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BALANCE SHEET EFFECTS, EXTERNAL VOLATILITY, AND EMERGING MARKET SPREADS

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This paper studies the determinants of emerging market spreads, and thus of the cost of borrowing for emerging market sovereigns, using recent data from JP Morgan's EMBI+ index for a panel of 19 countries. Controlling for traditional spread determinants, we focus on three additional factors whose importance is suggested by recent work: external shocks, the balance sheet effect of real devaluations, and the degree of current account leverage. We find clear and strong evidence that the variables in the foregoing categories have an economically and statistically significant relationship with spreads. In particular, we find a major role for the terms-of-trade volatility and the level of current account leverage in explaining spread variation. The result on current account leverage establishes an important link between a factor shown to make countries more vulnerable to sudden stops of capital flows, and the premium required by international investors on their foreign debt.

JEL classification codes: C33, F34
Key words: balance sheet effects, emerging market debt, external volatility, country risk premium

I. Introduction

The study of emerging market spreads, defined as the difference between the yield on emerging market bonds and the yield on US Treasury bonds with the same or similar maturity, extends back to Edwards (1984, 1986). Spreads on debt reflect several factors. In addition to a premium for the probability of default on the

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underlying bond and the recovery rate that investors assume they will receive in the event of default, spreads may include an additional premium related to the liquidity of the underlying bonds, the prevalent degrees of liquidity and risk-aversion in the market, and even tax privileges realized by the investor.[1] In this study, we focus on highly liquid, dollar denominated debt instruments of emerging market sovereigns that are traded in international markets and included in JP Morgan's EMBI+ index.

Panel data studies of emerging market spreads that focus on "classic" determinants of sovereign risk include: Rowland and Torres (2004), Ades et al. (2000), Eichengreen and Mody (1998), Min (1998), and Cantor and Packer (1996). A good survey can be found in Sobrinho (2004). The "traditional" candidates for the determinants of sovereign spreads, which have found to be significant statistically and/or economically in at least one of these studies, include: the economic growth rate, the debt-to-GDP ratio, the reserves-to-GDP ratio, the debt-to-exports ratio, the exports-to-GDP ratio, the ratio of debt service-to-GDP, the fiscal balance, international interest rates, the default history of the country, net foreign assets, and the domestic inflation rate. We try most of these candidates as control variables in the present study.

Despite the contributions of the above literature to understanding the determinants of emerging market spreads, however, an understanding of the importance of balance sheet effects in the presence of sudden stops of capital inflows, and macroeconomic volatility, in provoking financial and debt crises is much more recent. Important papers on the latter topics, respectively, include Calvo, Izquierdo, and Talvi (2003), Calvo, Izquierdo, and Mejia (2004), and Catão and Kapur (2006).

The primary contribution of the present paper is to demonstrate that both balance sheet effects and terms-of-trade volatility have economically and statistically significant effects on the spreads of emerging market sovereigns, after controlling for a variety of other factors that have been shown to affect spreads. In particular, we establish a robust link between the degree of current account leverage, a key variable in determining the impact of sudden stops of capital inflows, and emerging market spreads. We define the degree of current account leverage, following closely

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[1] See, e.g., Huang and Huang (2003) for evidence that structural credit risk models for corporates calibrated to reproduce observed default frequencies tend to systematically underpredict spreads, and Pan and Singleton (2008) for a recent discussion of global liquidity and risk factors as determinants for sovereign CDS spreads. Although we do not include measures of international liquidity or risk aversion directly in our regressions, we do control throughout for fixed year effects, and this should capture any direct effects on spreads from time variation in the preceding factors.

the work of Calvo, Izquierdo, and Mejia (2004), as the value of foreign financing of the current account measured as a percentage of the value of a country's imports. The rationale for this variable is straightforward: given a sudden stop of foreign financing of the current account, a country will be forced to reduce its purchases of imports. The percentage of import purchases it will need to forgo in the event of a sudden stop is an important measure of the duress caused by that event.

Calvo, Izquierdo, and Mejia (2004) also emphasize that current account leverage is connected to the degree of real exchange rate depreciation that a sudden stop will require. Another recent paper, by Berganza, Chang, and García-Herrero (2004), directly tests the effects of unexpected real devaluations on sovereign spreads, which are presumed to work through negative net worth effects, as hypothesized for example by Aghion, Bacchetta and Banerjee (2004), and Céspedes, Chang and Velasco (2000). Berganza, Chang, and García-Herrero (2004) find that the interaction between unexpected real devaluations and the ratio of foreign debt service-to-GDP is significantly associated with higher spreads. In the present study, we show additionally that countries with high values of current account leverage face higher spreads, *even after* taking into account the direct balance sheet effects due to the interaction between real devaluations and the debt burden. Thus, there are other reasons besides real devaluations, perhaps related to the fungibility of foreign currency revenue for import purchases, which explain the importance of current account leverage for the cost of borrowing.

Regarding our finding that higher terms-of-trade volatility is associated with higher spreads, this is consistent with the closely related finding of Catão and Kapur (2006) that higher terms-of-trade volatility is associated with a higher number of incidences of default. This finding is intuitive, because higher terms-of-trade volatility is associated with a higher volatility of foreign currency income, and countries with more volatile income streams face a higher probability of being in a position in which the value of their foreign debt service needs exceed the value of their foreign currency reserves and short-term revenues. Such countries, as a consequence, face higher probabilities of default, and thus lenders can be expected to demand higher premiums on their debt. Our findings are consistent with recent work by Hilscher and Nosbusch (2007), who also find a statistically and economically significant role for the volatility of a country's terms-of-trade in influencing EMBIG spreads.

Other recent regression studies of emerging market sovereign spreads include Westphalen (2001) and Ferrucci (2003). In particular, Westphalen (2001) finds that changes in the volatility over the last 20 trading days of the local MSCI country stock index positively and significantly affects spreads. This result provides another indication, in addition to the results of Hilscher and Nosbusch (2007) and the present study, that the volatility of fundamentals can be an important determinant of spreads. It is worth noting that the R^2 values obtained in our regressions, which range from 71% to 91% across the various specifications tested, are noticeably higher than those obtained in the previous studies mentioned. We attribute our ability to explain a significant degree of spread variation primarily to our focus on identifying and testing simultaneously the effects of distinct and important categories of factors that have been identified in the literature –in particular the term-of-trade volatility and the balance sheet variables inspired by recent work.

