

Systemic Risk, Dollarization, and Interest Rates in Emerging Markets: A Panel-Based Approach

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This study investigates the impact of systemic risks and financial dollarization on real interest rates in emerging economies. Higher systemic risks induce both higher real interest rates and increased dollarization. Using appropriate instruments for the dollarization ratio, the study overcomes the simultaneous equation problem and correctly estimates a negative coefficient for the dollarization ratio in the interest rate equation. It confirms the theoretical prediction that a strategy of “dedollarizing” the economy will raise the equilibrium domestic real interest rate if the strategy fails to address fundamental macroeconomic risks. Even so, it also finds that this effect is small, after controlling for the risks of dilution and default. The results bring to light the systemic-risk reasons for high interest rates in emerging economies—and contribute to evaluating the difficulties of dedollarization policies. JEL codes: E43, F31, O16, O23, O54

In a study of financial contracts and risks in emerging economies, De la Torre and Schmukler (2004) argue that dollar contracts at home and abroad 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 can thus be understood as risk-mitigating mechanisms. This contrasts with the well-known “original sin” hypothesis developed by Eichengreen and Hausmann (1999), who posit that currency mismatches are the result of international market failures that prevent the issuance of local-currency-denominated bonds abroad.

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This article follows De la Torre and Schmukler in emphasizing systemic risks as the main culprits behind currency mismatches. It differs, however, in also considering the potential role of interest rate differentials in compensating for risks. 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. 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 through, say, a U.S. dollar contract. Similarly, if the interest rate on a domestically executed contract fails to 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 evident in the literature on financial dollarization—defined as the domestic use of a stronger foreign currency as a credit instrument and a reserve of value.¹ The dominant paradigm in this literature is the minimum variance portfolio hypothesis, in which the volatility of returns is the key to explaining financial dollarization. In this framework, the local-currency interest rate is usually assumed to be given by an interest parity condition 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 minimum variance portfolio allocations are associated with high real domestic interest rates, categorically 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 relates to the quality of institutions as a key driver of contract dollarization (Levy-Yeyati 2006). A weak institutional environment may boost dollarization in many ways. 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 such cases, 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’s value may generate risk mispricing and excess dollarization. De la Torre, Levy-Yeyati, and Schmukler (2003) argue that government guarantees were an important determinant of contract dollarization during Argentina’s currency board regime, but the argument also

1. See Armas, Ize, and Levy-Yeyati (2006); Barajas and Morales (2003); De La Torre and Schmukler (2004); De Nicoló, Honohan, and Ize (2003); Galindo and Leiderman (2005); IADB (2005); Ize and Levy-Yeyati (2003); Levy-Yeyati (2006); Reinhart and Nozaki (2006); and Reinhart, Rogoff, and Savastano (2003). The terms *dollarization*, *financial dollarization*, and *deposit dollarization* are used here interchangeably to express the same empirical concept: the ratio of foreign currency deposits to total banking deposits in a given country. The use of the term *dollarization*, which refers to asset substitution, should not be confused with its earlier use in the literature on currency substitution.

applies to countries with flexible exchange rates that exhibit “fear of floating” (Calvo and Reinhart 2002).

Irrespective of particular theoretical models, it stands to reason that the same systemic risks that explain dollarization—yield volatility, default, loss given default, dilution, and confiscation—could also generate high real local-currency interest rates. Some emerging market economies such as Brazil notably avoided deposit dollarization and developed diversified local financial markets almost entirely in domestic currency. Short durations are pervasive but these countries’ high real interest rates draw the most attention. So, it is somewhat surprising that not a single study in the empirical dollarization literature deals with the local-currency interest rate as an associated dependent variable.

This article expands the scope of the financial dollarization literature to analyze the effects of systemic risks and deposit dollarization on the real interest rate in emerging economies. Higher systemic risks induce both increased dollarization and higher real interest rates. So, it is not surprising that the raw data here indicate a positive correlation between the local-currency interest rate and actual dollarization. Using an instrumental-variable procedure, the analysis overcomes the simultaneous equation problem and correctly estimates a negative coefficient for the dollarization ratio in the interest rate equation. When investors are offered the possibility of holding more dollar-denominated deposits, they charge a lower spread to hold domestic-currency-denominated deposits.

