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Do High Interest Rates Defend Currencies During Speculative Attacks? New evidence*

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Abstract

A recent paper by Kraay (2003) documents the lack of any systematic association between monetary policy and the outcome of a speculative attack. This paper extends Kraay's work by introducing an improved measure of monetary policy and an additional country-specific fundamental, short-term corporate debt, to capture balance sheet vulnerabilities emphasized by the recent currency crises literature. The results show that for low levels of short-term corporate debt, raising interest rates lowers the probability of a successful attack. This effect decreases and eventually reverses for higher levels of debt. These findings contrast earlier empirical evidence and imply a fundamental reconsideration of the role of monetary policy during currency crises.

Keywords: speculative attacks; currency crises; monetary policy; short-term debt
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1 Introduction

During the last thirty years, both developed and developing countries with fixed exchange-rate regimes have suffered significantly from speculative attacks against their currencies. To prevent such attacks from developing into currency crises, academics and policymakers around the world have been investigating the appropriate policy responses. In this context, an important question is whether a monetary policy tightening could help a country protect a fixed exchange rate.

The conventional wisdom argues that an increase in interest rates could help a country defend its exchange rate by making it prohibitively expensive for speculators to take short positions in the currency under attack. Moreover, higher interest rates could also signal the monetary authority's commitment to the fixed exchange rate, which could further avert speculation. In the aftermath of the Asian crises, however, this view has come under scrutiny. Critics argue that raising interest rates could be a self-defeating strategy because of the harm it inflicts on the economy— often aggravating the very problems that motivated speculation in the first place. As the costs of higher interest rates mount, the monetary authority's signal becomes less credible, raising devaluation expectations, and thus intensifying speculative pressures. Hence, depending on the economy's ability to withstand the adverse effects of higher interest rates, the efforts of the monetary authority might increase, rather than decrease, the probability of a successful attack.[1]

A recent paper by Kraay (2003)—published in this *Journal*— investigates the existence of such non-linear effects of monetary policy. The study employs a large cross-section of speculative attacks and several episode-specific fundamentals (i.e., the recent occurrence of a banking crisis, exchange rate overvaluation, the level of international reserves, the external payments position, and the business cycle), but fails to find any significant effect.[2]

This paper builds on Kraay and extends his work in two ways. First, we construct an improved measure of the response of monetary policy by documenting the most appropriate episode-specific indicator of monetary policy and experimenting with alternative timings. Second, we introduce short-term debt as an additional factor that might affect the ability of monetary policy to defend a

[1] Bensaid and Jeanne (1997) formalize these devaluation spirals, while Furman and Stiglitz (1998) and Radelet and Sachs (1998) provide an extensive discussion of why higher interest rates might increase the probability of a devaluation. More recently, Lahiri and Vegh (2003) and Flood and Jeanne (2005) incorporated some of these channels—the unsustainability of public debt— in 'first generation' models of currency crises.

[2] This result mirrors the mixed findings in the rest of the empirical literature (e.g., Basurto and Ghosh (2001), Caporale et al. (2005), Furman and Stiglitz (1998), Gould and Kamin (2001), and Zettelmeyer (2004)). Some of these studies find that monetary policy decreases the probability of a successful attack, others find the opposite, while some find no effect. Most of these studies, however, focus on the experiences of a handful of different countries. Hence, if the effectiveness of monetary policy depends on the country-specific circumstances, these seemingly conflicting results are probably not surprising.

fixed exchange rate. Interest rate defenses are usually short-lived, intended to buy the government some time to correct the imbalances that triggered the speculation. They could, however, have important real implications if a country has high levels of short-term debt. Higher interest rates increase the service cost of debt, erode the borrower's net worth, and thus make it more difficult for borrowers to meet their current debt obligations or to roll-over their short-term debt. As a result, a monetary tightening may actually increase the probability of devaluation.

To test this hypothesis, we constructed a large cross-section of speculative attacks from 1986 to 2002 using Kraay's methodology. To approximate a country's short-term debt, we use data on short-term corporate debt, given that data on short-term public debt are not publicly available. This is not a such big caveat, since the private sector is much more sensitive to short-term changes in interest rates than most governments (i.e., it is more likely that a firm will be credit-rationed or go bankrupt than a government). The results confirm that the efficacy of monetary policy in defending a fixed exchange rate depends on short-term debt. For low levels of short-term debt, raising interest rates lowers the probability of a successful attack. This effect decreases and eventually reverses for higher levels of debt. Our findings also suggest that the way monetary policy is measured plays an important role for the results and the model's goodness of fit. Finally, our results are robust to a wide range of robustness checks, including additional non-linear effects, alternative definitions of short-term debt, and an alternative classification of fixed exchange rates.