The rest of this paper is organized as follows. In section II, we outline a simple theoretical framework for analyzing the determinants of emerging market spreads that justifies the log-linear form of our spread regressions. Section III then describes the data and independent variables and states the baseline regression. Section IV presents the main empirical results of the paper, including robustness tests of the baseline regression. Section V analyzes the connection between our current account leverage measure, FDI and portfolio flows, and spreads. Section VI concludes.

II. Basic theoretical framework

Assuming that lenders are risk neutral, there is high capital mobility, and that the return on the sovereign bond to lenders is zero in the event of default, the sovereign spread s is determined by the following condition, which has been used by others (see Min 1998 and Nogués and Grandes 2001):

$$1 + r = (1 - P)(1 + r + s),$$

where r is the risk-free rate and P is the probability of default. If the recovery rate is nonzero and there are no fixed default costs, then the above equation generalizes to:

$$1 + r = (1 - P)(1 + r + s) + P\theta, \tag{1}$$

where the return in the event of default is given by θ. For models with more detailed considerations of the costs of default, such as spillover costs, see for example Catão and Kapur (2006). The sovereign spread implied by the above condition is

$$s = \frac{P}{(1-P)}(1+r-\theta). \tag{2}$$

Similar to Nogués and Grandes (2001), approaching P with a logistic function such as

$$P = \frac{\exp\left[\gamma + \sum_{i=1}^{n} \beta_i X_i\right]}{1+\exp\left[\gamma + \sum_{i=1}^{n} \beta_i X_i\right]},$$

where the variables X_i determine the probability of default, leads to the following log-linear form for the spread equation:

$$\log(s) = \log(1+r-\theta) + \gamma + \sum_{i=1}^{n} \beta_i X_i, \tag{3}$$

We will now describe the data and dependent variables, after which we will state the baseline regression for the paper, which we adapt from the above equation.

III. Dataset and econometric specification

A. The data and independent variables

We analyze the determinants of the country risk premium on external, dollar denominated emerging market debt using yearly data on the implied country spread for the JP Morgan Emerging Market Bond Index Plus (EMBI+). The EMBI+, according to JP Morgan, is the "most liquid US-dollar emerging market debt benchmark, and tracks total returns for actively traded external debt instruments in emerging markets" (JP Morgan 2004). We take as our sample all of the countries (19 in total) that have been part of the index from their first year on the index up until 2004. This time period includes both the Russian debt crisis in 1997-98 and the Argentine default of 2001, as well as the generally very positive performance in emerging market debt seen in 2004. The countries and years used in the study are summarized in Table 1.

The dependent variable in our study will be the logarithm of the EMBI+ spread reported by JP Morgan, denoted by *log_spread*. For each year, we use the average monthly spread in that year. The variables used to run the main regressions discussed in the paper are defined in Table 2.

Table 1. Countries and years used in the study

Country name	Yearly observations
Argentina	1997-2004
Brazil	1994-2004
Bulgaria	1997-2004
Colombia	1999-2004
Ecuador	1997-2004
Egypt	2002-2004
Malaysia	2002-2004
Mexico	1997-2004
Morocco	1997-2004
Nigeria	1997-2004
Panama	1997-2004
Peru	1997-2004
Philippines	1997-2004
Poland	1997-2004
Russia	1997-2004
South Africa	2002-2004
Turkey	1999-2004
Ukraine	2001-2004
Venezuela	1997-2004

The variables in the study can be grouped into three categories: traditional macroeconomic variables, variables capturing some aspect of external volatility, and variables capturing balance sheet effects. In our preferred regression, we settled for parsimony on three traditional macroeconomic variables: the ratio of debt-to-GNI (*debt_to_gni*), the ratio of reserves-to-GNI (*res_to_gni*), and the five year rolling rate of GNI growth (*5year_growth_rate*). We also experimented with other traditional variables, such as a measure of openness, the trade surplus, the government surplus (fiscal surplus as a ratio to GDP), and the rate of inflation of the consumer price index, but these did not prove robustly significant.

In the second category of variables we include the terms-of-trade (*tot*) and the rolling ten year terms-of-trade volatility (*tot_volatility*). Since we include yearly dummies to account for time effects in all of our regressions, there is no scope for including variables such as the US interest rate, or the VIX implied volatility index, which exhibit only time variation.

Table 2. Dependent and independent variables

Variable	Description
log_spread	The natural logarithm of the EMBI+ spread in basis points. Source: JP Morgan.
debt_to_GNI	Total debt stock in dollars divided by total Gross National Income, in percentage terms. Source: World Development Finance Database, World Bank.
res_to_GNI	Total non-gold international reserved in dollars divided by Gross National Income, in percentage terms. Sources: International Financial Statistics, IMF, and World Development Finance Database, World Bank.
5year_growth_rate	The five-year rolling mean of the logarithm of the ratio of current year GNI to previous year GNI. Source: World Development Finance Database, World Bank.
tot	The ratio of average export price to average import price. The average export price was calculated using current exports divided by constant exports, and the average import price was calculated analogously. Source: World Development Finance Database, World Bank.
tot_volatility	The ten-year rolling standard deviation of the terms-of-trade measure.
ds_to_GNI	The ratio of debt service to GNI. Source: International Financial Statistics, IMF.
change_in_RER	The year-on-year change in the real exchange rate, divided by the value of the real exchange rate in the year 2000. The real exchange rate was calculated as the nominal exchange rate in domestic currency per dollar times the ratio of the yearly CPI for the United States to the CPI for the country in question. Sources: International Financial Statistics, IMF.
currency_mismatch	Equal to the debt service to GNI ratio, multiplied by the real exchange rate change variable, *change_in_RER*, described above. Sources: International Financial Statistics, IMF, and World Development Finance Database, World Bank.
CA_leverage	This equals (imports plus debt service minus exports) divided by imports. Source: World Development Finance Database, World Bank.
FDIP_leverage	This equals (FDI plus portfolio investment) divided by imports. Source: World Development Indicators Database, World Bank.
default_dummy	This equals 1 if the government is currently rated as non-performing on any of its outstanding debt, and 0 otherwise. Source: Borensztein and Panizza (2008).

