errors are not independent normal, it has been found that the Johansen method has a greater probability of rejecting the null of non cointegration even when there are no cointegration relations. In this fashion, we have selected the number of lags indicated by Schwartz (BIC) and Hannah-Quinn (HQ) criteria in all stages except for the term 1978-2005 where lags were chosen on the basis of the Akaike (AIC) criterion which has provided better results for Gaussian errors. On the basis of these information criteria, the best lag order is one year for the longer periods, 1962-2005 and 1962-2000, and two years for the shorter ones, 1978-2005 and 1962-1990. For brevity the results are not reported here. Following the Box and Jenkins (1970) approach, the diagnostic checking listed in table (2) deals with residual Portmanteau (Q) and Breusch-Godfrey Lagrange

Multiplier (LM) autocorrelation tests, White heteroscedasticity and Jarque-Bera residual normality test via Cholesky ( $JB_{CHOL}$ ) and Urzua ( $JB_{URZ}$ ) factorizations and leads to well-behaved residuals in all periods.

Next, we apply Johansen and Juselius (1990) procedure testing for number and estimations of cointegrating relations. Let  $r$  be set from zero to  $k - 1$ , where  $k = 4$  is the number of endogenous variables in our modeling. The procedure leads to two statistics for cointegration: the *trace statistic*,  $\lambda_{trace}$ , tests the hypothesis that there are at most  $r$  cointegrating vectors while the *maximal-eigenvalue statistic*,  $\lambda_{max}$ , tests that there are  $r$  cointegrating vectors against the alternative that  $r + 1$  exists. The results of this sequential testing performance are reported in table (4) for every sample. We remark that the non-standard critical values are taken from Osterwald-Lenum (1992) which differ slightly from those reported in Johansen and Juselius (1990). Both statistics<sup>1</sup> confirm the existence of at most one cointegrating equilibrium relationship among the logarithms of TB, national and foreign income and real exchange rate at the 5% level.

Table (4) summarizes the estimated cointegrating vectors normalized on trade balance and the adjustment parameters,  $\lambda$ . Each cointegrating coefficient,  $b_1, b_2$  and  $b_3$ , measures the trade balance elasticity with respect to the Argentine income, the US income and the RER respectively, that is, the percentage change in TB for one unit percentage change in each of the explanatory variables. As expected, in all cases trade balance is negatively associated with domestic output and positively associated with international output. However, except for the sub-sample 1962-1990, in all periods trade balance and real exchange rate are found to be positively cointegrated and the elasticity coefficient  $b_3$  is positive and statistically significant at the 95% confidence level.

These results hint us to conclude that, in these terms, the Marshall-Lerner condition is fulfilled and an increase in the real exchange rate has not only influenced but also has improved the Argentinean trade balance. Interestingly, ML condition only holds when the fix exchange rate period during Convertibility Plan in the nineties is included (observe that only in 2002 the fix parity dollar-peso was abandoned and ML holds in all periods counting the Convertibility Plan<sup>2</sup>) and, on the contrary, it is not fulfilled in previous periods when the exchange rate policy has shown more flexible systems. In this

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<sup>1</sup> Johansen and Juselius (1990) suggest that, in case that the statistics yield conflicting results, the maximum eigenvalue test may be better.

<sup>2</sup> In fact, we have tested different periods and ML condition begins to be fulfilled after 1994.



sense, these results are aligned with those of Mahmud, et al. (2004) for developed countries and of Gomes and Paz (2005) for Brazil during Real crawling-peg exchange rate regime system in the nineties. As occurred in Brazil, real exchange rate in Argentina was supposed to be appreciated during the Convertibility Plan.

Moreover, in table (4), we can observe that when ML condition holds, the foreign and domestic income coefficients,  $b_1$  and  $b_2$ , are not statistically significant at the 5% level. However, in the 1962-90 period, when ML rule is not verified, income coefficients are significant indicating that during not fixed exchange rate periods, TB is more influenced by foreign and domestic income and therefore by foreign and domestic output growth rhythms. From our point of view, these results are suggesting that currency devaluation in 2002 was necessary to improve the TB and recover an economic growth path more consistent with the balance of payments constraint that Argentine economy seems to bear in the long run (López and Cruz (2000) and Perraton (2003). Finally, we note that the significance of the parameter  $\lambda$  in all samples indicates that trade balance changes does not even up changes in past disequilibrium of either national and foreign income or real exchange rate during the same period.