The econometric investigation here uses the most recent cross-country multi-year data sets developed by international agencies and other researchers. The panel-based results, obtained with instrumental-variable and panel-data econometric techniques, confirm the presumption that price-dilution and debt-default risks increase the real interest rate. They also verify the tradeoff between real interest rates and deposit dollarization—for given systemic risks, an increase in the relative supply of local dollar assets reduces the real returns that investors require on home currency assets, but the magnitude of this effect is small.

The policy implications of the findings are embedded in estimates of the prices that investors charge to hold financial assets, the values of which can be diluted by volatile and accelerating inflation or a high probability of default. The study also finds that investors’ memories of past deeds find expression in the yield spreads that emerging market governments are currently required to pay on their debts. In other words, it unveils the numerical magnitudes of the systemic risks underlying high interest rates in emerging market economies. Finally, it provides tentative estimates of the impact of dedollarization policies on domestic-currency interest rates.

Section I describes the panel-based data and empirical methods of estimation. Section II discusses the econometric results. Section III discusses some implications of the findings. The appendix provides details on data sources and procedures.

I. DATA AND ESTIMATION METHODS

In the empirical model here, the interest rate is assumed to be a function of risk- and policy-related variables that are suggested in the financial dollarization literature. It is also assumed that deposit dollarization is negatively associated with the real interest rate. The argument can be summarized as follows. Consider a simple portfolio-allocation model that allows agents to choose between a domestic-currency-denominated financial asset and a dollar-denominated asset (either locally or abroad), assumed to be imperfect substitutes. In equilibrium, a certain amount of dollar assets will be held and a domestic-currency interest rate determined. If the government introduces a restriction on the dollar assets agents can hold, one consequence would be a higher domestic-currency interest rate, to induce agents to hold a large amount of domestic-currency-denominated assets.

The regressors for the real interest rate considered here can be grouped into three types:²

- Price-dilution risks, captured by the minimum variance portfolio variable discussed earlier³ and by a delta-inflation variable (this year's inflation minus the previous year's inflation). The delta-inflation variable is designed to capture a possible inadequacy of the measured real local-currency interest rate, which subtracts ongoing inflation from the nominal interest rate. Suppose that investors are concerned with next-period wealth and extrapolate current inflation trends. Then, when inflation accelerates, they would demand a higher real interest rate as protection.⁴
- Sovereign default risks, captured by a dummy variable indicating whether the country is investment grade or not according to Standard & Poor's⁵ and by the country's per capita income, a variable often used in the dollarization literature as a proxy for governance quality (Levy-Yeyati 2006).
- Policy environment variables, captured by a 0–5 scale measuring the degree of legal restrictions to onshore dollar deposits, by a 0–100 index

2. See the appendix for sources and construction details of each variable.

3. Theoretically speaking, Ize and Levy-Yeyati (2003) develop the minimum variance portfolio as a measure of the portfolio share allocated to foreign currency assets that minimizes the variance of a portfolio constituted with local and foreign currency assets. Recently Rennhack and Nozaki (2006) use the minimum variance portfolio in estimates of a dollarization equation for Latin American economies.

4. More specifically, suppose that the extrapolation of inflation by investors implies that expected inflation is a weighted average of current and future inflation rates: $\pi_t^e = (1 - \alpha)\pi_t + \alpha\pi_{t+1} = \pi_t + \alpha(\pi_{t+1} - \pi_t)$, where α is the weight. Thus the real interest rate is $RIR \equiv NIR - \pi_t^e = NIR - \pi_t - \alpha(\pi_{t+1} - \pi_t)$, where NIR is the nominal interest rate. The real interest rate can be approximated by subtracting the current inflation rate from the nominal interest rate, and α can be estimated by including the term $(\pi_t - \pi_{t-1})$ among the regressors, as a proxy for the term $(\pi_{t+1} - \pi_t)$.

5. Standard & Poor's specific country ratings, converted into a numerical sequence, were also tested, but the results were poorer and are not reported here. It seems that for real interest rate determination, the speculative grade of the sovereign matters far more than its progress within this specific grade.

