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ON THE RELATIONSHIP BETWEEN EXCHANGE RATES AND INTEREST RATES: EVIDENCE FROM THE SOUTHERN CONE*

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ABSTRACT

This paper provides a closer view on the interaction of exchange rate volatility and interest rate volatility in the Mercosur countries. We discuss several models that explain systematic correlations between the movements of both variables and their second statistical moments, i.e. their volatilities. In contrast to the "fear of floating" argument that could lead to a volatility trade-off, we argue that both variables are largely driven either by the credibility of a country or by politics in general and thus should move in the same direction. Subsequently, we

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test this hypothesis of a positive correlation between both variables empirically. As a final step, we control for the impact of third variables such as exchange rate misalignment, financial stress, and monetary volatility. Our results show that – independent from third variables–there is a notable co-movement of exchange rates and interest rates in Mercosur countries.

RESUMEN

Este estudio examina en detalle la interacción entre el tipo de cambio y el tipo de interés en los países del Mercosur. Se discuten varios modelos que explican el comportamiento de las dos variables. Un argumento común es el "fear of floating" que puede resultar en un trade-off de volatilidades. En comparación, argumentamos que las dos variables son influidas o por la credibilidad de un país o por política, y por ese motivo se moverán en la misma dirección. En la segunda parte del texto analizamos, empíricamente, la correlación entre las dos variables. Finalmente se analiza la influencia de terceras variables como misvaloración del tipo de cambio real, tensiones en el mercado financiero y volatilidad monetaria. Nuestros resultados muestran que –independiente de terceras variables– existe un movimiento similar del tipo de cambio y del tipo de interés en los países del Cono Sur.

1. INTRODUCTION

After the forced exit from its currency board arrangements Argentina has joined its neighbors in the Southern Cone in terms of its exchange rate arrangement. After the break-up of the Brazilian currency regime in 1999, the obviously differing exchange rate systems of the Mercosur countries have been held responsible for the missing progresses towards a deeper monetary integration in Latin America. But probably this will not be the end of the story. The actual problems that appeared as an outcome of the Argentinean and Brazilian crises have shown that an optimal exchange rate system for Latin American countries is far from being found.

In Europe, a similar crisis (1992/3/5) could not impede monetary union. Thus, monetary integration could one day again become a real option for the Mercosur area as well.[1] As an alternative, target zones and fixed exchange rates (to the U.S. dollar and/or to the euro) still are subject to discussions.

[1] Before the outbreak of the Argentina crisis, authors such as Eichengreen (1998) and Giambiagi (1999) even discussed the sense or nonsense of a common currency for the Mercosur member countries. Corresponding declarations of intention were made at that time by policy circles, i.e. the president of Argentina, Fernando de la Rúa, and by the president of Brazil, Fernando Henrique Cardoso. An instructive source in this respect is Levy-Yeyati and Sturzenegger (2000).

One key feature of a fixed exchange rate regime is lower exchange rate volatility. Thus, to qualify the costs and benefits of fixed regimes, it is essential to quantify the effects of a lower exchange rate volatility on other economic variables such as interest rates, investment, and labor markets. The last two effects are investigated more detailed in Belke and Gros (2002). But not only exchange rate policy might be a source of potential costs –also interest rate policy could impose costs. The purpose of this paper is to provide a closer view on how exchange rate volatility and interest rate volatility are linked in the Mercosur countries.

Our paper proceeds as follows. After explaining why one should take care of the interaction between exchange rates and interest rate in the Southern Cone (section 2) we document the theoretical framework which serves as a benchmark for our statistical tests of the nature of correlation between volatilities (trade-off versus co-movement) (section 3). The latter are conducted in section 4. Section 4.1 explains our measures of volatility. Section 4.2 presents some simple tests of the significance and of the sign of the correlation between the relevant volatility measures. Section 5 checks whether these first results are robust with respect to the consideration of potential third variables. Section 6 draws the implications of the results for the debate on the suitable exchange rate regime for the Southern Cone.

2. Motivation

What drives interest rate volatility? In an OECD country with a flexible exchange rate one would consider short term domestic interest rates to constitute a measure of monetary policy. In emerging market economies this might not be the case, whatever the exchange rate regime. Especially for highly indebted countries like Argentina and Brazil, developments in international financial markets might be much more important. Both exchange rates and interest rates can shoot up if foreign financing is no longer available (contagion after the Asian and Russian crisis) or the perception in international financial markets of the country's political and economic future changes (witness the 30 % depreciation of the real when present-day president Lula da Silva had a lead in the opinion polls).

It can by now be considered a stylized fact that exchange rates are "disconnected" from fundamentals (e.g., Obstfeld and Rogoff, 2000 and the July 2002 issue of the *Journal of Monetary Economics*). To a certain extent, section 5 below gives additional support to this view using the second statistical moment. It finds that there is a significant correlation between exchange rates and monetary policy but that this correlation cannot be interpreted in the sense of a direct bilateral causal relationship. Third variables like the constant threat of a speculative attack on emerging market economies can actually cause a co-movement of exchange rates and interest rates, which does not exist for developed economies as reported by Belke and Gros (2002a). They find that the correlation coefficient between the volatilities of the bilateral dollar/euro exchange rate and the respective interest rate differential is essentially zero (around 0.1).

However, we cannot rule out in this contribution that variability in the exchange rate and the interest rate are jointly caused by variability in monetary policy. If this were the case the cost of exchange rate volatility reported here should be considered the cost of erratic monetary policy. However, we are confident that for Argentina and Brazil the general "disconnect" between exchange rates and fundamentals also holds in the short run, and is even extended to (domestic) interest rates, which for emerging markets largely are determined by shocks coming from international financial markets.

There is a number of works on the interaction between exchange rate volatility and interest rate volatility: Some authors like, e.g., Reinhart and Reinhart (2001) argue that there is a trade-off between lower G-3 exchange rate volatility on the one hand and higher G-3 interest rate volatility (and consumption) on the other hand. As the main reason it is presumed that major countries can only accomplish a lower degree of exchange rate volatility if their central banks change short-term interest rates as a reaction to cross exchange rate changes. This, in turn, tends to increase G-3 income and spending volatility. The latter effects spill over to emerging market economies which are net debtors to the G-3 in different ways. First, coordination of G-3 monetary policies delivers more stable terms of trade for the emerging markets at the cost of a more variable interest service on foreign debt. This might hamper investment within the emerging market economies. Second, the higher degree of G-3 interest volatility makes the demand for the emerging markets' exports more variable if import demand in the G-3 has a positive income elasticity. However, the larger the foreign trade ties with the larger country the more important this kind of spill-over effect should be in reality. Those emerging market economies which predominantly export relatively income-inelastic primary commodities will not suffer to the same extent from an increase in G-3 interest rate volatility like developing countries do which export income-elastic manufacturing goods. In other words, the export performance of countries like, e.g., Argentina should be less exposed to G-3 interest rate variability like that of East Asian countries (Reinhart and Reinhart 2001, pp. 7 ff.).

Reinhart and Reinhart examine volatility between G-3 currencies – but what we examine here is volatility between G-3 and emerging markets' currencies what has also been analyzed by Calvo and Reinhart (2000). They apply a similar argument like Reinhart and Reinhart (2001) directly to emerging market economies. If the authorities lack credibility and if there is an inherent "fear of floating", the outcome is biased towards lower conditional exchange rate volatility (towards G-3) and higher interest rate volatility within the emerging market economies themselves ("pro interest variability bias", Calvo and Reinhart 2000, p. 8). Their empirical analysis for thirty-nine countries (including Argentina, Brazil, and Uruguay) and monthly data ranging from January 1970 to April 1999 corroborates exactly this conclusion, independent on whether the country under investigation is classified as a peg or a float. Hence, the authors conclude that the so-called "demise of fixed exchange rates" which is often maintained referring to the examples of, e.g., Brazil, Chile, and Colombia is not more than a myth. However, according to Calvo and Reinhart (2000) the low observed degree of exchange rate variability is not due to

the absence of asymmetric shocks in the emerging countries but to monetary policies aimed at stabilizing the exchange rate.[2] Interest rate policies seem to have replaced ineffective foreign reserve interventions in this respect. This context might be circumscribed by the defense effect of interest rate policy. Hence, interest rate volatility should be observed to increase when exchange rate volatility is dampened.[3] The Calvo and Reinhart argument holds if there is a national monetary policy that influences both prices for currency and for money itself.

