IS BRAZIL DIFFERENT? RISK, DOLLARIZATION, AND INTEREST IN EMERGING MARKETS[1]

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Abstract: With a panel-data approach, this paper expands the scope of the financial dollarization literature to investigate the determinants of the real interest rate in emerging economies. We found that real interest rates depend on the risks of debt dilution and default, expressed by inflation volatility and acceleration, as well as public debt size, investment-grade status, and per capita income. As anticipated in an analytical model, the availability of dollar-denominated deposits reduces the local-currency real interest rate. The estimated model is used to analyze the mystery of Brazil's high real interest rates. Our empirical model is unable to explain the sky-high level of real interest rates in the aftermath of Brazil's 1994 exchange-rate-based inflation stabilization. However, with the help of a proposed Central Bank prudence rule in face of adverse expectations, we argue that, since the adoption in 1999 of inflation targeting and floating exchange rates, Brazil's real interest rates are slowly converging to our model's predicted values.

JEL Classification: E43, F31, O16, O23, O54
Key words: financial dollarization, interest rates, emerging economies, panel data, Brazil

Resumo: A partir de uma abordagem em painel, este artigo expande o escopo da literatura sobre dolarização financeira para investigar os determinantes da taxa real de juros em economias emergentes. Nós encontramos que a taxa real de juros depende do risco de diluição de dívida e calote, expresso pela volatilidade e aceleração da inflação, assim como o tamanho da dívida pública, a classificação de risco soberano e a renda per capita. Como antecipado em um modelo analítico, acessibilidade a depósitos denominados em dólares reduz a taxa de juros em moeda local. O modelo estimado é usado para analisar o mistério das altas taxas reais de juros no Brasil. Nosso modelo empírico, contudo, é incapaz de explicar as altas taxas reais de juros após 1994. Entretanto, com a ajuda de uma regra de prudência proposta para o banco central que enfrenta expectativas adversas, nós argumentamos que, desde a adoção do regime de metas de inflação e de taxas de câmbio flutuantes, as taxas reais de juros vem convergindo lentamente para valores previstos pelo nosso modelo para as taxas reais de juros.

Classificação JEL: E43, F31, O16, O23, O54
Palavras-Chaves: dolarização financeira, taxa de juros, economias emergentes, análise em painel, Brasil.

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I. Introduction

In a seminal paper on financial contracts and risks in emerging economies, de la Torre and Schmukler (2004) argue that dollar contracts at home and in a foreign jurisdiction are rational responses of agents trying to cope with high systemic risks. Such risks include interest rate and exchange rate volatility, default risk, loss given default due to poor contract enforcement, and dilution and confiscation risks. In an environment of high systemic risk, currency mismatches, highlighted in the "original sin" hypothesis (Eichengreen and Hausmann, 1999), can be understood as risk-mitigating mechanisms. The original sin hypothesis poses that currency mismatches are the result of international market failures that prevent the issuance of local-currency-denominated bonds abroad. This contrasts with our focus, which emphasizes systemic risk as the main culprit for the mismatches.

De la Torre and Schmukler explicitly assume that investors are not compensated through the return on a given financial contract for risks that are diversifiable by the use of other contracts. Thus, for example, if the interest rate on a long-duration local-currency contract does not compensate investors for the risk of unexpected changes in inflation, such risk will be hedged via, say, a dollar contract. Similarly, if the interest rate on a contract written at home does not compensate investors for the confiscation risk, such risk will be diversified away by writing the contract in a foreign jurisdiction.

This lack of attention to interest rate differentials as part of risk-coping in emerging economies is also present in the rapidly growing literature on financial dollarization—defined as the use of a stronger foreign currency domestically as a credit instrument and a reserve of value.[3] The dominant paradigm in this literature is the so-called minimum variance portfolio (MVP) hypothesis, according to which the volatility of returns are key to explaining financial dollarization. In this framework, more often than not the local-currency interest rate is assumed to be given by an interest parity condition that is unrelated to the degree of financial dollarization. Thus, Ize and Levy-Yeyati (2006, p. 39), although recognizing cases in which deviations of the dollarization ratio from MVP allocations are associated to high real domestic interest rates, flatly assert that: "*…financial dollarization is immune to systematic differences in rates of return (through arbitrage, interest rates adjust to equalize ex ante rates of return). Instead, financial dollarization is all about risk differences.*"

Another view of financial dollarization sees the quality of institutions as a key driver of contract dollarization (Levy-Yeyati, 2006). There are many ways a poor institutional environment may boost dollarization. When institutional quality is low, the government may be unable to assure debt holders that it will not inflate away the real burden of local-currency debt. In this case, a credible commitment mechanism may be achieved by issuing dollarized debt (Calvo and Guidotti, 1990). On a related interpretation, implicit government guarantees about the exchange rate value may generate mispricing of risks and excess dollarization. De la Torre et al. (2003) argue that government guarantees were an important determinant of the contract dollarization during Argentina's currency board regime, but the argument is also applicable for countries with more flexible exchange rate regimes that exhibit "fear of floating" (Calvo and Reinhart, 2002).

Irrespectively of particular theoretical models, it stands to reason that the same systemic risks—price volatility, default, loss-given-default, dilution, and confiscation—that explain dollarization should also generate high real local-currency interest rates. To witness, Brazil,

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[3] Cf. the papers in Armas, Ize, and Levy-Yeyati (2006), plus Barajas and Morales (2003), De La Torre and Schmukler (2004), De Nicoló, Honohan, and Ize (2005), Galindo and Leiderman (2005), IADB (2005), Ize and Levy-Yeyati (2003), Levy-Yeyati (2006), Reinhart and Nozaki (2006), Rogoff and Savastano (2003). We use indifferently the terms 'dollarization', 'financial dollarization', and 'deposit dollarization' to express the same empirical concept, namely, the ratio of foreign currency deposits to total banking deposits in a given country. Our use of the term 'dollarization' should not be associated with the earlier literature on currency substitution, as it in fact refers to the phenomenon of asset substitution.

despite its high systemic risks, notably avoided deposit dollarization, and developed a deep local financial market almost entirely in domestic currency: short duration is pervasive but what calls most attention are the country's persistently very high real interest rates. It is, therefore, somewhat surprising that not a single one of the papers in the empirical dollarization literature deals with the local-currency interest rate as an associated dependent variable.

One purpose of this paper is to expand the scope of the financial dollarization literature to analyze the effect of deposit dollarization on the real interest rate in emerging economies. For this endeavor, we make use of the most recently available cross-country multi-year data sets developed by international agencies and other researchers (including some of our own). Our results, obtained by use of instrumental-variable and panel-data econometric techniques, confirm the presumption that systemic risks increase the real interest rate. They also document the existence of a trade-off between real interest rates and deposit dollarization – for given systemic risks, the more financial dollarization a country has the lower is its local-currency real interest rate.

Our second objective is to throw some light on the factors behind the mystery of very high real interest rates in Brazil, a subject of much dispute in the country[4]. In particular, we want to determine the role of systemic risks and restrictions to dollarization in the explanation of Brazil's continually high real interest rates even after the adoption of floating exchange rates and inflation targeting in early 1999. An additional exercise investigates how much of the post-1999 excess of Brazil's actual real interest rate over our panel-based estimation can be attributed to the actions of a prudent Central Bank trying to establish the credibility of its brand-new inflation-targeting regime.

The paper is organized as follows. The following section outlines a simple analytical model that demonstrates how systemic risks and the degree of dollarization can affect the real local-currency interest rate. Section three describes the data and empirical methods. Section four presents and discusses the econometric results. Section five analyzes the Brazilian case. Section six concludes. Detail on data sources and procedures are in the appendix.