Finally, the third category of determinants consists of the *currency_mismatch* variable and the current account leverage variable, *CA_leverage*, both of which are important for assessing balance sheet effects. In the first case, the *currency_mismatch* variable is equal to the product of the foreign debt-service-to-GNI ratio and the year-on-year change in the real exchange rate normalized by the real exchange rate in the year 2000. Second, the *CA_leverage* variable is defined as the ratio of debt service, minus net exports, to imports, cf. the definition in Table 2 above. Net exports is a proxy for the current account, so this ratio can be interpreted as a proxy for debt service minus the current account, divided by imports: $(DS - CA)/I$. The fraction of debt service not financed by the current account must be financed by a combination of new debt issuance, foreign direct investment flows, other new portfolio investment flows, and income on foreign assets. The first three of these four components, which normally account for the majority of the capital account, may be reduced significantly in the event of a sudden stop of capital inflows. Thus, the numerator in the current account leverage variable represents an approximate upper bound for the shortfall in the receipt of foreign currency income the country would face in the event of a sudden stop.

B. The baseline equation

Having discussed the variables, we now turn to the baseline equation in our study. Given the difficulty of estimating the expected cost in the event of default, as well as the possibility of unobserved factors that affect the spread, we adapt equation 3 in the previous section to the following empirical model, which is the one we estimate as our baseline regression:

$$\begin{aligned}\log(s_{it}) = {} & \alpha + \gamma_t + \beta_1 debt\_to\_GNI_{it-1} + \beta_2 res\_to\_GNI_{it-1} \\ & + \beta_3 5year\_growth\_rate_{it-1} + \beta_4 tot_{it-1} + \beta_5 tot\_volatility_{it} \\ & + \beta_6 currency\_mismatch_{it} + \beta_7 CA\_leverage_{it-1} + \varepsilon_{it}.\end{aligned} \quad (4)$$

For each observation, the subscript i refers to the country, and the subscript t (or $t-1$) refers to the year. The term γ_t is a yearly dummy variable included to control for time effects. We control for time effects in all of our regressions.[2] In addition, we run several variations on the baseline regression, including a version with fixed country effects, in which α is replaced by a country-specific constant α_i, to test for the presence of unobserved country-specific factors.

The first four primary independent variables in the baseline specification above were taken from previous studies and were robustly significant in our data set, and the last three variables are those most of interest to us in the present study. In all our specifications, which will be discussed in more detail in the following section, we used a random effects GLS regression with robust standard errors to correct for the possible presence of heteroskedasticity.

To reduce concerns about possible endogeneity between average yearly spread and yearly income, exports, imports, and so on, all explanatory variables were

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[2] We would like to thank an anonymous referee for noting the importance of the inclusion of time effects.

introduced with a one year lag, with the exception of the variables *tot*, *tot_volatility*, and the variable *currency_mismatch*. It must be noted that, if political factors or some other un-modeled heterogeneity exists that affects the lagged variables and is persistent, using lagged values may not address all endogeneity concerns. Without claiming a structural relationship for our regression, however, the use of lagged values for potentially endogenous variables, in conjunction with country and year fixed effects, is likely to reduce potential endogeneity bias even where it cannot eliminate it entirely.[3]

The three variables introduced without a lag deserve further comment. The terms-of-trade is simply the trade-weighted average export price divided by the trade-weighted average import price for a given country in a given year. The terms-of-trade can be regarded as exogenous, because the spreads on foreign debt of any one country are unlikely to affect the international prices, which are determined by global supply and demand, of the traded goods exported or imported by that country.[4] For this reason, there is no problem with using the contemporaneous values of the terms-of-trade and its rolling volatility in our spread regressions.

In the case of the *currency_mismatch* variable, however, there is a reasonable argument for the existence of simultaneity bias, as for instance, changes in the sovereign spread might very well affect the contemporaneous real exchange rate. Nonetheless, as we show in Section IV.C, there is no statistical evidence for the presence of endogeneity problems related to this variable in our study.

In all of our regressions, in order to correct for the effects on the EMBI+ spread of a country going into default on any of its outstanding external debt, we excluded all of those observations corresponding to a country listed as being in default that year. For this we made use of the *default_dummy* variable, noted in Table 2, from Borensztein and Panizza (2008).

IV. Regression estimates

The baseline regression results are displayed in column (1) of Table 3. As can be seen, the coefficients for all of the explanatory variables in the baseline spread regression have the expected signs and are statistically significant at the 1% level, with the exception of the terms-of-trade coefficient, which is significant at the 5%

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[3] The author would like to thank an anonymous referee for emphasizing this point.

[4] Hilscher and Nosbusch (2007) note as well, in their study of emerging market spreads, this attractive property of the terms-of-trade, and by extension its volatility.

level. The results indicate that a higher debt-to-GNI ratio, higher terms-of-trade volatility, and greater balance sheet effects, whether a greater change in the real value of debt service or a higher degree of current account leverage, are associated with higher sovereign spreads. In contrast, a higher reserves-to-GNI ratio, higher average recent economic growth, and better terms-of-trade are associated with lower sovereign spreads.

Table 3. Determinants of *log_spread*: Baseline regression and robustness checks

Explanatory variables	(1)	(2)	(3)	(4)
	RE	FE	RE	FE
log_spread_1			0.659	0.309
			(0.120)***	(0.161)*
debt_to_gni_1	0.008	0.003	0.005	-0.001
	(0.003)***	(0.005)	(0.002)**	(0.006)
res_to_gni_1	-0.028	-0.023	-0.014	-0.021
	(0.006)***	(0.008)***	(0.005)***	(0.009)**
5year_growth_rate_1	-1.576	-2.663	-0.341	-2.329
	(0.551)***	(0.739)***	(0.518)	(0.838)***
tot_volatility	7.419	6.650	3.626	6.395
	(1.343)***	(1.737)***	(1.144)***	(2.473)**
tot	-0.770	-0.315	-0.512	-0.201
	(0.385)**	(0.558)	(0.309)*	(0.571)
currency_mismatch	0.061	0.062	0.065	0.065
	(0.022)***	(0.025)**	(0.024)***	(0.025)**
CA_leverage_1	0.545	0.681	0.329	0.397
	(0.167)***	(0.283)**	(0.122)***	(0.320)
Constant	6.126	6.279	1.691	3.857
	(0.479)***	(0.589)***	(0.964)*	(1.086)***
Observations	100	100	84	84
Number of countries	19	19	19	19
Wald test statistic	1467.62	13.35	31554.81	387.50
Within R^2	0.751	0.766	0.744	0.797
Between R^2	0.847	0.748	0.954	0.833
Overall R^2	0.796	0.706	0.898	0.795

Note: all regressions include time dummies to account for fixed year effects.