We have checked that in all periods the estimated VEC models with one cointegrating relations are stable<sup>3</sup> and that the innovations are contemporaneously uncorrelated. This enables us to analyze the J-curve phenomenon for Argentina by taking into account the dynamic lag structure of the VEC formulation. A one time shock to the real exchange rate is traced and the generalized impulse response function of  $\ln TB$  are obtained for Cholesky one standard-deviation  $\ln RER$  innovations. The results over the hold period are represented in figure 1 and suggest that for Argentina we do not find a negative effect of devaluation on the trade balance and the most important improvements on the TB have around four to five years of duration. However, for the period 1962-1990, Figure 2 shows that the effect is negative firstly from the fourth to the sixth year and again from the ninth to the eleventh year. We note that is precisely the unique sample where it is not verified the Marshall-Lerner condition. Hence, with the exception of the sub-period before the Convertibility Plan, no evidence in favour of the J-curve short term TB adjustment was found for Argentina, by using annual data.

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<sup>3</sup> The stability of the estimated VAR and VEC has been checked in each of the sub-periods from the inverse  $kp$  roots of the characteristic AR polynomial, where  $k$  is the number of endogenous variables and  $p$  is the largest one. The stability condition is verified if all the roots have modulus less than one. In a VEC estimation with  $r$  cointegration relations this implies that  $kr$  roots should be equal to unity,

#### **IV. Conclusions and policy implications.**

In this paper we assess the long and short run effects of real exchange rate on the Argentinean TB in a long period beginning in 1962. By using VAR-based cointegration tests and impulse response functions, we show that ML condition is fulfilled in the periods including fix exchange rate regime policy but not in those periods when exchange rate has shown more flexible policies. This result holds even though there have been episodes of RER overvaluation with relatively flexible exchange rate periods in the Argentine economy as have shown Richaud et al. (2003). Besides our results coincides with those reported by Mahmud et al. (2004) for developed countries. In the short run, Argentine TB has not usually followed the J-curve pattern of adjustment. Only before the Convertibility Plan launching in 1991, the impact of RER is negative on the long-term and short-run TB showing that though the ML condition does not hold a J-curve-type phenomenon is observed.

A policy-making implication of our results suggests that, likely, currency devaluation in 2002 (and, therefore, the abandon of the currency board implemented in the Convertibility Plan) was necessary for improving TB and recovering a more sustainable economic growth path. In this sense, flexible exchange rate policies seems to be necessary to induce a balance of payments long run sustainability and, therefore, for Argentine economic development.

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## APPENDIX

**Table 1 . Augmented Dickey-Fuller test (ADF). Argentina 1962-2005.**

$$H_0 : \delta = 0$$

$$H_1 : \delta < 0$$

$$(i) \Delta y_t = \beta_1 + \beta_2 t + \delta y_{t-1} + \sum_{i=1}^m (\alpha_i \Delta y_{t-i}) + \varepsilon_t$$

$$(ii) \Delta y_t = \beta_1 + \delta y_{t-1} + \sum_{i=1}^m (\alpha_i \Delta y_{t-i}) + \varepsilon_t$$

$$(iii) \Delta y_t = \delta y_{t-1} + \sum_{i=1}^m (\alpha_i \Delta y_{t-i}) + \varepsilon_t$$

variable	k	Model (i)		Model (ii)		Model (iii)
		$\Phi_3$	$t_{tc}$	$\Phi_1$	$t_c$	$t_{nc}$
$\ln TB$	0	0.171	-3.428	2.128	-3.49	-2.697***
$\Delta \ln TB$	0	n.a.	n.a.	n.a.	n.a.	-5.889***
$\ln Y$	1	2.079	-2.355	1.2366	-1.101	2.039
$\Delta \ln Y$	1	n.a.	n.a.	n.a.	n.a.	-4.069*
$\ln Y^*$	0	3.59	-3.729	2.767	-1.662	10.256
$\Delta \ln Y^*$	0	n.a.	n.a.	n.a.	n.a.	-2.144*
$\ln RER$	0	-0.094	-2.791	2.007	-2.851	-1.960
$\Delta \ln RER$	0	n.a.	n.a.	n.a.	n.a.	-6.875* **

Notes:  $k$  is the lag structure order chosen to guarantee white noise residuals and  $\Delta$  is the first differenced lag operator; subscripts  $tc$ ,  $c$  and  $nc$  indicate if trend and intercept, intercept or none is included in test equation (iii), (ii) and (i).  $\Phi_3$ ,  $\tau_{\beta\delta}$ ,  $\Phi_1$ ,  $\tau_{\alpha\mu}$  denote statistics for individual or joint significance of trend and intercept assuming unit root. \* and \*\* show 5% and 1% significance level in accordance to MacKinnon critical values; n.a is non available. Results implemented using Eviews 4.1.