II. Analytical Model

This section illustrates in a very simple model the price-quantity trade-offs involved in the choice between dollar and local-currency (peso) denominated bonds. Suppose that a representative domestic agent can choose from two types of securities: peso bonds, which yield a nominal interest rate of i_P in pesos; and dollar bonds, which pay a return of i_D in dollars. Dollar inflation is assumed to be zero. The domestic economy is relatively small, so that the interest rate i_D can safely be assumed exogenous. The domestic agent values wealth in terms of peso's purchasing power, meaning that he converts any financial resources generated abroad or at home into its real value in pesos to infer the implied utility. Let W_0 be the domestic agent's initial wealth in real pesos. One period later, his wealth will be given by

(1) $$W_1 = \left[(1 + i_P - \pi)\theta_P + (1 + i_D + q)\theta_D\right]W_0,$$

where π is the inflation rate and q is the rate of real exchange rate depreciation between periods 0 and 1; and θ_P and θ_D are, respectively, the shares of peso and dollar bonds in domestic agent's portfolio (where, of course, $\theta_P + \theta_D = 1$).

We assume that the inflation rate and the real exchange rate depreciation rate are normally distributed random variables. Furthermore, the representative domestic agent has a utility function with constant absolute risk aversion, $U(W)=-\exp\{-\gamma W\}$, where $\gamma > 0$ is the coefficient of absolute risk aversion. The domestic agent's problem is to choose a portfolio (i.e., the value of the share θ_P or, equivalently, of the share θ_D) to maximize utility given the

[4] Cf. Arida, Bacha, and Lara-Resende (2005); Barcelos-Neto and Portugal (2006); Fraga (2005); Gonçalves, Holland, and Spacov (2007); Miranda and Muinhos (2003); Muinhos and Nakane (2006); Salles (forthcoming).

constraint (1). If wealth W_1 is normally distributed (which is the case given our assumptions about π and q), maximizing the expected value of U(W_1)=-exp{- γW_1} is equivalent to maximizing E(W_1) - $\frac{\gamma}{2}$Var(W_1), where E(.) and Var(.) are the expectation and variance operators given the information available as of period 0. Using the fact that $\theta_P + \theta_D = 1$, this maximization problem yields the following expression:

(2) $$\left[i_P - E(\pi)\right] - \left[i_D - E(q)\right] = \gamma W_0 \{\left[Var(\pi) - Cov(\pi, q)\right] - \theta_D \left[Var(\pi) + Var(q) + 2Cov(\pi, q)\right]\}$$

To relate the issues addressed in this paper to the "minimum portfolio variance" explanation of financial dollarization, we rearrange equation (2), placing $\left[Var(\pi) + Var(q) + 2Cov(\pi, q)\right]$ in evidence, which yields:

(3) $$\left[i_P - E(\pi)\right] - \left[i_D - E(q)\right] = \gamma W_0 \left[Var(\pi) + Var(q) + 2Cov(\pi, q)\right] \{\left[Var(\pi) + Cov(\pi, q)\right] / \left[Var(\pi) + Var(q) + 2Cov(\pi, q)\right] - \theta_D\}$$

Ize and Levy-Yeyati (2003) demonstrate that the "minimum portfolio variance" share of dollar deposits (which we will denominate as *MVP*) is given by:

(4) $$MVP = \left[Var(\pi) + Cov(\pi, q)\right] / \left[Var(\pi) + Var(q) + 2Cov(\pi, q)\right]$$

Moreover,

(5) $$Var(e) = \left[Var(\pi) + Var(q) + 2Cov(\pi, q)\right]$$

where *Var(e)* is the variance of the nominal exchange rate.

Introducing (4) and (5) in (3), we obtain the following simplified relation:

(6) $$\left[i_P - E(\pi)\right] - \left[i_D - E(q)\right] = \gamma W_0 Var(e)\ \{MVP - \theta_D\}$$

Equation (6) shows that uncovered interest parity does not hold in our model provided that actual dollarization (θ_D) differs from the minimum variance portfolio dollarization (*MVP*). Instead, there is a risk premium between the ex ante real returns of peso ($i_P - E(\pi)$) and dollar ($i_D - E(q)$) bonds, which is positively related to the minimum variance portfolio dollarization (*MVP*) and negatively related to actual dollarization (θ_D). Therefore, the less dollarized the economy is (*vis-à-vis* "optimum" dollarization given by *MVP*), the higher will be the equilibrium real peso interest rate (*vis-à-vis* the interest parity rate).

Equation (6) represents a demand for bonds. Ize and Levy-Yeyati (2003) close their model by postulating a supply side that is the mirror image of the demand side for bonds. We choose not to do so and opt instead to treat the currency composition of bond supply as a predetermined variable, cognizant of local governments' importance in its determination, through both rules and regulations and public debt composition. Thus, we leave the supply side unspecified, and merely ask how the demand-side equilibrium is affected if the available shares of peso and dollar bonds change.

The model's main message can thus be summarized as follows. If there is no alteration in underlying systemic risks, any change in the composition of bonds (quantities) will have effects on real interest rates (prices). Thus, for example, a strategy of forcing a "dedollarization", if it doesn't properly address the fundamental macroeconomic risks of the economy, may only transform one problem (vulnerability to exchange rate shifts) into another (high real interest rates).

This framework is used as a generic benchmark for an empirical analysis on the determination of real domestic interest rates in emerging market economies, which contemplates a series of other systemic risks and policy-related variables, as suggested in the dollarization literature and on the debate on Brazil's high real interest rates.

III. Data and Estimation Methods

We use equation (6) as a departure point for the analysis of the determination of the real domestic-currency interest rate in emerging markets. Besides dollarization, this rate is assumed to be a function of systemic risks and policy-related variables that are suggested in the financial dollarization literature and in the debate on interest rates in Brazil. See the appendix for sources and construction details of each variable. The regressors we consider can be grouped into three types:

(i) price-dilution risks, captured not only by the minimum variance portfolio variable (MVP) previously discussed, but also by a delta-inflation variable (this year's inflation minus last years' inflation) measuring price acceleration. In the following we will informally refer to MVP simply as (relative) inflation volatility. Inflation acceleration on the other hand captures a possible inadequacy of our measured real local-currency interest rate (RIR), which subtracts on-going inflation from the nominal interest rate. Suppose investors are concerned with next-period wealth and extrapolate current inflation trends. Then, when inflation accelerates, as a protection mechanism investors might demand a higher RIR and a higher dollar deposit share.

(ii) sovereign default risks, quantified by the size of the public debt to GDP ratio; by a dummy variable indicating whether the country is investment grade or not according to Standard&Poor's[5]; and by the country's per capita income (a variable often used in the dollarization literature (e.g., Levy-Yeyati, 2006) as a generic proxy for governance quality).

(iii) policy-environment variables, captured by a 0-to-5 scale measuring the degree of legal restrictions on onshore dollar deposits; by a 0-to-100 index of capital account liberalization constructed by Sebastian Edwards (2005); and by the complement of the World Bank 0-to-100 "rule-of-law" index[6] -- the later as a proxy to the "jurisdictional uncertainty" concept proposed in Arida, Bacha, and Lara-Resende (2005) to capture government-related uncertainties besieging financial investors in weak jurisdictions.

Further to these variables, earlier experiments indicated that the real local-currency interest rate was a strongly autoregressive variable, thus, its one-period lagged value was included as a further regressor in the equation.

Our data-set spans from 1996 to 2004 across 66 countries from different parts of the world, including emerging market and OECD economies, and therefore we have relatively few time-series observations in an unbalanced panel[7]. Table 1 presents basic statistics for the variables in the model, indicating their mean, median, maximum and minimum values, and standard deviations.