The rest of the paper is organized as follows. Section two describes the methodology and the data. Section three discusses our main findings, describes various robustness checks, and deals with concerns of endogeneity of monetary policy. Section four concludes.

2 Methodology and Data

The probability of a successful speculative attack is analyzed using a Probit model as follows:

$$P(Y_{i,t}=1) = F(\beta_0 + \beta_1 X_{i,t-k} + \beta_2 Z_{i,t-k} + \beta_3 X'_{i,t-k} Z_{i,t-k}) + \epsilon_{i,t}, \tag{1}$$

where $F(.)$ is the standard normal distribution. $Y_{i,t}$ is equal to one if during month t there was a successful speculative attack in country i, and is equal to zero if there was a failed attack. $X_{i,t-k}$ is an indicator that captures the response of monetary policy to speculative pressures, where $k > 0$. Matrix $Z_{i,t-k}$ includes episode-specific fundamentals that are expected to affect the outcome of a speculative attack (e.g., the level of international reserves, the growth rate of real GDP, short-term corporate debt). The interaction term between $X_{i,t-k}$ and $Z_{i,t-k}$ captures how the effect of monetary policy changes for different levels of fundamentals. The paper's central hypothesis is tested using the interaction between monetary policy and short-term corporate debt. Next, we discuss how the *key* components of equation (1) have been constructed.

2.1 Identifying episodes of speculative attacks

The dependent variable $Y_{i,t}$ is constructed following the methodology developed by Kraay (2003). A *successful* attack is defined as a situation where a large nominal depreciation was preceded by a relatively fixed nominal exchange rate.[3] A *failed* attack, instead, is defined as a situation where there were downward spikes in reserves or upward spikes in the spread (between the short-term interest rates in the home country and the anchor country) that occurred during periods of relatively fixed exchange rates and were not followed by a devaluation for at least three months.

This methodology was applied on a sample of countries for which data on short-term corporate debt and monetary policy (our key variables) were available. Table 1 reports the resulting list of episodes during the sample period 1986:1 to 2002:12. From 1986 to 1999—the common sample period with Kraay— our results are exactly the same.[4] For the remaining period up to 2002, we identified ten more episodes, four of which were successful. In total, we have 55 episodes of speculative attacks: 21 successful and 34 failed attacks.

2.2 Measuring the response of monetary policy

Unfortunately, there is no consensus in the literature as to which variable captures best the *stance* of monetary policy. Over the years, several indicators have been proposed, most of which are short-term interest rates (e.g., discount rates, interbank rates). Any given interest rate, however, is only a noisy signal of monetary policy.[5] Hence, there is a great deal of disagreement as to which variable captures best the stance of monetary policy. Kraay, for example, argues that discount rates, compared to other interest rates, are less noisy since they are under the direct control of the monetary authorities. Hence, he uses the discount rate for every episode in his sample.

[3] Following Kraay, we do not require the exchange rate to be perfectly fixed prior to the attack, in order to be able to identify episodes in which narrow target zones or tightly-managed crawling pegs were abandoned. In the sensitivity analysis, we investigate the robustness of our results to alternative definitions of fixed exchange rate regimes using the classification of Reinhart and Rogoff (2004).

[4] The episodes that we identified for the sub-period 1986 to 1999 were previously identified by Kraay, and our timing and classification (i.e., successful or failed) is the same. Compared to Kraay, our sample is smaller: Kraay has 192 episodes, while we only have 55. The number of episodes in our sample is mainly constrained by data availability of short-term corporate debt, our key variable. Later on, however, we show that the key properties of Kraay's sample hold for our sub-sample as well.

[5] Variations in short-term interest rates can arise from any factor that influences the market for the underlying asset, and thus do not necessarily reflect changes in monetary policy.

Alternatively, Goldfajn and Gupta (2003) argue that "discount rates tend to remain flat and often do not reflect short run tight policies". They mention, as an example, the 500% increase in the Swedish interest rates in September 1992, which was not reflected at all in the discount rate.