Let us examine briefly the magnitudes of the point estimates for each of our explanatory variables. The interpretation of the coefficient values is as the percentage change in spreads, divided by one hundred, that results from a one point increase in the explanatory variable.

In our sample, the average debt-to-income ratio is 53.9%, with a sample standard deviation of 20.71%, and the average reserves-to-income ratio is 13.2%, with a sample standard deviation of 7.63%. Thus according to our regression estimates an increase in the debt-to-income ratio by one sample standard deviation leads on average to an 16.6% increase in spreads over their current levels, and an increase of one sample standard deviation in the reserves-to-income ratio leads on average to 20.6% reduction in spreads from their previous levels.

A one percentage point increase in the (lagged) five year rolling average economic growth (for example, from 5% to 6%, which is coded as an increase of 0.01 in the above regression) is associated with a 1.6% decrease in the EMBI+ country spread.

An increase in the terms-of-trade by the amount 0.150, which is the sample standard deviation for this variable, corresponds according to the baseline model estimates in equation (1) of Table 3 to an 11.6% reduction in spreads.

The 10-year terms-of-trade volatility has an average value of 0.075 across the sample and a sample standard deviation of 0.053. In light of this, we see that an increase of the terms-of-trade volatility by one sample standard deviation would lead, according to the baseline model, to a 39.3% increase in the EMBI+ spread. This indicates that countries with higher terms-of-trade volatility are likely, holding other factors constant, to face significantly higher spreads. In addition, as we will see in the following sections, the finding that terms-of-trade volatility is a significant determinant of emerging market spreads is highly robust to a variety of alternative specifications.

Given the relative novelty of this variable in studies of country risk, it is instructive to compare the economic significance of our result on terms-of-trade volatility to that of the result obtained for the economic significance of the terms-of-trade volatility by Hilscher and Nosbusch (2007). Because the regressions of those authors are run using the level of the EMBI spread as the dependent variable, whereas our regressions are run using the logarithm of the EMBI+ spread, we must resort to an approximate comparison. Since the EMBI and EMBI+ series are very similar, but not identical, we will use the percentage change of spreads due to a one standard deviation increase in the sample terms-of-trade volatility as the basis for comparison. We use the median spread in their sample, of 411 basis points, as the base value for converting their estimate of spread changes in response to a one sample standard deviation increase in the terms-of-trade volatility into a percentage change.[5] As Hilscher and Nosbusch (2007) estimate (in Table 3, Panel B of their paper) that a one sample standard deviation increase in terms-of-trade volatility increases spreads by 149.8 basis points, that translates into an increase of 31.1% over the median spread in their study. This is slightly lower than our figure, of 39.9% for model (1) in Table 3, but quite similar to the implied percentage changes using the slightly lower coefficients in models (2) and (4) of our Table 3. On the whole, our study and that of Hilscher and Nosbusch (2007) appear to agree quite well about the approximate magnitude of the effect of terms-of-trade volatility on spreads, as well as the fact that this effect is economically very significant, since one standard deviation changes in the terms-of-trade volatility produce relatively large percentage changes in spreads.

The average value for the *currency_mismatch* variable in our sample is 0.098, with values ranging from a minimum of -3.368 to a maximum of 4.844 over the sample. This variable measures changes in the real debt service burden due to the impact of changes in the real exchange rate and the total external debt service scaled by national income. The sample standard deviation of the variable is approximately 1.129, so according to our model an increase in this variable by one standard deviation results in an increase in spreads of approximately 6.9%.

The figure above is worth comparing, at least approximately, with the percentage increase in the cost of borrowing, as measured by the excess return on the EMBI index, obtained by Berganza, Chang, and García-Herrero (2004). Given that these authors, like Hilscher and Nosbusch (2007), use spread levels rather than log spreads, we proceed as above to compute a comparable percentage change of spreads due to an increase of one sample standard deviation of the *currency_mismatch* variable, which the above authors label as "BALA", in their study. Given a point estimate of 49.457 for the "BALA" variable as reported in column II of Table 1 in their paper, a sample average cost of borrowing of 548.76, and sample standard deviation for the "BALA" variable of 1.99, as reported in the latter two cases in their Table A3, we obtain an implied percentage change in the cost of borrowing of 16.5%. This figure is about 10 percentage points higher than our estimate in the preceding paragraph, although some of this discrepancy is likely due to the larger sample size in their study, which causes the sample standard deviation of their *currency_mismatch* variable to be somewhat larger than the sample standard deviation of the variable in our study. Perhaps more importantly, as we show in Section IV.B, our point

[5] In particular, we compute the logarithm of: the change plus the base value divided by the base value.

estimate for the *currency_mismatch* variable more than doubles when we include the normalized change in the real exchange rate and the debt-service-to-GNI variables separately in the baseline regression, and this alone can explain the majority of the discrepancy reported above.

Proceeding now to the most novel variable in our study, *CA_leverage*, the average degree of current account leverage in the sample is 26.5%, with a sample standard deviation for this variable of 24.9%. Thus given an increase in the degree of current account leverage of one sample standard deviation, the baseline model predicts a resulting increase in the EMBI+ country spread of 13.6% of the previous value. The economic significance of current account leverage, as measured by the percentage change in spreads in response to a one sample standard deviation increase of the variable, is higher than the economic significance of the *currency_mismatch* variable, but lower than the economic significance of the *tot_volatility* variable for terms-of-trade volatility.

The Wald Chi-squared test statistic for joint significance of the baseline regression has a value of 1467.62, and an associated p-value of 0.0000, which indicates that the joint explanatory power of the seven variables (and the yearly dummies) included is quite significant.

A. Robustness of the baseline regression to spread persistence and country fixed effects

To evaluate the robustness of these findings, we first test for the presence of unobserved heterogeneity by running the baseline model with country fixed effects. Table 3 displays the results of this regression in column (2). We performed a Hausman test on the difference of coefficients between specifications (2) and (1) to determine if there was a systematic difference in the set of coefficients with and without country fixed effects. Under the null hypothesis that there is no systematic difference in coefficients, the fixed effects estimator is unbiased but inefficient, and the random effects estimator is both unbiased and efficient. Under the alternative hypothesis that there is a systematic difference in coefficients, however, the fixed effects estimator remains unbiased while the random effects estimator is biased. In this case the Hausman test statistic is distributed as a χ^2 with 15 degrees of freedom, on account of the fact that yearly time dummies are included in both regressions in addition to the explanatory variables whose coefficients are shown in the tables. We obtain a Hausman test statistic of 16.96, which has a p-value of 0.3212. Thus we cannot reject the null hypothesis at conventional significance levels, and there is no clear evidence in support of the presence of unobserved heterogeneity and the use of country fixed effects.