It might be argued that Calvo and Reinhart (2000) as well as Reinhart and Reinhart (2001) more or less make use of the old and common argument against reducing exchange rate variability that volatility must have a valve somewhere else. In other words, could the gains from suppressing exchange rate variability get lost if the volatility reappears elsewhere, for example in higher interest rate variability?

We would argue that recent research on OECD economies is suggestive in this respect. Seen on the whole, the existing literature is skeptical about the "squeeze the balloon" theory, i. e. a trade-off between exchange rate volatility and the volatility of other variables. Rose (1996), for example, shows that official action can reduce exchange rate variability even holding constant the variability of fundamentals such as interest rates and money. Co-ordination between the Fed and the ECB could thus keep the dollar-euro volatility under control. This view is supported by the results of Flood and Rose (1995) who show that there is no clear trade-off between exchange rate volatility and macroeconomic stability. Furthermore, Jeanne and Rose (1999) develop a model of a foreign exchange market with an endogenous number of noise traders and multiple equilibria of high and low exchange rate volatility. In their model monetary policy can be used to lower exchange rate volatility without affecting macroeconomic fundamentals. Similarly, Canzoneri *et al.* (1996) show, e.g., for some G-3 countries that exchange rates do not generally move in the direction one would expect if they were to offset shocks. Flood and Jeanne (2000) show that in an extended Krugman-Flood-Garber model, raising interest rates has ambiguous effects on exchange rate behavior. On the one hand, higher interest rates make domestic assets more attractive while they damage credibility on the other hand what thus could lead to a weaker domestic currency –especially in case of underlying fiscal fragility.

From our point of view, credibility is a very important influence factor in the development of both exchange rates and interest rates. Thus, both variables might be driven by other factors that influence the credibility of a country (e.g. one might suppose that in case of emerging markets, the link between exchange rates and

2 On the contrary, the terms of trade in most of the emerging market economies are subject to larger and more frequent shocks than their counterparts in the G-3. This appears intuitive given the large share of primary commodities in their exports.

3 Calvo and Reinhart (2000) e.g. found that the probability of a monthly interest rate change of less than plus/minus 2.5 percents was only 11.1 percent in Brazil (during the real managed floating period, 1994 to 1999), only 14.3 percent in currency board Argentina while it was slightly below/above 60 percent in the U. S. and Japan in the aftermath of Bretton Woods.

interest rates could be affected by capital flows, country risks, or the rates of money growth) and therefore will move similarly. We call this credibility approach.

But the question how exchange rate and interest rate volatility do move in emerging markets is not yet fully described in the literature. On the basis of the Reinhart and Reinhart argument (higher exchange rate volatility could lead to a negative economic performance in the industrialized countries that finally ends up in more volatile interest rates), one could also argue that bigger fluctuations between the prices of emerging markets' currencies (towards G-3 currencies) lead to an unsound economic performance in the emerging markets itself (with larger indebtedness and especially lower investor confidence) what finally ends up in a more expensive access to international capital in the form of higher interest rate differentials.

In this paper we examine whether the view of an existing volatility trade-off is correct for the Mercosur countries. One point of departure for our study could be the consideration that there might be other variables that drive exchange rates as well as interest rates. If existing, these could be emerging market specific influences that outweigh national exchange rate and interest rate specific parameters (e.g. national monetary and fiscal policy, government performance, or economic growth).

3. Theoretical Framework – the Connection between Exchange Rate Volatility and Interest Rate Volatility

Calvo and Reinhart (2000) use a simple version of a conventional monetary model where exchange rates are driven by money supply and expectations. Applied on the emerging market case where a currency depreciation occurs, a policymaker will face the dilemma that he could either jack up money supply (what could end up in even lower credibility and worse expectations) or he could face the real interest rate increasing (what could mean disturbances in both financial and real sectors). Calvo and Reinhart (2000) argue that a policymaker faced with the choice between exchange rate stabilization and interest rate stabilization would probably opt for stable external prices.

Another way of modeling the behavior of exchange rates and interest rates in emerging markets could be a simple Mundell Fleming approach. The Mundell Fleming model can describe both a small open economy that suffers or profits from foreign influences and a two-country case. For an emerging market, the small open economy case looks more valuable. But from our point of view, the Mundell Fleming world disposes of a weakness that we cannot cope with: In a standard model with rigid prices, an appreciation affects the economy in a contractionary way while a depreciation has expansionary effects. This would make us argue that emerging markets' policymakers would be reluctant to appreciations but not to depreciations. Thus, they would not be stability-oriented. According to this, a Mundell Fleming model would leave out most of the Calvo and Reinhart (2000) arguments for "fear of floating" and therefore is not valuable for our purposes.

Like Calvo and Reinhart (2000), Lahiri and Végh (2001) observe a concrete reluctance to large exchange rate swings. They also find lower exchange rate volatility and higher reserve volatility in emerging than in industrialized countries. But unlike Calvo and Reinhart (2000), they detect from an observed positive correlation between changes in the exchange rate and interest rate that the interest rate probably may not act as a defender of a certain exchange rate.

The key effects of a certain interest rate policy in the Lahiri and Végh (2001) model are: First, an increase in the interest rate of government bonds urges commercial banks to allow lending only in case the received interest rate there climbs in the same amount as governmental interest rates did. In other words: A rise in governmental interest rates leads also to a rise in lending interest rates. Thus, bank credit is reduced and output contracts. Lahiri and Végh (2001) call this the output effect of a certain interest rate policy. Second, due to the higher competition on the financial market, banks are urged to pay also higher rates on bank deposits. Therefore, demand for bank deposits increases. This is described as the money demand effect.

We have now presented two crucial considerations for volatility behavior modeling. We have also tried to classify the existing range of scientific work on volatility behavior in two groups: first, interest rates acting as a defensive policy measure to offset large exchange rate swings (defense approach) and second, interest rates and exchange rates both driven by the credibility-based factors (such as e.g. capital flows, country risks, rates of money growth, or belief in the political system) what we have called credibility approach.

At first glance, the two approaches contradict each other. But we can show that both cases lead to a similar behavior of exchange rates and interest rates. In case of the credibility approach a simultaneous movement of both variables is obvious. For the defense approach case, Lahiri and Végh (2001) show that even with active defense of the currency, a similar behavior becomes plausible. In their model, they incorporate an output cost of raising interest rates. Let the effects of higher interest rates be the two above mentioned output and money demand effect.

In this model context, they consider both a small and a large shock to real money demand. In case of a small shock, the output costs entailed by the resulting currency depreciation will also be small. Therefore, as Lahiri and Végh assume, policymakers should not intervene. Instead, they should partly offset the shock to money demand by raising domestic interest rates. It might be argued thus, that in case of a small shock exchange rates and interest rates move in the same direction.

If there occurs a large shock, the supposed exchange rate fluctuations would cause too large output costs so that policymakers probably would intervene and try to stabilize the exchange rate completely. But in this case, there is no more need to change interest rates. Hence, exchange rates and interest rates move in a similar manner. According to Lahiri and Végh, the model predicts a positive correlation between exchange rate and interest rates.

To summarize our theoretical framework, we argue that both exchange rates and interest rates in emerging markets might be driven by politics (as argued in

Calvo and Reinhart (2000), in Lahiri and Végh (2001), and Flood and Jeanne (2000) among others). The rationale for this is the intention of policymakers to influence specific economic variables (inflation, capital inflows, exchange rates or interest rates) for a certain motive. As it is not the intention of this contribution to identify theoretically the triggers of exchange rate and interest rate movements, we also provide for the influence of credibility in both variables by defining a "credibility approach" (also argued in Calvo and Reinhart (2000) or in Reinhart and Reinhart (2001)). Thus, both variables are market driven.

Both theoretical backgrounds predict an analog behavior of exchange rates and interest rates in the first moments in most cases. This builds a testable hypothesis that will be further examined in the following section.

4. The Link Between Exchange Rate and Interest Rate Volatility

We now test empirically whether both volatilities in the Southern cone show a co-movement or a trade-off. Our results are based on estimated correlation coefficients. We also test for third variables which if significant and, hence, relevant could severely limit the scope for conclusions. Section 4.1 explains our measures of volatility. Section 4.2 presents some simple tests of the significance and of the sign of the correlation between the relevant volatility measures. Section 5 checks whether these first results are robust with respect to the consideration of potential third variables. Section 6 draws the implications of the results for the debate on the suitable exchange rate regime for the Southern Cone.