Choosing the "best indicator" of monetary policy in a cross-country analysis is very difficult as the most "appropriate" indicator is not necessarily the same across countries and time.[6] To deal with this problem, we collected information on the most appropriate indicator for each episode in our sample using information from: *i*) the websites of the monetary authorities (i.e., we searched for stated "targets" of monetary policy), *ii*) direct contact with the monetary authorities, and *iii*) other empirical studies. The resulting list of instruments consists of various short-term interest rates. Most of them are interbank rates, and only a few of them are discount rates. Table 2 reports the instrument that was identified as the best indicator of monetary policy for each episode. They are all short-term interest rates. Most of them are interbank rates, and only a few are discount rates.

Using the interest rates in Table 2 (our indicator) and the discount rates (Kraay's indicator) as the underlying indicators of monetary policy we create two alternative measures of the *response of* monetary policy to speculative pressures. This step, however, involves some controversial assumptions about the timing of speculative pressures and the outcome of an attack. Kraay, for example, takes the change in the stance of monetary policy in the month in which speculative pressures peak. For successful attacks, he assumes that speculative pressures peak in the month prior to the large devaluation. Hence, he calculates the change in the interest rate spreads between $t-1$ and $t-2$. For failed attacks, he assumes that pressures peak in month t and thus takes the difference between t and $t-1$. Kraay's indicator is therefore calculated as follows:

$$X_{i,t-k} = \begin{cases} (s_{i,t-1} - s_{i,t-2}) & \text{if } Y_{i,t} = 1 \\ (s_{i,t} - s_{i,t-1}) & \text{if } Y_{i,t} = 0, \end{cases} \tag{2}$$

where t is the month of the attack, $s_{i,t}$ is the difference between the real interest rate that captures the stance of monetary policy in country i at time t and the corresponding interest rate of the anchor country.[7] Applying equation (2), we get two alternative measures: one using the episode-specific interest rates, MP_1, and another using the discount rates, $DISC_1$.

We also experiment with modified versions of equation (2). The first modification uses an

[6] The instruments of the various central banks are not necessarily the same. Hence, the most appropriate indicators of monetary policy can also differ.

[7] Using the spread of real interest rates removes variations from changes in inflation rates and changes in the anchor country's interest rates (or monetary policy). The nominal rates are deflated using the consumer price index, taken from the International Financial Statistics (IFS) database. The discount rates are also taken from the IFS.

alternative *timing*, and the second uses the *percentage change* in the spread, as opposed to the *change*. Both of these modifications are discussed in turn below. In particular, when there is a successful attack at time t, speculative pressures probably peak sometime between t and $t-1$. Given the monthly frequency of the data and the fact that it takes some time before changes in monetary policy affect the exchange rate, it is not unreasonable to use the change in the spread between $t-1$ and $t-2$. Moreover, using the difference between t and $t-1$ would have been more problematic, since the spread at t might already reflect the response of monetary policy after the devaluation. For failed attacks, Kraay assumes that pressures peak in month t, and thus takes the difference between t and $t-1$. For sensitivity, however, it would be useful to also experiment with the difference between $t-1$ and $t-2$. If one believes that it takes some time before monetary policy has an impact on the exchange rate, then monetary authorities would be most effective if they act before speculation reaches its peak (i.e., when Kraay's procedure identifies a speculative attack). Hence, we create two more measures, MP_2 and $DISC_2$, as follows:

$$X_{i,t-k} = s_{i,t-1} - s_{i,t-2}. \tag{3}$$

Finally, the percentage change in the spread, instead of the change, might be more appropriate if one wants to capture the extent to which monetary policy tightens. For example, an increase in the interest rate from 1% to 11% is not equivalent to an increase from 10% to 20%. Using modified versions of equations (2) and (3), where the change in the spread is replaced with the percentage change, we create four additional measures: $\widetilde{MP}_1$, $\widetilde{DISC}_1$, $\widetilde{MP}_2$, and $\widetilde{DISC}_2$.[8] When these measures are used, the initial level of the spread is also included as a control variable.

The first panel of Table 3 reports correlations between the various indicators of monetary policy. If we only change the underlying interest rate that is used to calculate the spread, then the correlations between the resulting measures are quite high (e.g., see correlation between MP_1 and $DISC_1$). Alternatively, if we only change the timing over which we calculate the change in the spread, then the correlations between the measures are significantly lower than those where the only difference is the underlying interest rate (e.g., see correlation between MP_1 and MP_2). Using the percentage change, as opposed to the change, in the spread results in even lower correlations (e.g., see correlation between MP_1 and $\widetilde{MP}_1$). Hence, combining a different timing and the percentage change results in very low correlations (e.g., see correlation between MP_1 and $\widetilde{MP}_2$).