All variables remain statistically significant in the regression with country fixed effects except the debt-to-GNI ratio and the terms-of-trade level, which are no longer significant in the fixed effects regression. This loss of significance may be due in part to the fact that the standard errors for all variables are higher in the regression with fixed country effects, which is inefficient under the null hypothesis of no significant difference in coefficients.

The next question we pose is to see whether the importance of the external shock variables and the balance sheet variables stands up to inclusion of the lagged dependent variable, which in our case is the lagged log spread. This is also a test of the degree of spread persistence. The results of running the baseline model with random effects and the inclusion of the lagged log spread is shown in column (3) of Table 3.

The model with random effects shows strong evidence for the presence of spread persistence, as the coefficient of the lagged log spread is equal to 0.66 and is significant at the 1% level. The estimates of the coefficients on the 10-year rolling terms-of-trade volatility, the *currency_mismatch* variable, and the current account leverage variable all remain statistically significant at the 1% level, indicating that the primary variables of interest in our study are robust to the inclusion of the lagged dependent variable in the baseline regression. The magnitudes of all coefficients in regression (3) with the lagged dependent variable are lower than the values obtained in the baseline regression (1), with the exception of the value of the *currency_mismatch* variable, which is slightly higher. All variables remained significant at least at the 10% level except the coefficient on the 5-year growth rate of GNI, which is now insignificant in the regression with the lagged dependent variable.

Since the Hausman test for the presence of fixed country effects in the baseline regression was insignificant, we have no strong motive for believing that fixed effects will be relevant in the baseline regression with the lagged dependent variable included, either. To test that assumption rigorously, we performed a Hausman test for the presence of unobserved heterogeneity in specification (3) using the estimates shown in specification (4) after the inclusion of fixed effects. The value of that Hausman test, which is distributed as a chi-squared with 15 degrees of freedom, is equal to 14.95. The p-value corresponding to that value is 0.4547, which indicates that we have no evidence for rejecting the null hypothesis that there is no significant difference in coefficients between specifications (3) and (4) at conventional significance levels.

There may be an argument that some individual variables, in particular the average five year growth rate of GNI, might be correlated with unobserved country effects, given that in specification (4) the coefficient on economic growth is again significant at the 1% level and its magnitude is comparable with the values estimated in specifications (1) and (2), whereas this is not the case in specification (3). However, there is no evidence of a systematic difference in coefficients.

In the general setting with a lagged dependent variable and panel data, the Arellano-Bond regression, which is estimated by the generalized method of moments (GMM), provides a robust way of testing for spread persistence, dealing with the problem of serially correlated errors, and hence handling the possible endogeneity between regressors and the error term due that would result from omitting the lagged dependent variable. In our case, however, because we are using unbalanced panel data with a modest sample size, the cost of implementing an Arellano-Bond regression in terms of information loss is large, amounting to one third of the sample. In light of this, our inclusion of the lagged dependent variable is the most feasible means of dealing with the possible problem of serially correlated errors.

B. Testing the effect of exchange rate shocks and debt-service to GNI in the baseline regression

Having established that the baseline regression is robust to the inclusion of country fixed effects and the lagged dependent variable, we now devote the remainder of the section to examining two issues related to the *currency_mismatch* variable in our study.

The first issue has to do with the fact that the *currency_mismatch* variable, defined as in Table 2 as the product of the (normalized) year-on-year change in the real exchange rate and the ratio of debt service to GNI, represents an interaction effect between these two variables, and it would be worthwhile to include both variables individually to see whether they are individually significant, or if they change the estimated coefficient of the *currency_mismatch* variable itself.[6]

The variable *currency_mismatch* captures the effect on spreads due to unexpected changes in the real debt service burden. A rise in the real debt service burden, for a country with a nonzero amount of dollar denominated debt, could occur for example due to a real depreciation, because this makes the value of foreign currency-denominated debt service higher in domestic currency terms.

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[6] The author would like to thank an anonymous referee for making this suggestion.

There is reason, however, to believe that the unexpected change in the real exchange rate may exert a direct effect on spreads, apart from its role in influencing the real debt burden. In particular, a rise in the real exchange rate is likely to have a positive effect on net exports, as a real depreciation makes imports relatively more expensive to domestic agents and exports cheaper to foreigners. This improvement in net exports will exert a positive influence on net foreign currency income via an improvement in the current account. That, in turn, is likely to lower spreads by increasing the country's capacity to repay foreign currency debt.

With respect to the debt service-to-GNI ratio, we would expect higher debt service-to-GNI ratios to be associated with higher spreads, as other things equal, higher debt service burdens represent higher leverage for the borrowing country, and thus a higher probability of default on foreign currency debt. This higher probability of default must be compensated for by higher spreads paid to lenders. In our study, however, the debt-service-to-GNI ratio has a moderately positive correlation of 0.345 with the (lagged) debt-to-GNI ratio we have already included in our baseline regression. Thus, we expect that in our alternative regression, the debt-service-to-GNI ratio will have either a positive and significant or (quite possibly) a statistically insignificant coefficient.

The results of running our alternative regression, which consists of including the two dependent variables mentioned above in the baseline regression (1) of Table 3, is shown in column (1) of Table 4. Our predictions about the signs of the new variables are correct: the coefficient on the change in the real exchange rate is negative and significant at the 10% level, while the lagged debt service-to-GNI measure is not statistically significant. With respect to our baseline regression, the coefficients on the dependent variables in that regression change little, with the exception of the coefficient on the *currency_mismatch* variable, which more than doubles from its value in the baseline regression of 0.061 to a value of 0.128 in the alternative regression.

This finding has a natural interpretation. It indicates that, for low debt burdens, measured by debt service-to-GNI, real exchange rate depreciations have a negative effect on spreads, due most likely to the positive effect on net receipt of foreign currency income. For higher debt burdens, however, the net effect of real exchange rate depreciations is to raise spreads, as the adverse balance sheet effects of real devaluations dominate the beneficial effects of an improved current account. In particular, taking the ratio of the coefficients on the *change_in_RER* and *currency_mismatch* variables in column (1) of Table 4, we find that the critical value of debt service-to-GNI at which real exchange rate shocks begin to have the effect of raising spreads is 5.32%. A majority of the observations in our study possess debt service-to-GNI ratios greater than this threshold, which explains the positive coefficient we found earlier in the baseline regression on the *currency_mismatch* variable before including the *change_in_RER* variable on its own.