4.1 The operational definitions of volatilities

After having stated what the empirical exercise is all about, we now proceed to the second practical issue: How should one measure exchange rate and interest rate variability? Let us first define our measures of exchange rate and interest rate variability which are relevant for Mercosur countries. We used a very simple measure: for each year of our total sample from 1970 to 2001 we calculated a standard deviation on the basis of twelve monthly observations of the first difference of the respective exchange rate and interest rate measure. In order to take into account the closer ties to the EU than to the U.S. as a special pattern of Mercosur foreign trade relationships (see section 2), we also include the volatilities of the euro exchange rates of the Argentine peso, of the Brazilian real, and of the Uruguayan peso. However, extra calculations show that the correlation between dollar and euro volatilities of the respective home currencies amount close to 99 percent for Argentina and Brazil, as could have been expected. Finally, like Reinhart and Reinhart (2001) we include real euro-dollar exchange rate volatility. Besides, we also utilize nominal euro-dollar exchange rate volatility as results may significantly differ. Since over a short-term horizon nominal and real exchange rates are usually highly correlated, their correlation should be quite high –at least

in theory. Thus, our empirical research will clarify whether it matters or not to focus on the relationship only in one of the two cases.

At this stage, it is useful to illustrate the exact definitions of the exchange rate and interest rate volatility variables based on the example of Argentina. Here, we consider the volatility of the nominal and real exchange rate vis-à-vis the US-dollar $\varsigma_e^{AR,US}$ and $\varsigma_q^{AR,US}$, of the nominal and real exchange rate vis-à-vis the euro $\varsigma_e^{AR,EU}$ and $\varsigma_q^{AR,EU}$, of the nominal and real dollar-exchange rate of the euro $\varsigma_e^{US,EU}$ and $\varsigma_q^{US,EU}$, of the real effective exchange rate ς_Q^{AR}, and of the nominal and real effective intra-Mercosur exchange rate $\varsigma_E^{AR,MERCOSUR}$ and $\varsigma_Q^{AR,MERCOSUR}$. The volatility of the nominal short-term interest rate is called ς_R^{AR}, the one of real interest rate volatility ς_{RR}^{AR}.[4] In Figures 1 to 3, some examples of our volatility measures are displayed graphically.

Due to the specific sequencing of exchange rate regimes in each of the Mercosur countries, it seems to be useful to split the total sample up into different sub-samples to check the results for robustness.

What kind of exchange rates did we take as the basis for our calculations? To measure volatility of the Mercosur currencies themselves, we used both the nominal and real bilateral US-dollar rates and the real effective exchange rates of the Mercosur currencies. Following the hypothesis by Reinhart and Reinhart (2001) who state that it is G-3 volatility which matters for the real sector of emerging markets (especially those with a peg to a G-3 currency), we use the nominal and real bilateral exchange rate of the US-dollar vis-à-vis the euro area (reconstituted for the past) and the effective rates of the dollar and the euro. In order to have percentage changes we either used directly the first difference of the raw numbers for the exchange rates when they are indices, with a base around 100. In the case of the remaining rates we used the first difference of the natural logarithm. The historical series of the external effective exchange rate of the euro area was taken directly from the official sources, which calculate the average of bilateral exchange rates of the 11 present euro countries, with weights given by the non-euro trading partners.[5]

4 We used money market rates as a proxy for the short-term interest rate in the cases of Brazil and the euro zone. For the U.S., we focus on the treasury bill rate. However, for Argentina, Uruguay and Paraguay, we preferred the deposit rate because this enables us to use a by far larger data set (starting in March 1977 instead of March 1979 in the case of Argentina, in November 1992 instead of July 1999 in the case of Paraguay, and in July 1976 instead of December 1991 in the case of Uruguay).

5 A description of the algorithm for the construction of the volatility variables (labeled with ς...) can be found in Belke and Gros (2002a).

FIGURE 1
VOLATILITIES OF REAL EFFECTIVE EXCHANGE RATES

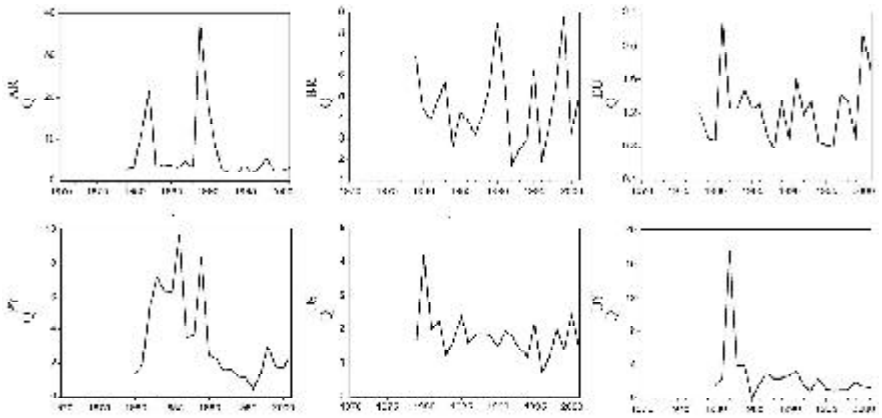


FIGURE 2
VOLATILITIES OF INTRA-MERCOSUR REAL EFFECTIVE EXCHANGE RATES

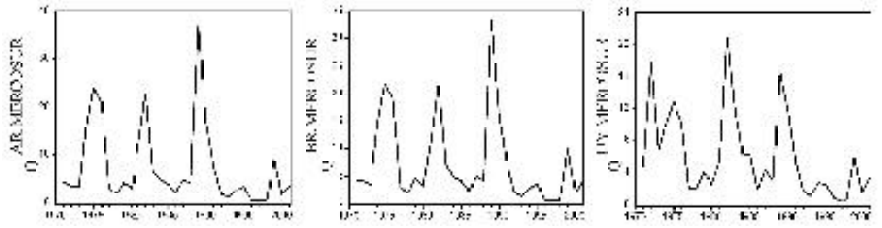
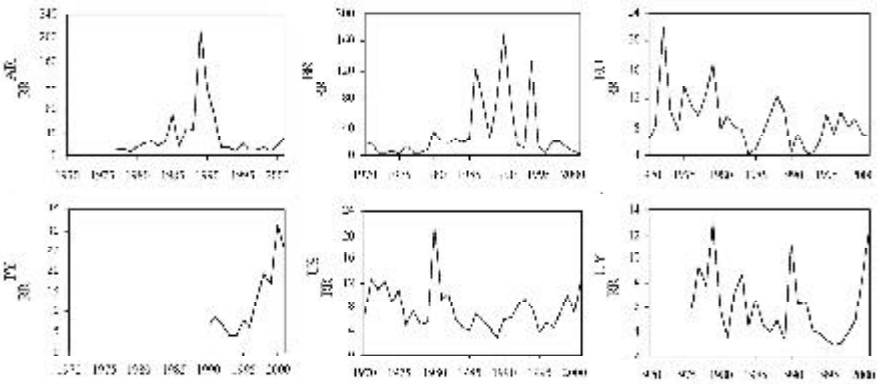


FIGURE 3
VOLATILITIES OF REAL SHORT-TERM INTEREST RATES



We use monthly exchange rates to calculate volatility instead of daily (or other higher frequency) volatility because the required data were easier to obtain on a consistent basis for the entire sample period. Another reason to prefer this measure over more short-term alternatives (e.g., daily variability) was that we are convinced that while the latter might be important for financial actors it is less relevant for decisions whether to employ or to invest, which have a longer time horizon. The drawback of this decision was that we had to use annual data in order to have a meaningful measure of variability. We thus had only about 31 observations for each country, which turned out to be sufficient.

In principle one could have used option prices to extract implicit forward looking volatilities, but option prices are generally available only for the US dollar and sometimes against the DM (the euro), and even then only for limited periods. Hence, it would not have been possible to construct a measure of euro volatility on a consistent basis using option prices. We used actual exchange rate changes instead of only unanticipated ones. But at the monthly horizon the anticipated change is usually close to zero. That's why actual and unanticipated changes should have the same results. An advantage of using monthly data is that price indices are available on a monthly basis so that one could use real exchange rates.

Concerning our measure of interest rate volatility we apply an analogous procedure. In most cases (Argentina, Paraguay and Uruguay) we refer to the deposit rate. In the case of Brazil, we use the money market rate; for the euro zone we choose the German money market rate until December 1994 and from January on the 3-month rate. Finally, the U.S. interest rate is approximated by the treasury bill rate. Real interest rates are deflated with the respective consumer price index (see Annex). When calculating the relevant volatilities for the euro-dollar relationship, we used the interest rate differential instead of the interest rate levels in this case, because it is not ex ante obvious whether, e.g. the U.S. interest rate is exogenous to the euro interest rate (as it might be presumed for the U.S. interest rate with respect to, e.g., Argentina).