TABLE 1. Basic Statistics—Full Sample of 66 Economies

Variable	Mean	Median	Maximum	Minimum	Standard deviation
Real interest rate, average annual (percent)	3.5	3.1	66.2	-38.2	6.3
Nominal interest rate, average annual (percent)	12.7	7.7	92.0	0.1	15.0
Dollarization index (0 – 100, percent) ^a	18.6	9.3	88.4	0.0	22.0
Capital control index (0 – 100) ^b	68.8	62.5	100.0	37.5	21.1
Restrictions (0 – 5) ^c	0.6	0.0	5.0	0.0	1.3
Jurisdictional uncertainty (0 – 100)	35.6	33.0	86.1	0.0	23.9
Minimum variance portfolio (in decimal fraction)	0.5	0.5	1.2	0.0	0.3
Change in inflation rate ^d (percentage points)	-1.4	-0.4	58.1	-65.0	9.7
Inflation, average annual ^d (percent)	9.1	5.2	85.7	-0.8	14.0
Standard & Poor's sovereign ratings (0 – 16) ^e	8.1	7.0	16.0	0.0	4.5
Per capita income (US\$)	9,129.3	4,366.5	37,164.6	752.3	9,931.2

^aRatio of dollar deposits to total deposits.

^bA higher number denotes a higher degree of capital mobility.

^cA higher number denotes more restrictions on residents' holdings of foreign currency deposits.

^dConsumer price index.

^eThe rating scales were converted to values of 0 to 16, where 0 to 6 are speculative grades and 7 to 16 are investment grades.

Source: Authors' analysis based on data from World Bank (Various years); World Bank (2007); Worldwide Governance Indicators database; IMF (Various years); Edwards (2005); Levy-Yeyati (2006); and Standard & Poor's (2005).

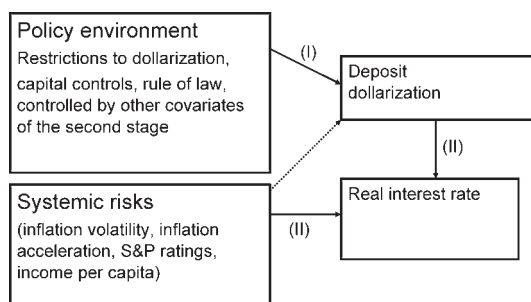
of capital account liberalization constructed by Edwards (2005), and by the complement of the World Bank 0–100 rule-of-law index as in the Worldwide Governance Indicators (World Bank 2007)⁶—the third as a proxy for the “jurisdictional uncertainty” concept proposed in Arida, Bacha, and Lara-Resende (2005) to capture government-related uncertainties besieging financial investors in weak jurisdictions.

In addition, because preliminary analysis of the data indicated that the real local-currency interest rate was a strongly autoregressive variable, its one-year lag was included as a further regressor. Generally, many economic relationships are dynamic, but this inclusion implies some difficulties for the estimations here, soon to be described.

The data set spans 1996–2004 for 66 economies from different parts of the world, including emerging and high-income market economies, so there are

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

FIGURE 1. Two-step Empirical Strategy



relatively few time-series observations in an unbalanced panel.⁷ Table 1 presents basic statistics for the variables in the model. Also reported in this study, they are estimations for dollarized emerging market economies, excluding all advanced economies, even with some dollarization, and also nondollarized emerging market economies. This data set spans 1996–2004 for 33 economies.⁸

Two steps are summarized in figure 1.⁹ Step I uses the policy-environment variables, along with other covariates, to generate an instrument for the deposit dollarization ratio. This instrument subsequently enters the equation that determines 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-denominated assets. Because the dollarization ratio is positively correlated with the error term of the interest rate equation, its coefficient will be positively biased if the dollarization ratio is not properly instrumented using exogenous variables that are noncorrelated with

7. The 66 economies in the sample are, for speculative grade: Argentina, Bolivia, Brazil, Bulgaria, Colombia, El Salvador, Grenada, Guatemala, India, Indonesia, Morocco, Mozambique, Pakistan, Paraguay, Philippines, Romania, Russian Federation, Sri Lanka, Turkey, Ukraine, Uruguay, and Venezuela; and for investment grade: Australia, Austria, Bahrain, Belgium, Canada, Chile, China, Hong Kong (China), Croatia, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Republic of 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, and United States.

8. The 33 economies in this sample are, for speculative grade: Argentina, Bolivia, Bulgaria, Croatia, El Salvador, Grenada, Indonesia, Mozambique, Pakistan, Paraguay, Philippines, Romania, Russian Federation, Sri Lanka, Turkey, Ukraine, and Uruguay; and for investment grade: Chile, China, Hong Kong (China), Cyprus, Estonia, Hungary, Israel, Kuwait, Latvia, Lithuania, Malaysia, Mexico, Poland, Slovak Republic, Slovenia, and South Africa. According to the basic statistics, the dollarization ratio averages 30 percent, with standard deviation of 23 percent, for this sample of dollarized emerging market economies.