**Table 2. VAR. Lags structure and residuals**

Period	Lag structure		Residuals-Diagnostic Views					
	Lag order	Stability	Ho: non autocorrelation			Ho: normality		Ho: homocedasticity
			Q	LM	JB <sub>Chol</sub>	JB <sub>Urz</sub>	White	
1962-2005	1	yes	215.25	13.51	9.07	62.78	89.95	
1962-2000	1	yes	185.77	11.82	7.91	61.14	88.13	

1978-2005	2	yes	102.12	11.59	12.34	33.51	164.36
1962-1990	2	yes	93.76	9.16	10.62	41.66	170.83

Notes:

Lags for autocorrelation tests are taken as the third part of the observations . Results carried out by Eviews 4.1

**Table 3. Johansen and Juselius Cointegration Test**

Period	Lags	Johansen Test					
		Number of cointegration relations under Ho	$\lambda_{trace}$	CV(5%)	$\lambda_{max}$	CV(5%)	
1962-2005	1	r=0	49.38*	47.21	32.04*	27.07	
		r=1	17.34	29.68	10.38	20.97	
		r=2	6.95	15.41	6.84	14.07	
		r=3	0.12	3.76	0.12	3.76	
1962-2000	1	r=0	55.12*	47.21	32.23*	27.07	
		r=1	22.88	29.68	14.89	20.97	
		r=2	7.98	15.41	7.89	14.07	
		r=3	0.09	3.76	0.09	3.76	
1978-2005	2	r=0	63.22**	47.21	33.32**	27.07	
		r=1	29.91*	29.68	16.43	20.97	
		r=2	13.47	15.41	12.81	14.07	
		r=3	0.66	3.76	0.66	3.76	
1962-1990	2	r=0	85.71**	47.21	56.52**	27.07	
		r=1	29.19	29.68	16.26	20.97	
		r=2	12.92	15.41	12.89	14.07	
		r=3	0.03	3.76	0.03	3.76	

Notes: Lag structure is drawn in each period from Table 3 results. (\*\*) denotes rejection of the hypothesis at the 5%(1%) level taking into account Osterwald-Lenum critical values. Trace and Max-eigenvalue test indicates 1 cointegrating equation(s) both 5% level levels. Results computed with Eviews 4.1

**Table 4 . Johansen. Estimated cointegrating equation**

Period	Cointegrating coefficients				ECM
	$b_0$	$b_1$	$b_2$	$b_3$	$\lambda$
1962-2005	0.1591	-0.3395	0.3339	0.6095	- 0.8837
		[0.8281]	[-1.362]	[-5.51]	[-4.483]
1962-2000	1.423	- 0.6121	0.3295	0.3887	-0.692
		[1.541]	[-1.323]	[-3.336]	[-3.98]
1978-2005	0.0128	-0.115	0.124	0.8231	-1.943
		[ 0.323]	[-0.769]	[-10.887]	[-3.683]
1962-1990	-0.512	- 0.8296	1.1224	- 0.0283	-3.022

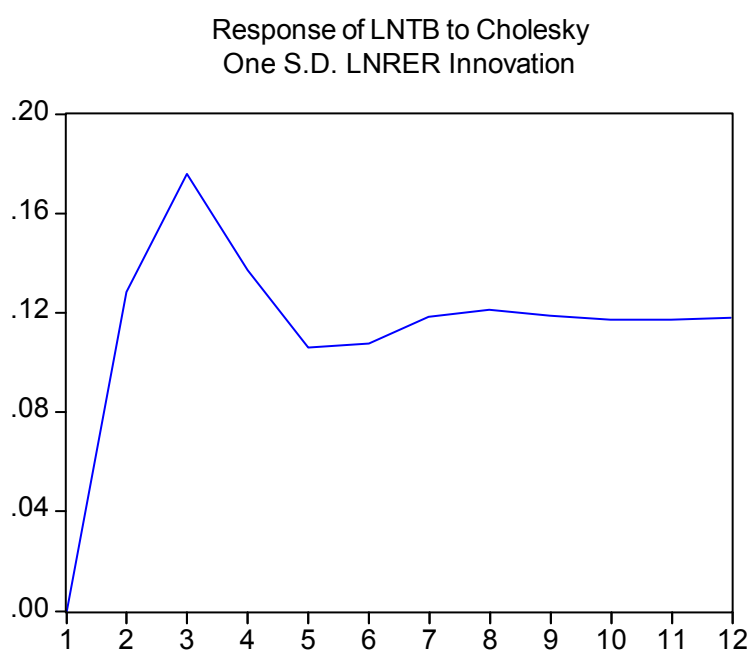
[9.454] [-15.149] [0.863] [-7.956]

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*Notes:* The vectors are normalized for TB;  $b_1$ ,  $b_2$  and  $b_3$  denote the Argentine GDP, USA GDP and TCR elasticities of trade balance, respectively. Figures in parentheses represent asymptotic  $p$ -values associated with the tests. Results carried out by Eviews 4.1.

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**Figure 1.**



**Figure 2.**

Response of LNTB to Cholesky  
One S.D. LNRER Innovation

