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Abstract

This study gives a non-traditional framework for the evaluation of the convenience of an asymmetric monetary association (such as dollarization), from the point of view of the country that gives up its monetary sovereignty. In the analytical part it is discussed the relationship between dollarization and real volatility in a new model where traditional OCA criterium supporting a positive GDP correlation between partners is neither a necessary nor sufficient condition to reduce output fluctuations (even when prices are sticky and factor mobility is weak). Finally, we show that empirical evidence is very weak in order to support the case for "official dollarization" in Argentina

DOLLARISATION ET VOLATILITE REELLE

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Résumé

Cette étude présente un cadre d'analyse non-traditionnel pour l'évaluation des unions monétaires asymétriques (telle que la dollarisation), du point de vue du pays qui abandonne sa souveraineté monétaire. Dans la partie théorique on examine la relation entre dollarisation et volatilité réelle à partir d'un modèle particulier où le critère traditionnel des zones monétaires optimales (appuyant une corrélation positive du PIB parmi les pays associés) n'est plus une condition nécessaire ni suffisante pour réduire la taille des fluctuations macro-économiques (même si les prix sont rigides et la mobilité de capitaux est-elle faible). Finalement, on montre que l'évidence empirique est très fragile afin de soutenir la dollarisation " de droit " en Argentine.

Keywords: Monetary union, dollarization, VECM, volatility, transmission channels.

Mots clés: Union monétaire, dollarisation, VECM, volatilité, moyens de transmission

J.E.L. Clasification: C5, F3

Contents

1 Introduction

Dollarization is a very important issue in the economic policy agenda of several emerging countries. After the crisis of the nineties, the discussion as regards the virtues of the different exchange rate regimes has reappeared. Nowadays, the alternative of dollarizing an economy has become highly relevant, in academic as well as in political spheres. While some aspects of the discussion on the costs and benefits of dollarization relate to the contrast between flexible and fixed exchange rate regimes, a deeper analysis requires advancing in other aspects of a process of dollarization[1].

Most of the recent studies on monetary unions have focused on the transmission of shocks through trade flows, Rose (2000), Rose and Van Wincoop (2001), Melitz (2001). However, the main objective of this paper is to concentrate on both the trade flows and the financial aspects of a monetary association given the fact that, contrary to the experience of the 60s (when the optimal currency area theory was born), currently the high capital mobility has increased the importance of financial flows in the determination of the optimal monetary policy .

In the analytical part of the paper it is discussed the concept of real volatility and nominal volatility, the behavior of the channels of transmission of external shocks and its relations with real volatility. In the empirical section the analytical framework is applied to the case of Argentina. To estimate the association of the business cycles coefficients of cyclical correlation are used. The effect and relative magnitude of the financial and trade channels are extracted from the impulse-response functions and variance decompositions of a Vector Error Correction Model (VECM). It is analyzed the stability of the results re-estimating the model with rolling sub-samples. Finally, in the conclusions the analytical framework deductions and the results of the empirical part are combined to determine if a higher level of dollarization could reduce the real volatility of Argentina's economy.

2 Asymmetric monetary union and volatility

The dollarization of an economy can be understood as the conformation of a monetary union between a country that substitutes the its domestic currency

[1]The analytical part of this paper is also useful for the discussion of the case of "euroization" that is of interest in several European countries. On this issue, see Posen (2000).

for the US dollar. The important characteristic of this type of union is that it is asymmetric[2], in the sense that there is a big country which acts as leader (the United States) while the rest of the countries (those opting for dollarization) act as followers[3].

To analyze the effects of a process of dollarization it is useful to review the recommendations of the theory of optimum currency areas (OCA). If the countries fulfil the conditions for an OCA then they are able to optimally coordinate their monetary policies. This theory was initiated in the sixties with the works of Mundel (1961), McKinnon (1963) and Kenen (1969)[4]. The common argument in the traditional framework[5] is that if shocks are similar (that is, if we find that the correlation of business cycles is positive, with similar intensity and duration) then, using exchange rate policy (between partners) is not effective to compensate for shocks.

In order to implement a monetary union, an important issue is to evaluate how the real volatility of the economy changes before and after the unification. When the case is an asymmetric monetary union with a leader-follower relationship the issue is centered on how a greater monetary inte-

[2]The level of asymmetry is a characteristic that differentiates dollarization from the European Monetary Union experience (see Cohen and Wyploz, 1990, or De Grawe, 1992). While in Europe the asymmetry refers to the degree of marginal influence of each country in the decisions of a supra-national institution, in the case of dollarization it seems difficult to think about the incorporation of the countries which abandon their domestic currencies, into the Board of the Federal Reserve Bank of the United States.

[3]The are several papers that study the problem of monetary unions in the framework of game theory under a symmetric set up. However, only few do so in an asymmetrical context. Amongst these we find the work of Canzoneri, Henderson and Sweeney (1987) for a game between Europe and the United States, Cooper (1991) for an application of a Stackelberg solution and Carrera (1995) for the specific case of an asymmetric monetary union within a leader-follower framework.

[4]In the nineties there has been a revalorization of this theory. In the theoretical aspects of the discussion Cassella (1993) gives microfundations to the OCA. Ghosh and Wolf (1994) have established a genetic approach to define its optimality and Mélitz (1991) has suggested an important theoretical reformulation. As regards the empirical aspects of the discussion Bini Smaghi and Vori (1993) study the European case and Chamie, DeSerres and Lalonde (1994), Bayoumi and Einchengreen (1992) and Rogoff (1991) study the case of NAFTA.

[5]Among them we found: 1) The degree of similarity in their economic structures (Kenen criterion). 2) The level of integration of the economies as measured by the volume of total trade between the countries (McKinnon criterion). 3) The existence of trade not based on comparative advantages. 4) Price and wage flexibility. 5) Mobility of factors of production across countries (Mundel criterion). 6) The existence of inter-jurisdictional fiscal transfers.

gration affects real volatility in the associated country. Behind this idea it is the problem highlighted by Poole (1970) in his pioneering paper on how the most convenient regime to reduce real volatility depends on the source of the economic shocks.

There exists an intense debate on the relationship between exchange rate regime and real volatility. Devereux (1999) has stated that there is no a trade-off between exchange rate flexibility and output volatility. On the contrary, Ghosh, Gulde, Ostry and Wolf (1997) have shown that pegged regimens are characterized by lower inflation and more intense real fluctuations. Additionally, Levy-Yeyati and Sturzenegger (2001) in analyzing developing countries have found that less flexible exchange rate regimes are strongly associated with slower growth, as well as with a greater amplitude in the magnitude of cyclical fluctuations.

One of the most obvious costs of adopting a monetary union is that the associated country (AC) loses control over its monetary policy. Then, the AC cannot use this instrument to stabilize its business cycle. Alesina, Barro and Tenreyro (2002) have argued that countries exhibiting large co-movements of outputs and prices have lowest costs from abandoning monetary independence vis-à-vis their partners.