Table 4. Determinants of *log_spread*: Testing the effect of exchange rate shocks and debt service-to-GNI in the baseline regression

Explanatory variables	(1) RE	(2) FE	(3) RE	(4) FE
log_spread_1			0.612	0.320
			(0.128)***	(0.166)*
debt_to_gni_1	0.008	0.004	0.005	0.000
	(0.003)***	(0.006)	(0.002)**	(0.007)
res_to_gni_1	-0.027	-0.023	-0.015	-0.021
	(0.006)***	(0.008)***	(0.005)***	(0.010)**
5year_growth_rate_1	-1.511	-2.469	0.334	-2.013
	(0.531)***	(0.711)***	(0.514)	(0.803)**
tot_volatility	7.866	7.027	4.481	6.936
	(1.401)***	(1.763)***	(1.253)***	(2.529)***
tot	-0.794	-0.360	-0.647	-0.286
	(0.387)**	(0.534)	(0.300)**	(0.571)
change_in_RER	-0.681	-0.493	-0.760	-0.467
	(0.368)*	(0.363)	(0.350)**	(0.532)
ds_to_gni	0.007	0.002	0.014	0.000
	(0.011)	(0.015)	(0.011)	(0.022)
currency_mismatch	0.128	0.111	0.137	0.109
	(0.041)***	(0.044)**	(0.043)***	(0.058)*
CA_leverage_1	0.579	0.731	0.290	0.468
	(0.174)***	(0.287)**	(0.110)***	(0.334)
Constant	6.078	6.186	1.917	3.702
	(0.469)***	(0.647)***	(0.963)**	(1.149)***
Observations	100	100	84	84
Number of countries	19	19	19	19
Wald test statistic	537.25	12.64	17265.27	82.66
Within R^2	0.761	0.773	0.762	0.802
Between R^2	0.867	0.780	0.974	0.884
Overall R^2	0.807	0.727	0.910	0.828

Note: all regressions include time dummies to account for fixed year effects.

To test the robustness of our alternative regression, shown in column (1) of Table 4, we go through the same process of including fixed effects and the lagged dependent variable, separately and together, as we did in the case of the baseline regression in Table 3. The results of including country fixed effects in the alternative regression is shown in column (2) of Table 4, the results of including the lagged dependent variable is shown in column (3), and the results of including both fixed effects and the lagged spread is shown in column (4). The general conclusions of these robustness exercises are identical to the conclusions obtained from performing the same robustness checks on the baseline regression (1) in columns (2)-(4) of Table 3. For instance, a Hausman test of regression (2) against regression (1) in Table 4 indicates no evidence of a systematic difference in coefficients between the fixed effects and random effects version of the alternative regression. In addition, a comparison of regressions (1) and (3) reveals that our three primary variables of interest are all still significant at the 1% level when the lagged spread is included. We can conclude that, while it is clearly important to include both the change in the real exchange rate and its interaction with the debt service-to-GNI ratio to correctly measure the net effect of real devaluations on emerging market spreads, this modification does not substantially affect any of our core results on the other variables.

C. Possible endogeneity of the currency mismatch variable

The second major issue we must address in relation to the *currency_mismatch* variable is its possible endogeneity. In their original paper, Berganza, Chang, and García-Herrero (2004) recognize the possible problem of simultaneity bias between the spread and the contemporaneous real exchange rate, which is used in the calculation of the *currency_mismatch* measure. In this case, they note, the coefficient on *currency_mismatch* can only be interpreted as a reduced form coefficient and not as giving the impact of that variable on the cost of credit. They deal with this problem by assuming that the debt service is predetermined and instrumenting the change in the real exchange rate component of the *currency_mismatch* variable by inflation, which is plausibly correlated with changes in the real exchange rate but not with sovereign spreads. They find no strong evidence for endogeneity, and a Hausman test between the regular fixed effects regression and the version with *currency_mismatch* appropriately instrumented cannot reject the null hypothesis of no systematic difference in coefficients (no simultaneity bias).

Following Berganza, Chang, and García-Herrero (2004), we feel it is worth testing for simultaneity bias caused by the *currency_mismatch* variable in our study as well. As noted previously, *currency_mismatch* may not be the only potentially endogenous variable in our study, so a finding of no endogenous relationship in this particular case does not allow us to assert that our model represents a structural relationship between spreads and fundamentals, per se. Such a finding would, however, help to reassure us about one of the variables most likely to be the source of simultaneity bias in our regression. We follow the procedure of Berganza, Chang, and García-Herrero (2004) of instrumenting the change in the real exchange rate by inflation, and in light of the results in the previous section indicating that it is worthwhile to include the change in the real exchange rate on its own as well as via the *currency_mismatch* variable, we will use the alternative regression displayed in column (1) of Table 4 in running the test for simultaneity bias.

The results of the alternative regression and the IV regression are displayed in Table 5. The Hausman test for simultaneity bias in this case is distributed as a χ^2 with 17 degrees of freedom. We obtain a test statistic of 0.08 with a corresponding p-value of 1.0000. Thus, there is no evidence to reject the null hypothesis of no simultaneity bias and no endogeneity. This result is consistent with the findings of Berganza, Chang, and García-Herrero (2004).

V. Current account leverage, capital flows, and spreads

This is the first paper of which we are aware, since Calvo, Izquierdo, and Mejia (2004), to study the role of the current account leverage variable in adjustment to shocks. Our primary interest in current account leverage, however, is in terms of its ability to proxy for *vulnerability* to sudden stops and the effect that has on the cost of borrowing, rather than sudden stop events per se. For a recent, related study of "systemic sudden stop (3S)" episodes, defined as the simultaneous occurrence of large country-specific capital outflows and a significant increase in *aggregate* EMBI spread levels, we refer the interested reader to the paper by Calvo, Izquierdo, and Talvi (2006).

An important question that remains for us, however, is whether our current account leverage variable is indeed a good proxy for what it is supposed to measure, which is the potential exposure countries have to the risk of having to substantially reduce imports in the face of a sudden reversal of capital inflows. One reasonable way to accomplish this is to verify the existence of a clear and intuitive relationship between the current account leverage variable and a more direct measure of exposure to a contraction in capital flows.

