Macroeconomic interdependence and exchange rate regimes in Latin America*

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Resumo

Este trabalho investiga os mecanismos macroeconômicos de transmissão de choques nas quatro maiores economias da América Latina (Argentina, Brasil Chile e México), nos anos 90. Procura-se mostrar que a heterogeneidade dos regimes de taxa de câmbio entre aquelas economias não tem implicado diferenças em termos de autonomia da política monetária. Após um painel geral sobre o problema de escolhas de regimes cambiais, argumenta-se que essas economias devem buscar conjuntamente a formação de colchões de liquidez para lutar contra eventuais choques que afetam a região. Primeiramente, o "paper" destaca a heterogeneidade de regimes de taxa de câmbio entre as economias latino-americanas como um resultado de políticas de estabilização e de crises de liquidez ocorridas nos anos 90. Recuperam-se, então, alguns argumentos sobre as vantagens e as desvantagens dos distintos regimes de câmbio que têm sido suscitados no debate sobre a nova arquitetura financeira internacional. Em seguida, apresentam-se algumas evidências empíricas sobre transmissões macroeconômicas de perturbações na região, apontando que, embora diferentes regimes de câmbio impliquem diferentes respostas macroeconômicas, nenhuma economia tem se mostrado insular perante os choques que afetam a região. Os resultados deste artigo levam a sugerir que as economias da América Latina

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devem procurar construir algum tipo de defesa de liquidez em nível nacional, dado que, mesmo com esforços nacionais de diferenciação, ainda assim, o destino financeiro comum dessas economias se mostra relevante.

Palavras-chave

Interdependência macroeconômica; regimes cambiais; economias latino-americanas.

Abstract

This paper approaches the macroeconomic mechanisms of shock transmission among Latin American largest economies (Argentina, Brazil, Chile and Mexico) in the '90s. We attempt to show that the heterogeneity of exchange rate regimes among those economies has not implied their national autonomy insofar as monetary policy. As a policy conclusion, we argue that those economies should jointly search for national foreign-liquidity cushions against region-level shocks. Firstly, the paper outlines the heterogeneity of exchange-rate regimes among Latin American economies, as an outcome of stabilization policies and foreign-exchange crises in the '90s. We then recall some of the arguments regarding the adequacy of exchange-rate regimes that have been raised in the debate on the "international financial architecture". Afterwards, we present some econometric evidence on macroeconomic transmission of disturbances in Latin America, pointing out that even though different exchange rate regimes have implied different national macroeconomic responses, no one single economy has been able to escape from regionally significant shocks. Our results lead us to suggest that Latin American large economies should jointly attempt to build some regional "liquidity defense" at each national level, given that their financial common fate does not seem to be vanishing, despite efforts of national differentiation.

Key words

Macroeconomic interdependence; exchange rate regimes; Latin American economies.

Classificação JEL: **F41, F42, C22, C5**

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Introduction

This paper approaches the macroeconomic mechanisms of shock transmission among Latin American largest economies (Argentina, Brazil, Chile and Mexico) in the '90s. We attempt to show that the heterogeneity of exchange rate regimes among those economies has not implied their national autonomy insofar as monetary policy. As a policy conclusion, we argue that those economies should jointly search for national foreign-liquidity cushions against region-level shocks.

Firstly, the paper outlines the heterogeneity of exchange-rate regimes among Latin American economies, which resulted from stabilization policies and foreign-exchange crises in the '90s. After successful stabilization programs based on exchange-rate pegging and on capital inflows, each one of the large Latin American economies underwent shocks associated to capital flows reversal. Whereas Mexico, Chile and Brazil moved towards more flexible exchange-rate regimes, Argentina stuck to her hard peg (currency board), making Latin America a blueprint case for the hypothesis of "bipolarization" of exchange-rate regimes as an inevitable trend among emerging economies (Eichengreen, 1999; Fischer, 2001).

We then review some of the arguments regarding the adequacy of those bipolar types of exchange-rate regimes — hard pegs and floating — which have appeared in the debate on the "international financial architecture". We must recall that there is "no single currency regime right for all countries or at all times" (Frankel, 1999). In fact, any generalization based on recent experience is liable to be dismissed by future developments.

Section 2 presents some econometric evidence on macroeconomic transmission of disturbances in Latin America, pointing out that even though different exchange rate regimes have implied different national macroeconomic responses to shocks, not a single Latin American economy has been able to escape from regionally significant shocks. Whether or not the region moves towards flexible or bipolar regimes, macroeconomic interdependence is likely to remain worth considering.

On our argument, we resorted to some time series econometric exercises regarding error correction models, causality tests and impulse-response analyses from dynamic simulations and forecast analyses. The estimated econometric models presented in Section 2 attempt to answer the following. In relation to exchange rate regimes in those countries, we try to investigate whether nominal and real exchange rates follow some long-term trajectory; whether there is evidence of Granger causality among these variables; and how intensively nominal and real exchange rate shocks of those economies affect the other exchange rates in the region. We develop a similar exercise regarding exchange rates and trade. Finally, we investigate how each of the Latin American large economies reacts to monetary shocks originated from neighbor countries, focusing mainly on whether external shocks on foreign exchange reserves have preceded changes in exchange rates as well as whether they were transmitted to interest rates, and to what degree. We expect to have been able to illustrate how the absence of a high nominal exchange-rate interdependence, due to the heterogeneity of regimes, may hide a very strong macroeconomic interdependence through other vehicles. This result comes out forcefully whenenever we gather both foreign exchange reserves and local interest rates as indicators of stress, in lieu of solely the former.

We conclude the paper by highlighting some means by which Latin American large economies could join efforts towards building a regional "liquidity blindage". Besides regional monetary cooperation, as well as individual negotiation of stand-by credit lines with foreign private sources, Latin American large countries might consider a joint movement towards gaining access to the so far unused Contingency Credit Line from IMF.

1 - Latin American exchange rate regimes and the bipolar view

There have been a wide variety of experiences with exchange rate regimes throughout Latin America since the '80s. The spectrum goes from adoption of "hard pegs" (currency board, dollarization), to experiences with fixed, but adjustable, exchange rates or sliding bands, with these "soft pegs" ending up being superseded by regimes with more flexible nominal adjustments of the exchange rate.

The most common sequence begun with the adoption, at some moment, of either exchange rate "soft pegs" (fixed-but-adjustable rates, crawling bands) or

"hard pegs" as a basis for inflation stabilization programs. Given residual rates of inflation — mostly from prices of non-traded goods and services — usually some overvaluation of local currencies took place. Loss of trade competitiveness and "domestic growth bubbles" (derived from consumption booms) often led to current--account deficits in the balance of payments, easily sustained by abundant capital flows to emerging markets in the first half of the '90s. Simultaneously, an excessive "dollarization of liabilities" tended to occur (both as unit-of-account and as means of payment), as well as a corresponding currency (and often maturity) mismatch in portfolios, given declining perceived exchange-rate risks.

After a "sudden stop" and reversal of capital flows, triggering a "twin" (private or public sector) financial and balance-of-payments crisis, "soft pegs" were replaced by exchange rate fluctuation, usually going through some intermediary period of overshooting of the local currency devaluation. Chile had the smoothest recent experience of change, with a band being replaced by a floating regime. In turn, Argentina's currency board was maintained during Mexico´s and Brazil´s exchange-rate regime upheavals.

Tables 1 and 2 illustrate how pegged exchange-rate regimes became widespread in Latin America until recently, as well as how only hardly pegged regimes have survived since then (Brazil´s change came after, as well as Equator's full dollarization). Intermediate ranges of Table 2 lost weight when compared to top and down ones.

This is the reason why Latin America became a major reference for the so--called "bipolar view" of surviving exchange rate regimes in emerging countries, according to which only extreme regimes are intertemporally sustainable when the emerging country is fully open to capital mobility (Eichengreen, 1999; Fischer, 2001). Indeed, each of the major "twin crises" in emerging economies involved some local sort of exchange-rate peg at corresponding core countries: Mexico (1994), Thailand, Indonesia and South Korea (1997), Russia and Brazil (1998), Argentina and Turkey (2000). On the other hand, economies with higher exchange--rate flexibility were able to undergo those turbulent moments without a major macroeconomic disruption: Taiwan (1997), South Africa, Israel, Turkey and Mexico (1998). Only "hard pegs" — Hong Kong and Argentina — survived.

Full capital mobility implies that markets avail themselves of arbitrage or speculative opportunities whenever there is some misalignment between active monetary and exchange-rate policies. Therefore, one of these has to be abdicated, i.e. one policy has to follow the other.