As it has been pointed out by Helpman and Razin (1982), changing from a monetary regime with a central bank to a monetary union implies a trade-off between the benefits of reducing excessive exchange rate volatility[6] and the cost of reducing the number of financial assets available in the economy. With imperfect financial markets a flexible exchange rate regime is superior to a fixed exchange rate because it increases the efficiency with which economic agents diversify risk (Helpman and Razin, *op.cit.*)[7]. A typical example of how an instrument of hedging is lost with a monetary union is the possibility of devaluating to adjust relative prices in response to shocks.

When policymakers have a propensity to generate policy shocks which are expected by the population there will exists an inflationary bias whose

[6]From the financial point of view we can make a distinction between "good" or "bad" nominal volatility of the exchange rate whether its origin is a "political" shock or a real shock (in preferences, in resources or in productivity). This last type of volatility is functional to the reallocation of factors and resources in an efficient way (Neumeyer, 1998).

[7]An important assumption in this case is that there are adequate instruments for risk diversification within the countries but not amongst them. This is consistent with a context where there is a preference for domestic assets, or where there are no enforcement authorities at a supra-national level.

volatility could be influenced by short run electoral objectives; in such a case a fix regime or a monetary rule could be optimal. Neumeyer (1998) has stated that a monetary union is desirable when the gains from the elimination of excess volatility generated by policy shocks ("bad" nominal volatility) exceed the costs of reducing the number of instruments available to hedge against risk. In this sense, Calvo and Reinhart (2000) have argued that in cases in which the monetary policy is not properly used as a stabilization instrument, the loss of monetary independence is not a substantial cost.

This paper moves a step forward in respect of the works already discussed by taking into account the problem of how an exchange rate regime (dollarization) affects the real volatility of the economy.

3 Dollarization as an asymmetric monetary union: channels of business cycle transmission

3.1 Theoretical framework

The business cycles of the different countries, understood as the variations of output around its trend, do not relate directly but through channels that transmit shocks from one economy to the other.

In the case of an asymmetric relationship big country-small country the transmission of the effects of the business cycle originated in the main economy to the different small countries occurs mainly through the transactions of goods (and services) and financial assets (Canova and Ubide 1997; Schmitt-Grohé, 1998).

With the aim of simplifying the theoretical and empirical analysis, the channels of transmission are decomposed into two great groups: the financial channel and the trade channel.

Figure 1 presents a simplified representation of the channels of transmission of cyclical fluctuations from USA to the AC.

In this simplified world, each country suffers from domestic shocks but the small associated country also receives the influence of external shocks that are transmitted from the main center (the United States). The two channels of transmission are the financial channel (represented by the level of the United States interest rate) and the trade channel (represented by the

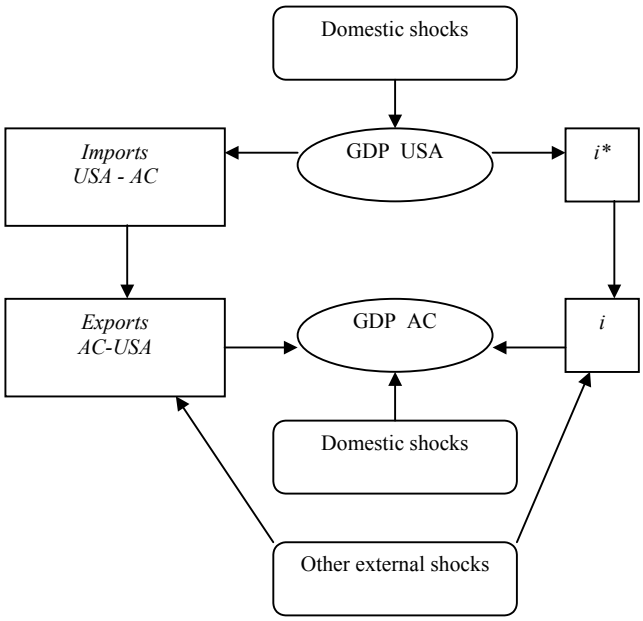

Figure 1: An asymmetric monetary union: A stylized model of shock transmission

trade between the two countries). Prior to any connection there is some level of GDP correlation (between USA and the AC, defined as ρ_{GDP}), which could be positive, negative or zero.

From the perspective of the AC, the economic intuition behind this simplified representation for the transmission of economic shocks is as follows: when the USA's GDP is hit by a positive shock, two simultaneous processes begin: a) United States imports increase (affecting positively the GDP of AC through the trade channel), and b) the Federal Reserve increases the interest rate to slow down the economy to avoid an over-heating (transmitting a shock through the financial channel that will affect negatively AC).

The financial channel is related to the effects of the international interest rate on the level of capital flows to the developing economies. This effect could be very significant as regards the size of fluctuations in the periphery for two reasons: 1) its determination is dominated by the economic conditions of the main center and thus they do not necessarily respond to the countercyclical needs of the emerging countries; 2) the high level of dependence on external savings by the emerging economies makes them very vulnerable to

the perturbations in the international interest rate and capital flows.(Calvo, Leiderman and Reinhart, 1993).On the other hand, in the trade channel, the effect of fluctuations in the business cycle of the leading economy (the United States) is transmitted through the movements in the trade flows (due to changes in quantities as well as in the terms of trade).

The size of each channel will indicate the magnitude of the effect on the economy hit by shocks. If the channel has a very small magnitude in relationship to the economy under study, shocks coming through it will have only moderate effects on the cycle.

3.2 The model

The hypothesis which refers to the mechanism of transmission of the business cycle through the trade channel may be formalized in the following expressions:

$$\frac{\partial M_{USA-AC}}{\partial GDP_{USA}} > 0 \tag{1}$$

$$\frac{\partial X_{AC-USA}}{\partial M_{USA-AC}} = 1 \tag{2}$$

$$\frac{\partial GDP_{AC}}{\partial X_{AC-USA}} > 0 \tag{3}$$

Where X_{AC-USA} represents exports from AC to the United States (symmetrically, M_{USA-AC} represents United States' imports coming from the country dollarizing its monetary system). Combining these equations an expression that summarizes the multiplier effect of the trade channel on AC's GDP is obtained:

$$TC = \frac{\partial GDP_{AC}}{\partial M_{USA-AC}} > 0 \tag{4}$$

As regards the transmission through the financial channel the following expressions are implied:

$$\frac{\partial i*}{\partial GDP_{USA}} > 0 \tag{5}$$

$$\frac{\partial i}{\partial i*} > 0 \tag{6}$$

$$\frac{\partial GDP_{AC}}{\partial i} < 0 \tag{7}$$

These equations together result in an expression for the multiplier effect of the financial channel on the output of the associated country:

$$FC = \frac{\partial GDP_{AC}}{\partial i*} < 0 \tag{8}$$

From the previous ideas, it has been determined how the different channels of transmission affect the output of AC. However, it is necessary to specify the way in which the real volatility of the AC depends on the channels of transmission as well as on the degree of cyclical correlation of both economies.