Our theoretical and empirical approach is related to, but not identical to the work of Reinhart and Reinhart (2001) as well as Calvo and Reinhart (2000a). These authors speak of volatility, but discuss in reality the impact of changes in the first moments (levels) of the G-3 exchange rates on "innocent bystanders", like Mercosur countries. In our contribution, we look only at the second statistical moment. However, it seems to be extremely important to note that the model for a negative relationship between G-3 exchange rate and interest (or monetary aggregate) volatility developed by Reinhart and Reinhart (2001), pp. 5 ff., is not exactly based on our measure of volatility. But their measure is more closely linked to ours than to the first moment of exchange rate and interest rate changes which are also often used in this context. See for this also Calvo and Reinhart (2000), pp. 13 ff. As a proxy for exchange rate volatility, they use the frequency distribution of monthly exchange rates (in percent) based on certain threshold values. It immediately becomes clear that their measure is rather close to ours or even only a monotonous transformation since the mean of the monthly change of monthly exchange or interest rates can be interpreted as a threshold for the actual changes

in the framework of our standard deviation measure as well. This is surprisingly analogous to the threshold values used by Reinhart and Reinhart (2001) and Calvo and Reinhart (2000).

The average variability (standard deviations) of the nominal dollar exchange rate of the ARP was 7.32 % for the whole period, that of the BRR, the PYG, and the URP was much lower at 3.69, 2.11, and 2.52 %.[6] Also in nominal terms, interest rate variability usually moves around an aberrant 31.87 % for Argentina, 28 % for Brazil, 11 % for Paraguay, and 4.57 % for Uruguay. Calculating real exchange rate variability makes more sense in principle and is much lower than the nominal one for each Mercosur country (6.38 % for Argentina, 2.54 % for Brazil).

4.2. Evidence from simple tests of the volatility trade-off

In the following, we present some simple tests of the significance and of the sign of the correlation between the relevant volatility measures. More specific, we expect a negative sign if there is a trade-off between two volatilities and a positive sign if there is a co-movement of volatilities.

The estimated correlations between our measures of exchange rate and interest rate variability are shown in Tables 1A to 1C below. Note that these tables display the correlation coefficients (Bravais, Pearson) in percent. Are the correlation coefficients significant? Under the assumption that both variables are (commonly) normally distributed, the (one-sided) test-statistics $(\text{cor.coef.}/\sqrt{(1-\text{cor.coef.})^2}) \cdot \sqrt{N-2}$ may be used for a tentative answer. The latter is student-t-distributed with N-2 degrees of freedom (N = number of observations). As corresponding calculations immediately reveal, the lowest empirical realization of this test statistics (Table 1A) amounts to 1.53 for Argentina which is still significant on the ten percent level, whereas the relevant test statistics especially for Uruguay, but also in some cases for Brazil and Paraguay are not significant on the usual significance levels.

Starting from our total sample from 1970 to 2001, we compute each of the second moments for the Bravais Pearson correlation coefficient, using all non-missing observations for the relevant series. Hence, we use the maximum number of observations for our unbalanced sample. In the case of Argentina, we additionally limited the sample to the period from 1981 on, taking the transition from pre-announced sliding peg ("tablita") to floating exchange rate into account. Finally, we limited the sample to annual data from 1991 on. By this, we operationalize Argentina's transition from different attempts to fix or to control the exchange rate (Alfonsín and Menem) to the convertibility plan. In the case of Brazil, we introduced a sample split for the year 1994 (real plan). For Paraguay, reliable data were only

6 However, one has to be cautious because this measure calculated over the whole available sample includes, e. g., for Argentina such different periods like the period of extreme exchange rate instability like 1989/90 and the currency board phase in the nineties. Hence, using sample splits are highly recommended.

available from 1990 on, i.e., after the transition to flexible exchange rates. For Uruguay, no sample split seems to be indicated according to our above considerations.[7]

TABLE 1A
CORRELATION MATRICES OF INDICATORS OF EXCHANGE RATE AND INTEREST RATE VARIABILITY
(FULL SAMPLE, ONLY PARAGUAY FROM 1990 ON)

	Argentina		Brazil		Uruguay		Paraguay	
	ς_R^{AR}	ς_{RR}^{AR}	ς_R^{BR}	ς_{RR}^{BR}	ς_R^{UY}	ς_{RR}^{UY}	ς_R^{PY}	ς_{RR}^{PY}
$?_e^{\_\_, US}$	0.90***	–	0.82***	–	0.27*	–	0.43**	–
$?_q^{\_\_, US}$	–	0.83***	–	0.31**	–	0.24*	–	0.36*
$?_e^{\_\_, EU}$	0.91***	–	0.80***	–	0.23*	–	0.26	–
$?_q^{\_\_, EU}$	–	0.85***	–	0.22*	–	0.23*	–	0.30*
$?_e^{US, EU}$	0.29**	–	-0.16	–	0.05	–	0.33*	–
$?_q^{US, EU}$	–	0.29*	–	-0.16	–	-0.01	–	0.40**
$?_Q^{\_\_}$	–	0.82***	–	0.34**	–	0.15	–	-0.12
$?_E^{\_\_, MERCOSUR}$	0.85***	–	0.41***	–	0.01	–		
$?_Q^{\_\_, MERCOSUR}$	–	0.80***	–	0.17	–	0.15		

Sample: $\varsigma_e^{BR,US}$, $\varsigma_q^{BR,US}$, ς_R^{BR}, ς_{RR}^{BR}, $\varsigma_e^{UY,US}$, $\varsigma_q^{UY,US}$, $\varsigma_e^{PY,US}$, $\varsigma_q^{PY,US}$ from 1970 on; $\varsigma_e^{AR,US}$ and $\varsigma_q^{AR,US}$, $\varsigma_E^{AR,MERCOSUR}$, $\varsigma_Q^{AR,MERCOSUR}$, $\varsigma_E^{BR,MERCOSUR}$, $\varsigma_Q^{BR,MERCOSUR}$, $\varsigma_E^{UY,MERCOSUR}$, $\varsigma_Q^{UY,MERCOSUR}$ from 1971 on; ς_R^{UY} and ς_{RR}^{UY} from 1976 on; ς_R^{AR} and ς_{RR}^{AR} from 1977 on; $\varsigma_e^{PY,EU}$, $\varsigma_q^{PY,EU}$, $\varsigma_e^{US,EU}$, $\varsigma_q^{US,EU}$ from 1978 on; $\varsigma_e^{AR,EU}$, $\varsigma_q^{AR,EU}$, ς_Q^{AR}, $\varsigma_e^{BR,EU}$, $\varsigma_q^{BR,EU}$, ς_Q^{BR}, $\varsigma_e^{UY,EU}$, $\varsigma_q^{UY,EU}$ from 1979 on; ς_Q^{PY}, ς_Q^{UY} from 1980 on; ς_R^{PY} and ς_{RR}^{PY} from 1990 on.

Significance levels are ***: 1%; **: 5%; *: 10% respectively.

Note: __ = AR, BR, UY, PY.

7 As a robustness check, we calculated the correlation coefficients based on breaks in 1981, 1989, 1991, and 1994 for all countries of the sample under investigation here. The outcome did not change the general pattern of results displayed above.

TABLE 1B
CORRELATION MATRICES OF INDICATORS OF EXCHANGE RATE AND INTEREST RATE VARIABILITY
(LIMITED SAMPLES)

	Argentina (from 1981 on)		Argentina (from 1991 on)		Brazil (from 1994 on)	
	ς_R^{AR}	ς_{RR}^{AR}	ς_R^{AR}	ς_{RR}^{AR}	ς_R^{BR}	ς_{RR}^{BR}
$?_e^{-, US}$	0.90***	–	0.90***	–	0.83***	–
$?_q^{-, US}$	–	0.83***	–	0.93***	–	-0.07
$?_e^{-, EU}$	0.90***	–	0.90***	–	0.87***	–
$?_q^{-, EU}$	–	0.84***	–	0.94***	–	-0.07
$?_e^{US, EU}$	0.26*	–	0.57***	–	-0.31	–
$?_q^{US, EU}$	–	0.26*	–	0.61***	–	-0.31
$?_Q^{-}$	–	0.82***	–	0.81***	–	-0.31
$?_E^{-, MERCOSUR}$	0.84***	–	0.44**	–	0.83***	–
$?_Q^{-, MERCOSUR}$	–	0.79***	–	0.52***	–	-0.03

According to Table 1C, the correlation coefficient of the *nominal* dollar-euro exchange rate variability ($\varsigma_c^{US.EU}$) and the variability of euro zone-U.S. *nominal* interest differential ($\varsigma_{RDif}^{EU,US}$) (from 1978 on due to availability of $\varsigma_e^{US,EU}$) is 0.13. The correlation coefficient of *real* dollar-euro exchange rate variability and variability of euro zone-U.S. *real* interest differential (from 1978 on due to availability of $\varsigma_e^{US,EU}$) amounts to 0.19. Finally, the coefficients of correlation between the volatilities of the euro zone and the U.S. real effective exchange rate and the variability of euro zone-U.S. *real* interest differential are –0.03 and –0.18 respectively. However, none of them is significant.