9. The authors are indebted to Fernando Velloso for suggesting this two-step procedure. When they ran instrumental variable estimations, they included in the first stage all the variables that were also included in the second.

TABLE 2. First Step Estimation

Variable	(1)	(2)	(3)
Constant	38.4** (0.045)	37.6** (0.05)	39.1** (0.042)
Restrictions (<i>R</i>)	-7.55** (1.75)	-7.50** (2.01)	-7.255** (2.01)
Jurisdictional Uncertainty (<i>JU</i>)		0.22** (0.080)	0.25** (0.080)
Capital Control (<i>CAPLIB</i>)			-0.095 (0.04)
R^2	0.28	0.31	0.33
No. of countries	66	66	66
No. of observations	369	358	358

Dependent Variable: Dollarization Index (DOLLAR)

*Significant at the 10 percent level.

**Significant at the 5 percent level.

TABLE 3. First-Step Estimation for the Sample of 33 Dollarized Emerging Market Economies

Variable	(1)	(2)	(3)
Constant	36.63** (0.038)	41.16** (0.044)	48.36** (0.057)
Restrictions (<i>R</i>)	-9.18** (2.65)	-9.64** (2.57)	-9.41** (2.05)
Jurisdictional uncertainty (<i>JU</i>)		0.33** (0.05)	0.33** (0.05)
Capital control index (<i>CAPLIB</i>)			-0.03 (0.05)
R^2	0.33	0.35	0.35
Number of countries	33	33	33
Number of observations	285	283	283

Dependent Variable: Dollarization Index (DOLLAR).

* Significant at the 10 percent level.

** Significant at the 5 percent level.

Note: Numbers in parentheses are standard errors. Coefficients and standard errors of the other covariates, as in equation (1), are not reported for convenience. Countries in the sample are, for speculative grade: Argentina, Bolivia, Bulgaria, Croatia, El Salvador, Grenada, Indonesia, Mozambique, Pakistan, Paraguay, Philippines, Romania, Russian Federation, Sri Lanka, Turkey, Ukraine, and Uruguay; and for investment grade: Chile, China, Hong Kong (China), Cyprus, Estonia, Hungary, Israel, Kuwait, Latvia, Lithuania, Malaysia, Mexico, Poland, Slovak Republic, Slovenia, and South Africa.

Source: Authors' analysis based on data from World Bank (Various years); World Bank (2007); IMF (Various years); Edwards (2005); Levy-Yeyati (2006); and Standard & Poor's (2005).

the error term of the interest rate equation and strongly correlated with the dollarization ratio. Appropriate instruments already appear to be in the regressor set as the three policy environment variables—restrictions to dollarization, degree of capital-account liberalization, and rule of law index.

Previous researchers (Levy-Yeyati 2006, for example) showed the fundamental importance of the restrictions-to-dollarization variable in determining actual dollarization, while the initial estimates here (not reported) indicated that dollarization restrictions do not belong in the interest rate equation. The results in tables 2 and 3 indicate the relevance of capital-account controls and the rule of law for the degree of dollarization.

It could be argued that rule of law and capital-account liberalization are not good instruments because of their likely impact on interest rates. Low rule of law could make contract enforcement more difficult. So, other things equal, it could increase the cost of borrowing and be associated with higher real interest rates. Similarly, capital-account restrictions could affect the availability of credit and thus the cost of credit. But, as Fraga (2005) argues, such effects may be relevant for bank credit spreads but are unlikely to affect a country's basic local short-term real interest rate (the interbank or money-market rate), the left-hand variable here, which would normally be firmly anchored on the central bank's repurchase rate. Furthermore, previous panel-based studies (Gonçalves, Holland, and Spacov 2007; Salles 2007) have found that capital controls and rule of law do not belong in the real money-market interest rate equation. It may thus be tentatively concluded that the instruments used here are not correlated with the disturbance term in the equation of interest.