The second panel of Table 3 provides summary statistics for each measure. Comparing the

[8] The notation is similar to the one introduced above: index 1 refers to the timing introduced by Kraay, index 2 refers to our alternative timing, and the symbol $\tilde{}$ is used to denote percentage changes.

first four measures reveals that monetary policy is more responsive when spreads are calculated using the episode-specific interest rates, instead of the discount rates (i.e., the average change in the spread and the standard deviation are much larger for MP_1 and MP_2 than for $DISC_1$ and $DISC_2$), consistent with Goldfajn and Gupta's argument. When the percentage change in the spread is used, the indicators using the discount rates are more responsive, suggesting that the initial spreads are larger when they are calculated using the episode-specific interest rates. Finally, our alternative timing captures more variation in monetary policy than Kraay's timing (e.g., the means and standard deviations of $\widetilde{MP}_1$ and $\widetilde{DISC}_1$ are larger than those of $\widetilde{MP}_2$ and $\widetilde{DISC}_2$).

The third panel of Table 3 provides a simple classification between the response of monetary policy and the outcome of an attack. For each outcome, we report the number of attacks and the fraction for which monetary policy tightened. Regardless of which measure is used, the results suggest that monetary policy tightens equally often during successful and failed attacks. This is in line with Kraay's findings on a much larger sample, suggesting that our sub-sample is similar to Kraay's with respect to the outcome of an attack and the response of monetary policy.

2.3 Episode-specific fundamentals

To estimate equation (1), we include a number of episode-specific fundamentals that are expected to affect the outcome of a speculative attack. These variables—with the exception of short-term corporate debt— are taken from previous studies. Four indicators are taken from Kraay: the growth rate of the real exchange rate with respect to the US dollar, reserves to imports, IMF loans to quota, and deviations from GDP trend. Apart from Kraay's indicators we also included two variables that were previously found to be statistically significant in at least two studies: the current account balance to GDP and the growth rate of exports.[9] All variables are included with lags and were taken either from the IFS or the World Development Indicators, depending on availability. The corresponding studies provide detailed definitions for each indicator.

To capture the degree to which a country's corporate sector is leveraged, we use the "representative" firm's ratio of short-term debt to total assets. The data were obtained from the Worldscope database, which contains financial information for a large number of publicly listed companies in developed and emerging markets. The short-term debt variable is defined as the portion of debt payable within a year, including the sinking fund requirements of preferred stock or debentures. The information is provided annually at the level of the individual companies. Using this informa-

[9] Our selection was based on a review article by Lestano et al. (2003).

tion, we constructed a measure of the degree to which a country's corporate sector is leveraged, by taking the average of the individual short-term debt to total assets ratios the year before the attack.[10] Figure 1a shows the resulting debt ratios for each episode in our sample. As can be seen in Figure 1a there is no systematic relationship between the outcome of a speculative attack and the level of short-term debt. In fact, the average short-term debt ratio is equal to 13.28% for successful attacks and 12.26% for failed attacks. The corresponding standard deviations are 5.54% and 4.63%, suggesting that the small difference in these ratios is not statistically significant.

Finally, the Worldscope database contains two additional debt ratios: long-term debt to total assets and total debt to total assets, where long-term debt is equal to the portion of debt that is due in more than a year and total debt is equal to the sum of short-term and long-term debt. Using these ratios, in the same way as the short-term debt ratios, we constructed two additional indicators of corporate indebtedness. These additional indicators are used in the sensitivity analysis to show that what matters is not debt in general, but its short-term component.

3 Results

Table 4 provides estimation results from a benchmark specification of equation (1) with no interaction terms. The eight columns of Table 4 correspond to our alternative indicators of monetary policy, where $DISC_1$ is Kraay's indicator and $\widetilde{MP}_2$ is our preferred indicator. For each regressor we report the estimated coefficient from a Probit model, its standard error, and the change in the probability of a successful attack if the corresponding regressor increases by one standard deviation from its sample mean (i.e., the marginal effect of each coefficient).[11] As can be seen in Table 4, we fail to find any statistically significant effect of monetary policy on the outcome of a speculative attack. None of the eight indicators of monetary policy yields a statistically significant coefficient. This result is consistent with Kraay's findings in similar specifications (see Table 3 in Kraay). Overall, these findings suggest that our sub-sample has properties similar to those of Kraay's, and that Kraay's benchmark results are robust to our alternative indicators of monetary policy.