Let us begin whit a general expression for the real volatility of AC output:

$$\sigma_{_{AC}} = f[TC(d, \rho_{_{GDP}}), FC(d, \rho_{_{GDP}}), V(d, \rho_{_{GDP}})] \tag{9}$$

Where $\sigma_{_{AC}}$ is the real volatility of the associated country, TC and FC are the trade and financial channels, V is a vector of variables which include the domestic shocks, the extra union shocks and all relevant variables which affect the volatility of AC, and d is a continue variable, bounded between zero and one, which measures the degree of flexibility of the exchange rate regime. In this way, full dollarization could be interpreted as a value of d very close to one[8].

From this simplified model we may establish the following sentences:

Proposition 1 *Assuming the usual mechanisms for the transmission of the business cycle in a leader-follower framework, an asymmetric monetary union will reduce real volatility of AC if and only if the following conditions are fulfilled: a) if correlation between business cycles is positive, the financial channel should dominate the trade channel. b) if the correlation between the cycles is negative, the trade channel should dominate the financial one.*

[8] d is a variable which is determined by both the degree of declared flexibility of the exchange rate system and the level of currency substitution in transactions and deposits (i.e. *de facto* dollarization that characterizes several emerging economies). The higher the currency substitution is, the lesser the degree of freedom available for exchange rate policy.

Proposition 2 *Traditional OCA criterium for a positive GDP correlation between partners is neither a necessary nor sufficient condition to reduce real volatility with an asymmetric monetary union (even when prices are sticky and factor mobility is weak).*

Proposition 3 *Moreover, a rather negative GDP correlation could be optimal to undertake an asymmetric monetary union if regional trade flows are more important than financial links.*

Proof. See appendix. ■

4 Methodology

The empirical analysis for our main propositions tries to determine the final sign and stability of expression (13, the key for the proof of these propositions. See appendix first section). The methodology consist in a two-stage process. In the first one it is examined the effect and relative importance of the trade and financial channels through a vector autoregressive model (VAR) on the one hand, and the correlation between the business cycle of the AC and the cycle of the United States, on the other. In the second stage, the stability of the result found for (13) is cheeked. The reason to do that is that a drastic decision as increasing the degree of dollarization requires that all the parameters involved in (13) remain constant through time.

4.1 Effect and relative importance of the different channels of transmission of the business cycle: a VEC model approach

Using a consolidated methodology to analyze the structure of the different shocks that hit the economy[9], it is built a vector autoregressive model (VAR) to describe the way in which shocks are transmitted from the main center to the associated country.

VAR models are used in the identification of the different kinds of shocks, affecting the economies. Our application makes use of two tools derived

[9]See Sims (1980), Blanchard and Quah (1989), Johansen and Juselius (1992), and Amisano and Giannini (1997) for theoretical and empirical applications in which VAR or VEC models are used to identify the different shocks hitting an economy.

from VAR models: impulse-response functions and variance decomposition procedure.

To use the impulse-response functions, in order to obtain $sign(TC)$ and $sign(FC)$ and the variance decomposition procedure, in order to determine θ_{TC} and θ_{FC}, it is necessary to identify the shocks for each and every variable in the system. In more general terms, n(n-1)/2 restrictions are needed to exactly identify the model (where n is the number of variables in the model).

For that purpose, one methodology that provides these restrictions is the Cholesky decomposition which imposes that the matrix A (0) (which incorporates the contemporaneous effects of the variables) be triangular inferior[10].

Different authors have criticized the arbitrary methodology of imposing restrictions of identification on the Cholesky decomposition, indicating, for example, that the results in most cases (when there is correlation amongst the residuals of the equations) are very sensitive to the order in which the variables are included[11].

Alternative solutions have appeared. Among them, the developments of Blanchard and Quah (1989) and Johansen (1991, 1995) which stand out using long run restrictions to identify the different models.

However, there are noticeable differences as regards the reasons why restrictions are introduced in each methodology. While Blanchard and Quah (based on the supposition of a vertical aggregate supply curve in the long run) determine that demand shocks will not last, Johansen's methodology takes the long run restrictions from the data generating process without imposing ad-hoc behavioral restrictions . Because of that, in this paper Cholesky decomposition to find short run identification restrictions and Johansen's methodology[12] to estimate long run relationships without having to impose a priori restrictions are used.

4.2 Correlation between cycles

The second element to be taken into account to determine why it is convenient for a potential Associated Country to undertake a process of dollarization is, according to the analytical framework which has been presented in the

[10] For further detail see Hamilton (1994).

[11] See Enders (1995).

[12] In section 2 of the appendix it is presented an example of a VEC model whit n variables and one lag for each variable, following the description presented by Enders (1995).

previous sections, the correlation between the business cycle of the AC and the cycle of the United States.

There are several ways of empirically calculating the cyclical component of a series but the literature has not found a definition that is stated as the most adequate (Canova, 1995; Crivari-Neto, 1993). Two widely used ways of separating trend and cycle are:

a) The cycle from the first difference of the series, this assumes that the best specification for the behavior of the series is a random walk. This alternative meaning that differentiation eliminates completely the trend component of the series.

b) The cycle from the de-trending through the H-P filter (Hodrick and Prescott, 1980), which implies a stochastic trend, independent of the behavior of the cyclical component. This mechanism of de-trending is widely used in the contemporaneous business cycle literature.

4.3 Stability analysis

To evaluate the temporal robustness of the final sign of (13) it is implemented a stability analysis using a rolling procedure similar to the one developed by Banerjee, Lumsdaine and Stock (1992) to analyze the shifting root hypothesis. Unlike recursive estimation (developed by Brown, Durbin and Evans, 1975), the rolling estimations are computed using sub-samples that are a constant fraction of the full sample. In this way it can be kept constant the marginal weight of each observation. The rolling stability analysis is made for the VECM and the correlation analysis.

5 An application to the case of Argentina

In this section it is developed an empirical application of the analytical framework presented in the previous sections to assess the potential impact of dollarization on the real volatility of Argentina's economy.

The selection of Argentina as a case of study relates to the fact that in this country dollarization debate has reached a higher level of intensity in relation to other Latin American countries.

After a number of stabilization plans failed in the early nineties, the government relied on a radical solution to nominal instability and fixed the

exchange rate with a compromise to not devaluate the currency and to fully back the monetary base with its international reserves.