We proceed in two steps that are summarized in Graph 1[8]. In step I we use the policy-environment variables to generate an instrument for the deposit dollarization ratio, which subsequently enters the equation determining the real interest rate together with the systemic risk regressors (step II). The two-step procedure is necessary because the real interest rate and the dollarization ratio are jointly determined variables in a supply-and-demand model for local currency and dollar bonds, of which our equation (6) is merely its demand side. Thus, the dollarization ratio is positively correlated to the error term of the interest rate equation, and, if not properly instrumented, its coefficient will be biased toward a positive value. The correction

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[5] S&P's specific country-ratings converted into a numerical sequence were also tested with poorer results, which we do not report.

[6] Other World Bank institutional quality indicators were tested, with poorer results.

[7] The countries in the sample are as follows: (1) Speculative grade: Argentina, Bolivia, Brazil, Bulgaria, Colombia, El Salvador, Grenada, Guatemala, India, Indonesia, Morocco, Mozambique, Pakistan, Paraguay, Philippines, Romania, Russia, Sri Lanka, Turkey, Ukraine, Uruguay, Venezuela, and (2) Investment grade: Australia, Austria, Bahrain, Belgium, Canada, Chile, China, Hong Kong, Croatia, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Kuwait, Latvia, Lithuania, Malaysia, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Singapore, Slovak Republic, Slovenia, South Africa, Spain, Sweden, Switzerland, Thailand, Tunisia, United Kingdom, United States.

[8] We are indebted to Fernando Velloso for suggesting this econometric procedure.

of this bias requires an appropriate choice of instruments for the dollarization ratio–i.e., exogenous variables that are simultaneously not correlated with the error term of the interest rate equation and strongly correlated with the dollarization ratio. Fortunately, these instruments are at hand in our regressor set, namely, the three policy-environment variables: restrictions-to-dollarization, degree-of-capital-account-liberalization, and rule-of-law-index. This is indeed how we visualized the "supply side" in our analytical model–it's given by government ordinance. Previous research (Levy-Yeyati, 2006, for example) had already indicated the fundamental importance of the restrictions-to-dollarization variable to determine actual dollarization. Our results below indicate the complementary relevance of capital account controls and rule-of-law. Furthermore, previous research (Gonçalves, Holland, and Spacov (2007) and Salles (forthcoming)) also found that at least two of our three policy-related variables, namely, capital controls and rule of law, do not belong to the real interest rate equation. Our own initial estimations (not reported) indicated that dollarization restrictions do not belong there either.

Thus, in a first step we generate an instrument for deposit dollarization, which are the fitted values of the auxiliary regression:

(7) $dollar_{it} = \beta_0 + \beta_1 R_{it} + \beta_2 JU_{it} + \beta_3 CAPLIB_{it} + \eta_{it},$

where *t* indexes years and i indexes countries; *dollar* is the bank deposit dollarization ratio, R is the index of restrictions on holdings of foreign currency deposits by residents (developed at the IMF and made available in Levy-Yeyati (2006)); JU, or jurisdictional uncertainty, is the complement to the World Bank rule-of-law 0-to-100 index; CAPLIB is the 0-to-100 capital account liberalization index described in Edwards (2005); and η is the error term. This equation was estimated according to a random effect model to generate the instrumental variable for the dollarization ratio (*D**) subsequently used in the second-step regression for the interest rate equation.

The general equation for the second-step estimation of the real interest rate (r) is as follow:

(8) $r_{it} = \gamma_t + \omega_i + \beta_1 r_{it-1} + \beta_2 D^*_{it} + \beta_3 MVP_{it} + \beta_4 \Delta\pi_{it} + \beta_5 B_{it} + \beta_6 IGRADE_{it} + \beta_7 y_{it} + \varepsilon_{it}$

where: γ_t and ω_i are respectively the time and country specific effects, D* is the instrument for the dollarization ratio, *MVP* is the minimum variance portfolio (see appendix for more details on its construction), $\Delta\pi$ is the change in CPI inflation rate, B is fiscal debt to GDP, IGRADE is sovereign risk measured by the Standard & Poor's ratings as captured by a dummy variable for the investment grade category, y is per capita income, and ε is the error term.

To estimate the real interest rate equation with its one-year lagged value as one of the regressors, we adopted the two-step GMM system estimation (level and difference combined, GMM-SYS) proposed by Blundell and Bond (1998), based on Arellano and Bond (1991) and Arellano and Bover (1995). The consistency of GMM estimators depends on whether lagged values of the explanatory variables are valid instruments. We addressed this by considering two specification tests. The first is a Sargan test of overidentifying restrictions, which tests the overall validity of the instruments[9]. The second test examines the null hypothesis that the error term is not serially correlated[10]. In both tests the model specifications are supported as the null hypothesis is not rejected (see Table 3).

[9] We use the two-step version of the GMM system estimator to obtain the Sargan test statistics, as the one-step version of the Sargan test over-rejects the validity of the set of instruments in presence of heteroskedasticity. However, it is well known that the Sargan test may have low power in finite sample. To have some indication of the power of the test, we estimated the real interest rate equations with its endogenous lagged one year value as an additional (but invalid) instrument in the transformed equations. This test overwhelmingly rejects the null hypothesis of instrument validity.

[10] Arellano and Bond's (1991) test of serial correlation suggests that the error terms are white noise.

IV. Empirical Findings

Statistical results are reported in Tables 2 and 3. Consider initially the results of the instrumental regression (7) for the dollarization ratio, in Table 2. All coefficients are significant at 5% and R2 is equal to .33. Local restrictions to dollar holdings as expected have by far the strongest impact on dollarization -- as they go from a minimum of zero to a maximum of 5, dollarization declines by 36.25pp, a figure not very different from the value of the constant term in the equation (which means that as restrictions are at a maximum, dollarization is not significantly different from zero). Jurisdictional uncertainty as captured by the complement to the World Bank 0-to-100 rule-of-law index is also relevant -- as it goes from zero to 100, dollarization increases by 25pp. Finally, the 0-to-100 capital liberalization index is also significant -- as capital controls are reduced from a maximum of 100 to a minimum of zero, the dollarization ratio declines by 9.5pp.

The dollarization ratio thus instrumented, denoted by D*, has a significant negative impact on the real interest rate, as indicated in the regressions in Table 3. In the following, we consider regression (6) of this table, which includes all variables specified in equation (8) of the previous section. The coefficient of D* is 0.0011, which means that, as dollarization rises from zero to 100, the interest rate declines by 1.1 percentage point (pp) on impact, and by 2.3pp in the long run (this last figure is obtained by dividing the impact coefficient by 1 minus .511, and multiplying the result by 100, where .511 is the coefficient of the one-year lagged interest rate). Interestingly enough, when we substitute actual by instrumented dollarization in the regression (not shown), the coefficient of this variable becomes positive (although not significant). This is as expected, on the presumption that shocks to the interest rate equation are positively correlated to actual dollarization. On the other hand, the policy-environment variables used in the instrumental regression have no reason to be correlated to the error term of the interest rate equation; hence, by using the instrumental procedure, we're able to overcome the simultaneous equation problem and correctly estimate a negative coefficient for the dollarization ratio, as anticipated in the analytical model.

Our findings also throw quantitative light on the impact of jurisdictional uncertainty (measured by rule of law) and capital account controls in the domestic interest rate, as first suggested by Arida, Bacha and Resende (2005). We found that these policy-related variables do not directly belong to the interest rate equation (this is as in Gonçalves, Holland, and Spacov, 2007, and in Salles, forthcoming), and also that they have very small indirect impacts on it, through their effect on dollarization. These indirect effects can be calculated by multiplying each of these policy-related variables' coefficients in the dollarization ratio regression by the instrumented dollarization ratio's coefficient in the real interest rate regression. The conclusion is that, although significant, the effects of these policy-environment variables on the real interest rate are very small.