The bipolar view stems from the classic "impossible trinity", represented by the triangle in Figure 1 below. Only "corner solutions" are feasible, combining at most two objectives (as already exemplified in classical Mundell-Fleming approaches).

Table 1

Pegged exchange rate regimes in Latin American countries — 1979-2002

1979	1982	1985	1988	1990	1991	1995	1998	2002
Bolívia	Equador	Guatemala	Equador	Haiti	**Argentina**	**Argentina**	**Argentina**	Panama
Chile	El Salvador	Haiti	El Salvador	Panama	Nicarágua	**Brazil**	**Brazil**	
Costa Rica	Guatemala	Nicarágua	Guatemala	Rep. Dom.	Panama	Panama	Panama	
Rep. Dom.	Haiti	Honduras	Haiti			**Mexico**		
Equador	Honduras	**Paraguai**	Honduras			**Chile**		
El Salvador	**Mexico**	**Peru**	Nicarágua					
Guatemala	Nicarágua	**Venezuela**	**Paraguai**					
Haiti	Panama	Panama	Panama					
Honduras	**Paraguai**		**Peru**					
Nicarágua	Rep. Dom.		**Venezuela**					
Panama	**Venezuela**							
Paraguai								
Venezuela								

SOURCE: IMF. *IFS.*

NOTE: Both softly and hardly US$-pegged regimes (inc. dollarization).

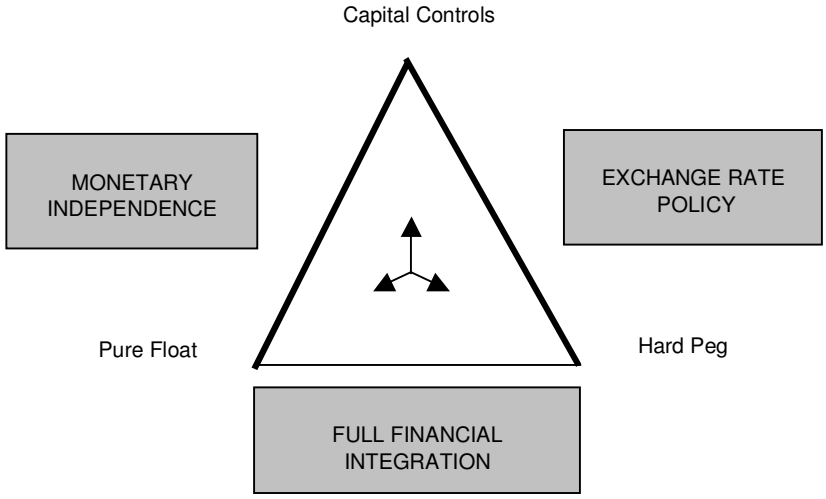
Table 2

Exchange rate regimes in Latin America: experiences and main features

Regimes	Main Features	Examples
1 - *Free or Managed ("Dirty") Float*	In case of Central Bank interventions upon market exchange rates ("dirty float"), they occur without an explicit target and not systematically. Active intervention (sterilized and non sterilized) results in changes in foreign exchange reserves.	Mexico after the 1994-5 crisis, Brazil and Chile 1999 onwards. Argentina after 2001.
2 - *Crawling (or Moving) Band*	A band system whose central parity slides over time.	Chile (very wide) bands from 1986 to mid-1998. Brazil: 1995-98.
3 - *Crawling peg*	Nominal exchange rates are adjusted periodically in accordance with a series of indicators or another rule.	The system became popular in the decades of 60s and 70s in Chile, Colombia and Brazil. Longest duration in Colombia.
4 - Fixed but adjusted exchange rate	Fixed nominal exchange rate but the central bank is not committed to stick to the parity. Parity realignments (depreciations) become a powerful policy instrument. Very rigid exchange rate system. The monetary authority can only interfere when has liquid capital inflows.	It is the most popular regime of the century. Example: Mexico, 1983--93.
5 - *Currency Board*	Generic name given to an extreme form of the currency board system, where the country abandons its monetary autonomy completely by adopting the currency of another country as a fixed nominal anchor, as well as a guarantee of full convertibility.	Historically, a small number of countries have adopted such a system. Tranquil exits only occurred when local currencies were tending to be appreciated with respect to anchor currencies. Argentina has a quasi-currency board system.
6 - *Full Dollarization (or Euro-ization)*	Unilateral adoption of a foreign currency	Panama, Equator.

Figure 1

The Impossible Trinity



On the other hand, as Frankel (1999) reminds us, it is still possible to have something like "half" monetary independence and "half" discretionary exchange--rate policy. As long as boundaries of coherence (alignment) among policy instruments and targets continue to be respected, a mix of monetary and exchange-rate policies can be (softly or loosely) pursued. Until 1999, Chile combined her Inflation Targeting (IT) monetary regime with wide exchange-rate bands.

It is true, though, that either one or the other policy tends to remain subsidiary. An example comes from an IT framework in which direct and indirect instruments of intervention in foreign exchange markets are used as a complement to interest rate policy, in order to avoid pass through of exchange-rate hikes on inflation. Even when there is some (implicit and temporary) exchange rate level target, interventions aim at the inflation rate, not the other way around.

After accepting the theoretical and empirical evidence on the pressure posed by increasing capital mobility towards predominance of either monetary or exchange-rate policies, it naturally follows the question of whether one of them is inevitably the most appropriate choice for all (Latin American) emerging economies. Defendants of passive monetary policies by those countries argue for "hard pegs", whereas those who are skeptical about the capability of the real

side of developing economies to appropriately adjust to shocks tend to recommend (re)active monetary policies and passive (flexible) exchange rates.

Let us briefly recall some of the advantages and disadvantages attributed to each of the polar exchange-rate regimes, in the context of Latin American emerging countries (Mishkin; Savastano, 2000; Calvo, 2000).

Advantages of hard pegs:

- it provides a strong nominal anchor to domestic prices, definitely locking in stabilization gains and locking out any sparkle of domestic cost-price spirals;
- it imposes discipline on domestic fiscal, monetary and financial policies, avoiding discretion and dynamic time-inconsistency problems (as well as bailing out of private agents and other sources of "moral risk");
- it provides simplicity and clarity (transparency); and
- it eliminates (or reduces) currency risks of domestic financial transactions, lowering funding costs for both private and public sectors, as well as fostering financial deepening.

Disadvantages of hard pegs:

- monetary policies will not be available against domestically originated shocks (e.g., supply shocks). Most Latin American economies feature lack of "fiscal flexibility", as well as a low capacity to swiftly adjust to shocks on the real side of the economy. In this setting, large and protracted fluctuations of investments, output and employment may generate credit risks so high as to more than compensate for reduced currency risks;
- there will be no Lender of Last Resort, what circumscribes "financial safety nets" to privately constituted deposit insurances and thin interbank markets. Given low degrees of domestic financial development, hard-to-access financial safety nets tend to curb the propensity to assume risks and, therefore, financial leverage and investments; and
- easy "exit strategies" are very difficult to find. Given that optimality conditions may change over time (see below), an occasional need of regime change will face strong hysteretic effects (liability dollarization and strong "fear of floating").

Advantages of floating exchange rates:

- monetary policy becomes free to target inflation or other macroeconomic goal. Thus, monetary policy can deal with investment and output fluctuations, including certain external shocks. Simultaneously, exchange rate flexibility helps to adjust nominal and relative prices;
- exchange rates become a thermometer of the economy's health, something that may remain hidden within a hard peg; and

- it decreases the likelihood of underestimation of effective exchange-rate risks

Disadvantages of floating exchange rates:

- exchange-rate instability may lead to high currency risks and financial instability, whenever there is partial dollarization of (private and/or public sector) liabilities (as unit of account or as an effective means of payment). Vulnerability with respect to currency fluctuations adds to the other "financial fragility" features of emerging economies. On the other hand, one must not forget that protracted real adjustments under hard pegs may result in other even more dangerous sources of risks;
- some degree of financial development is required in order to make appropriate instruments available to manage currency risks. Otherwise, foreign exchange markets will become too subject to herding behavior and manipulation, i.e. it will be too volatile. In any case, one should expect a higher degree of "dirtiness" in emerging economies´ fluctuation, as compared to advanced countries, given their dependence on foreign capital flows and their more frequent "liquidity droughts" and sudden credit squeezes;
- nominal price volatility of tradable goods may increase inflation volatility, given the critical position assumed by imported inputs and products in emerging countries´ GDP. This pass-through is one of the main reasons underlying the observed "fear of floating" in emerging countries (Calvo; Reinhart, 2000);
- price volatility of imports and exports may also hurt trade; and
- active monetary policies require a strong national will to build policy credibility, rigorous prudential supervision of finance, no "fiscal dominance" on monetary policy, and adjustment flexibility in the production system, whereas hard pegs directly impose a discipline towards these attributes. On the other hand, one knows that those are pre-requisites for any monetary system to be stable and efficient. An attempt to establish hard pegs can also be frustrated at its beginning if the country fails to attend those preconditions. The relevant difference may come down to the higher speed at which monetary credibility tends to be attained in the hard peg case, if successfully established.