TABLE 1C
CORRELATION MATRIX OF DOLLAR-EURO EXCHANGE RATE VOLATILITY AND VARIABILITY OF EURO ZONE-U.S. INTEREST DIFFERENTIAL

	$\varsigma_e^{US,EU}$	$\varsigma_q^{US,EU}$	ς_Q^{EU}	ς_Q^{US}
$\varsigma_{RDif}^{EU,US}$	0.13	–	–	–
$\varsigma_{RRDif}^{EU,US}$	–	0.19	-0.03	-0.18

Sample: for all variables from 1987 on.

The general picture emerging from these correlation exercises is the following. For countries subject to speculative attacks and/or bouts of hyperinflation exchange rate and interest rate volatility move together. The case of Argentina is remarkable in this respect where both volatilities nearly move one-to-one. Even during calmer periods (either of a currency board that is perceived to be credible, or of a floating exchange rate regime with inflation under control) the relationship is tight as both variables seem to be driven by a country's ability to access international capital markets. However, the experience of Argentina has reinforced once more the lesson that calmer periods will last only if the underlying arrangement is stable. Hence, nothing assures that pegging the Argentine peso to the dollar will automatically lead to calm periods, smoothing the movements in the interest rates. The last three years of the currency board provide evidence on this. The contrary applies for the major floating exchange rates. As shown in tables 1A to 1C, dollar (or euro) volatility is not systematically related to interest rate volatility (this holds irrespectively of whether one uses the volatility of dollar interest rates, or that of interest rate differentials dollar-euro).

The fact that the real exchange rate indices are somewhat less variable than the nominal ones (at least for the South American currencies considered here) just confirms that exchange rates during high inflation periods, even in the short run, do move to somewhat offset price developments. Our approach is related to, but not identical to the work of Reinhart and Reinhart (2001) as well as Calvo and Reinhart (2000a). These authors speak of volatility, but discuss in reality the impact of changes in the first moments (levels) of the G-3 exchange rates on "innocent bystanders", like Mercosur countries. We look only at the second moment. Table 1A suggests that a higher variability of the dollar/euro exchange rate is not strongly correlated with interest rate volatility in Mercosur (correlation coefficients of 0.29 and -0.16 respectively for Argentina and Brazil). As for Mercosur, i. e. for Argentina and Brazil, interest rate volatility is almost the same as exchange rate volatility. This implies that dollar/euro volatility is also not strongly correlated with volatility of the Mercosur currencies. Just to repeat: we are comparing and correlating second moments. Even if they are not correlated it can still remain true that a weak euro creates difficulties for Argentina when it is pegged to the dollar.

5. "Third" Missing Variables as Additional Arguments?

So far, we have identified a positive association between both volatility measures. As a final step, we now extend the empirical section to check whether it is necessary to include multivariate analysis. Correcting for other determinants of the exchange rate may shed more light on how viable the positive association between the volatility variables really is.

What other potential determinants of exchange rate volatility and interest rate volatility might be considered here? In section 5.1, we focus our investigations on the real sector variables employment, unemployment and real investment as potential fundamentals driving exchange rate volatility and interest rate volatility.

At the same time, these variables typically affect the expected level of the exchange rate and, hence, may serve as a proxy for the expected exchange rate in our investigations. In section 5.2, we relate to the level of the exchange rate and the level of the real interest rate as the potential explaining variables behind the volatilities. In section 5.3, we test explicitly whether the respective volatilities are driven by domestic monetary volatility. According to all experience with emerging markets, the rate of money growth is one of those variables which typically affect the level of country risk.[8] In each section, we give reasons for the choice of these robustness check variables in detail.

5.1. Exogeneity of volatility variables with respect to real economy?

Former investigations by the authors suggest that exchange rate variability (whether extra- or intra-Mercosur) and interest rate variability have had a statistically significant negative impact on employment and investment for those Southern Cone countries investigated in this contribution (Belke and Gros 2002, 2002a). This piece of evidence, taken by itself, is a possible objection against these results, since in our former investigations exchange rate variability and interest rate volatility influence real variables with a lag. Hence, reverse causation and a case for third missing variables appear less plausible. But even in cases of a contemporaneous relationship reverse causation appears not to be a problem as suggested by additional pairwise Granger causality tests which are applied to exchange rate and interest rate variability and three real sector variables, namely employment, unemployment and real investment.

In our Granger-causality tests, the lag length l=2 corresponds to our reasonable beliefs about the longest time over which one of the variables could help to predict the other. We run bivariate pairwise regressions of the form:

(1) $$y_t = \alpha_0 + \alpha_1 y_{t-1} + ... + \alpha_l y_{t-l} + \beta_1 x_{t-1} + ... + \beta_l x_{t-l} + \varepsilon_t \text{ and}$$

$$x_t = \alpha_0 + \alpha_1 x_{t-1} + ... + \alpha_l x_{t-l} + \beta_1 y_{t-1} + ... + \beta_l y_{t-l} + u_t ,$$

with y = volatility variable and x = robustness check variable. The reported p-values are the probability values of the F-statistics which for each equation corresponds to the Wald statistics for the joint hypothesis:

(2) $$\beta_1 = \beta_2 = ... = \beta_l = 0$$

[8] We do not consider measures of political stability in our context because these variables often move very slowly and, hence, are of no apparent use in empirical studies like this one which focus on individual countries instead of a panel of economies.

TABLE 2
EXOGENEITY OF VOLATILITY VARIABLES WITH RESPECT TO REAL ECONOMY? PAIRWISE GRANGER CAUSALITY TESTS FOR EXOGENEITY, ARGENTINA (UNTIL 1990)

Sample: 1970 1990 (lags: 2)

Null Hypothesis:			Obs	F-Statistic	Probability
du^{AR}	does not Granger cause	$\varsigma_e^{AR, US}$	18	--------	--------
dl^{AR}	does not Granger cause	$\varsigma_e^{AR, US}$	14	--------	--------
dII^{AR}	does not Granger cause	$\varsigma_e^{AR, US}$	18	--------	--------
du^{AR}	does not Granger cause	$\varsigma_q^{AR, US}$	18	--------	--------
dl^{AR}	does not Granger cause	$\varsigma_q^{AR, US}$	14	--------	--------
dII^{AR}	does not Granger cause	$\varsigma_q^{AR, US}$	18	--------	--------
du^{AR}	does not Granger cause	$\varsigma_e^{AR, EU}$	10	--------	--------
dl^{AR}	does not Granger cause	$\varsigma_e^{AR, EU}$	10	--------	--------
dII^{AR}	does not Granger cause	$\varsigma_e^{AR, EU}$	10	--------	--------
du^{AR}	does not Granger cause	$\varsigma_q^{AR, EU}$	10	--------	--------
dl^{AR}	does not Granger cause	$\varsigma_q^{AR, EU}$	10	--------	--------
dII^{AR}	does not Granger cause	$\varsigma_q^{AR, EU}$	10	--------	--------
du^{AR}	does not Granger cause	$\varsigma_e^{US, EU}$	11	--------	--------
dl^{AR}	does not Granger cause	$\varsigma_e^{US, EU}$	11	--------	--------
dII^{AR}	does not Granger cause	$\varsigma_e^{US, EU}$	11	3.46332	0.10000
du^{AR}	does not Granger cause	$\varsigma_q^{US, EU}$	11	--------	--------
dl^{AR}	does not Granger cause	$\varsigma_q^{US, EU}$	11	--------	--------
dII^{AR}	does not Granger cause	$\varsigma_q^{US, EU}$	11	--------	--------
du^{AR}	does not Granger cause	ς_Q^{AR}	10	--------	--------
dl^{AR}	does not Granger cause	ς_Q^{AR}	10	--------	--------
dII^{AR}	does not Granger cause	ς_Q^{AR}	10	--------	--------
du^{AR}	does not Granger cause	$\varsigma_E^{AR, MERCOSUR}$	18	--------	--------
dl^{AR}	does not Granger cause	$\varsigma_E^{AR, MERCOSUR}$	14	--------	--------
dII^{AR}	does not Granger cause	$\varsigma_E^{AR, MERCOSUR}$	18	--------	--------
du^{AR}	does not Granger cause	$\varsigma_Q^{AR, MERCOSUR}$	18	--------	--------
dl^{AR}	does not Granger cause	$\varsigma_Q^{AR, MERCOSUR}$	14	--------	--------
dII^{AR}	does not Granger cause	$\varsigma_Q^{AR, MERCOSUR}$	18	--------	--------
du^{AR}	does not Granger cause	ς_R^{AR}	18	--------	--------
dl^{AR}	does not Granger cause	ς_R^{AR}	14	4.35821	0.04747
dII^{AR}	does not Granger cause	ς_R^{AR}	18	--------	--------
du^{AR}	does not Granger cause	ς_{RR}^{AR}	12	--------	--------
dl^{AR}	does not Granger cause	ς_{RR}^{AR}	12	--------	--------
dII^{AR}	does not Granger cause	ς_{RR}^{AR}	12	4.20507	0.06317