Consider now the impact of the price-dilution risk variables on the interest rate. Firstly, the real interest rate is positively associated to MVP (loosely interpreted here as the volatility of inflation relative to the volatility of the sum of itself with that of the real exchange rate). As this inflation-volatility ratio increases from 0 to 1, the real interest rate increases by 0.3pp on impact and by 0.6pp in the long run. Contrary to the expectations of the theoretical model, this is much smaller than, not equal in absolute value to, 100 times the coefficient of the instrumented dollarization ratio, D*–a result that we attribute to the difficulties of properly estimating volatility in a panel-based regression (we estimated the volatilities year-by-year for each country using 12 monthly observations for the relevant variables). The coefficient of the inflation-acceleration variable indicates that as yearly inflation increases by, say, 10pp, the real interest rate increases by 0.1pp on impact and by 0.2pp in the long run.

Our three proxies for sovereign-default risk all work very well, indicating that they probably capture different aspects of such risk. We consider particularly significant the results obtained for IGRADE–i.e., the 1-0 dummy variable indicating whether a country is investment grade or not according to S&P. Investment grade status reduces the real interest rate by a full 2pp on impact and by a whooping 4pp in the long run. Per capita income (measured in units of 1,000 dollars) has also a very strong impact – an increase in per capita income of $1,000 reduces the real interest rate by 0.8pp on impact and by 1.6pp in the long run. This effect is probably highly nonlinear, fading away for the largest per-capita income figures, but we're not able to capture this nonlinearity either by using a reciprocal transformation of per capita income or its squared value. In contrast, the coefficient of the public debt ratio to GDP, although significant, turned out to be disappointingly small–a 100pp increase in this variable raises the interest rate by a mere .55pp on impact and by 1.1pp in the long run. This might be a consequence of debt demand for investment-grade sovereigns being highly elastic, but we're unable to capture this effect with the introduction of a multiplicative IGRADE-times-Y dummy variable in the regression. Other possibility is that the proxies we used for public debt for some emerging countries are not a good approximation to their true values (see Appendix for a description of this variable's construction).

In summary, we have shown that, appropriately instrumented, financial dollarization has a significant negative impact on the real interest rate–which indicates that this variable cannot remain absent in empirical analysis of financial dollarization as has been the case in the relevant literature until now. We also found the real interest rate to be a significantly autoregressive variable, indicating the importance of using dynamic panel-data regressions rather than simple static regressions to obtain statistically significant results for the estimation of the impact of systemic risk variables on the real interest rate. We also established the negative effect on the real interest rate of price-dilution risks measured both by inflation volatility and inflation acceleration. Public debt impacted positively on the real interest rate but perhaps with a weaker effect than we would obtain if our sample could have been appropriately split into investment and non-investment grade sovereigns. Investment-grade status and per-capita income were shown to have large negative effects on the real interest rate. We could not determine any quantitatively relevant direct or indirect effect on the real interest rate of rule of law, capital controls, or dollarization restrictions. These variables were however shown to have a significant role to play as instruments for the dollarization ratio entering the determination of real interest rates.

V. Brazil's special case

Brazil offers an interesting case study for our findings. A "serial defaulter" in the terminology of Reinhart and Rogoff (2004b), and second only to Congo in the magnitude of currency depreciation in the 1970-2001 period (Reinhart and Rogoff, 2004a), it nonetheless managed to avoid financial dollarization and developed a large and sophisticated financial market based entirely on its own domestic currency. Short-duration is pervasive, but what most calls attention are the country's very high real interest rates. Our presumption is that these are interrelated phenomena: if systemic risks are high, unusually high real interest rates would be the price to pay to escape dollarization *and* develop a large local-currency-based financial market.

Let us first establish a few facts, starting with Brazil being indeed 'underdollarized' when compared to its peers. This is shown in Graph 2, taken from the 2005 Inter-American Development Bank report (IDB, 2005), which depicts deposit dollarization ratios, both domestic and off-shore, for Latin American countries in 2001 (the IDB report calculates offshore on the basis of deposits by country of origin in BIS-surveyed off-shore banks). With a 10% ratio of (fully off-shore) dollar deposits to total onshore and off-shore bank deposits, Brazil is by far the country with the lowest dollarization ratio in the region. Moreover, despite its high systemic risks, Brazil managed to develop a large domestic-currency-based financial market, as indicated for example by the M3 to GDP ratios in the IMF's IFS database[11]. By this measure Brazil has the largest financial market in Latin America, comparable in size to those in Europe. Finally, indeed Brazil has very high real interest rates. This is indicated in Graph 3, in which these rates are compared with the overall and the sub-investment grade country RIR mean values in our sample, and with the sums of such means with one standard deviation. From 1996 to 1999, Brazil's rates are higher than the means-plus-one-standard-deviation limits. Since then, they hover around these limits (particularly if we take the electoral transition years of 2002 and 2003 altogether), but are always much higher than the sample means.

Our statistical procedures for the determination of RIRs would seem able to capture Brazil's idiosyncrasies: high inflation volatility, sub-investment grade status, and lack of dollarization together with a highly developed local capital market (the latter is captured in our regressions by Brazil's public debt to GDP ratio). Furthermore, Brazil's capital controls and poor jurisdiction (as captured by the WB rule-of-law index) are also present in our empirical analysis. How far then are we able to unveil the mystery of Brazil's very high interest rates?

To answer this question, we constructed Table 4 on Brazil's interest and prices. In it we added RIR forecasts for 2005 and 2006 to our estimated RIRs in the 1996-2004 period, always based on regression (6) of Table 3. The column items are self-explanatory, except for a concept discussed below, that of Central Bank's 'targeted' RIR, defined as the minimum between estimated and 'expected' RIR, where the later results from the deflation of nominal interest rates by expected inflation.

Column (7) of Table 4 exhibits the excess of actual over predicted RIRs–thus summarizing our panel-based regression's power to explain Brazil's observed real interest rates. Graph 4 summarizes the evolution of actual, predicted, and targeted RIRs. To analyze the results, consider first predicted RIRs in the 1996-2004 period. Except for two extreme values in the neighborhood of 10% during Brazil's 1998-99 balance of payment crisis, these predicted RIRs are surprising stable in the range of 5.5% to 7.5%. The overall (geometric) average is 7.2% but, excluding the crisis years of 1998 and 1999, the average is 6.7%. In the 2000-2004 period, after exchange rate floating and inflation targeting were adopted, the (geometric) average of predicted RIRs is 6.6%. We feel entitled to take this to be the value of Brazil's "standard" real interest rate in the period under consideration.

Comparing predicted to actual RIRs, we conclude that our empirical model is totally unable to replicate the extremely high real interest rates in 1996-99. As Graph 4 illustrates, in this period actual RIRs are up to three times as high as predicted RIRs. In the aftermath of the exchange-rate based stabilization of 1994, an overvalued exchange rate peg prevailed, in a context of successive international financial crises. The exchange rate peg collapsed in early 1999, which was the first year of a new floating exchange rate regime. In 1999, monetary policy was held extremely tight to prevent an inflation blow-out. Our model fails to capture the idiosyncrasies of this early inflation-stabilization period[12].

We thus center attention on the 2000-06 period, during which a regular inflation-targeting framework was in force and the exchange rate was allowed to float rather freely. Even then, 2002 excepted, actual RIRs are higher than predicted RIRs. Thus part of the mystery of Brazil's very high interest rates remains after our empirical investigation. More specifically, in 2000-04 the actual RIR geometric mean is 9.4% which compares with a mean predicted RIR of 6.6% in the same period–actual RIRs are thus on average 40% higher than our panel-based estimated values.