The first step generates an instrument for deposit dollarization, the fitted value of the auxiliary regression:

$$dollar_{it} = \beta_0 + \beta_1 R_{it} + \beta_2 JU_{it} \beta_3 CAPLLIB_{it} + \beta_4 \mathbf{X}_{it} + \eta_{it} \quad (1)$$

where *dollar* is the share of bank deposits in US dollars, *t* indexes years and *i* indexes countries, *R* is the index of restrictions on holdings of foreign-currency deposits by residents (computed by De Nicoló, Honohan, and Ize 2003 and also used by Levy-Yeyati 2006), *JU*, or jurisdictional uncertainty, is the complement to the World Bank rule of law index, *CAPLIB* is the capital-account liberalization index constructed by Edwards (2005), \mathbf{X}_{it} is a vector of covariates used in the second stage of the two-stage estimation, and η is the error term. This equation was estimated according to a random-effects model¹⁰ 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 follows:

$$r_{it} = \gamma_t + \omega_i + \beta_1 r_{it-1} + \beta_2 D_{it}^* + \beta_3 MVP_{it} + \beta_4 \Delta \pi_{it} + \beta_5 IGRADE_{it} + \beta_6 y_{it} + \varepsilon_{it} \quad (2)$$

where γ_t and ω_i are time- and country-specific effects, D^* is the instrument for the dollarization ratio, *MVP* is the minimum variance portfolio, $\Delta \pi$ is the change in the consumer price index inflation rate, *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

10. A fixed-effects model was also estimated, but a Hausmann test showed that a random-effects model fitted better, possibly because some explanatory variables of this first stage have limited time variation.

error term. Further details on each of these variables are provided in the appendix.

For dynamic panel-data models, the ordinary least squares estimator is known to be biased and inconsistent. In dynamic panel-data models, where the autoregressive parameter is moderately large and the number of time series observations is moderately small, as in the data set here, Blundell and Bond (1998) find the widely used linear generalized method of moments (GMM) estimator obtained from the first differences of the sample variables to have large finite sample biases and poor precision in simulation studies. Lagged levels of the series provide weak instruments for first differences in this case (see Alonso-Borrego and Arellano 1999 and Blundell and Bond 1998).

When estimating a dynamic model for the equation of the real interest rate, the authors were interested in transformations that allowed using lagged endogenous variables as instruments in the transformed equation. Thus, to estimate the real interest rate equation with its one-year lagged value as one of the regressors, they adopted a two-step GMM system estimation (level and difference combined) proposed by Blundell and Bond (1998), and based on Arellano and Bond (1991) and Arellano and Bover (1995). In this procedure, the one-year lagged real interest rate is treated as an endogenous variable, and the two-year lagged real interest rate is an additional instrument.¹¹ Also used was the variance of the two-step estimation to deal with the downward bias in variance estimation in small samples (Windmeijer 2005). The consistency of GMM estimators depends on whether lagged values of the explanatory variables are valid instruments. This was addressed by considering two specification tests. The first is a Sargan test of overidentifying restrictions, which tests the overall validity of the instruments.¹² The second examines the null hypothesis that the error term is not serially correlated.¹³ In both tests, the model specifications are supported because the null hypothesis is not rejected (tables 4 and 5).

II. EMPIRICAL FINDINGS

Statistical results are reported in tables 2–5. Consider initially the results of the instrumental regression for the dollarization ratio in table 2, for the full sample

11. Several types of panel unit root tests were run, but for convenience the results are not reported here. In general, they strongly fail to accept the null hypothesis of the presence of unit roots. The results are available on request.

12. The two-step version of the GMM system estimator was used to obtain the Sargan test statistics, because the one-step version of the Sargan test overrejects the validity of the set of instruments in the presence of heteroskedasticity. It is well known, however, that the Sargan test may have low power in finite samples. To have some indication of the power of the test, the real interest rate equations with the endogenous one-year lagged value was estimated as an additional (but invalid) instrument in the transformed equations. This test overwhelmingly rejects the null hypothesis of instrument validity.

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

TABLE 4. Second-Step Estimation for the Full Sample of 66 Economies

Variable	(1)	(2)	(3)	(4)	(5)
Lag of real interest rate (r_{-1})	0.491** (0.146)	0.501** (0.15)	0.511** (0.149)	0.509** (0.15)	0.510** (0.148)
Dollarization instrument (D^*)	-0.013** (0.005)	-0.0129** (0.005)	-0.0129 (0.005)	-0.012** (0.005)	-0.011** (0.005)
Investment grade dummy (I_{GRADE})		-1.710** (0.551)	-1.714** (0.554)	-1.850** (0.550)	-1.902** (0.741)
Minimum variance portfolio (MVP)			0.288** (0.144)	0.270* (0.133)	0.285** (0.129)
Delta inflation ($\Delta\pi$)				0.011** (0.006)	0.0112** (0.007)
Per capita GDP (Y)					-0.001 (0.001)
Number of countries	66	66	66	66	66
Number of observations	456	456	456	456	456
Specification tests (p -value) ^a					
Sargan test	0.98	0.97	0.98	0.97	0.98
First-order serial correlation	0.001	0.002	0.002	0.000	0.000
Second-order serial correlation	0.455	0.454	0.452	0.543	0.575

Dependent Variable: Real Interest Rate (RIR).