Although most control variables enter with the expected sign, they are not statistically significant, and should be viewed with caution. The only exception is the ratio of IMF loans to quota.

[10] For example, if an attack takes place sometime during 1996, we use the ratios of December 1995. In the sensitivity analysis, we introduce alternative *timings* (e.g., using a combination of a one and a two-year lag, depending on the timing of an attack during a given year) and alternative *specifications* (e.g., a median or a weighted average).

[11] The standard errors of the marginal effects are calculated using the Delta method. Hence, the statistical significance of the estimated coefficient can be different from the statistical significance of the marginal effect. Finally, at the bottom of each column we report the probability of a successful attack if all regressors are set at their sample mean, P_0, so that the marginal effects can also be expressed in percentage terms.

This indicator is significant in most specifications and enters with a positive sign, suggesting that difficulties in obtaining extra funding, increase the probability of a successful attack. This effect is not only statistically significant, but also economically relevant. Depending on the specification, an increase in this ratio by one standard deviation (i.e., by 5%) leads to an increase in the probability of a successful attack by 41% to 83%. The level of short-term debt to total assets enters with a positive sign in most specifications, indicating that, ceteris paribus, a higher level of short-term debt to total assets increases the probability of a successful attack. Deviations from GDP trend always enter with negative signs, indicating that during periods of economic slowdown or recessions there is a larger probability of a successful attack. The current account balance enters with a negative sign in most specifications, which implies that a higher current account deficit increases the probability of a successful attack.[12] The signs of the coefficients for the initial level of the spread and reserves to total imports are mixed, whereas the real exchange rate growth and the growth rate of exports do not have the expected signs in most specifications.

As expected given the results above, the model's goodness of fit is rather poor (see bottom of Table 4). In particular, the pseudo R-squared is quite low and the model has a high probability of predicting a failed attack, even when an attack is successful (i.e., on average, 44% of successful attacks is wrongly classified as a failed attack). Given that most independent variables are not statistically significant, the model is biased towards predicting a failed attack.

To investigate whether the effect of monetary policy depends on the level of short-term debt, in Table 5 we allow for an interaction term between the indicators of monetary policy and short-term debt. Overall, the results confirm our prior expectations. We find that an increase in interest rates leads to a decrease in the probability of a successful attack, although the extent to which this is true depends on the level of short-term debt. The higher the level of short-term debt, the lower the probability that a given increase in interest rates will defend the currency under attack.

It should be emphasized that this result depends on the way we measure the response of monetary policy. The relevant coefficients are statistically significant only when $\widetilde{DISC}_2$ and $\widetilde{MP}_2$ are used. This suggests that using the percentage change (as opposed to the change in the spread) and our timing (as opposed to Kraay's timing) is very important. Using our country-specific interest rates (as opposed to the discount rate) is also important, since it increases the statistical significance of the coefficients of interest from 5% to 1%, and it improves significantly the model's goodness of fit. Although the pseudo R-squared is already much higher for $\widetilde{DISC}_2$, the model's

[12] In some cases, the marginal effects are significant at 10%, even though the estimated coefficients are insignificant. These are cases in which the p-values of the coefficients are slightly above the 10% cut-off point.

ability to distinguish between a successful and a failed attack increases significantly when $\widetilde{MP}_2$ is used (i.e., both types I and II errors are relatively small when $\widetilde{MP}_2$ is used).

All in all, the results in Table 5 show that if we allow for the possibility that it takes some time for monetary policy to have an effect, and if we use the percentage change in the spread as an indicator of monetary policy, we find strong evidence of a non-linear effect of monetary policy on the outcome of a speculative attack. Figure 1b depicts this effect graphically. According to our estimates, for levels of short-term debt that are equal to or less than 13%, a tightening of monetary policy decreases the probability of a successful attack. Instead, for levels of short-term debt that are equal to or higher than 16%, a tightening of monetary policy increases the probability that an attack will succeed. For all numbers in-between, the two channels of monetary policy cancel each other out and thus lead to a statistically insignificant effect.