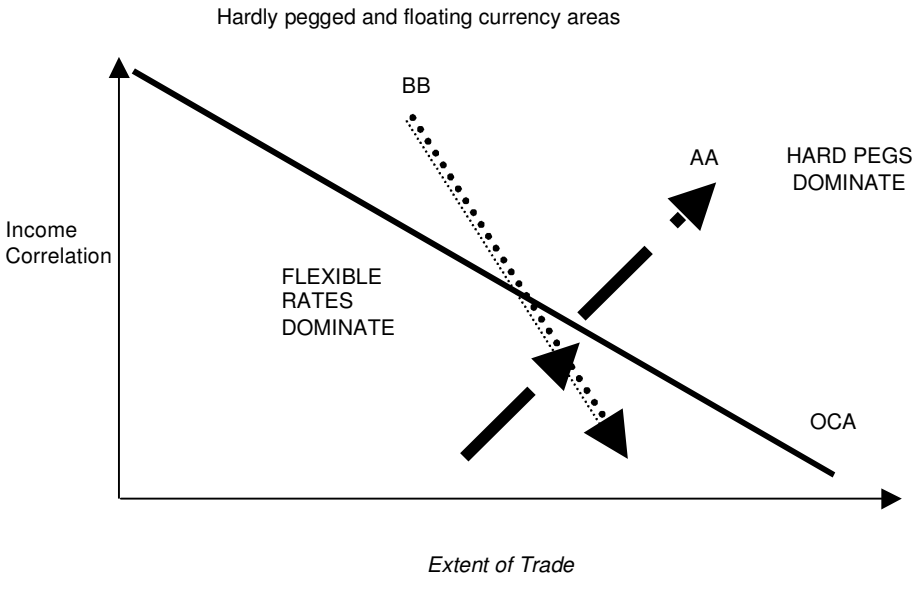
This balance of advantages and disadvantages can be translated into Robert Mundell´s criteria for an Optimum Currency Area (OCA), as adapted by textbook discussions about the convenience of tying local currencies *versus* letting them float. As the degree of economic integration with the rest of the world increases, advantages of fixed exchange rates increase with it, whereas advantages of

flexible exchange rates tend to fall. This happens because of: larger potential gains in terms of lower transaction costs and currency risks; higher inflationary credibility and heavier weight of nominal anchor via hard pegs; and lower losses derived from the loss of monetary policy.

Lower losses derived from the loss of monetary policy can be approached through by observing the degree of correlation among shocks in the economy and in the rest of the world (or for that matter a regional currency whose pegging to is under consideration). Symmetry between those shocks means that required monetary initiatives can be let to abroad. In turn, labor mobility alleviates inconveniences associated to asymmetry of shocks, whereas an overall redistributive fiscal system is also helpful to compensate for that asymmetry.

Figure 2 (adapted from Frankel, 1999) presents the "extent of trade" and the "degree of income-correlation" between the regions as indicators for assessing optimum degrees of exchange-rate pegging (or OCA). The OCA line divides the space into two sets, to the right of which , under prevailing conditions, the advantages of hard pegs predominate.

Figure 2



Frankel (1999) draws attention to differing possible hypotheses about what tends to occur through time with respect to income-correlation as cross-border trade rises. Line AA describes a trajectory for a country whose income-correlation with the rest of the world grows as its trade increases. Some authors, however, sustain that increasing specialization, accompanying higher trade, might reduce income-correlation as represented by line BB.

The only unambiguous conclusion is that there is "no single regime right for all countries or at all times". In this respect, the difficulties to exit from hard peg strategies should be taken into account.

One can also notice that OCA criteria should not be approached exclusively from a static base. Provided that the starting position is not too far from the borderline, OCA favourability can be endogenously built through institutional adaptation.

A more recently stressed criterion for choosing exchange rate regimes is the existing degree of policy credibility, as outlined above. Lack of monetary credibility makes hard pegs more attractive. One cannot forget, on the other hand, that this credibility will only be sustained, once stabilization gains have been settled, if the latter ends up followed by good performance also in other macroeconomic criteria (such as growth, high employment, low default risks etc.).

Insofar as current exchange-rate regimes in Latin American economies, at this point we propose the following intuitive observations (to be empirically supported in the following section):

(i) its (bipolar) heterogeneity stems from their different recent experiences with exchange-rate-based stabilization and crises. But there is nothing to allow any expectation that their present configuration will remain as such in the future, or converge either towards one or the other extreme of the continuum of regimes;

(ii) current levels of foreign trade among Southern neighbours are relatively large — and sectorally important — enough to support currency pegging among themselves. At the same time, those levels are perhaps sufficiently high as to undermine national currency pegs to outside regions; and

(iii) notably in the case of Latin American emerging countries, OCA trade--based criteria adapted to Optimum Exchange-rate Regimes leave aside some relevant financial dimensions of macroeconomic interdependence. Contagion and other neighborhood financial effects may turn their interdependence into a more significant fact than it seems from a trade perspective. These are the points to be discussed next.

2 - Shocks and macroeconomic interdependence in Latin America: an econometric approach

This section presents some econometric evidence on macroeconomic transmission of shocks throughout the largest Latin American economies. We intend to show that, despite national differences in responses to shocks — coming from abroad or within the region —, they all have shown some common macroeconomic sensitivity to them. Heterogeneous exchange rate regimes have implied different national macroeconomic responses, but neither flexible nor hardly pegged exchange rates have implied isolation. Whether or not the region moves towards flexible or bipolar regimes, macroeconomic interdependence is likely to remain worth considering by their policy makers.

The estimated econometric models here presented deal with the following.

With respect to exchange rate regimes in those countries, we try to investigate whether exchange rates follow some long-term trajectory and how intensively exchange rate shocks of those economies affect the other exchange rates in the region. As one can expect from our previous discussion, no significant structural trend towards convergence of regimes or rates was found.

On the other hand, we investigate how each of Latin America's large economies reacts to monetary shocks originated from neighbors, focusing mainly on whether external shocks on foreign exchange reserves have preceded changes in exchange rates as well as whether the former were transmitted to interest rates, and to what degree. We expect to have been able to illustrate how the absence of a high exchange-rate interdependence, due to the heterogeneity of regimes, may hide a very strong macroeconomic interdependence through other vehicles. This result comes out forcefully when we gather both foreign exchange reserves and local interest rates as indicators of stress, instead of including only those reserves.

Our sample for exchange-rate interdependence goes from the first quarter of 1990 to the first quarter of 2000. A first approach is made through a graphic analysis of the series to be researched. We then present some estimates of VAR models for exchange rates of those countries, searching for long run movements in terms of dynamic effects, according to impulse-response analysis. A similar procedure was followed to observe relations among foreign exchange reserves, interest rates for each economy, aiming to discover their reactions to external shocks.

2.1 - Exchange rate interdependence

Table 3 shows the outcomes of the unit root tests for exchange rate in level and in first difference for Brazil, Chile and Mexico. As known, a unit root test is always necessary before the empirical studies. Under null hypothesis of unit root against alternative hypothesis of stationarity, the test is basically a regression of the series in study according to the equation:

$$\Delta y_t = \mu + \beta t + \alpha y_{t-1} + \sum_{i=1}^{p} \delta_i \Delta y_{t-1} + \varepsilon_t \qquad (1)$$

where **t** is the linear deterministic trend. That equation is estimated in the beginning with very large lags and, afterwards, it is not significant to go through eliminating lags immediately. We use this procedure to obtain white noise error. The significance of the trend and of the constant is evaluated in each lag reduction. The critical values of the ADF test are not obtained from a usual distribution, but they were derived by MacKinnon (1991) for any sample size. However, the ADF test is a weak one when the sample includes extreme events of types such as intense price depression, supply shocks, among others. To control this problem Perron and Vogelsang (1992) introduced dummy variables in (1):

$$\Delta y_t = \mu + \beta t + \alpha y_{t-1} + \gamma DU_t(\lambda) + \sum_{i=1}^{p} \delta_i \Delta y_{t-1} + \varepsilon_t \qquad (2)$$

where $DU_t(\lambda) = 1$ to $t > T\lambda$, e $DU_t(\lambda) = 0$; $\lambda = T_B/T$ represents the moment where the structural break is observed, T is the sample size and T_B is the date on which the structural break occurred.