Note: "------" substitutes p-values of more than 0.10.

The null hypothesis is that x does not Granger-cause y in the first regression and that y does not Granger-cause x in the second regression. Table 2 displays the results from (11 volatility variables times 3 real sector variables =) 33 *pairwise* Granger causality tests. Further information can be found in Belke *et al*. (2003), Table 3. The real variables considered are changes (first differences) in unemployment rate (u), employment rate (l), and real investment (II). (See Annex for details of variables).

In case of Argentina and Brazil we are not forced to reject the hypothesis that the real sector variables do not Granger cause our volatility measures in 65 out of 66 cases.[9] In addition, there are also some other arguments which speak in favor of our exogeneity hypothesis for the volatility variables. We are skeptical in general about the possibility that exchange rate and interest rate variability at our high frequency was caused by slow moving variables such as labor market rigidities or unemployment and investment. A further argument validating our methodology and our results comes from the work of Canzoneri, Vallés and Viñals (1996) and others who show for a different sample of countries that exchange rates reacted mainly to financial shocks rather than real fundamentals. Hence, financial variables remain the main suspects with respect to the question whether there are still some determinants of exchange rate volatility which have not been considered here. Rose (1996) and Flood and Rose (1995) also emphasize that exchange rate volatility is largely noise. It does not make much sense to treat a noise series as endogenous. Seen on the whole, this fosters our theoretical background.

Let us now turn to the second group of variables suspect of being neglected in our interpretation of the simple correlation coefficients in section 4, namely other financial variables. In order to be legitimized to neglect them in our empirical correlation analysis, we have to test and not to reject empirically that our volatility variables are exogenous with respect to these financial variables. We do this in the following section.

5.2. Exogeneity of volatility with respect to financial variables?

The purpose of the following is to report the results of some tests for the robustness of the relationships found so far. We try to take into account the two most plausible ways in which our measures of exchange rate and interest rate variability could stand for some other variable. For each hypothesis we then implement the same Granger causality test procedure as described in section 5.1.

The two hypotheses we consider are:

i) Exchange rate variability is just a sign of a misalignment (i.e. a wrong level of the exchange rate). A first possible caveat might be that this volatility

9 However, based on former estimates (Belke and Gros (2002a), pp. 41 f.) we do in the overwhelming majority of cases reject the hypothesis that our volatility measures do not "cause" the three real sector variables. Therefore it appears that "causality" runs from volatility to the real sector and not the other way around.

just stands for misalignments of the real exchange rate. Mercosur currencies were usually variable when they were very weak. But this argument needs to be addressed because it is claimed that devaluations are contractionary.

ii) Interest rate variability just reflects the financial stress defined as high real (short-term) interest rates. Interest rate variability could also just be the result of a tight monetary policy. However, this problem of identification can be reduced by explicitly by considering a variable that indicates the degree of tightness. We use the (real) interest rate as a first tentative indicator.

In order to take these hypotheses into account, we added the first difference (the level is not stationary) of the exchange rate in the Granger causality regressions displayed in Table 3 below and in table 4 of Belke *et al.* (2003), if the implemented volatility measure is one for exchange rate variability. In contrast, if an interest rate volatility measure enters the regression equation, the change in the respective interest rate (again, the level is non-stationary) is inserted in the Granger causality test equations. On the whole, these tests confirm that our correlation results are not spurious so that we can still assume that volatilities are driven by factors such as market confidence and politics.

TABLE 3
PAIRWISE GRANGER CAUSALITY TESTS FOR COLLINEARITY, BRAZIL
(UNTIL 1993)

Sample: 1970 1993 (lags: 2)

Null Hypothesis:			Obs	F-Statistic	Probability
$de^{US, EU}$	does not Granger cause	$\varsigma_e^{US, EU}$	21	--------	0.03893
$dq^{BR, US}$	does not Granger cause	$\varsigma_q^{BR, US}$	21	--------	--------
$de^{BR, EU}$	does not Granger cause	$\varsigma_e^{BR, EU}$	13	--------	0.07460
$dq^{BR, EU}$	does not Granger cause	$\varsigma_q^{BR, EU}$	13	--------	0.07293
$de^{US, EU}$	does not Granger cause	$\varsigma_e^{US, EU}$	13	--------	--------
$dq^{US, EU}$	does not Granger cause	$\varsigma_q^{US, EU}$	13	--------	--------
dQ^{BR}	does not Granger cause	ς_Q^{BR}	13	--------	0.01132
$dQ^{BR, MERCOSUR}$	does not Granger cause	$\varsigma_Q^{BR, MERCOSUR}$	20	--------	--------
$dE^{BR, MERCOSUR}$	does not Granger cause	$\varsigma_E^{BR, MERCOSUR}$	20	--------	--------
dR^{BR}	does not Granger cause	ς_R^{BR}	21	--------	--------
dRR^{BR}	does not Granger cause	ς_{RR}^{BR}	21	--------	--------

Note: "------" substitutes p-values of more than 0.10.

5.3. Is volatility caused by monetary influences?

We also enacted some preliminary statistical analysis to investigate whether interest rate volatility and exchange rate volatility are driven by (in case of exchange

rate volatility, relative) domestic monetary volatility.[10] For this purpose, we calculated the relevant correlation matrices like in section 4 (tables 4 and 5) and again conducted a Granger causality analysis (see tables 6 and 7 in Belke *et al.* (2003)). In the first two rows we ask whether domestic monetary policy volatility (volatility of M1 Argentina respectively the volatility of monetary base Brazil) does systematically 'cause' interest rate volatility in Argentina and Brazil. The second two rows refer to the test whether domestic monetary policy volatility relative to the U.S. does 'cause' exchange rate volatility in Argentina and Brazil. However, the availability of data was limited to the time span 1980 to 2000. The Granger causality analysis is conducted in greater detail in Belke *et al.* (2003). There, we include Argentina's currency board period because otherwise the estimates might have been unreliable due to the low number of observations. Alternatively, we only refer to tests based on a sample excluding Argentina's currency board period. The drawback in this case is that we have only few numbers of observations available and the results maybe not reliable. The notations are as before.

TABLE 4
CORRELATION MATRIX (BALANCED SAMPLE 1980-2000): DOMESTIC INTEREST VOLATILITY AND DOMESTIC MONETARY VOLATILITY (MERCOSUR VIS-À-VIS U.S.)

	ς_R^{AR}	ς_R^{BR}
ς_{M1}^{AR}	0.73	
ς_{MBase}^{BR}		0.57

TABLE 5
CORRELATION MATRIX (BALANCED SAMPLE 1980-2000): EXCHANGE RATE VOLATILITY AND RELATIVE MONETARY VOLATILITY (MERCOSUR VIS-À-VIS U.S.)

	$\varsigma_{MRel}^{AR, US}$	$\varsigma_{MRel}^{BR, US}$
$\varsigma_e^{AR, US}$	0.87	
$\varsigma_e^{BR, US}$		0.30

The main results of our preliminary analysis are as follows. First, we find a high correlation between domestic monetary policy volatility and interest rate

10 Like all the other volatility measures used here, volatility is again defined as described in the algorithms in the annex of Belke and Gros (2002a).

volatility, and, second, a high correlation between exchange rate volatility and relative monetary policies in the case of Argentina. However, the results seem to indicate that this correlation cannot be interpreted in the sense of a causal relationship. This emphasizes again our confidence that both volatilities are driven either by politics or by international financial markets. For a closer view, further research will be necessary.