In 2001-2002 after a deep recession, take place a period whit high capital outflows that preceded the passage to a flexible exchange rate regime and capital controls. However exist in Argentina as in several emerging markets a huge debate regarding the convenience of increase the dollarization of the economy (increasing d) or to go to a more independent flotation (decreasing d). This last option includes the *de-dollarization* or *pesification* of the economy that means to eliminate the incentives given in the nineties to bimonetarism. So, as it is possible to see, the degree of dollarization is a more complex question that the simple binary decision of adopting the US dollar as legal tender.

5.1 The vector Error correction model

In this section it is developed a vector error correction model with three endogenous variables:[13] Federal Reserve Interest Rate ($FEDRATE$), imports of the United States from Argentina ($IMPOUA$)[14] and the Industrial Production Index of Argentina ($IPIARG$), and an intercept in each equation. It has been included an exogenous dummy variable: BRASIL. This variable takes into account the abrupt Brazilian devaluation which produced a sudden variation in the regime and both in the level and in the tendency of the real and nominal exchange rate of the major commercial partner of Argentina[15].

The variables are in logs, seasonally adjusted[16] and in first differences[17]. $FEDRATE$ and $IMPOUA$ represent the financial and trade channels respectively[18]. The $IPIARG$ is taken as an approximation of Argentine GDP. As it can be seen in the section 3 of the appendix, it is used the Industrial Production Index instead of the actual GDP because there are no reliable estimations for Argentina's GDP on a monthly basis and because the correlation coefficient between these variables is extremely high.

[13] The sample period for the model is 1991:4 to 2000:12, with monthly data.

[14] Equivalently, exports of Argentina to the United States.

[15] This variable takes value 1 from 1/1/1999 to the end of the sample.

[16] Through X-11 ARIMA methods.

[17] It is convenient to remember that in the error correction mechanism(s) the variables appear in levels and lagged one period.

[18] In section 3 of the appendix we present the characteristics of the series (periodicity, transformations, etc.) and the source of the information for each variable.

The model is thus defined as follows:

$$\Delta z_t = \sum_{i=1}^{k-1} \Psi_i \Delta z_{t-i} + \Pi z_{t-1} + \mu_t + \Lambda D_t + \varepsilon_t \tag{10}$$

Where:
z_{t-1} is the (3x1) vector $[FEDRATE_{t-1}, IMPOUA_{t-1}, IPIARG_{t-1}]$,
Δz_t is the (3x1) vector $[\Delta FEDRATE_t, \Delta IMPOUA_t, \Delta IPIARG_t]$,
ε_t is the (3x1) vector $[\varepsilon_{1t}, \varepsilon_{2t}, \varepsilon_{3t}]$,
μ_t is the (3x1) vector of deterministic components,
D_t is the dummy variable,
Ψ_i is the (3x3) matrix of parameters,
Λ is the (3x1) vector of responses to the dummy variable and
Π is the (3x3) matrix of rank r (to be tested) which contains the parameters of the cointegrating vectors.

The next step consists in verifying the conformity of the model with the data generating process evaluating the order of integration of each variable, the rank of Π and the optimal lag length.

5.1.1 Unit root test

For each variable (in levels and in first differences) in the model we perform the ADF (Dickey and Fuller, 1979)[19] tests to detect the presence of unit roots in the series[20].

In table A.1 in section 4 of the appendix we present the results of the different tests for a confidence level of 95%. We verify that all variables are I (1) (integrated of first order). Since every variable can be considered I (1) we fulfill the first necessary condition for the construction of a VECM[21]. The second necessary requisite to build the model is that the rank of the matrix of the cointegrating vectors should be greater that 0 (zero) and less than n. For our model the rank of the matrix should be equal to one or two.

[19] The number of optimal lags for each specification was obtained following Akaike criterion (Akaike,1973).

[20] We checked the following three specification for the deterministic component : 1) unrestricted, which includes time trend and intercept, 2) idem 1, but without the time trend, and 3) restricted, without any deterministic component.

[21] Pessaran et al. (1999) have proposed a new approximation to test the existence of long run relationships that is independent of the order of integration of the regressors.

5.1.2 Tests for the optimal lag length

According to Canova (1995a) "the trade-off between over-parametrization and oversimplification is at the heart of the selection criteria designed to choose the lag length ".

There are different selection criteria to determine the optimal number of lags in VEC models. In this paper we use some of the more traditional such Akaike criterion (Akaike, 1973) and Schwarz criterion (Schwarz, 1978). In both cases, the criteria select the number of lags that minimize a loss function that has implicit the trade-off described by Canova (1995a) in the previous reference. The main distinction between the different criteria is the relative weight given to the explicative power in relation to the degrees of freedom.

The results of these tests are presented in table A.2 (included in section 5 of the appendix).[22]. The optimal number of lags for our model is 3 for the Akaike criterion and 2 for Schwarz criterion. To overcome this contradiction a likelihood ratio test, as it is recommended by Sims (1980), is performed:

$$(T - c)\left(\log|\Sigma_r| - \log|\Sigma_u|\right) \tag{11}$$

Where T is the number of usable observations, c is the number of parameters estimated in each equation of the restricted system and $\log|\Sigma_r|$ and $\log|\Sigma_u|$ are the natural logarithms of the determinants of the variance / covariance matrix of the residuals in the restricted and unrestricted system respectively.

The likelihood ratio statistic has the asymptotic χ^2 distribution whit degrees of freedom equal to the number of restrictions in the system. Its value is 35.14 and the critical χ^2 for a significance level of 5% and nine degrees of freedom is 16.9. Then, the null hypothesis of two lags is rejected.

5.1.3 Establishing the number of cointegrating vectors

The third step in the construction of the VECM is to identify the number of cointegrating vectors (the rank Π of the matrix) to establish the long run relationships between the variables.

Postulating linear trends for the series, the results of the Johansen trace test (1988) (when it is assumed the existence of an intercept in the error correction mechanism) show the existence of 1 (one) cointegrating vector.

[22] Obtained, as usual, from an unrestricted VAR which includes the variables of the model expressed in levels.

	Trace Test for cointegrating vectors			
H0 (number of cointegrating vectors):	Eigenvalue	Lik.R.Test	5% C.V.	1% C.V.
None *	0.16	31.83	29.68	35.65
At most 1	0.10	12.74	15.41	20.04
At most 2	0.01	1.11	3.76	6.65

* denotes rejection of the hypothesis at 5% significance level.

Table 1. Cointegration Analysis

Having determined the specification for the model that best adapts to the joint data generation process, it is proceeded to obtain the impulse-response functions and the variance decomposition.

5.1.4 The signs of the channels trough impulse-response functions

Examining the response of IPIARG to a shock of one standard deviation on FEDRATE and on IMPOUA the signs needed in equation (13) to determine the impact of the financial channel and the trade channel on Argentina's economy are found. As it can be seen in figure 2 the different channels affect IPIARG according to the hypothesis established in equations (4) and (8). The financial channel has a negative effect on IPIARG, while the trade channel has a positive effect on it.