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[11] Several cross-country studies of 'financial deepening' (IADB, 2005, for example) fail to capture the extension of Brazil's capital markets because they use as indicators either M2 (which does not include the all-important money-market Brazilian funds industry) or private bank credit (which fails to capture the important role of bank credit to government in Brazil, either directly or through the money-market funds industry).

[12] On Brazil's 1994 stabilization program, see Bacha (2003); on the country's subsequent crises and economic policy making, see Giavazzi et al. (2005).

Can we at least say that there is a trend toward the convergence of actual to predicted RIRs? It is to try to answer this question that we used our regression results to forecast predicted RIRs for 2005 and 2006, as shown in the last two lines of Table 4, and the answer is: unfortunately not, as the ratios of actual to forecast RIRs in this latter period are even higher than in 2000-2004. An important caveat is however in order, and here we introduce our concept of Central Bank's targeted RIR. The Central Bank board members most directly responsible for monetary policy in the 2003-06 period have correctly argued in Bevilaqua et al. (2007) that a fundamental challenge for monetary policy in this period was to establish Central Bank's inflation fighter reputation in a context of adverse expectations and above-the-target inflation rates. Inflation expectations were always higher than actual inflation in 2003-06. Table 4 also displays the inflation surge of 2003 that was subsequently contained despite adverse inflationary expectations. We thus conceived the following scheme to elicit the targeted RIR of a prudent (and all-knowing) Brazilian Central banker in the 2000-06 period: it would fix the nominal interest rate according to the following rule:

Actual nominal interest rate = Targeted real interest rate multiplied by the maximum between actual and market-expected inflation rate.

This essentially says that if the Central Bank 'knows' that actual inflation will be higher than market expectations, it fixes the nominal interest rate according to actual inflation (this occurred in 2001 and 2002, as seen in Table 4). If however it observes an expected inflation rate higher than the actual rate, then (in order to bring inflationary expectations down) it fixes the nominal interest rate according to expected inflation (this occurred in 2000 and 2003-06). Inverting the terms of the above equation, we constructed a series for targeted RIRs, simply by dividing the nominal interest rate by the higher of actual inflation and expected inflation. The conclusion of this procedure is that Brazil's high real interest rate mystery diminishes but is still there (except for 2002). On average for 2000-06, targeted RIRs are 28% higher than predicted RIRs. Furthermore, we do not observe a trend for this difference to subside through time.

Should we throw the towel? We not think so. Thus, observe in Graph 4 that the lack of convergence is due to two targeted RIR outliers, in 2003 and 2005. The former was the initial year of Lula's left-leaning presidency. It was only natural that Central Bank's recently-appointed board would wish to leave no doubt in market-participant minds of their commitment to fight an inflation rate that reached 12% in the previous year--hence a very high targeted RIR for 2003 is explainable. 2005 is another story. Although there was a temporary inflation surge in mid-2004, the Central Bank seems to have overreacted to this surge, as suggested by the well-below-the-target inflation rate in 2006[13]. However, from late-2005 the Central Bank started an easing cycle that is still on course. Thus, 2007 and 2008 are our final tests for convergence. Market participants in the latest Central Bank surveys (BCB, 2007) anticipate an accumulated overnight rate of 11.5% for 2007. They also expect an inflation rate of 3.9% in 2007, thus implying a RIR of 7.4%. Better still are the expectations for 2008: an accumulated overnight rate of 10.5% and inflation of 4.0%, implying an expected real interest rate of 6.3%. We thus conclude that Brazil is finally converging toward a RIR compatible with its fundamentals and policy idiosyncrasies--it is still high, but there is no longer a mystery about it.

VI. Conclusions

One purpose of this paper was to expand the scope of the dollarization literature to analyze the systemic risk determinants of the real interest rate in emerging economies. We're particularly interested in investigating the negative relation between deposit dollarization and local-currency real interest rates, as anticipated in our simple analytical model. Our findings, obtained with a panel of 66 countries in the 1996-2004 period, indicated that, appropriately instrumented, deposit dollarization has a negative impact on the real interest rate. This implies that this

[13] Target of 4.5% ± 2%; actual inflation of 3.1%.

variable cannot remain absent in empirical analysis of financial dollarization as has been the case in the literature until now.

We found the real interest rate to be a strongly autoregressive variable, indicating the importance of using dynamic panel regressions rather than simple static panel regressions to obtain statistically significant results for the estimation of the impact of systemic risk variables on the real interest rate. We also established the negative effect on the real interest rate of price-dilution risks measured both by inflation volatility and inflation acceleration. Public debt impacted positively on the real interest rate but perhaps with a weaker effect than would obtain if we had better quality debt data. Investment-grade status and per-capita income were shown to have large negative effects on the real interest rate. Thus, obtaining an investment grade rating reduces the real interest rate by 2pp on impact and by a whooping 4pp in the long run. We could not determine any substantive direct or indirect effects on the real interest rate of rule of law, capital controls, or dollarization restrictions. These policy-environment variables were however shown to have a critical role to play as instruments for the dollarization ratio entering the determination of real interest rates.

Brazil is an interesting case study for our findings, because despite high systemic risks it managed to avoid financial dollarization and developed a large local-currency-based financial market. Short-duration is pervasive, but what most calls attention are the country's very high real interest rates. We started with the presumption that these phenomena were interrelated: if systemic risks are high, high real interest rates are the price to pay to avoid dollarization *and* develop a large local-currency-based financial market. However, we had some surprises on the way. First, during the 1996-98 period, when an exchange rate peg prevailed and monetary policy was mostly driven by adverse balance of payments considerations, Brazil's real interest rates proved to be up to three times as high as our panel-based estimates.

We thus centered attention on the 2000-06 period, during which a regular inflation-targeting framework was in force and the exchange rate was allowed to float. Even then, 2002 excepted, we found actual real interest rates to be much higher than predicted, thus part of the mystery of Brazil's very high interest rates seemed to remain even after our empirical investigation. Allowing for the fact that in 2003-06 the Central Bank under Lula had to establish its reputation as an inflation fighter, we devised an exercise incorporating adverse expectations and Central Bank prudence in our estimates, thus being able to reduce Brazil's high real interest rate mystery to less than we initially estimated. Although we did not discern a clear trend for the remaining disparity between observed and predicted rates to diminish after 1999, we observed that this lack of convergence was due to two outliers, namely 2003 and 2005. Making use of market-based expectations for 2007 and 2008, we finally concluded that Brazil's real interest rates are in the process of converging to our model's standard RIR for the country, which is 6.6%.

A weak spot in our analysis is that our sample is very limited in the time dimension. Future research should thus endeavor to uncover dynamic relations not contemplated by our results. In this context, much additional effort on the part of the international organizations is badly needed to provide comparable fiscal and monetary data for a larger number of countries and years. Finally, we only considered two of the possible financial consequences of systemic risk, i.e., domestic financial dollarization and high real interest rates. Further research effort is required to incorporate offshore dollarization, short-termism, indexation, and financial shallowness as alternative systemic-risk-coping mechanisms in emerging economies in general, and Brazil in particular.