* Significant at the 10 percent level.

** Significant at the 5 percent level.

Note: Numbers in parentheses are standard errors. Coefficients and standard errors of the other covariates, as in equation (1), are not reported for convenience. Countries in the sample are, for speculative grade: Argentina, Bolivia, Brazil, Bulgaria, Colombia, El Salvador, Grenada, Guatemala, India, Indonesia, Morocco, Mozambique, Pakistan, Paraguay, Philippines, Romania, Russian Federation, Sri Lanka, Turkey, Ukraine, Uruguay, and Venezuela; and for investment grade: Australia, Austria, Bahrain, Belgium, Canada, Chile, China, Hong Kong (China), Croatia, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Republic of 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, and United States.

^aThe p -values of the tests for the first- and second-order serial correlations report the probability of rejecting the null of no serial correlation. Windmeijer (2005) derives a small-sample correction, implemented here.

Source: Authors' analysis based on data from World Bank (Various years); World Bank (2007); IMF (Various years); Edwards (2005); Levy-Yeyati (2006); and Standard & Poor's (2005).

TABLE 5. Second-Step Estimation for the Sample of 33 Dollarized Emerging Market Economies

Variable	(1)	(2)	(3)	(4)	(5)
Lag of real interest rate (r_{-1})	0.520** (0.151)	0.543** (0.149)	0.551** (0.150)	0.548** (0.152)	0.550** (0.160)
Dollarization instrument (D^*)	-0.0155 (0.005)	-0.0145 (0.005)	-0.0151 (0.004)	-0.0158** (0.0045)	-0.0157** (0.0051)
Investment grade dummy (I_{GRADE})		-1.548** (0.401)	-1.550** (0.412)	-1.545** (0.423)	-1.550** (0.450)
Minimum variance portfolio (MVP)			0.295** (0.129)	0.275* (0.132)	0.292** (0.128)
Delta inflation ($\Delta\pi$)				0.0241** (0.0001)	0.0225** (0.0001)
Per capita GDP (Y)					0.0009 (0.0011)
Number of countries	33	33	33	33	33
Number of observations	283	283	283	283	283
Specification tests (p -value) ^a					
Sargan test	0.87	0.82	0.85	0.86	0.89
First-order serial correlation	0.003	0.004	0.002	0.0012	0.0014
Second-order serial correlation	0.389	0.401	0.402	0.405	0.411

Dependent Variable: Real Interest Rate (RIR).

* Significant at the 10 percent level.

** Significant at the 5 percent level.

Note: Numbers in parentheses are standard errors, coefficients and standard errors of the other covariates, as in equation (1), are not reported for convenience. Countries in the sample are, for speculative grade: Argentina, Bolivia, Bulgaria, Croatia, El Salvador, Grenada, Indonesia, Mozambique, Pakistan, Paraguay, Philippines, Romania, Russian Federation, Sri Lanka, Turkey, Ukraine, and Uruguay; and for investment grade: Chile, China, Hong Kong (China), Cyprus, Estonia, Hungary, Israel, Kuwait, Latvia, Lithuania, Malaysia, Mexico, Poland, Slovak Republic, Slovenia, and South Africa.

^aThe p -values of the tests for the first- and second-order serial correlations report the probability of rejecting the null of no serial correlation. Windmeijer (2005) derives a small-sample correction, which is implemented here.

Source: Authors' analysis based on data from World Bank (Various years); World Bank (2007); IMF (Various years); Edwards (2005); Levy-Yeyati (2006); and Standard & Poor's (2005).

of economies (66 economies). All coefficients are significant at the 5 percent level, except capital control, and the coefficient of determination (R^2) is 0.33 for the complete model (column 3 of table 2). Local restrictions to dollar holdings have by far the strongest impact on dollarization: as they rise from a minimum of zero to a maximum of 5, dollarization declines by 36.25 percentage points, a figure similar in magnitude, but opposite in sign, to the equation's constant term (which means that, as restrictions reach a maximum, dollarization is practically equal to zero). Jurisdictional uncertainty, as captured by the complement to the World Bank 0–100 rule of law index, is also relevant: as the index rises from zero to 100, dollarization increases by 25 percentage points. In addition, the 0–100 capital-liberalization index has a significant impact: as capital controls drop from a maximum of 100 to a minimum of zero, the dollarization ratio declines by 9.5 percentage points.¹⁴ Estimation results for the restricted sample of 33 dollarized emerging market economies show slight differences (see table 3). Restrictions to dollar and jurisdictional uncertainty remain statistically significant at the 5 percent level, with slightly larger coefficients than for the full sample of 66 economies.