Unit root tests shown synthetically in table 3, indicated that[1]:

- nominal exchange rates of Mexico and Chile are first order integrated in level, and stationary in first difference;
- whereas nominal exchange rates in Brazil are second order integrated in level, with no significant trend and constant components.

Through Graphs 1 and 2 of time series in level and in difference, one can observe that all of the exchange rates, except for the case of Chile, present strong structural breaks in the '90s. This is due to changes in exchange rate

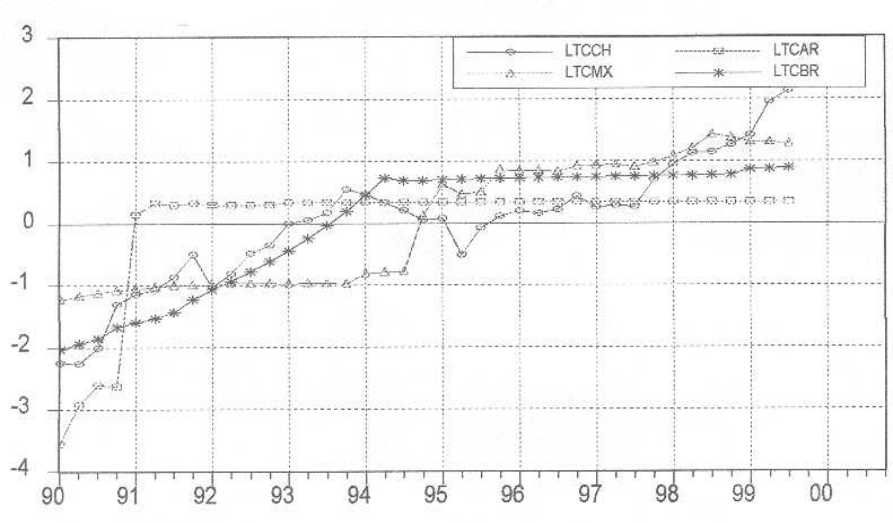
[1] The nominal exchange rate of Argentina is stationary in level — as it should be expected, given her rigid exchange rate regime — whereas deterministic trend and constant components were shown not to be significant.

regimes, such as the adoption of the currency board in Argentina in 1991, the regime of more fixed exchange rates in Brazil in 1994, and the Mexican foreign exchange crisis at the end of 1994 and beginning of 1995. The econometric tests take into account those structural breaks through Phillip-Perron test procedures.

The occurrence of such structural breaks in different periods of time implies that attempts of cointegration analysis for the exchange rates in these four economies will have very strong limitations. In other words, it is not likely that exchange rates of those economies have presented some equilibrium path among them.

Graph 1

Logarithm of the nominal exchange rate in Latin American economies — 1990:01-2001:01

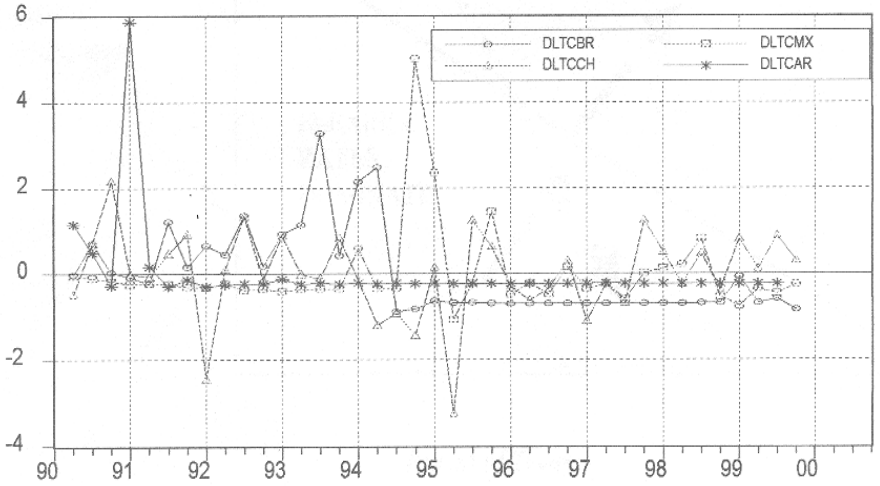


SOURCE: IMF. IFS, CD-Rom and Central Banks.

NOTES: LTCAR = Natural logarithm of the nominal exchange rate in Argentina; LTCBR = Natural logarithm of the nominal exchange rate in Brazil; LTCCH = Natural logarithm of the nominal exchange rate in Chile; and LTCMX = Natural logarithm of the nominal exchange rate in Mexico.

Graph 2

Latin American selected countries: variability of the nominal exchange rate — 1990:01-2001:01



SOURCE: IMF. IFS, CD-Rom and Central Banks.
NOTES: DLTCAR = First difference of the log nominal exchange rate in Argentina; DLTCBR = First difference of the log nominal exchange rate in Brazil; DLTCCH = First difference of the log nominal exchange rate in Chile; and DLTCMX = First difference of the log nominal exchange rate in Mexico.

Table 3

Unit tests for exchange rate in level and in first difference Argentina, Brazil, Chile e Mexico – Sample — 1990-2001

VARIABLES	LAGS	ADF	RESULTS
LTCAR	5	3,33[a]	Stationary
LTCBR	1	-2,35[a]	Not Stationary
LTCCH	1	-2,00[b]	Not Stationary
LTCMX	3	-2,36[b]	Not Stationary
DLTCBR	1	-3,06[b]	Not Stationary
DLTCCH	1	-6,04[a]	Stationary
DLTCMX	1	-4,29[b]	Stationary
DDTCBR	1	-7,50[b]	Stationary

Critical Values: (a) 5% = -2,953 e 1% = -3,642. (b) 5% = -3,531 e 1% = -4,216.

How intensively exchange rate shocks of those economies affect the other exchange rates along the region? Impulse-response functions were estimated to answer this question. Impulse-response functions are useful to summarize dynamic relations between the variables in a vector autoregressive. We used the stationary form of the series to estimate VARs with five lags, reducing them up to one lag. We are concerned about the error that must follow a white noise specification, so we have chosen the system which best meets the Information Criteria, as we can see in Table 4. It was necessary to introduce variables dummies to obtain the gaussian errors in the estimated VARs, in all model specifications in this paper, in every impulse-response analysis, either for exchange rate system, or for foreign exchange reserve and interest rate soon ahead.

Table 4

Model selection for VAR I(0) for impulse-response analysis of exchange rate

SYSTEMS/METHODS	LOG LIKELIHOOD	AKAIKE INFORMATION CRITERIA	SCHWARZ CRITERIA
System 05 lags	177,29	182,54	186,39
System 04 lags	153,37	157,49	160,57
System 03 lags	130,58	133,64	135,98
System 02 lags	79,97	59,40	43,40
System 01 lags	33,63	32,52	31,64