These results support the argument that interest rate defenses are not credible if short-term debt is high, since speculators realize that the high interest rates cannot be maintained without devastating effects. Underlying this argument is the notion that it is short-term debt that renders interest rate defenses ineffective or even counterproductive, and not debt in general. To test this distinction, using our main specification with $\widetilde{MP}_2$, we replaced short-term debt with total debt and afterwards with long-term debt. The results are presented in the first two columns of Table 6. In particular, when total debt is used we obtain results similar to those presented earlier using short-term debt, although the interaction term is significant at 5%, as opposed to 1%. When long-term debt is used the results break down (i.e., both coefficients are insignificant), suggesting that what matters is not debt in general, but its short-term component.

We also subjected our results to a number of *robustness checks*. First, we allowed for interaction terms between monetary policy and the other episode-specific fundamentals, with and without the short-term debt interaction. Even without the debt interaction, none of the other fundamentals yield any statistically significant effect, consistent with Kraay's findings. When the debt interaction is included, our main result is unchanged and none of the other variables resulted in any statistically significant coefficient. Second, we experimented with alternative definitions of the short-term debt ratios. Our results are robust to using the median or a weighted average of the individual ratios as well as alternative timings (a "two-year lag" or a combination of one and two-year lags depending on the timing of the attack during a given year).[13] Finally, we also reconstructed our dataset using

[13]For the weighted average measure, we weigh the various firms using their ratios of total debt to total assets. Everything else equal, highly leveraged firms (i.e., with high levels of total debt relative to their size) are more likely to default or to experience difficulties in rolling-over their short-term debt and thus are given a larger weight. For the alternative timings we create two measures as follows: *i*) if an episode takes place in year X, we use the debt

the classification of fixed exchange rates in Reinhart and Rogoff (2004) (hereafter RR), instead of Kraay's definition.[14] This classification leads to a somewhat different set of episodes (see Table 1). In particular, we have 17 new episodes that were previously not in the sample because according to Kraay's definition the exchange rate was too volatile. Similarly, we loose 13 episodes because the exchange rate is relatively constant in Kraay's window, but too volatile in RR's longer window. To investigate the sensitivity of our results we re-estimate all of our specifications using three alternative samples: *i*) the episodes in RR's sample, *ii*) the episodes in both samples, and *iii*) the episodes in either sample. All of our results go through for all three samples (i.e., the confirmation of Kraay's findings and our results with respect to short-term, long-term, and total debt).

A potential problem in our analysis arises from the possible *endogeneity of monetary policy*. Although the objective functions and the constraints of both the monetary authorities and the speculators are not necessarily common knowledge, some of the factors that affect their behavior are probably the same. If some of the common factors are not included as control variables, the estimates presented above could be biased. Following Kraay, we instrument for monetary policy using the percentage *change* in real reserves between $t-1$ and $t-2$, for a sub-sample of countries with low levels of capital controls.[15] Due to publication lags, this variable is not observed by speculators and thus cannot be one of the factors that drives their actions (see discussion in Kraay (2003), p. 314-315). It is, however, one of the factors that is expected to affect monetary policy, particularly in countries without alternative lines of defense, such as capital controls. The third column of Table 6 reports estimation results for a regression of $\widetilde{MP}_2$ on the percentage change in reserves and all episode-specific fundamantals. As expected the instrument enters with a negative sign and is statistically significant at the 5% level. The instrumental variables (IV) estimates, presented in the last column of Table 6, are very similar to those presented earlier: the indicator of monetary policy enters with a negative sign and is significant at 5% and its interaction with debt enters with a positive sign and is statistically significant at 5%.[16] More importantly, the two

ratios at the end of $X-2$, and *ii*) if an episode takes place in the second half of a year, we use the debt ratios at the end of $X-1$, whereas if it takes place in the first half of year X, we use the debt ratios at the end of $X-2$.

[14] Both procedures require that a country's exchange rate does not vary "too much" for a given period. There are two main differences between them: *i*) RR use a five-year window, while Kraay uses a one-year window, and *ii*) the cut-off point of what is considered "too much" is more conservative in Kraay than in RR (i.e., Kraay: 1% for OECD and 2.5% for non-OECD; RR: 5% for de facto crawling bands and 2% for everything else).