Hence, these questions of what is driving the volatilities of the exchange rates and the interest rates cannot finally be answered within this paper. Our main finding is that correcting for important potential determinants of the exchange rate cannot help to establish the conditions under which the suggested positive association is viable. Since our results based on estimated correlation coefficients appear to be robust with respect to the consideration of potential third variables, we do not feel that our scope for conclusions is severely limited. On the contrary, we are rather confident in concluding that there is –in contrast, e.g., to the US and the euro area– no volatility trade-off in the Southern Cone.

6. Conclusions

Our contribution examines the interrelation between exchange rate volatility and interest rate volatility in Mercosur countries. Our findings can be summarized to three major points:

First, other than authors like Calvo and Reinhart (2000), we cannot detect a trade-off between both variables for the Mercosur. Instead, the data from the past suggest that there is a statistically co-movement of exchange rate and interest rate volatilities in the Southern Cone. This goes very much in line with our theoretical framework that provided us with the testable hypothesis of co-movement. However, this result stands in sharp contrast to our results for the euro area and the US. Hence, we conclude that countries like Argentina or Brazil are able to realize not only lower interest rates (due to a lower exchange rate risk) but also lower interest rate volatility when they peg their currency to a stable external anchor.

Second, with an eye on the model in section 3 and backed by our empirical evidence, we conclude that exchange rates are driven by different factors for Mercosur countries than for industrialized countries. This might seem obvious, but it has important implications. Our model predicts that Argentinean and Brazilian exchange rates are largely influenced by confidence (in the ability to serve external debt and the solidity of domestic political institutions) and the solidity of domestic political institutions. Although we do not test directly the influence of both factors on the volatilities we can reject the influence of several other related macro variables on exchange rates and interest rates. Identifying some additional determinants of exchange rate volatility, other than interest rate volatility, would have allowed us to establish the conditions under which a positive association between exchange rate and interest rate volatility holds. However, according to our robustness checks all variables under suspect finally proved to be variables to which exchange rate and interest rate variability in the Mercosur are clearly exogenous.

In this contribution, we approximate the country risk of emerging markets by the rate of money growth. However, we can think of other variables which typically also affect the level of country risk, like for instance capital flows, debt to GDP ratios and measures of political stability. Their explicit inclusion in the analysis of the volatility trade-off is left for future research which should then perhaps rely on a panel analysis.

Third, another fact here is the different behavior of real and nominal volatilities. As mentioned in section 4, theory would suggest that both variables should move similarly as we have stressed credibility to be a major influence factor in exchange rate and interest rate behavior. This, in turn, would make either nominal or real variables redundant for our analysis. In fact, our investigations lead to partly different effects for real and nominal variables. We do not examine this in more detail – also leaving here space for future research. Anyway, a possible explanation might be "pricing to market" behavior that makes real and nominal exchange rates behave differently.

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ANNEX

1. Data – variable definitions

The following variables have been used:

M	Money supply	RR	Real interest rate
P	Price level	ς	Volatility
e	Nominal exchange rate	L	Employment
E	Nominal effective exchange rate	l	Employment rate
q	Real exchange rate	u	Unemployment rate
Q	Real effective exchange rate	I	Investment
R	Nominal interest rate	II	Real investment

The country is noted in the variable's exponent, further explanations are made in the variable's basis.

Nominal bilateral exchange rates:

$e^{AR, US}$	Nominal exchange rate Argentinean Peso to U.S. Dollar: IMF – Statistical Yearbook and various Monthly Reports.
$e^{BR, US}$	Nominal exchange rate Brazilian Real to U.S. Dollar: IMF – Statistical Yearbook and various Monthly Reports.
$e^{PY, US}$	Nominal exchange rate Paraguayan Guarani to U.S. Dollar: IMF – Statistical Yearbook and various Monthly Reports.
$e^{UY, US}$	Nominal exchange rate Uruguayan Peso to U.S. Dollar: Banco Central del Uruguay (until June 1973) and IMF – Statistical Yearbook and various Monthly Reports (from July 1973 on).
$e^{US, EU}$	Nominal exchange rate Euro to U.S. Dollar: period average, Source: IMF – Statistical Yearbook and various Monthly Reports, IFS (IMF) series 111..EB.ZF... .

The remaining bilateral nom. exchange rate time series were created via cross-rates.

$de^{US, EU}$	Growth rate of the nominal exchange rate Euro to U.S. dollar: $= D(LOG(e^{US, EU}))*100$.

The remaining growth rates are constructed analogously.

Nominal effective exchange rates:

E^{EU}	Nominal effective exchange rate of the euro: Source: IFS (IMF) series 163..NEUZF…
E^{PY}	Nominal effective exchange rate of the Paraguayan Guarani: Source: IFS (IMF) series.
E^{US}	Nominal effective exchange rate of the U.S. dollar: based on unit labor costs, Source: IFS (IMF) series 111..NEUZF... .
E^{UY}	Nominal effective exchange rate of the Uruguayan Peso: Source: IFS (IMF) series.

Real effective exchange rates:

Q^{AR}	Real effective exchange rate of the Argentinean Peso: Monthly data: = $4.739*q^{AR, JP} + 22.058*q^{AR, US} + 35.402*q^{AR, EU} + 35.004*q^{AR, BR} + 2.797*q^{AR, UY}$ (weights from Center for Global Trade Analysis (2001): GTAP 5: exports + imports). Annual data: Real effective exchange rate Argentina in terms of import prices, Source: Comisión Económica para América Latina y el Caribe. http://www.eclac.org/publicaciones/DesarrolloEconómico.

Q^{BR}	Real effective exchange rate of the Brazilian Real: Monthly data: = $8.258*q^{BR, JP} + 31.974*q^{BR, US} + 41.362*q^{BR, EU} + 16.431*(1/q^{AR, BR}) + 1.974*q^{BR, UY}$ (weights from Center for Global Trade Analysis (2001): GTAP 5: exports + imports).Annual data: Real effective exchange rate Brazil in terms of import prices, Source: Comisión Económica para América Latina y el Caribe. http://www.eclac.org//publicaciones/DesarrolloEconomico.
Q^{EU}	Real effective exchange rate of the euro: based on unit labor costs, Source: IFS (IMF), series 163..REUZF... .
Q^{PY}	Real effective exchange rate of the Paraguayan Guarani: based on relative CPI, Source: IMF – Statistical Yearbook and various Monthly Reports.
Q^{US}	Real effective exchange rate of the U.S. dollar: based on unit labor costs, Source: IFS (IMF) series 111..REUZF... .
Q^{UY}	Real effective exchange rate of the Uruguayan Peso: based on relative CPI, Source: IMF – Statistical Yearbook and various Monthly Reports.

Exchange rate volatility:

ς_E^{EU}	Volatility of the nominal effective euro exchange rate: based on E^{EU}.
ς_E^{US}	Volatility of the nominal effective U.S. dollar exchange rate: based on E^{US}.
ς_Q^{EU}	Volatility of the real effective euro exchange rate: based on Q^{EU}.
ς_Q^{US}	Volatility of the real effective U.S. dollar exchange rate: based on Q^{US}.
$\varsigma_e^{US, EU}$	Volatility of the nominal exchange rate U.S. dollar to euro. based on $e^{US, EU}$.
$\varsigma_O^{AR, Mercosur}$	Volatility of the real Argentinean Peso exchange rate towards the other Mercosur currencies = $0.926 * \varsigma_q^{AR, BR} + 0.074 * \varsigma_q^{AR, UY}$.
$\varsigma_Q^{BR, Mercosur}$	Volatility of the real Brazilian Real exchange rate towards the other Mercosur currencies = $0.8927 * \varsigma_q^{AR, BR} + 0.1073 * \varsigma_q^{BR, UY}$.
$\varsigma_O^{UY, Mercosur}$	Volatility of the real Uruguayan Peso exchange rate towards the other Mercosur currencies = $0.60 * \varsigma_q^{BR, UY} + 0.40 * \varsigma_q^{AR, UY}$.
$\varsigma_E^{AR, Mercosur}$	Volatility of the nominal Argentinean Peso exchange rate towards the other Mercosur currencies = $0.926 * \varsigma_e^{AR, BR} + 0.074 * \varsigma_e^{AR, UY}$.
$\varsigma_E^{BR, Mercosur}$	Volatility of the nominal Brazilian Real exchange rate towards the other Mercosur currencies = $0.8927 * \varsigma_e^{AR, BR} + 0.1073 * \varsigma_e^{BR, UY}$.
$\varsigma_E^{UY, Mercosur}$	Volatility of the nominal Uruguayan Peso exchange rate towards the other Mercosur currencies = $0.60 * \varsigma_e^{BR, UY} + 0.40 * \varsigma_e^{AR, UY}$.