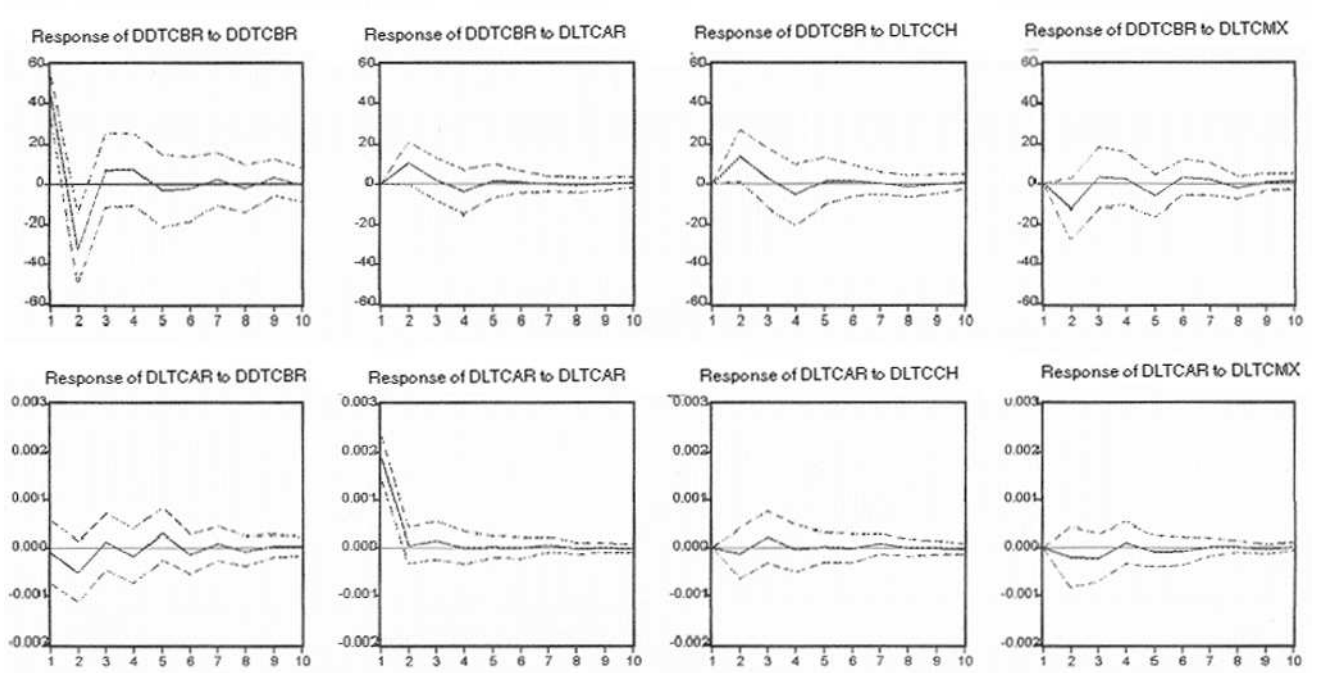
Impulse-response functions for exchange rate systems are shown in Graph 3. The first line of graphs indicates the response of Brazilian exchange rate to impulse of the exchange rate from three other economies, Argentina, Chile and Mexico, with two standard-error band. The second line shows the response of Argentina´s exchange rate to two standard-error impulses originating from Brazil, Chile and Mexico's exchange rates, and so on.

Notice a weak relation of the exchange rate changes of Argentina on exchange rates of the other economies. It can be observed, however, that impulses coming from Brazilian exchange rates affect the other economies in a substantial way. It is true that all economies are affected, but the response of other exchange rates to the impulses of Argentina´s exchange rate is not significant. There is, in fact, evidence that the shocks in terms of exchange rates in those four main Latin American economies show, at first sight, important asymmetry in terms of timing and intensity.

Graph 3

Impulse-response functions for exchange rates systems

Response to One S.D. Innovations ± 2 S.E.

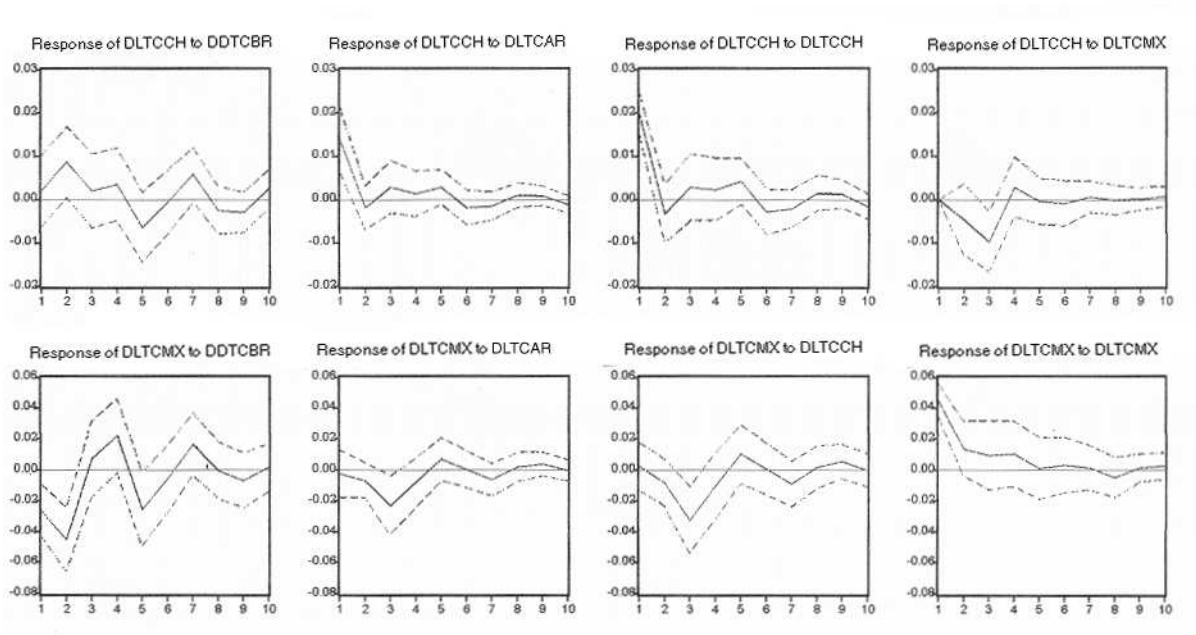


(continue)

Graph 3

Impulse-response functions for exchange rates systems

Response to One S.D. Innovations ± 2 S.E.



2.2 - Exchange rate, foreign exchange reserves and interest rates

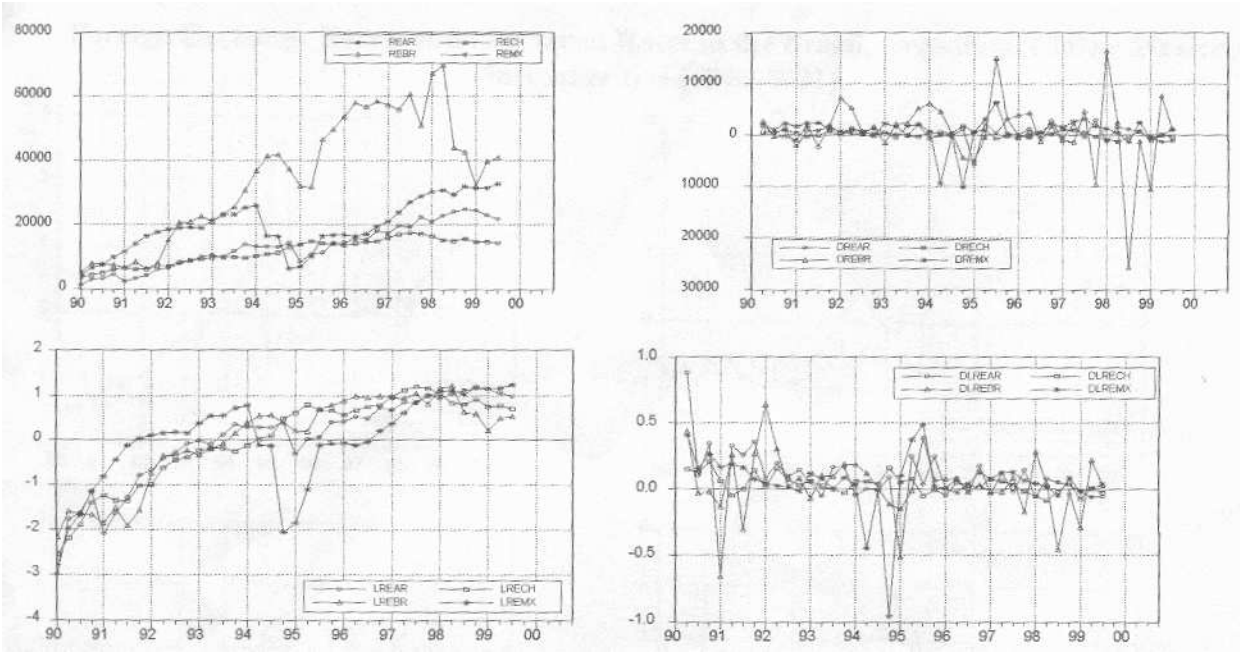
Now we analyze the empirical relations between exchange rates and foreign exchange reserves. It is known that, under more rigid exchange rate regimes, foreign exchange reserves should be either high or at least grow equally or more than proportionally to the increase of eventual trade balance and current account deficits. As Chile's exchange rate was, throughout the period, more flexible than the ones of the other countries, one could expect that relation to be weaker in this country. On the other hand, insofar as foreign exchange reserves as a leading indicator of foreign exchange crises, it is often expected that, under conditions of abrupt falls of the former, the latter undergoes strong alteration, and even that the exchange rate regime will change to another.