5.1.5 Relative size of the channels. A variance decomposition approach

The variance decomposition will allow us to estimate the relative importance of the trade and financial channels of transmission of the business cycle from the United States to Argentina.. Figure 3 shows the results of the variance decomposition.

As it can be observed there are no great differences in the percentage of IPIARG variance due to each channel. In the very short run (the first year after the shocks have been produced), the commercial channel explains a higher percentage in the variance of the Argentinean industrial production index. However, from the second year on, the financial channel dominates the trade one and the differences between them increase through time. As a criterion to establish which channel dominates the other it has been selected that

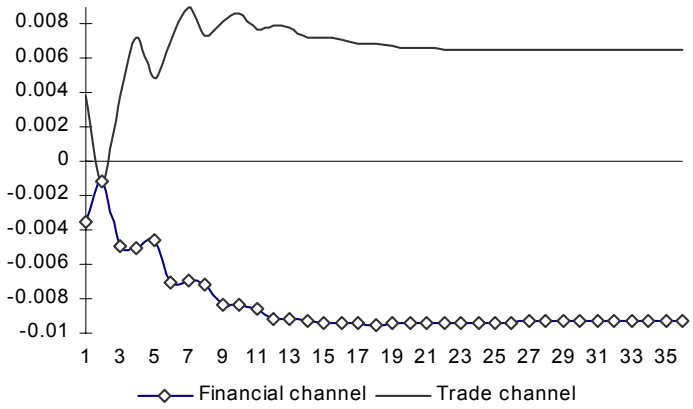

Figure 2: IPIARG response to one standard innovation in:

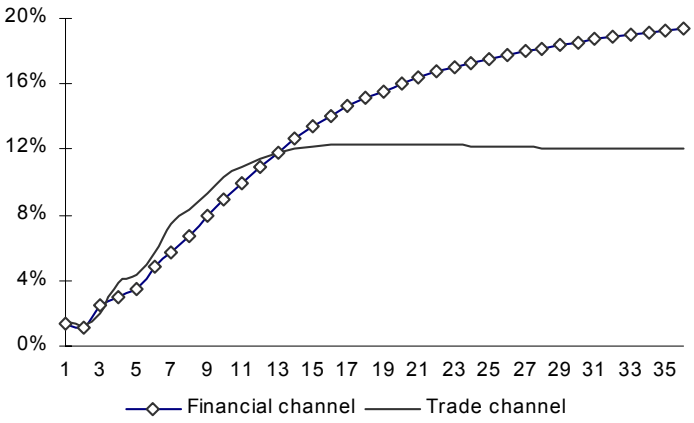

Figure 3: Percent IPIARG variance due to:

channel which has the major average variance for the first 36 periods. This measure takes value 13.04% in the case of the financial channel and 10.21% in the case of the trade channel. Then, the financial channel dominates the trade channel. The joint analysis of the impulse-response and the variance decomposition indicate that in the event of a positive shock to the economy of the United States, the negative impact of the increase in FEDRATE on IPIARG dominates the positive effect of the increase in IMPOUA.

In terms of equation (13) the final result of dollarization on real volatility will now depend on the sign of the coefficient of correlation between the cycles of Argentina and the United States.

5.2 Correlation analysis

The contemporaneous coefficients of correlation of the cycles of IPIARG and IPIUSA according to the two different specifications before mentioned are presented in table 2.

	Industrial production index (ARGENTINA)	
Industrial production index (USA)	First diff.	H-P filter
First difference	0.10	0.18
	(1.10)	(1.91)
Hodrick-Prescott filter	-0.14	0.21
	(-1.52)	(2.20)

Table 2: Correlation between Argentina's cycle and USA's cycle.(t statistic in parenthesis).

In general, it is found that, for the period under analysis (1991:4 2000:12), the contemporaneous average correlation between the business cycles of these countries is positive but not very high.

Given those results (the coefficient of cyclical correlation is positive and the negative effect of the financial channel on Argentinean IPI dominates the positive effect of the trade channel), it can be established the preliminary conclusion that dollarization could reduce the magnitude of Argentina cyclical fluctuations. To confirm this preliminary conclusion it is necessary to ensure that all the results found (the impulse responses, the variance decomposition and the business cycle correlation) are stable over time.

5.3 Stability in the VECM

The VECM model is re-estimated to evaluate the variability of the results of the impulse-response and variance decomposition of IPIARG. For this analysis we take 57 "rolling" sub-samples with 60 observations each (five years), beginning the estimation with the sub-sample that starts in 91:4 and ends in 96:3.

As a whole, the stability analysis (figures presented in section 6 of the appendix) indicates that there exists variability in the results. Until approximately the middle of 1999 the financial and trade channels present the correct signs, from that moment on the results are not clear enough and usually contrary to our theoretical expectations. Similarly, for the variance decomposition it is found that, with a few exceptions, until the date mentioned before the financial channel dominates the trade channel while from the middle of 1999 on, it is found just the opposite.

The main conclusion which it can be established here is that it is not possible to guarantee that the effect of the financial channel dominates the effect of the trade one and also the fact that those effects remain constant over time. Summing up, it is not possible to define a unique and stable sign for (13).

5.4 Stability in the correlation between the business cycle

It is possible that the correlation between the cycles is not constant in time. If the correlation were unstable the results, as in the previous case, should be taken with care.

To evaluate the temporal evolution of the correlation between the business cycles it is calculated the rolling coefficients of correlation keeping the sample size fixed in 36 months (3 years)[23]. The two specifications are presented in Figure 4.

Both, the first difference and the H-P rolling correlation coefficients show a highly variable behavior through time. There are two periods. In the first the correlations goes from negative to positive. After the Asian and Russian

[23] Thus, the "rolling" coefficient of correlation associated with 94:3 includes data from the period 91:4-94:3, that associated with 94:4 includesdata from 91:5-94:4, and so on.

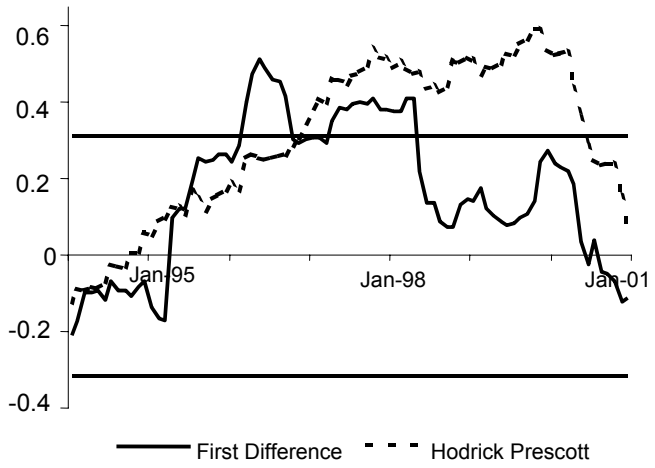

Figure 4: Rolling crossed correlation coefficients: IPIARG - IPIUSA. Note: the horizontal solid lines denotes those values for the coefficient of correlation which makes them statistically significant (t=1.96).

crisis correlation goes down and it is not statistically different from zero. This reversion is more evident in first difference.