Table 1 - Basic Statistics (1996-2004)

	Capital Control Index (0-100)	Debt to GDP (%)	Dollarization Index (%)	Change in Inflation Rate	Per Capita Income (USD)	Inflation (CPI % annual)	Nominal Interest Rate (% annual)	Jurisdictional Uncertainty	MVP	Real Interest Rate (% annual)	Sovereign Ratings -Standard and Poor´s (SRSP)	Restrictions
Mean	68.75	57.35	18.63	-1.40	9,129.31	9.07	12.67	35.58	0.45	3.50	8.06	0.59
Median	62.50	53.84	9.25	-0.37	4,366.51	5.19	7.68	33.00	0.45	3.07	7.00	0.00
Maximum	100.00	149.00	88.40	58.06	37,164.60	85.74	91.95	86.10	1.15	66.15	16.00	5.00
Minimum	37.50	5.86	0.00	-64.96	752.33	-0.84	0.11	0.00	1.43E-07	-38.19	0.00	0.00
Std. Dev.	21.12	27.11	21.98	9.65	9,931.15	14.00	15.00	23.92	0.34	6.34	4.48	1.29

Sources: World Bank, WDI on line; World Bank, Governance Indicators; IMF, IFS on line; Edwards (2005); Levy-Yeyati (2005), Standard & Poor´s (2005). Authors´ calculations.
Notes: The Capital Account Liberalization Index has a scale from 0 to 100, where a higher number denotes a higher degree of capital mobility; Dollarization Index is the deposit dollarization to the total deposits ratio and ranges from 0 to 100%; Sovereign Ratings is provided by Standard & Poor's and the rating scales were converted to assigned values from 0 to 16, where from 0 to 6 are speculative grades and from 7 to 16, investment grades; Restrictions has a scale from 0 to 5, where a higher number denotes more restriction on residents' holdings of foreign currency deposits.

Table 2 – Econometric Results – First-Step Estimate - Reduced Form
Dependent Variable: Dollarization Index (DOLLAR) (1996-2004)

MODELS	**1**	**2**	**3**
Constant	38.4**	37.6**	39.1**
	(0,045)	(0.05)	(0.042)
R (Restrictions)	-7.55**	-7.50**	-7.250**
	(1.75)	(2. 01)	(2. 01)
JU (100-Rule of Law)		0.220**	0.250**
		(0.080)	(0.080)
CAPLIB			- 0.095**
			(0.04)
$R2$	0.28	0.31	0.33
No. of Countries	57	57	57
No. of observations	369	358	358

Notes: * significant at 10%, ** significant at 5%. Standard Errors are in parentheses.

Table 3 - Econometric Results - Dependent Variable: Real Interest Rate (r) - Dynamic Panel Analysis (1996-2004)
GMM-SYS - Blundell and Bond (1998)

	(1)	(2)	(3)	(4)	(5)	(6)
r_1	0.491**	0.501**	0.511**	0.511**	0.512**	0.511**
	(0.146)	(0.15)	(0.149)	(0.15)	(0.16)	(0.157)
*D**	-0.0013**	-0.00129**	-0.00129**	-0.0012**	-0.0012**	-0.0011*
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
IGRADE		-1.710**	-1.714**	-1.717**	-1.910**	-2.009**
		(0.551)	(0.554)	(0.555)	(0.560)	(0.8111)
MVP			0.288**	0.275*	0.270**	0.298**
			(0.141)	(0.141)	(0.133)	(0.129)
B (Fiscal Debt to GDP)				0.0055**	0.0055**	0.0055**
				(0.001)	(0.0012)	(0.0014)
$\Delta\pi$					0.0111**	0.0112**
					(0.006)	(0.007)
Y (Per Capita GDP)						-0.0008*
						(0.0005)
No. of countries	66	66	66	66	66	66
No. of parameters	3	4	5	6	7	8
No. of observations	456	456	436	436	436	436
Specification Tests (*p* value)						
Sargan Test	0.98	0.97	0.98	0.99	0.99	0.99
First-Order Serial Correlation	0.001	0.002	0.002	0.002	0.000	0.000
Second-Order Serial Correlation	0.455	0.454	0.452	0.568	0.595	0.584

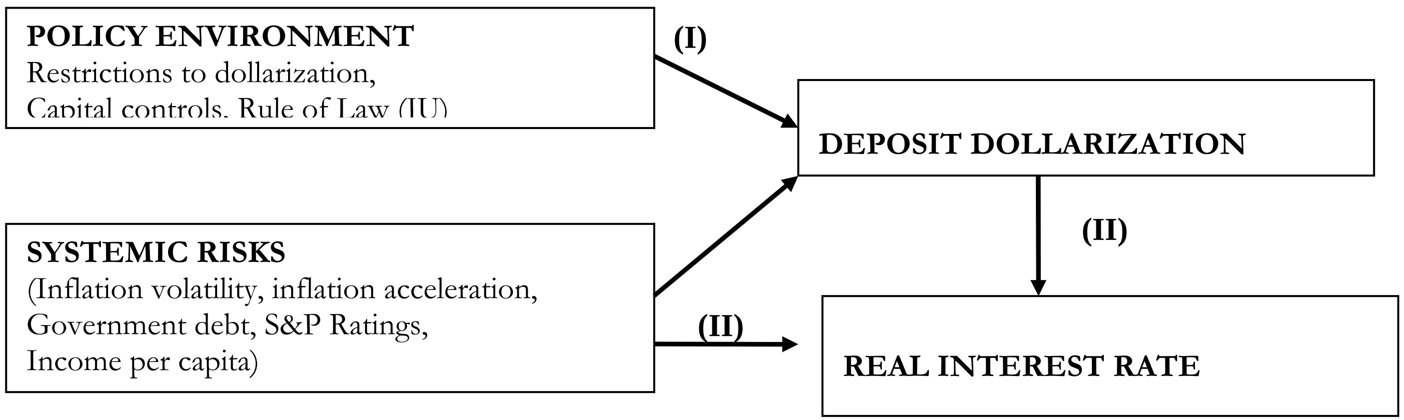
Notes: * indicates that a coefficient is significant at the 10% level, and ** significant at 5% level.
Standard errors and tests are based on the robust variance matrix. Wald (joint) tests the significance on all regressors except dummies; Wald (dummy) tests the significance on all dummies, Wald (time) the significance of the time dummies and the constant. The tests for 1st and 2nd order serial correlation are asymptotically distributed as standard normal variables (Arellano and Bond, 1991). The p-values report the probability of rejecting the null hypothesis of no serial correlation, where the first differencing will induce (MA1) serial correlation if the time-varying component of the error term in level is serially uncorrelated disturbance. The AR (2) test is listed as m_2 in Arellano and Bond (1991). Windmeijer (2000) derives a small-sample correction which is implemented here.