Initially, it can be questioned whether movements of foreign exchange reserves cointegrate among the researched economies. Many interpretations of foreign exchange crises attribute a unique role to the behavior of foreign exchange reserves[2], usually stressing some contagion effects among the economies in the region, through flows of liquid types of capital. A preliminary graph analysis seems to indicate that there is a strong upward movement along most of the decade in foreign exchange reserves of the four countries. Notice, however, that during external crises coming from abroad the area — such as the Asian and Russian crises — Brazil was much more vulnerable than the other countries. Finally, during the Brazilian foreign exchange crisis, it cannot be denied that there were downward movements in the foreign exchange reserves curve in Argentina, Mexico and Chile. Graph 4 — foreign exchange reserves in the four countries — clearly display three key moments in terms of neighborhood contagion: firstly, in the beginning of the decade (1990-1991); secondly, around the Mexican crisis (1994-1995); and finally starting from the middle of 1997 to the end of 1999.

[2] See, for instance, Andrade, Divino and Silva (2000, p. 225), where the authors state that "exchange rate crises are identified as starting from the cyclical behavior of the foreign exchange reserves". Later on we will argue that some of the abrupt movements in foreign exchange reserves have been associated in a stronger fashion with significant alterations in interest rates, rather than in exchange rate parities. Furthermore, strong movements upward in interest rates are not accompanied by proportional increases in foreign exchange reserves.

Graph 4

Foreign exchange reserves in level and in first difference — 1990:01-2001:01



SOURCE: IMF. IFS, CD-Rom and Central Banks.

We developed an empirical analysis for understanding the long run movement in foreign exchange reserves in those main four Latin American countries. The Cointegration analysis took place because we could obtain information about long term equilibrium trajectory for estimated VAR (Vector Auto--Regressive). Since Sims (1980), the VAR models have become an alternative to traditional estimation procedures. Sims considered, in a first stage, all variables as endogenous, avoiding capture false or spurious restrictions in the model. Starting from statistical procedures, the appropriate lag is determined, as well as the appropriate treatment to be given to the trend of variables. The estimation of the long term equilibrium relation is based on the following vector autoregressive:

$$\Delta y_t = \mu + \Pi y_{t-1} + \sum_{j=1}^{k-1} \Gamma_j \Delta y_{t-j} + \varepsilon_t \qquad (4)$$

where the matrix Π has a reduced rank when there is cointegration, that is to say, when linear combinations of Y_t are stationaries. So, the matrix Π can be decomposed in two matrix $p \times r$ α and β such as $\Pi = \alpha.\beta'$. The matrix β represents the co-integration vectors and the matrix α represents the weight, or the importance, of the cointegration relations in each equation. In other words, the Johansen test estimates the equation above under the restriction that Π has reduced rank; the non-restrictive model assumes that Π has a complete rank. ε_t is gaussian with covariance matrix Ω.

After tests for model reduction[3], we found that the system with just one lag could be adopted for effect of cointegration analysis, without loss of relevant information. Maximum eignvalue and trace statistics indicate that the hypothesis that there are at least two cointegration vectors for the estimated system cannot be rejected (Table 5).

Table 6 shows the α matrix (adjustment matrix) and β' matrix (co--integration vectors matrix). Each row of the matrix β' shows one co-integration vector. In this case the hypothesis of existence of one co-integration vector is valid, being equivalent to the hypothesis of a significant stationary linear combination among time series of the system. After normalized, the matrix β' of co-integration vectors can be interpreted as a long term parameter.

In the other part, each line of the α presents the group of weights with which the co-integration vectors appear in the respective equation. The matrix α measures the speed of adjustment of variables with respect to a disturbance in the balance relation. Such a matrix is denominated adjustment matrix.

[3] We always test the reduction in general model in terms of lags and chose the best model from Information Criteria, as we have written before.

Table 5

Test statistics for cointegration analysis of the foreign exchange reserves in Brazil, Argentina, Chile e Mexico — 1990-2001

Ho:rank = p	MAX EIGNVALUE TEST	95%	TRACE TEST	95%
p = 0	41.09**	28.1	77.43**	53.1
p ≤ 1	20.09	22.0	36.34**	34.9
p ≤ 2	12.42	15.7	16.25	20.0
p ≤ 3	3.825	9.2	3.825	9.2

Table 6

Cointegration analysis: standarded α and β' matrices

VARIABLES	α (adjustment matrix)				β' (co-integration vectors matrix)			
	LREAR	LREBR	LRECH	LREMX	LREAR	LREBR	LRECH	LREMX
LREAR	-0.7263	-0.0084	-0.1487	-0.00199	1.000	-0.0472	-1.053	-0.5285
LREBR	-0.2259	-0.2471	0.3170	0.04911	-4.993	1.000	8.516	5.233
LRECH	-0.0022	-0.0158	-0.1195	-0.0013	0.0589	-0.495	1.000	-0.137
LREMX	-0.2822	-0.0076	0.8825	-0.0193	3.458	-3.181	-1.001	1.000

Regarding the hypothesis that there is neighborhood contagion through movements of foreign exchange reserves, in the case of the system for foreign exchange reserves of the four Latin American economies, one can see that the first line of β implies a long term relation in which the coefficient of foreign exchange reserves in a country appears with the expected sign. Insofar as the matrix α, it seems to indicate that the significant co-integration vector is present in the foreign exchange's equation of other countries. In other words, one cannot consider the variables of the marginal process as being weakly exogenous for the parameters in foreign exchange's equation.

The analysis of weak exogeneity has an important implication in terms of economic policies. In other words, it was observed that each economy is not able to control its foreign exchange by itself, mainly under strong external shocks,

independently of the exchange rate regime. Notice that while Argentina´s foreign exchange reserves are weakly exogenous for Brazil´s foreign exchange reserves, the opposite is not a valid conclusion; in this case, the Brazilian foreign exchange is present in the foreign reserves equation of Argentina, Mexico and Chile. Whereas Mexico´s foreign exchange reserves are present in foreign exchange reserve equations of all the other countries, and Argentina´s foreign exchange is only present in Chile's foreign exchange equation.

Therefore, one cannot deny the hypothesis of a strong interdependence in terms of foreign exchange reserves among the four researched economies. On the other hand, such interdependence assumes asymmetrical characteristics, given that the hypothesis of some occasional neighborhood contagion effects cannot be rejected, since it is assumed that there are many more effects blowing from Brazil and from Mexico towards the other economies, more than the other way around. One might conclude, therefore, that this asymmetrical interdependence in terms of foreign exchange contagions cannot be taken as an exclusive function of the choice of exchange rate regime in each country.

2.3 - Adjustment under external shocks: the roles of foreign exchange reserves and of interest rates

As Latin American economies converged at some point over the '90s towards more rigid exchange rate adjustment mechanisms, with the exception of Chile, one could expect that foreign exchange reserves would assume a central role in their exchange rate management. Furthermore, one could also expect that, in situations of external disturbances, monetary authorities would use interest rates more intensively than exchange rates as a variable of accommodation to external shocks. Since not all of the economies were under the same exchange rate regime, particularly at the time of those adverse circumstances, it becomes interesting to examine whether the use of interest rates was substantially different under those divergent exchange rate regimes.

A preliminary graphic analysis points to the fact that all of the researched countries used interest rates as an instrument for taming capital flows, independently of the degree of flexibility in nominal exchange-rate adjustments. However, only Brazil and Chile made intensive use of this variable. At first sight, when focusing solely upon the interest rate — in per cent terms —, one is tempted to conclude that neither Argentina nor Mexico substantially used interest rates after the Mexican crisis, even under the Asian, Russian and Brazilian crises.

However, when the normalized interest rates are observed, it seems that all four countries made intense use of interest rates in circumstances of disturbances arising from monetary and financial markets. This becomes clear in Graph 6, especially in the third and fourth graphic illustration (6.c and 6.d). Thence we are allowed to conclude that not only did Brazil make substantial alterations in its basic interest rate but also that neither Brazil nor Chile made more regular use of this instrument, as all Latin American economies in several moments traded off some economic growth for sustaining exchange rate parities by raising interest rates.

We find it reasonable to understand these results as a denial of the hypothesis that an exchange rate crisis can be easily identified as starting from sudden movements in the levels and in the variance of foreign exchange reserves.