For both the full sample of 66 economies and the restricted sample of 33 dollarized emerging market economies, the instrumented dollarization ratio has a significant negative impact on the real interest rate, as indicated in regression 5 of tables 4 and 5, which includes all variables specified in equation (2). The coefficient of D^* for the full sample is -0.011 , which means that as dollarization rises from zero to 100, the interest rate declines by 1.1 percentage points on impact and by 2.3 percentage points in the long run (this last figure is obtained by dividing 100 times the impact coefficient by $1 - 0.510$, where the 0.510 is the coefficient of the one-year lagged interest rate). The coefficient increases slightly to -0.015 for the restricted sample of countries. When actual dollarization is substituted for instrumented dollarization in the regression (data not shown), the coefficient of this variable becomes positive (though not significant). This is not surprising given that higher systemic risks would induce both increased dollarization and higher real interest rates. Thus, the raw data should and does indicate a positive correlation between the local-currency interest rate and actual dollarization. The policy environment variables used as instruments for the dollarization ratio are able to reverse its “wrong” positive sign in the interest rate equation. So, using the instrumental procedure overcomes the simultaneous equation problem and correctly estimates a negative coefficient for the dollarization ratio.

Also tested was whether the policy environment variables—restrictions to dollarization, rule of law, and capital-account liberalization—had some direct explanatory power on the real interest rate. The results were negative,

14. As in equation (1) a vector of covariates used in the second stage of the two-stage estimation was also included. Their coefficients are not reported here for convenience. They are available on request.

confirming and expanding the finding by Gonçalves, Holland, and Spacov (2007) that—contrary to a presumption in Arida, Bacha, and Lara-Resende (2005)—jurisdictional uncertainty (measured by rule of law as here) and capital account controls (measured by a different index from here) were not significant explanatory variables for the real interest rate.¹⁵

Consider now the effect of the price-dilution risk variables on the interest rate. First, the real interest rate is positively associated with the minimum variance portfolio variable. As that variable increases from 0 to 1, the real interest rate rises by 0.3 percentage point on impact and by 0.6 percentage point in the long run for the full sample of countries. When the sample is restricted to the 33 dollarized emerging market economies, the size and the significance of the coefficient remain quite similar. The coefficient of the inflation-acceleration variable indicates that as annual inflation increases by, say, 10 percentage points (approximately one standard deviation of this variable in the sample), the real interest rate increases by 0.1 percentage point on impact and by 0.2 percentage point in the long run. The median real interest rate in both the full and the restricted samples is 3.1 percent (table 1 for the full sample), so the price-dilution effects do not seem very large.

Both proxies for sovereign-default risk work very well, indicating that they probably capture different aspects of this risk. Particularly significant are the results for *IGRADE*—the dummy variable indicating whether Standard & Poor's rates a country as investment grade. Investment grade status in the complete sample reduces the real interest rate by 2 percentage points on impact and by 4 percentage points in the long run. Per capita income (measured in units of \$1,000) also has a very strong impact—an increase in per capita income of \$1,000 reduces the real interest rate by 0.8 percentage point on impact and by 1.6 percentage points in the long run.^{16,17} For the restricted sample, *IGRADE* as a proxy for sovereign-default risk shows a smaller but still statistically significant coefficient, at 5 percent. Per capita income shows a similar coefficient size, but is not significant.

15. An anonymous referee expressed doubts about the true exogeneity of the policy-related instruments. If those doubts are correct, the instrumental-regression estimate of the (negative) impact of dollarization on the real domestic interest rate may be considered a lower bound for the true (more negative) coefficient.

16. This effect could be highly nonlinear, fading away for the largest per capita income figures, but this nonlinearity could not be captured using either the inverse of per capita income or its squared value.