The extreme volatility showed by the " rolling" coefficients in the period under analysis means that is not possible to consider a positive correlation between United States and Argentina as a " stylized fact" . This raises serious doubts with respect to the question relating to Argentina's convenience to leave its domestic currency instead of the dollar.

6 Conclusions

This study provides a non-traditional analytical framework for the evaluation of the convenience of an asymmetric monetary union (such as the dollarization) between a leading country and another that imports its monetary policy from it, from the point of view of the country that resigns its monetary sovereignty.

The main objective of this paper is to evaluate how dollarization affects the real volatility of the country associating with the United States. To this end, the characteristics of the business cycles in both countries (the leader and the associated country) and the behavior of the trade and financial

channels of shocks transmission from the United States are analyzed.

The main contribution of this paper is to include in the analysis the effect of dollarization, through the impact of this asymmetric monetary union on the real volatility of the economy. This relationship will depend on two central aspects: 1) the degree of synchronization between the cycles of the leader country and the associated country (AC), and 2) the effect and relative importance of the different channels of transmission of shocks from the leader to AC.

Under usual assumptions regarding the way of transmission of the business cycle[24], the loss of monetary sovereignty of a country associating to the dollar will reduce real volatility if one of the following conditions is fulfilled:

- That the business cycles of the United States and of the associated country are positively correlated and that the financial channel is the main channel of transmission of the shocks that have origin in the United States, or

- That the business cycles are negatively correlated and that the trade channel dominates the financial channel.

In both cases the clue relies on that dollarization of the economy implies importing from the United States a counter-cyclical policy that is adequate to reduce real volatility.

If, on the contrary, the cycles are negatively correlated and the financial channel dominates the trade channel, dollarization implies adopting a monetary policy that increases real volatility. In such circumstances, it is advisable to keep a national currency that allows us to use (albeit partially) a policy of stabilization of the business cycle. The same recommendation applies to the case where the correlation between the cycles is positive but the trade channel dominates the financial one.

In the empirical section of the paper it is applied the model to evaluate the case of Argentina in the 1990s. The signs and magnitudes necessary were estimated using a number of econometric tools that included two cyclical correlation coefficients and the development of a vector error correction model (VECM).

[24] That is, a positive shock in the economy of the United States affects positively AC's GDP through the trade channel (through bigger imports for the United States) and negatively through the financial channel (due to the Federal Reserve's counter-cyclical policy). These hypotheses are analyzed and corroborated empirically in the paper.

The main results are:

1. The financial channel has a negative impact on Argentina's output.

2. The trade channel impacts positively on Argentina's output.

3. The financial channel dominates the trade channel (the financial channel is the main means of transmission of shocks from the United States). But, the difference in the percentage of variance due to each channel is not extremely high.

4. The cycles of Argentina and the United States are on average positively correlated.

5. The results of rolling VECM are highly unstable from the middle of 1999 on. This affects both the variance decomposition and the impulse response functions.

6. The correlation between the cycles is unstable through time and changes, from positive to zero, after the Asian and Russian crisis.

Intertemporal instability is the key of these results and raises serious doubts about the stabilization properties of an official dollarization. Indeed, empirical evidence is very weak to support the case for a "quasi-irreversible" asymmetric monetary union.

Finally, some author postulate a sort of endogeneity theory according which there exists a positive link between output correlation and trade integration (Frenkel and Rose, 1997) and so higher correlation between GDPs a posteriori of monetary union. The general instability that the results show has taken place in a country which had a credible hard peg during ten years. This means that even a so long period does not endogenize the co-movements of output between Argentina and US. The main reason was the important role played by the extra-union shocks that have affected Argentina. A big proportion of shocks coming from outside the center country continued to be a key reason for avoiding a further increase in the hard peg in the form of full dollarization.

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7 Appendix

7.1 Proof for propositions 1 to 3

Proof. Differentiating (9) whit respect to d an expression which relates the volatility of AC to the dollarization is found:

$$\frac{\partial \sigma_{_{AC}}}{\partial d} = \left[\left(\frac{\partial \sigma_{_{AC}}}{\partial TC} \frac{\partial TC}{\partial d} \right) + \left(\frac{\partial \sigma_{_{AC}}}{\partial FC} \frac{\partial FC}{\partial d} \right) + \left(\frac{\partial \sigma_{_{AC}}}{\partial V} \frac{\partial V}{\partial d} \right) \right] \tag{12}$$

Assuming that d does not affects the variables included in V ($\frac{\partial V}{\partial d} = 0$) and the correlation enters multiplicatively in the right side of (10), and reformulating the notation the following expression is obtained:

$$\frac{\partial \sigma_{_{AC}}}{\partial d} = \left[f_1(\rho_{_{GDP}}) \frac{\partial TC}{\partial d} + f_2(\rho_{_{GDP}}) \frac{\partial FC}{\partial d} \right] \tag{13}$$

Where, $f_1(.) = \frac{\partial \sigma_{AC}}{\partial TC}$ and $f_2(.) = \frac{\partial \sigma_{AC}}{\partial FC}$ depend on $\rho_{_{GDP}}$ and represent (respectively) the impact of TC and FC on $\sigma_{_{AC}}$.

Regarding the effects of dollarization on the AC it is highly intuitive that fixing the exchange rate with the leader (or in the extreme to adopt the dollar as a legal tender) will imply more transactions of goods and services ($\frac{\partial TC}{\partial d} > 0$). In addition to this it is expected that a dollarization reduces the devaluation risk and increase the connections with the financial markets of the leader country respect the others. So dollarization will increase caeteris paribus the dimension of financial channel ($\frac{\partial FC}{\partial d} > 0$).

In order to determine the effect of a change of on the volatility of the AC output let us assume that the two economies are positively correlated ($\rho_{_{GDP}} > 0$). Given $f_2(.)$ an increase in d increases the importance of the trade channel, this produces a wide range of real fluctuations on the AC output since *caeteris paribus* each additional dollar of shock now implies a higher multiplier effect. In other words, when $\rho_{_{GDP}} > 0$ the trade channel has a procyclical behavior, according to equation (4), with respect to the associated country GDP. If the multiplier effect becomes higher, because of the change on d, the volatility of AC must increase. A similar reasoning might be applied to the financial channel. Given $f_1(.)$ and a positive correlation of the business cycle an increase on d increases the importance of the financial channel, caeteris paribus each additional point of shock in the international interest rate will affect more intensely the AC GDP. This channel of transmission acts

in a counter-cyclical way, according to equation (8), and the real volatility of AC will be smaller after the change on d.