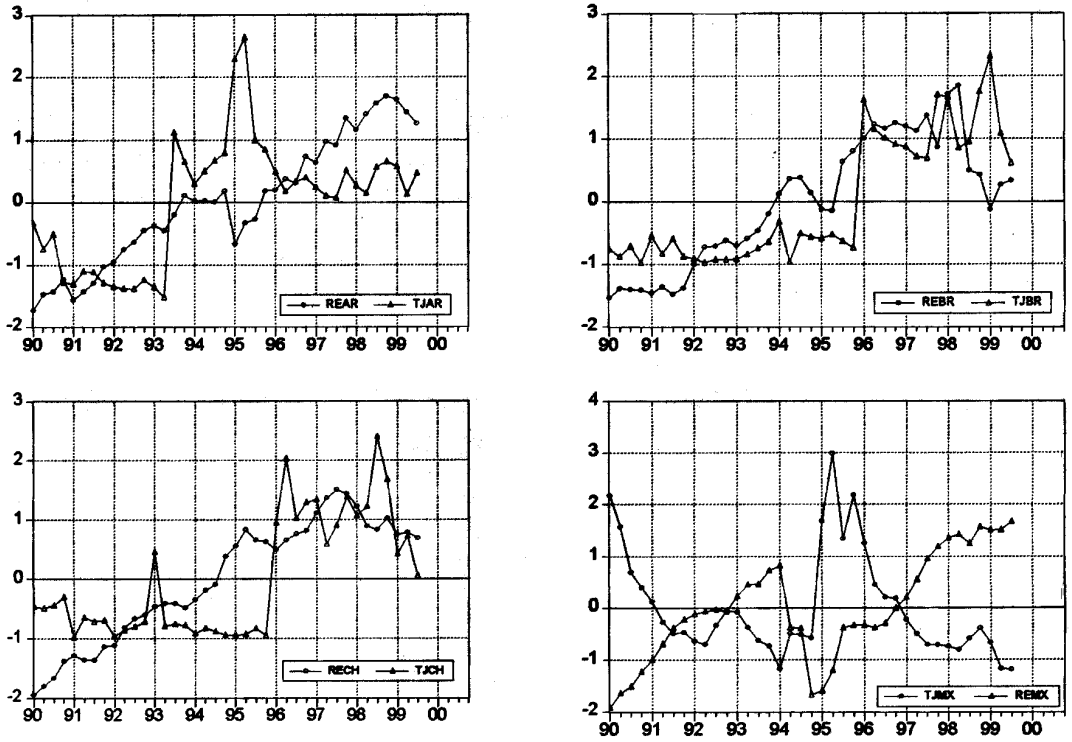
Before estimating the econometric model, tests were made for foreign exchange reserves, as well as for interest rates. The series were transformed into logarithms and, due to the fact that there is no stationarity in levels, they were, afterwards, transformed for the logarithm of first difference. The results of the Augmented Dickey-Fuller test are shown in Table 7.

As for the impulse-response analysis, Graph 7 indicates: the initial impulse in standard-error foreign exchange reserves (first graph of the first line of figure); the effect on the interest rate of an impulse in foreign exchange reserves (second graph of the first line of figure); the response in foreign exchange reserve to a standard-error impulse in interest rates (first graph of the second line of figure); and the response of the interest rate to the standard error impulse in foreign exchange reserves for the four economies.

Except for Chile, in all of the economies foreign exchange reserves resist very weakly to impulses coming from interest rates, whereas interest rates show very strong resistance to impulses coming from foreign exchange reserves. The response of the interest rate in Brazil and in Argentina to impulses from foreign exchange reserves may be indisputably considered as the sharpest and covering a time interval that extends over more than three quarters. In the case of Chile and Mexico, this response is much smaller and extends over less than two quarters. Mexico´s response in terms of interest rates to impulses from foreign exchange reserves is already stronger than the one of Brazil, although it extends beyond four quarters, with a clear definition of accommodation.

Graph 5

Foreign exchange reserves and interest rates in the Brazil, Argentina, Chile e Mexico (normalized) — 1990:01-2001:01

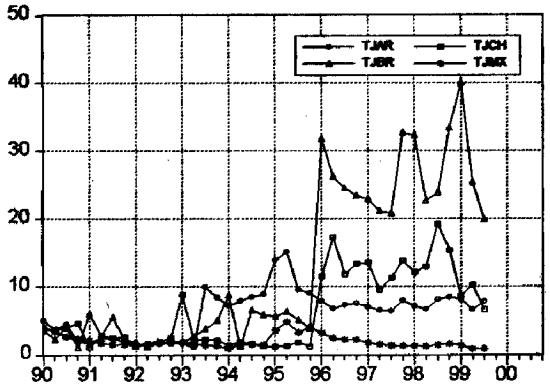


SOURCE: IMF. IFS, CD-Rom and Central Banks.

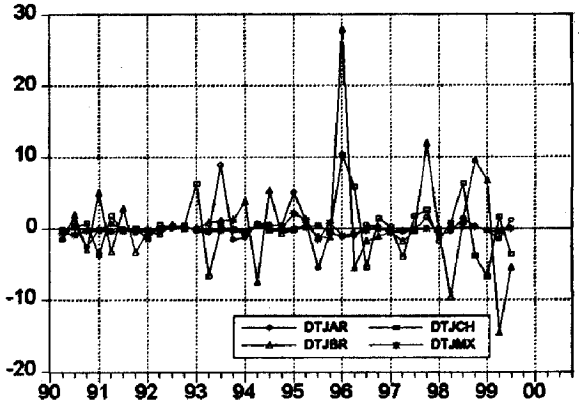
NOTE: ReAR = Foreign exchange reserve in Argentina; ReBR = Foreign exchange reserve in Brazil; ReCH = = Foreign exchange reserve in Chile; ReMX = Foreign exchange reserve in Mexico; TJDAR = Interest rate in rgentina; TJDBR = Interest rate in Brazil; TJDCH = Interest rate in Chile; and TJDMX = Interest rate in Mexico.

Graph 6

Interest rates in level (per cent), in first difference and adjusted mean — 1990:01-2001:01



6.a)

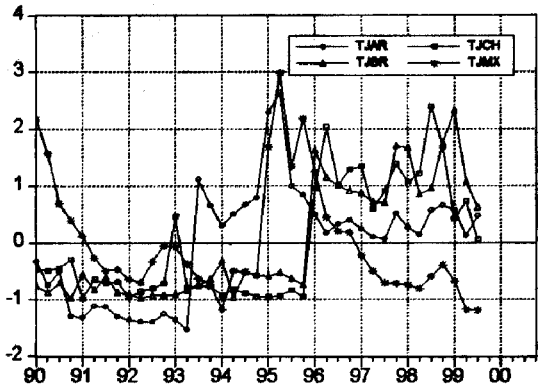


6.b)

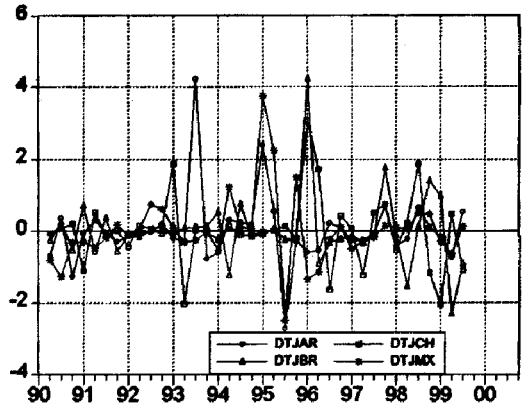
(continue)

Graph 6

Interest rates in level (per cent), in first difference and adjusted mean — 1990:01-2001:01



6.c)



6.d)

SOURCE: IMF. IFS, CD-Rom and Central Banks.

NOTE: TJDAR = Interest rate in Argentina; TJDBR = Interest rate in Brazil; TJDCH = Interest rate in Chile; TJDMX = Interest rate in Mexico; DTJDAR = First difference in interest rate in Argentina; DTJDBR = First difference in interest rate in Brazil; DTJDCH = First difference in interest rate in Chile; and DTJDMX = First difference in interest rate in Mexico.

Table 7

Unit root tests - ADF Sample — 1990-2001

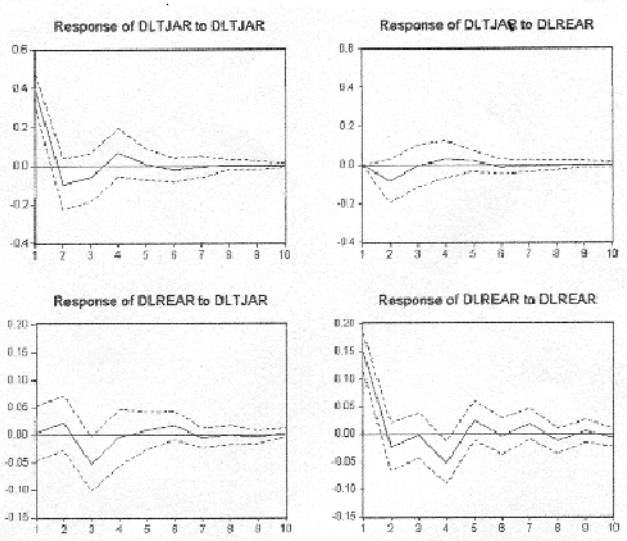
VARIABLES	ADF	RESULTS
LREAR	-2,456	Not Stationary
LREBR	-1,006	Not Stationary
LRECH	-1,292	Not Stationary
LREMX	-2,24	Not Stationary
DLREAR	-9,044	Stationary
DLREBR	-6,081	Stationary
DLRECH	-5,248	Stationary
DLREMX	-5,083	Stationary
LTJAR	-2,951	Not Stationary
LTJBR	-4,405	Not Stationary
LTJCH	-2,912	Not Stationary
LTJMX	-1,953	Not Stationary
DLTXAR	-7,205	Stationary
DLTJBR	-10,8	Stationary
DLTJCH	-7,906	Stationary
DLTJMX	-5,47	Stationary

NOTE: Critical Values: 5% = -3,535 e 1% = -4,224.