Weights = exports plus imports weights from Center for Global Trade Analysis 2001 for consistency reasons. The remaining volatility variables are constructed analogously.

Interest rates:

Interest rates:

R^{AR}	Nominal interest rate Argentina: Deposit Rate (in home curreny), Source: IFS (IMF) series 21360L..ZF...
R^{BR}	Nominal interest rate Brazil: Money Market Rate (in home currency), Source: IFS (IMF) series 22360B..ZF...
R^{PY}	Nominal interest rate Paraguay: Deposit Rate (in home currency), Source: IFS (IMF) series.
R^{UY}	Nominal interest rate Uruguay: Deposit Rate (in home currency), Source: IFS (IMF) series.
R^{EU}	Nominal interest rate euro zone: until December 1994: German money market rate, Source: Bundesbank; from January 1995 on: 3-month rate, Source: ECB, Monthly Reports.
R^{US}	Nominal interest rate U.S.: treasury bill rate, Source: Federal Reserve Bank.
$Rdif^{EU, US}$	Euro zone-U.S. nominal interest differential
RR^{AR}	Real interest rate Argentina: R^{AR} deflated by the consumer price index.
RR^{BR}	Real interest rate Brazil: R^{BR} deflated by the consumer price index.
RR^{PY}	Real interest rate Paraguay: R^{PY} deflated by the consumer price index.
RR^{UY}	Real interest rate Uruguay: R^{UY} deflated by the consumer price index.
RR^{EU}	Real interest rate euro zone: R^{EU} deflated by the consumer price index.
RR^{US}	Real interest rate U.S.: R^{US} deflated by the consumer price index.

Interest rates volatility:

ς_R^{EU}	Volatility of the nominal euro zone interest rate: based on R^{EU}.
ς_{RR}^{EU}	Volatility of the real euro zone interest rate: based on RR^{EU}.
$\varsigma_{RDif}^{EU, US}$	Variability of euro zone-U.S. nominal interest differential based on $Rdif^{EU, US}$

The remaining volatility variables are constructed analogously.

Price Level:

P^{AR}	Price Level Argentina: Consumer Price Index Argentina (1995=100), Source: Instituto Nacional de Estadística y Censos, (http://www.indec.mecon.gov.ar).
P^{BR}	Price Level Brazil: Consumer Price Index Brazil (1995=100), Source: IFS (IMF) series CPI (22364...ZF...) + IMF – Statistical Yearbook and various Monthly Reports.
P^{EU}	Price Level euro zone: Consumer Price Index (1995=100), Source: until December 1994 Bundesbank, from January 1995 on ECB.
P^{PY}	Price Level Paraguay: Consumer Price Index Paraguay (1995=100), Source: IFS (IMF) series CPI (22364...ZF...) + IMF – Statistical Yearbook and various Monthly Reports and Banco Central del Paraguay (from September 1999 on).
P^{US}	Price Level U.S.: Consumer Price Index (1995=100), Source: IFS (IMF) series CPI (11164...ZF...) + IMF – Statistical Yearbook and various Monthly Reports.
P^{UY}	Price Level Uruguay: Consumer Price Index Uruguay (1995=100), Source: IFS (IMF) series CPI + IMF – Statistical Yearbook and various Monthly Reports.

Investment:

I^{AR}	Investment Argentina: Gross Fixed Capital Formation Argentina (millions of Argentinean peso), Source: IMF Statistical Yearbook, IFS (IMF).
I^{BR}	Investment Brazil: Gross Fixed Capital Formation Brazil (millions of real), Source: IMF Statistical Yearbook, IFS (IMF).
I^{PY}	Investment Paraguay: Gross Fixed Capital Formation Paraguay (billions of guarani), Source: IMF Statistical Yearbook, IFS (IMF).
I^{UY}	Investment Uruguay: Gross Fixed Capital Formation Uruguay (millions of Urug. peso), Source: IMF Statistical Yearbook, IFS (IMF).

Money:

$M1^{AR}$	M1 Argentina: Source: national currency, thousands, IFS/IMF Series 21334...ZF... .
$MBase^{BR}$	Monetary Base Brazil: used instead of M1 for reasons of data availability, Source: http://www.bancocentral.gov.br
$M1^{US}$	M1 U.S.: Currency, travellers cheques, demand deposits and other checkable deposits, Source: Federal Reserve Bank.
$\varsigma_{M1}{}^{AR}$	Volatility of M1 Argentina
$\varsigma_{MBase}{}^{BR}$	Volatility of monetary base Brazil

Relative monetary policy:

$Mrel^{AR, US}$	Relative monetary policy Argentina/U.S.: $=M1^{AR}/M1^{US}$.
$Mrel^{BR, US}$	Relative monetary policy Argentina/U.S.: $=MBase^{BR}/M1^{US}$.
$\varsigma_{Mrel}^{AR, US}$	Volatility of relative monetary policy Argentina/U.S.
$\varsigma_{MRel}^{BR, US}$	Volatility of relative monetary policy Brazil/U.S.

Employment and employment rates:

l^{AR}	Employment rate Argentina: Evolución de la las principales variables ocupacionales (% of employed population to total pop.), Empleo, Tasa de Empleo en Aglomerados Urbanos, Src: Enc. Permanente de Hogares, INDEC. http://www2.mecon.gov.ar/infoeco/.
L^{BR}	Employment level Brazil: (in thousands) Persons aged 10 years and over. Excl. rural population of Rondônia, Acre, Amazonas, Roraima, Pará and Amapá. Sep. of each year. Prior to 1979: excl. rural areas of Northern Region, Mato Grosso, Goiás and Tocantins. 1992 methodology revised; data not strictly comparable. Source: LABORSTA (http://laborsta.ilo.org/), IFS (IMF) and http://www4.bcb.gov.br/series-i/default.asp.
L^{PY}	Employment level Paraguay: (in thousands), Source: Banco Central del Paraguay, Real sector data, pobl. ocupada (http://www.bcp.gov.py/gee/statistic/indice.htm), see http://www.ine.gub.uy/mercosur/english/cuadros/mc 3 1.htm for the data consistency is massively hampered by different definitions of the sample, e.g., Metropolitan area of Asunción.(4) Urban area. (5) National total for urban and rural areas. Encuesta Permanente de Hogares.
L^{UY}	Employment level Uruguay: (in thousands) urban areas, incl. professional army; excl. compulsory military service, persons aged 14 years and over. 1984 and 1986 first semester, aclaración importante: Hasta el año 1997 la encuesta cubría a las localidades de 900 y más habitantes y a partir del año 1998 cubre de 5.000 o más habitantes. Source: IFS (IMF), LABORSTA (http://laborsta.ilo.org/), Instituto Nacional de Estadística (http://www.ine.gub.uy/), Principales Resultados Encuesta Continua de Hogares.

Unemployment:

u^{AR}	Unemployment rate Argentina: Evolución de la las principales variables ocupacionales (en %), Desocupación (in percent), Sources: Encuesta Permanente de Hogares, INDEC. http://www2.mecon.gov.ar/infoeco/.
u^{BR}	Unemployment rate Brazil: Unemployment rate Brazil (in percent), Taxa de Desemprego aberto – original e dessazonalizada – taxas medias 30 dias; Source: http://www.ibge.gov.br on the page "Indicadores Conjunturais" [Conjuncture Indicators] under the heading "Trabalho e Rendimento" [Labor and Income]: "Ajuste sazonal – taxa de desemprego" [Seasonal adjustment - unemployment rate]. IBGE, Diretoria de pesquisas, departamento de emprego e rendimento, pesquisa mensal de emprego.
u^{PY}	Unemployment rate Paraguay: Source: Banco Central del Paraguay, Real sector data, población ocupada (http://www.bcp.gov.py/gee/statistic/indice.htm).
u^{UY}	Unemployment rate Uruguay: Source: Instituto Nacional de Estadistica INE, Tasa de desempleo anual – Total País urbano y por Departamento, http://www.ine.gub.uy/bancodedatos/ECH/ECH%20TOT%20Des%20A.xls.