[15] To eliminate countries with high levels of capital controls, we ranked the episodes in our sample according to both *de jure* and *de facto* measures of financial openness and eliminated those that ranked amongst the lowest 25% for both measures. This resulted in the elimination of three episodes: Colombia 95:12, Brazil 97:11, and Russia 98:9. For the de jure measure we used an index of financial openness from Chinn and Ito (2005). For the de facto measure we used the ratio of gross private capital flows to GDP, from the World Development Indicators.

[16] The IV estimation involves several steps as we have to instrument for both monetary policy and its interaction with short-term debt. First, we regress $\widetilde{MP}_2$ on the percentage change in reserves and all episode-specific fundamentals. We then interact the predicted values from this regression with the short-term debt ratio to construct a

effects cancel out when the short-term debt ratio is equal to 14.55% (i.e., this is the level of the short-term debt ratio for which $\partial P/\partial X_{i,t-k} = 0$). The corresponding number using the estimates from column (8) in Table 5 is 14.42%, suggesting that if there is endogeneity, it is probably not important enough to cause a statistically and economically significant bias. In fact, the Durbin-Wu-Hausman test does not reject the null hypothesis of no endogeneity with a p-value equal to 0.85.

4 Conclusions

From a policy perspective, our findings imply a fundamental reconsideration of the role of monetary policy during speculative attacks. A monetary policy tightening can only be used as a tool for crisis prevention in countries with relatively low corporate debt. If short-term debt is high, monetary policy will be ineffective and could even increase the probability that an attack results in a currency crisis. From a long-term perspective, our results suggest that strengthening the balance-sheet position of the corporate sector (i.e., limiting interest rate exposures) could be beneficial in reducing a country's vulnerability to speculative attacks.

second instrument for the interaction term (following Wooldridge (2002), p. 237). Finally, using both instruments, we perform Amemiya's (1978) generalized least-squares procedure for probit models with endogenous regressors.

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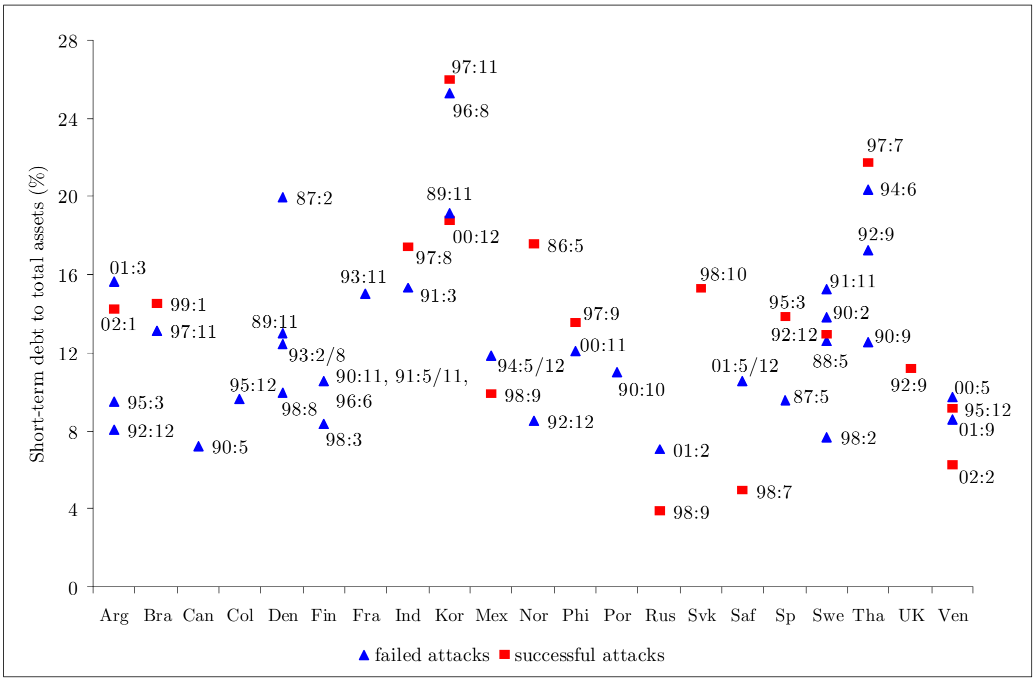