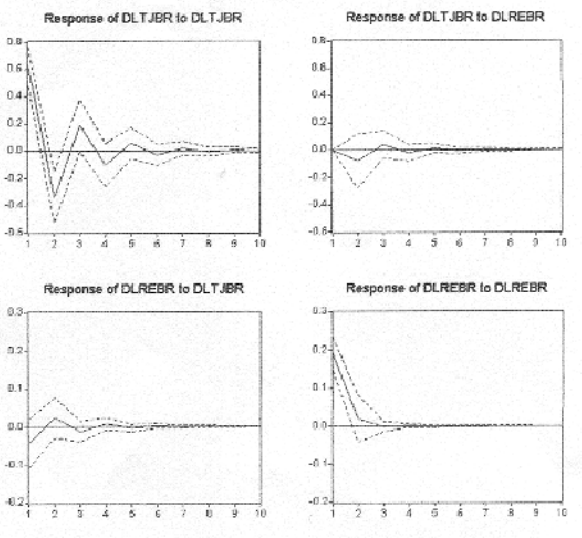
Graph 7

Impulse-response functions for foreign exchange reserves and interest rates

Response to One S.D. Innovations ± 2 S.E.



Response to One S.D. Innovations ± 2 S.E.

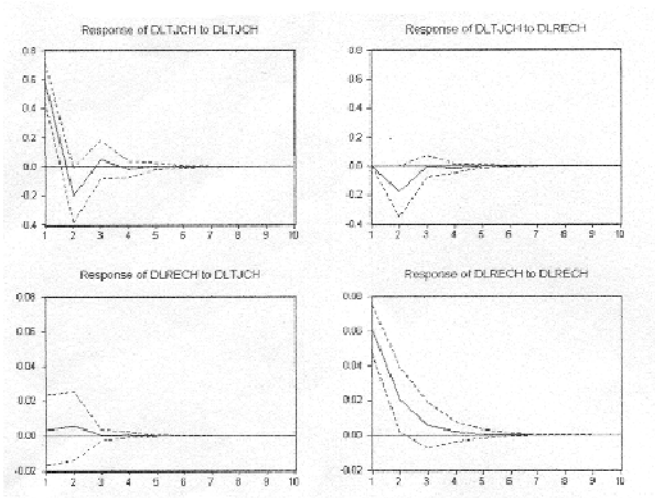


(continue)

Graph 7

Impulse-response functions for foreign exchange reserves and interest rates

Response to One S.D. Innovations ± 2 S.E.



Response to One S.D. Innovations ± 2 S.E.

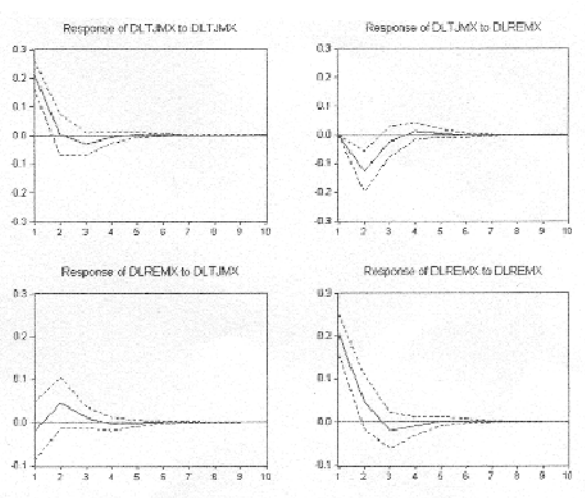


Table 8

Model selection for VAR I(0) for impulse-response analysis of interest rate and foreign exchange reserves shocks

COUNTRIES	SYSTEMS/METHODS	LOG LIKELIHOOD	AKAIKE INFORMATION CRITERIA	SCHWARZ CRITERIA
Argentina	System 05 lags	5,98	7,32	8,31
	System 04 lags	4,81	5,87	6,68
	System 03 lags	1,24	2,04	2,66
	System 02 lags	-4,69	-4,13	-3,69
	System 01 lags	-9,34	-9,01	-8,75
Brazil	System 05 lags	-17,62	-16,29	-15,29
	System 04 lags	-18,92	-17,86	-17,05
	System 03 lags	-20,42	-19,62	-19,00
	System 02 lags	-25,05	-24,49	-24,05
	System 01 lags	-25,87	-25,55	-25,29
Chile	System 05 lags	29,34	30,67	31,67
	System 04 lags	27,96	29,02	29,83
	System 03 lags	24,94	25,74	26,36
	System 02 lags	19,50	20,05	20,49
	System 01 lags	19,11	19,43	19,69
Mexico	System 05 lags	27,41	28,74	29,74
	System 04 lags	22,83	23,89	24,70
	System 03 lags	21,46	22,26	22,88
	System 02 lags	13,89	14,45	14,89
	System 01 lags	11,57	11,90	12,16

3 - Final remarks

Despite the fact that our empirical findings cover only the ´90s in four countries, our results suggest the following conclusions. Firstly, there is no indication of exchange rate interdependence among the economies analyzed, in the sense that the choice of an exchange rate regime in an economy has directly affected choices made by the other economies. Each experience with the adoption of a more rigidly pegged exchange rate regimes corresponded exclusively to specific domestic circumstances. This runs against the idea that historical evidence has recently pointed towards any homogeneity, even though a recent bipolarization movement in the region was evident. The possibility of future reconfigurations It remains open.

The second conclusion concerns the expected strong negative relation between degrees of flexibility in the exchange rate regime and needs of foreign exchange reserves. In this case, economies such as Argentina's would be required to operate with reserves much larger than Chile's. The most interesting case detected by our empirical exercises was that these economies presented signs of neighborhood contagion effects with respect to movements of their foreign exchange reserves, with common moments of intense oscillations in the later. One can come to the conclusion that, given strong contagion effects, the divergence among exchange rate regimes was not sufficient to imply significant differences with respect to autonomy of macroeconomic policies. Independently of their heterogeneous regimes, all four economies jointly presented to be vulnerable regarding abrupt changes in capital flows towards the region.

Fourth, we raised doubts about some established hypotheses regarding the use of macroeconomic adjustment mechanisms along the divergent exchange rate regimes in the region. According to our empirical results, except for Chile, foreign exchange reserves resist very weakly to the impulses coming from interest rates, whereas interest rates resist very strongly to the impulses from foreign exchange reserves. This implies that macroeconomic adjustment policies had to resort to very high interest rates as an instrument to control foreign exchange, in situations of impulses, given that increases in interest rates often presented weak response in terms of foreign exchange reserves. This also suggests that one should go beyond simple matching of sudden behavior changes of foreign exchange reserves with situations of exchange rate crises.

The interest rate responses in Brazil to impulses of foreign exchange reserves can be considered as the most accentuated and for a time interval that extends over more than three quarters. In the case of Chile, its response is weaker and extends over less than two quarters. Mexico´s response in terms of

interest rates to impulses from foreign exchange reserves is already stronger than that of Brazil, yet it extends beyond four quarters, with a clear definition of accommodation. One can conclude that the intensity of use of interest rates as a control instrument over foreign exchange reserves is independent from the degree of rigidity of exchange rate regimes in the economies, thus, one must look somewhere else in order to explain such a divergence in monetary policies.

As a last educated guess, insofar as policy, we suggest that Southern Latin American large economies should jointly attempt to build some regional "liquidity defense", given that their financial common fate does not seem to be vanishing, despite efforts of national differentiation. Besides searching for macroeconomic convergence and for private sources of stand-by credit lines, maybe the time is right for a joint negotiation to enter the Contingency Credit Line from IMF. Given current stages of macroeconomic policies and interdependence, joint movements towards national liquidity cushions might help substantially to reduce disruptive propagation of shocks along the region.

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