Table 4: Interest and Prices (%) 1996-2006

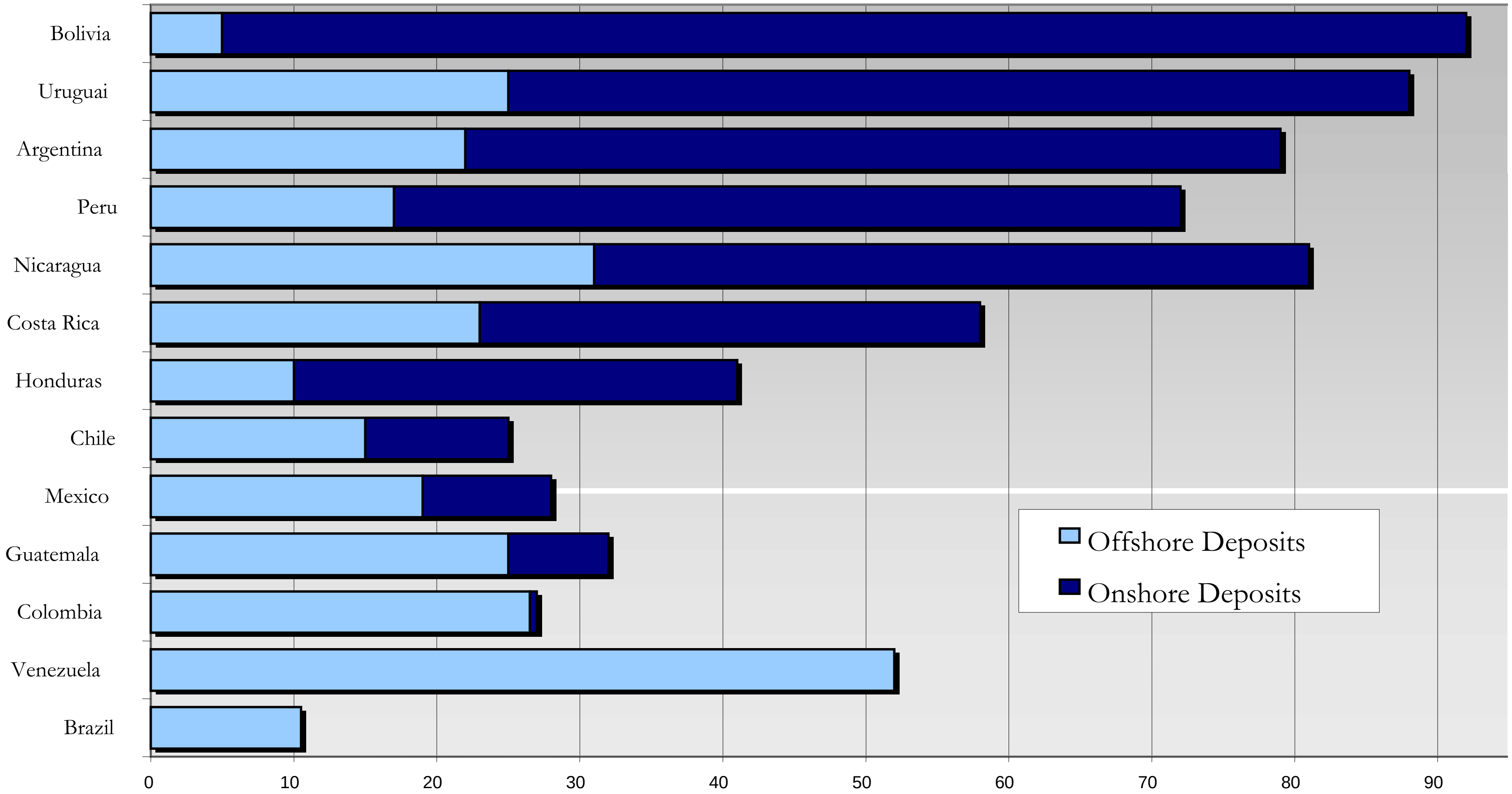
Year	Nominal Interest Rates [1]	Actual CPI Inflation [2]	Expected CPI Inflation [3]	Predicted RIR [4]	Actual RIR [5]	Targeted RIR [6]	Excess Actual/ Predicted [7]	Excess Targeted/ Predicted [8]
1996	27,41	9,56	n.a	5.45	16,3	n.a	10.3	n.a
1997	24,79	5,22	n.a	7.56	18,6	n.a	10.2	n.a
1998	28,79	1,66	n.a	10.21	26,7	n.a	14.9	n.a
1999	25,59	8,94	n.a.	9.02	15,3	n.a	5.8	n.a
2000	17.43	5.97	7.00	7.11	10.8	9.7	3.5	2.5
2001	17.32	7.67	4.30	6.88	9.0	9.0	1.9	1.9
2002	19.17	12.53	4.80	7.41	5.9	5.9	(1.4)	(1.4)
2003	23.35	9.30	12.56	6.21	12.9	9.6	6.3	3.2
2004	16.25	7.60	9.22	5.28	8.0	6.4	2.6	1.1
2005	19.05	5.69	7.47	6.65	12.6	10.8	5.6	3.9
2006	15.08	3.14	5.68	7.05	11.6	8.9	4.2	1.7

Sources: Central Bank of Brazil and Authors' Calculations.

Graph 1 – Two-step Empirical Strategy

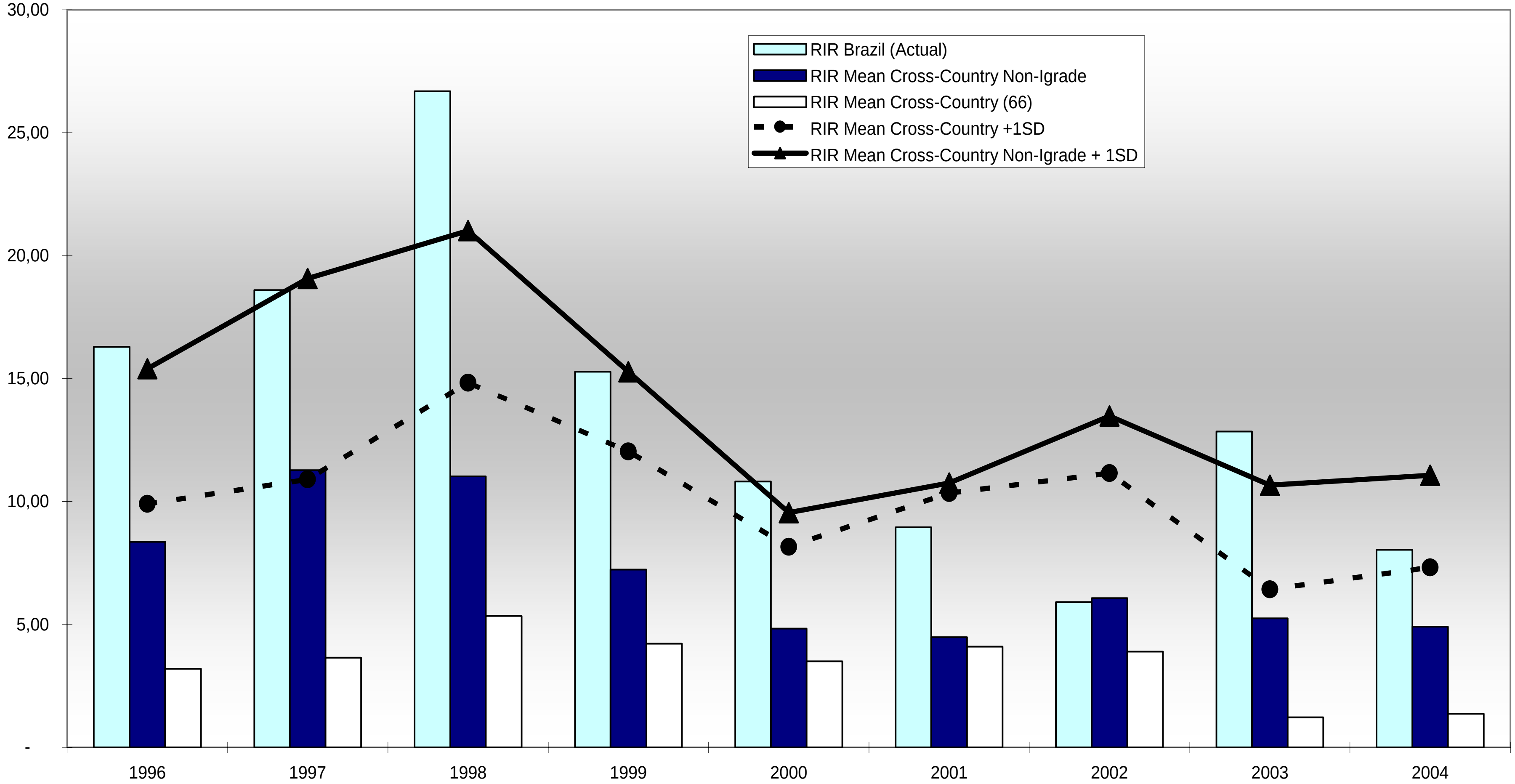


Graph 2 – Onshore and Offshore Deposit Dollarization in Latin America (2001)