17. Preliminary estimations also included the ratio of public debt to GDP as a regressor, with disappointingly small estimated coefficients. This might be a consequence of not properly accounting for domestic debt (which is important in many countries—such as Brazil, where it represents more than 80 percent of debt). It may also be that debt to GDP ratios do not capture important fiscal characteristics for each country, such as the degree of flexibility of revenue, expenditure pressures, and contingent liabilities. While fiscal positions are likely important determinants of interest rates, their effects are better summarized by the sovereign default-rating dummy variable used in the regression, as described in Beers and Cavanaugh (2006). So, the debt to GDP ratio is not included directly in the regressions.

In summary, appropriately instrumented financial dollarization has a significant negative impact on the real interest rate, but the economic magnitude of the impact is small. The real interest rate variable is significantly autoregressive, indicating the importance of using a dynamic model. Also established is the negative effect on the real interest rate of price-dilution risks as measured by inflation volatility and acceleration. Investment grade status and per capita income have large negative effects on the real interest rate. No direct effects were found on the real interest rate of rule of law, capital controls, and dollarization restrictions. These variables were shown, however, to be significant as instruments for the dollarization ratio that enters the real interest rate equation. It is important to stress that the results remain similar regardless of the sample of countries. This is likely due to the fact that some advanced economies experience dollarization while some emerging market economies do not allow it. So, the full sample, including advanced economies, appears accurate enough to allow drawing inferences.

III. CONCLUSIONS

This article expanded the scope of the financial dollarization literature by analyzing the systemic-risk determinants of the real interest rate in emerging market economies. Of particular interest was investigating the negative relation between deposit dollarization and local-currency real interest rates for a given set of fundamentals. The findings, obtained with panels of 66 and 33 countries for 1996–2004, indicated that deposit dollarization, properly instrumented, has a negative but small impact on the real interest rate.

A dynamic specification accounted for the fact that real interest rate changes are typically smooth (so, it is in general a strongly autoregressive variable). Also established were the negative effects on the real interest rate of price-dilution risks measured by inflation volatility and inflation acceleration. Generally speaking, investment grade status was shown to have large negative effects on the real interest rate: obtaining an investment grade rating would reduce the real interest rate by 2 percentage points on impact and by 4 percentage points in the long run. While no direct effects on the real interest rate were found for rule of law, capital controls, and dollarization restrictions, these policy environment variables were critical instruments for the dollarization ratio entering the determination of real interest rates.

The policy implications are embedded in the estimates of the high prices that investors charge to hold financial assets whose values may be diluted by volatile and accelerating inflation and by a high probability of default. Investors' memories of past deeds find expression in the yield spreads that governments of emerging market economies are required to pay on their newly issued debt. In other words, the numerical magnitudes of the systemic risks underlying the high interest rates in emerging market economies were unveiled.

A weak spot in the analysis is that the sample is short in the time dimension and includes only a limited number of emerging market economies. But the restricted sample of only dollarized emerging market economies can be considered a kind of robustness check on sample size. The estimation results stood when the same sample of countries was used in the first- and second-stage regressions. Future research with an expanded sample should thus seek to uncover dynamic relations not contemplated by the results here. Furthermore, only two of the possible financial consequences of systemic risk were considered: domestic financial dollarization and high real local-currency interest rates. Future research could incorporate financial shallowness, offshore dollarization, short-termism, and indexation as alternative systemic-risk-coping mechanisms in emerging economies.

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 the *International Financial Statistics* (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 to total bank deposits. *Source*: Levy-Yeyati (2006), who draws on IMF Staff Reports, central bank bulletins, Bolino, Bennett, and Borensztein (1999), De Nicoló, Honohan, and Ize (2003), and Arteta (2005).

Delta-inflation ($\Delta\pi$). 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.

Investment grade (IGRADE). Equal to 1 for a sovereign investment grade rating and zero for a speculative grade rating. 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. With only even-year values for this variable, odd-year values were interpolated. *Source*: World Bank, *Worldwide Governance Indicators*.

Capital account liberalization index (CAPLIB). Described in Edwards (2005) and provided by the author. It is a 0–100 scale, with higher values indicating increasing degrees of capital account liberalization.

Per capita GDP (Y). Measured 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 (2006), based on data from IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions*, revised and expanded by Levy-Yeyati from De Nicoló, Honohan, and Ize (2003) using the same methodology.

Minimum variance portfolio (MVP). This variable is derived from a portfolio choice model in which risk-averse local investors choose 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:

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

where π is the inflation rate in local currency and q is the real exchange rate. To estimate a country's MVP for a given year, monthly data were used on inflation (CPI) and exchange rate changes for that country in that year. *Source*: IMF's *International Financial Statistics*.

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