On the contrary, if it is assumed that the two economies were negatively correlated ($\rho_{GDP} < 0$), it is easy to show that the trade channel would reduce the magnitude of the real fluctuations while the financial channel would increase them. With synchronized cycles the financial channel (FC) reduces the volatility of the cycle and the trade channel (TC) increases it. On the contrary, with cycles negatively correlated, the FC increases real volatility and the TC reduces it.

With the aim to find out the sign of (13), it is presented a functional form, which can be estimated econometrically, in which real volatility σ_{AC} depends on the relationship between the business cycles of the United States and the associated country, and the relative importance of each channel:

$$\frac{\partial \sigma_{AC}}{\partial d} = g\left(\left\{\theta_{TC}[sign(TC)] + \theta_{FC}[sign(FC)]\right\}\rho_{GDP}\right) \tag{14}$$

Where θ_{TC} and θ_{FC} are the ratios of AC GDP variance explained by the trade channel and the financial channel to the total AC GDP variance respectively. They indicate the participation of the trade and financial channels in the volatility of AC's product. In turn, $sign(TC)$ and $sign(FC)$ represent the effect of each channel in the product of AC, and ρ_{GDP} is the correlation coefficient of AC GDP cycle and United States GDP cycle.

In terms of equation (14), when the possible results for each variable are combined, one of the following alternatives will be present:

$$\theta_{TC} > \theta_{FC} \text{ and } \rho_{GDP} > 0 \tag{15}$$

$$\theta_{TC} < \theta_{FC} \text{ and } \rho_{GDP} > 0 \tag{16}$$

$$\theta_{TC} > \theta_{FC} \text{ and } \rho_{GDP} < 0 \tag{17}$$

$$\theta_{TC} < \theta_{FC} \text{ and } \rho_{GDP} < 0 \tag{18}$$

$$\theta_{TC} = \theta_{FC} \tag{19}$$

$$\rho_{GDP} = 0 \tag{20}$$

In the case of expressions (15) and (18), dollarization will increase the real volatility of the GDP of AC (σ_{AC}). On the contrary, if we verify that the cyclical behavior and the relative importance of the different channels correspond to expressions (16) or (17), dollarization will allow the associated country to import a monetary policy that will act as an automatic stabilizer of its economy, reducing σ_{AC}. Finally, if the channels have the same relative importance (19) or if cyclical correlation is not significantly different from 0 (20), then dollarization induces no effect on the associated country's real volatility. ■

7.2 A VEC model

Let:

$$z_t = \Gamma_1 z_{t-1} + \varepsilon_t \tag{21}$$

where z_t is the (nx1) vector $[z_{1t}, z_{2t}, z_{3t}, z_{4t}, ..., z_{nt}]$ of variables in the model, ε_t is the (nx1) vector $[\varepsilon_{1t}, \varepsilon_{2t}, \varepsilon_{3t}, \varepsilon_{4t}, ..., \varepsilon_{4t}]$of gaussian errors and Γ_1 is an (nxn) matrix of parameters.

Subtracting from each side of (21) and letting I be an (nxn) identity matrix, we get,

$$\begin{aligned} \Delta z_t &= -(I - \Gamma_1) z_{t-1} + \varepsilon_t, \text{ or} \\ \Delta z_t &= \pi z_{t-1} + \varepsilon_t \end{aligned} \tag{22}$$

where π is the (nxn) matrix $-(I - \Gamma_1)$ and π_{ij} denotes the element in row i and column j of π.

If each π_{ij} is equal to 0, the rank of the matrix π is 0 and (22) is equivalent to an n-variable unrestricted VAR in first differences.

On the other extreme if π is of full rank the long run solution to the system is given by the n independent equations:

$$\begin{array}{ccccccccccc} \pi_{11} z_{1t} & + & \pi_{12} z_{2t} & + & \pi_{13} z_{3t} & + & ... & + & \pi_{1n} z_{nt} & = & 0 \\ \pi_{21} z_{1t} & + & \pi_{22} z_{2t} & + & \pi_{23} z_{3t} & + & ... & + & \pi_{2n} z_{nt} & = & 0 \\ . & & . & & . & & . & & . & & . \\ . & & . & & . & & . & & . & & . \\ \pi_{n1} z_{1t} & + & \pi_{n2} z_{2t} & + & \pi_{n3} z_{3t} & + & ... & + & \pi_{nn} z_{nt} & = & 0 \end{array}$$

In this case none of the series has a unit root, and the VAR may be specified in terms of the levels of all of the series.

If there are $r < n$ vectors of cointegration, the VAR should be re-expressed in first differences with the inclusion of the r independent error correction mechanisms that establish the long run relationships between the variables.

Assuming that $r = 1$, each sequence $\{z_{it}\}$ can be written in error correction form. For example, it can be written Δz_{1t} as:

$$\Delta z_{1t} = \pi_{11} z_{1t-1} + \pi_{12} z_{2t-1} + \pi_{13} z_{3t-1} + ... + \pi_{1n} z_{nt-1} + \varepsilon_{1t}$$

or, normalizing with respect to z_{1t-1}:

$$\Delta z_{1t} = \alpha_1 (z_{1t-1} + \beta_{12} z_{2t-1} + \beta_{13} z_{3t-1} + ... + \beta_{1n} z_{nt-1}) + \varepsilon_{1t} \qquad (23)$$

where α_1 determines the speed of adjustment to a long run dis-equilibrium, while the β_{1i} give us the coefficients which determine the long run relationship.

These results remain unchanged if we formulate a more general model by introducing the lagged first differences of each variable into each equation. In such fashion it is obtained the following expression that includes the n equations of the model (assuming that there exists only one vector of cointegration, that is $r = 1$):

$$\Delta z_{it} = \alpha_i (z_{1t-1} + \beta_{12} z_{2t-1} + \beta_{13} z_{3t-1} + ... + \beta_{1n} z_{nt-1}) + \sum_{i=1}^{n} \sum_{j=1}^{k} \psi_{ij} \Delta z_{it-j} + \varepsilon_{it} \qquad (24)$$

where ψ_{ij} is a (nx1) vector of parameters for equation i and lag j.

Equation (24) represents a VEC model with n variables, one cointegrating vector and k lags for the variables in first differences.

7.3 The data. Variables, source, frequency and sample size

The empirical analysis takes as period of reference from April 1991 (91:4) to December 2000 (00:12), with monthly periodicity, for every series used in the paper.

The frequency as well as the sample period relate to the existence of a structural break at the beginning of the 90s in Argentina. This structural

break has profoundly changed the behavior of the main macroeconomic variables of its economy. The implementation of the Convertibility Plan (in April, 1991) resulted in an evident reduction in the inflation rate, with a pronounced fall in the volatility of all nominal variables and an important increase in GDP, aggregate investment and consumption (Carrera, Féliz and Panigo, 1998).