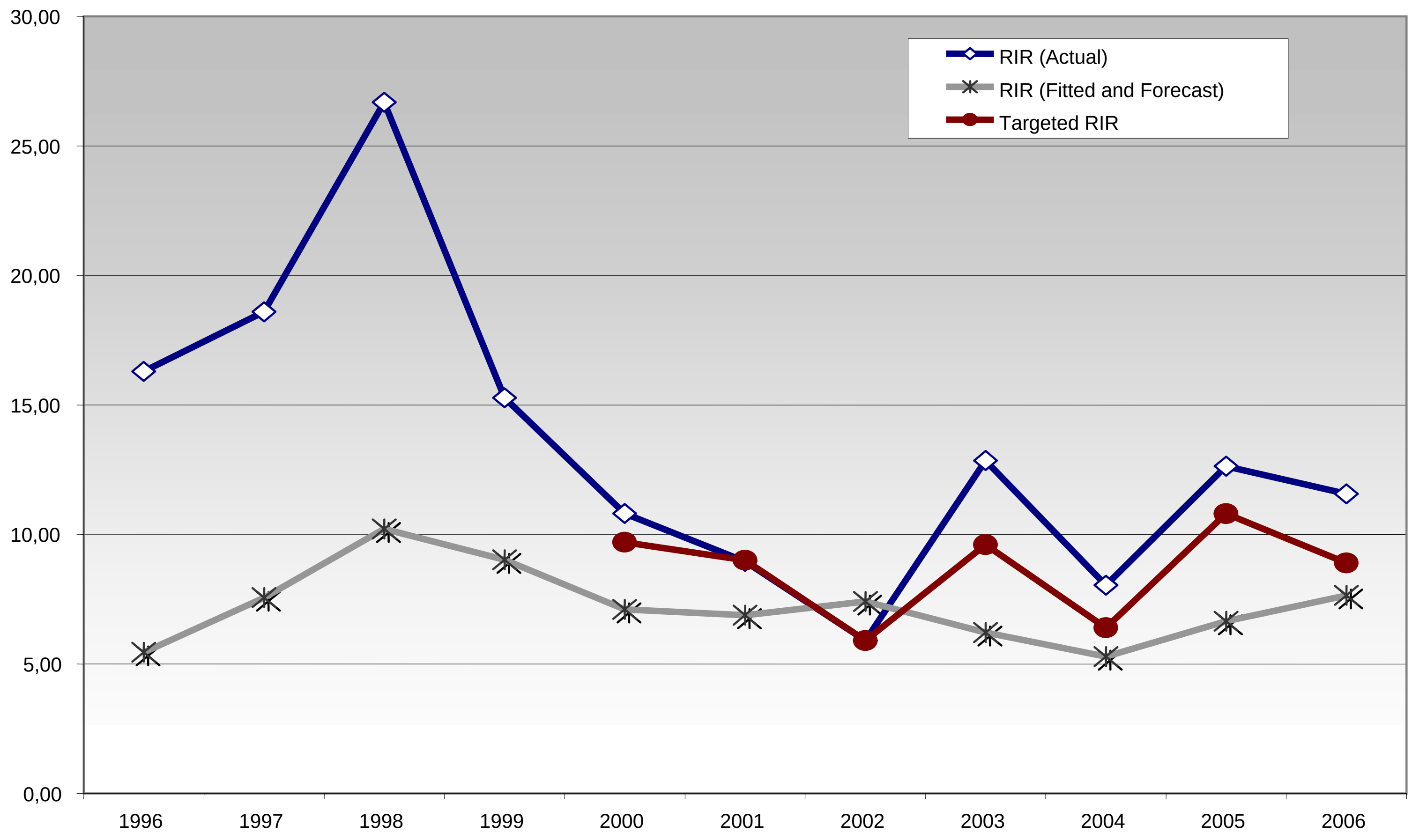
Source: IADB (2005)

Graph 3. Real Interest Rate: Brazil and Cross-Section Sample Means and +1 Standard Deviation (1996-2004)



Source: Bacen, IMF. *IFS on line,* and Authors' calculation.

Graph 4: Brazil. Real Interest Rate – Actual, Fitted/Forecast, and Targeted – 1996-2006 (% per year)



Source: Central Bank of Brazil; Table 3, equation 6, with forecasts for 2005-06.

APPENDIX

DATA SOURCES AND PROCEDURES

Real Interest Rate (RIR) – Ratio of one plus the average of the annualized end-of-month money-market interest rate in IFS (line 60B, ZF) to one plus the average of the annualized monthly consumer price index variation (IFS, line CPI), minus one, in percentage terms.

Dollarization Ratio (Dollar) – Ratio of Dollar (or Euro) deposits over total bank deposits. Source is Levy-Yeyati (2006). Original sources: IMF Staff Reports, Central Bank bulletins, Bolino et al. (1999), De Nicoló et al. (2003), and Arteta (2003).

Delta-inflation ($\Delta\pi$) – Absolute-value difference between this year's and last year's inflation, both calculated as the average of the annualized monthly consumer price index variation (IFS, line CPI), in percentage terms.

Public Debt to GDP Ratio (B) – Ratio of the consolidated public sector debt to GDP, in percentage terms, from Callen et al. (2003)'s data set and Central Banks. For approximately 30% of the sample, all developing countries, this data is not available and was proxied on the basis of a panel regression of debt-to-GDP to PPGD-to-GDP (public and publicly guarantee debt service to GDP from World Bank, *Global Development Finance on line*). With this regression, an estimate was constructed for the missing debt-to-GDP ratios on the basis of the countries' PPGD-to-GDP ratios. Regression results and estimates available from the authors.

Investment Grade (IGRADE) – Equal to 1 for a sovereign investment-grade rating and zero for a speculative-grade ratio. This variable was maintained constant for each country on the basis of its status in 2004. Source: Standard & Poor's.

Jurisdictional Uncertainty (JU) – Equal to 100 minus the World Bank rule-of-law index ranging from 0 to 100. As we had values for this variable only for even years, odd-years values were assumed equal to the immediately preceding even-values. Source: World Bank, Governance Indicators.

Capital account liberalization index (CAPLIB) – Index described in Edwards' (2005), gently provided to us by the author. It is a scale from zero to 100 in which higher values indicate increasing degrees of capital account liberalization.

Per Capita GDP (Y) – This is in constant 2000 US dollars. Source: World Bank, World Development Indicators.

Restrictions (R) – Index of restrictions on holdings of foreign currency deposits by residents, ranging from zero (no restrictions) to 5 (maximum restrictions). Source: Levy-Yeyati (2005). Original sources: IMF´s Annual Report on Exchange Arrangements and Exchange Restrictions (EAERR), revised and expanded by Levy-Yeyati from De Nicoló et al. (2003) using the same methodology.

Minimum Variance Portfolio (MVP) - This is derived from a portfolio choice model, in which risk-averse local investors opt between a local-currency-denominated and a dollar-denominated asset. As shown in Ize and Levy-Yeyati (2003), if the uncovered interest-parity condition holds, the dollar share of the optimal investment portfolio, which replicates the minimum variance portfolio, is equal to MVP = $\left[Var(\pi)+Cov(\pi,s)\right]/\left[Var(\pi)+Var(s)+2Cov(\pi,s)\right]$, where π is the inflation rate in local currency and s is the real exchange rate. To estimate a country's MVP for year t, we used monthly data on inflation (CPI) and nominal exchange rate changes for that country in year t. Source: IMF's IFS on line.

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