Table 5. Determinants of *log_spread*: Testing for simultaneity bias in the baseline regression

Explanatory variables	(1) RE	(2) RE (IV)
debt_to_gni_1	0.008	0.090
	(0.003)***	(0.445)
res_to_gni_1	-0.027	-0.014
	(0.006)***	(0.119)
5year_growth_rate_1	-1.511	-1.554
	(0.531)***	(11.73)
tot_volatility	7.866	9.645
	(1.401)***	(29.10)
tot	-0.794	-3.398
	(0.387)**	(11.852)
change_in_RER	-0.681	-54.630
	(0.368)*	(305.14)
ds_to_gni	0.007	-0.590
	(0.011)	(3.370)
currency_mismatch	0.128	7.089
	(0.041)***	(38.37)
CA_leverage_1	0.579	2.403
	(0.174)***	(12.36)
Constant	6.078	7.230
	(0.469)***	(8.397)
Observations	100	100
Number of countries	19	19
Wald test statistic	537.25	1.82
Within R^2	0.761	0.008
Between R^2	0.867	0.383
Overall R^2	0.807	0.073

Note: all regressions include time dummies to account for fixed year effects.

In that spirit, we gathered data from the World Development Indicators database on foreign direct investment (FDI) and portfolio investment (PI) flows for the countries in our sample, and constructed a variable equal to the combined value of FDI plus PI, divided by imports, for each country-year observation. This variable, which we labeled *FDIP_leverage*, captures the proportion that imports would have to contract by to compensate for a sudden and total contraction in foreign direct investment and portfolio investment flows, two primary sources of foreign capital, to the country. The mean of this variable in our sample is 0.109, with a sample standard deviation of 0.100, a minimum value of -0.059, and a maximum value of 0.464. While the minimum value of the variable is slightly negative and near zero, nearly all of the observations of this variable in the sample are positive, so that we can safely think about *FDIP_leverage* as measuring positive degrees of leverage of FDI and portfolio flows to finance import purchases. The sample correlation between the *CA_leverage* variable and the *FDIP_leverage* variable is relatively high, at 0.67, and a univariate regression of the *CA_leverage* variable on the *FDIP_leverage* variable gives an R^2 of 44.3%, with a point estimate of the coefficient of *CA_leverage* on *FDIP_leverage* equal to 1.60 and significant at the 1% level. The constant term in the regression, also significant at the 1% level, is equal to 0.091. These results show that our *CA_leverage* variable, which is constructed to capture both current account leverage due to the use of FDI and portfolio flows to finance imports, as well as leverage due to the fungibility of net debt service, foreign remittances, and other sources of foreign capital, moves more than one-for-one with the *FDIP_leverage* variable, just as we would expect. Also, our regression reveals that when *FDIP_leverage* is set to zero, *CA_leverage* is on average around 9.1%. Abstracting from FDI and portfolio flows, in other words, the residual components of the *CA_leverage* variable create a modestly positive degree of current account leverage for the average country-year in the study.

The above results establish that the variable *CA_leverage* behaves in a manner similar to *FDIP_leverage*, which has a clear interpretation in our sample, but deviates in ways that make it interesting to study in its own right. The main question to be answered then, in determining which "leverage" variable to use in our study, is whether the additional factors that influence the variable *CA_leverage* make it the more powerful and robust determinant of emerging market spreads after controlling for other factors, including the variable *FDIP_leverage* itself. The answer, as documented in Tables 6 and 7, is a fairly clear "yes".[7]

As with the *CA_leverage* variable, we lag the *FDIP_leverage* variable one year in all of the regressions presented here to reduce potential endogeneity problems. Table 6 repeats our basic four regressions, as displayed in Table 3 of the body of

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[7] Although the *CA_leverage* measure is positive for the large majority of country-years in our study, negative values for the measure present no theoretical difficulty. Rather, they can be interpreted roughly as the percentage by which a country whose current account surplus allows it to cover debt service and acquire net foreign assets could increase consumption of imports if it stopped acquiring net foreign assets. Countries in such a position can be thought of as possessing "negative" current account leverage.

Table 6. Determinants of *log_spread*: The primary regression results with the *FDIP_leverage* variable in place of the *CA_leverage* variable

Explanatory variables	(1) RE	(2) FE	(3) RE	(4) FE
log_spread_1			0.663	0.357
			(0.105)***	(0.150)**
debt_to_gni_1	0.009	0.007	0.006	0.002
	(0.003)***	(0.004)	(0.002)***	(0.005)
res_to_gni_1	-0.029	-0.023	-0.015	-0.017
	(0.006)***	(0.008)***	(0.005)***	(0.010)
5year_growth_rate_1	-1.350	-2.098	0.433	-1.697
	(0.630)**	(0.786)***	(0.537)	(0.913)*
tot_volatility	6.740	5.846	2.480	3.943
	(1.202)***	(1.276)***	(0.939)***	(1.661)**
tot	-0.708	-0.374	-0.551	-0.274
	(0.328)**	(0.297)	(0.230)**	(0.331)
currency_mismatch	0.073	0.078	0.075	0.0812
	(0.023)***	(0.023)***	(0.025)***	(0.024)***
FDIP_leverage_1	0.724	0.601	0.698	0.433
	(0.311)**	(0.419)	(0.298)**	(0.478)
Constant	6.205	6.048	2.365	3.882
	(0.363)***	(0.439)***	(0.738)***	(0.960)***
Observations	102	102	86	86
Number of countries	19	19	19	19
Wald test statistic	513.07	11.37	117173.96	10.82
Within R^2	0.722	0.731	0.738	0.772
Between R^2	0.824	0.784	0.953	0.890
Overall R^2	0.781	0.746	0.897	0.843

Note: all regressions include time dummies to account for fixed year effects.

the paper, with the *FDIP_leverage* variable in place of the *CA_leverage* variable. As can be seen, our estimates of the other coefficients of interest in the study do not change substantially, and the *FDIP_leverage* variable is only significant, at the 5% level, in regressions (1) and (3). The inclusion of fixed effects in regressions (2) and (4) renders the variable insignificant. This stands in contrast to the case of the *CA_leverage* variable in Table 3, in which the latter variable is significant at the 1% level in regressions (1) and (3), and also significant at the 5% level in regression (2), after the inclusion of country fixed effects.