As a proxy for the financial channel, it is used the Federal Funds Rate of the Federal Reserve of the United States (FEDRATE) (the data belong to the Federal Reserve Board's database) since amongst the available rates this is the one that best adapts to our analytical framework where the financial channel transmits the monetary policy shocks generated by the Federal Reserve when it uses the interest rate as an automatic stabilizer of the United States' economy.

The trade channel is proxied by imports of the United States from Argentina (IMPOUA), or, symmetrically, exports from Argentina to the United States (The data come from the database of the U.S. Census Bureau, Foreign Trade Division).

As an approximation of the output is used the Index of Industrial Production (IPI) for Argentina as well as in the United States (The data come from the Economy Ministry of Argentina and the Federal Reserve Board's database respectively). The of Industrial Production is taken as the cycle of reference instead of the GDP because there are no trustworthy estimations of this last variable on a monthly periodicity. Anyway, both variables (IPI and GDP) present high correlation in levels as well as cycles, for both countries when using quarterly data[25].

All the original series are transformed through the application of the natural logarithm function, and seasonally adjusted with the X-11 ARIMA

procedure. For the analysis of the correlation of the business cycles in both countries the series IPIARG and IPIUSA are used, while for the construction of the VECM with the series IPIARG, EXPOAU and FEDRATE are included.

[25]The coefficient of correlation between the cycle of Argentina's IPI and the cycle of Argentina's GDP (with quarterly data) are 0.865, while for the case of the United States the correlation between the cycle of the IPI and the cycle of the GDP (with quarterly data) is 0.876. On the other hand, the correlation between Argentina's IPI and Argentina's GDP (in levels, with quarterly data) is 0.840, whereas in the case of the United States the same correlation is of 0.991.

7.4 Unit Root Tests

Variable: IPIARG			
	ADF test		
Test Structure	Levels	1st Dif.	Critical Value 5%
Intercept	-2.044	-4.186	-2.89
Intercept&Trend	-3.034	-4.106	-3.46
None	0.475	-4.180	-1.94
Variable: IPIUSA			
	ADF test		
Test Structure	Levels	1st Dif.	Critical Value 5%
Intercept	-0.243	-4.947	-2.89
Intercept&Trend	-2.808	-4.923	-3.45
None	4.034	-2.805	-1.94
Variable: FEDRATE			
	ADF test		
Test Structure	Levels	1st Dif.	Critical Value 5%
Intercept	-2.449	-2.784	-2.89
Intercept&Trend	-2.927	-3.390	-3.45
None	-0.047	-2.788	-1.94
Variable: IMPOUA			
	ADF test		
Test Structure	Levels	1st Dif.	Critical Value 5%
Intercept	-0.809	-13.36	-2.89
Intercept&Trend	-2.824	-13.31	-3.45
None	1.180	-13.27	-1.94

Table A.1. ADF Tests for Unit Root.

7.5 Criteria to determine the optimal lag length for the VEC model

Lag structure	Akaike	Schwarz
12 lags	-9.56	-6.68
11 lags	-9.36	-6.70
10 lags	-9.32	-6.89
9 lags	-9.41	-7.21
8 lags	-9.40	-7.43
7 lags	-9.43	-7.69
6 lags	-9.44	-7.92
5 lags	-9.47	-8.18
4 lags	-9.58	-8.52
3 lags	-9.59	-8.76
2 lags	-9.39	-8.78
1 lag	-9.06	-8.68

Table A.2. Information criteria

7.6 Stability analysis results

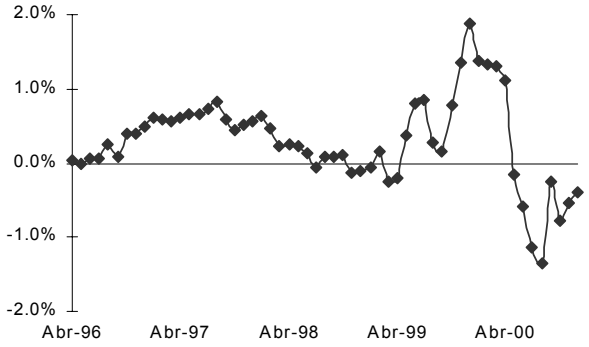

Figure 5: IPIARG average response for the first 24 periods to one std.innovation in the trade channel

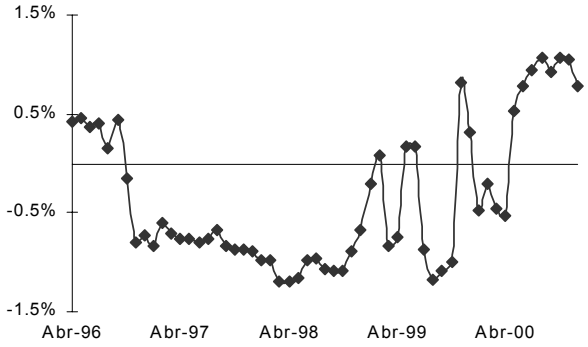

Figure 6: IPIARG average response for the first 24 periods to one std.innovation in the financial channel

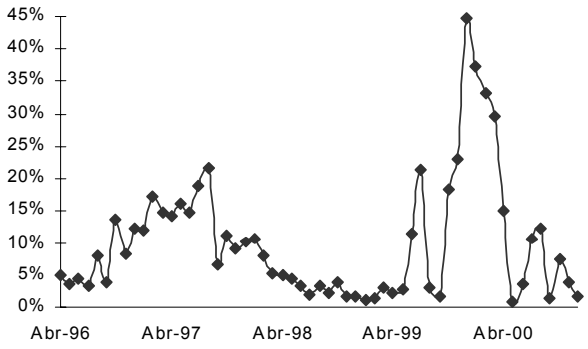

Figure 7: Average percent of IPIARG variance for the first 24 periods due to the trade channel

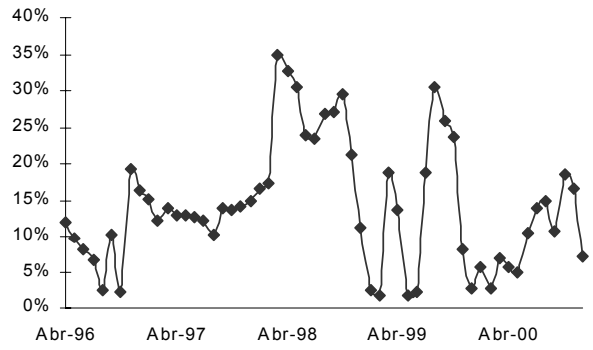

Figure 8: Average percent of IPIARG variance for the first 24 periods due to the trade channel