Table 7. Determinants of *log_spread*: The primary regression results after controlling for the *FDIP_leverage* variable

Explanatory variables	(1) RE	(2) FE	(3) RE	(4) FE
log_spread_1			0.655	0.336
			(0.118)***	(0.153)**
debt_to_gni_1	0.009	0.003	0.005	-0.001
	(0.003)***	(0.004)	(0.002)***	(0.005)
res_to_gni_1	-0.029	-0.026	-0.015	-0.025
	(0.006)***	(0.008)***	(0.005)***	(0.011)**
5year_growth_rate_1	-1.514	-2.587	0.388	-2.155
	(0.564)***	(0.765)***	(0.520)	(0.894)**
tot_volatility	7.386	6.860	3.490	6.687
	(1.343)***	(1.346)***	(1.131)***	(1.850)***
tot	-0.772	-0.333	-0.486	-0.209
	(0.378)**	(0.307)	(0.291)*	(0.336)
currency_mismatch	0.062	0.064	0.065	0.067
	(0.022)***	(0.023)**	(0.025)***	(0.024)***
CA_leverage_1	0.472	0.601	0.225	0.273
	(0.195)**	(0.250)**	(0.173)	(0.271)
FDIP_leverage_1	0.274	0.380	0.369	0.713
	(0.378)	(0.443)	(0.421)	(0.513)
Constant	6.199	6.254	2.193	3.674
	(0.467)***	(0.449)***	(0.901)**	(1.000)***
Observations	100	100	84	84
Number of countries	19	19	19	19
Wald test statistic	768.57	12.51	110836.21	11.65
Within R^2	0.753	0.769	0.749	0.805
Between R^2	0.841	0.734	0.955	0.820
Overall R^2	0.796	0.704	0.899	0.786

Note: all regressions include time dummies to account for fixed year effects.

Second, Table 7 repeats the exercise of Table 3 in the text, but with the inclusion of the *FDIP_leverage* variable in addition to the *CA_leverage* variable that is already in those regressions. The *FDIP_leverage* variable is significant in none of the regressions, while the *CA_leverage* variable remains significant at the 5% level in regressions (1) and (2), despite the inclusion of a variable with which it has a moderately high correlation. Although not shown here, performing the equivalent robustness checks using the alternative regression specification in Table 4 delivers very similar results. On the whole, the preceding findings provide reasonable grounds for electing to use the *CA_leverage* variable, rather than the *FDIP_leverage* measure, in our primary regressions, and suggest a nontrivial role for elements of the capital account besides FDI and portfolio flows in affecting the level of emerging market spreads.

VI. Conclusion

In this study, we have identified an important role for three additional variables largely absent in the pre-2003 literature on emerging market spreads, and shown them to be robust to a variety of alternative specifications. These variables were the terms-of-trade volatility, recently emphasized in studies by Catão and Kapur (2006) and Hilscher and Nosbusch (2007), and two variables measuring the strength of the balance sheet effects impacting the country. The first balance sheet variable, labeled *CA_leverage*, is adapted from Calvo, Izquierdo, and Mejia (2004) and measures the degree of current account leverage, calculated as the percentage of import purchases that would have to be forgone in the event of a sudden stop of current account financing. The second balance sheet variable, labeled *currency_mismatch*, was adapted from the study of Berganza, Chang, and García-Herrero (2004) and measures the impact of the effect of real exchange rate shocks on the foreign debt service burden.

We find that an increase in the 10-year rolling terms-of-trade volatility by one sample standard deviation corresponds to an increase in the EMBI+ spread on the order of 39%-41%. This finding is fairly robust across alternative specifications of the regression, and lends support to the claim that a country's terms-of-trade volatility is a highly significant factor in affecting the premium it must pay to borrow in international debt markets. In particular, the impact on spreads of having a terms-of-trade volatility measure one standard deviation higher than the average for the emerging market countries considered in our study is significantly higher than having, for example, a debt-to-income ratio that is one standard deviation higher than the sample average. In the latter case, the predicted rise in spreads is only 16.6%, and the debt-to-GDP measure is not robust to some alternative specifications, such as the inclusion of country fixed effects.

The inclusion of a previously unstudied spread determinant in our regressions, the degree of current account leverage, reveals that countries in which sudden stops of current account financing would require more painful contractions of import purchases, other things equal, are likely to face higher spreads. This finding supports the conclusion that balance sheet problems that magnify the adverse effects of abrupt reversals in capital inflows also impact sovereign risk, because foreign currency is fungible for both import purchases and external debt service. In this way, we connect the literature on sudden stops and emerging market spreads via the common denominator of balance sheet effects.

Complementing the study by Berganza, Chang, and García-Herrero (2004), we test the effect of changes in the real exchange rate on the cost of borrowing faced by emerging markets, both directly and via its interaction with the ratio of debt service-to-income. We find that, for sufficiently low debt service burdens, real devaluations lower spreads, but for high debt service burdens, real devaluations raise spreads. The break even debt service-to-income ratio above which the balance sheet effects of real devaluations, in terms of a higher cost of debt in local currency terms, begins to outweigh the beneficial effect on net exports is approximately 5.32%.

Our findings have several policy implications. First, while efforts to reduce the terms-of-trade volatility are likely to require long-term structural changes in the economy, which may or may not be desirable, or possible, for a variety of reasons, there may be other solutions available for reducing the impact of this important variable on spreads. It may be possible, for example, for a country to hedge some portion of its income by hedging the prices of the goods and/or commodities that it exports or imports. This strategy would be particularly useful for a large seller (or buyer) of commodities, such as Venezuela or Mexico in the case of oil. Hilscher and Nosbusch (2007) note, similarly, the potential benefits to countries of managing commodity price volatility, in terms of lower spreads and lower probabilities of default on sovereign debt.

Whereas external volatility may be difficult to control in the short run, the structure of the economy's balance sheet affects how external shocks impact the risk of default, and governments may have more scope for controlling vulnerabilities in the national balance sheet in the short and medium term. With respect to the two balance sheet factors we consider in our study, it may be possible to decrease current account leverage by decreasing debt service, for example through the use of debt management policies, and to reduce the balance sheet effects of devaluations via a shift towards debt denominated in domestic currency. Although domestic debt has played and continues to play an important role in sovereign finance, as demonstrated forcefully in recent work by Reinhart and Rogoff (2008), it is also true that the ability of governments to erode the value of domestic currency debt through inflation may present additional costs to the issuing government, as discussed by those authors as well as others, such as Gray and Malone (2008) in the context of structural models of sovereign credit risk with senior and subordinate debt. Understanding the net impact of such factors on the total cost of sovereign borrowing continues to serve as an interesting topic for ongoing research.

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