Figure 1a: Short-term debt to total assets

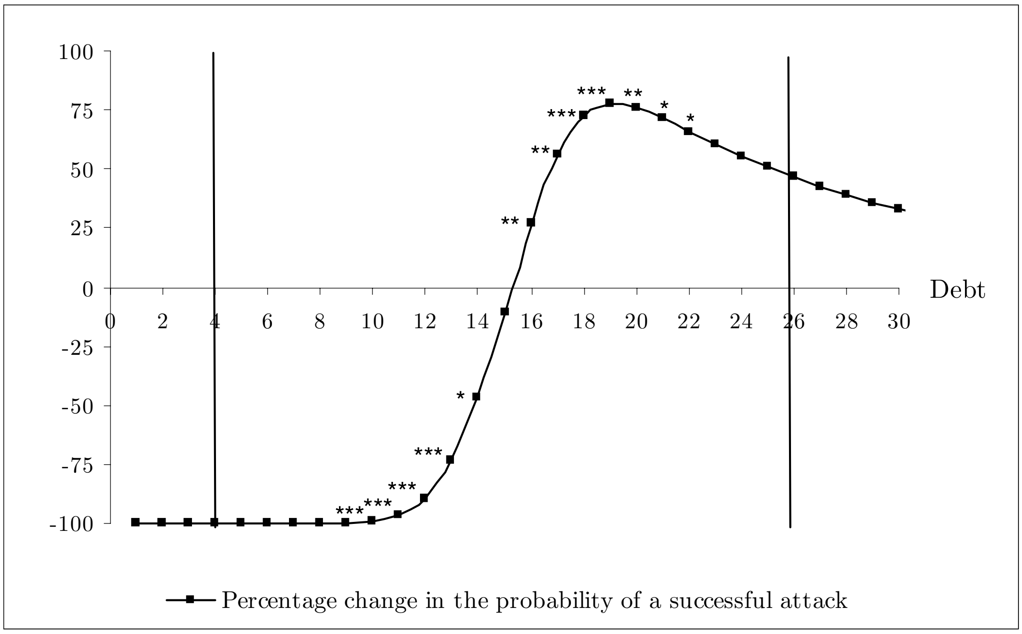

Figure 1b: The effect of monetary policy for various levels of short-term debt

Figure 1b is constructed using the specification of Table 3, column (5). It shows the percentage change in the probability of a successful attack if $\widetilde{MP}_2$ increases by 1-standard deviation (5%) from its sample mean (12.70%), for different levels of short-term debt. All other regressors are set at their sample mean. The vertical lines at the left and the right end of the figure show the min and the max values of short-term debt in the sample. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 1: Successful and failed speculative attacks during the period 1986:1-2002:12

	Kraay (2003)		Reinhart and Rogoff (2004)			
Country	Successful	Failed	Successful		Failed	
			(+)	(-)	(+)	(-)
Argentina	02:1	92:12, 95:3, 01:3				
Brazil	99:1	97:11				
Canada		90:5			92:10	
Colombia		95:12			98:6	
Denmark	93:8	87:2, 98:8, 89:11, 93:2			91:4	89:11
Finland	91:11	90:11, 91:5, 96:6, 98:3				
France		93:11			91:6, 92:9	
Indonesia	97:8	91:3				
Korea	97:11, 00:12	89:11, 1996:8		00:12		
Mexico	94:12, 98:9	94:5		98:9		
Norway	86:5	92:12		86:5	91:3	92:12
Philippines	97:9	00:11			92:12, 95:4	00:11
Portugal		90:10			94:4	
Russia	98:9	01:2		98:9		
Slovakia	98:10			98:10		
South Africa	98:7, 01:12	01:5		98:7, 01:12		01:5
Spain	95:3	87:5	92:10		89:12, 91:2, 95:8	
Sweden	92:12	88:5, 90:2, 91:11, 98:2				98:2
Thailand	97:7	90:9, 92:9, 94:6				
Turkey			98:3, 01:2			
UK	92:9				92:2	
Venezuela	95:12, 02:2	00:5, 01:9		95:12	97:6	

Slovakia 1993:7 was also identified as a successful attack. However, this episode is excluded, since it is due to the separation of Czechoslovakia into the Czech and Slovak Republics.

Table 2: Monetary Policy Interest Rates

Country	Monetary Policy Interest Rate	Identification	Source of Data
Argentina	Interbank 7-day-middle rate	Other	Datastream
Brazil	Financing overnight-middle rate	Other Studies*	Datastream
Canada	Bank rate as at Wed-middle rate	Central Bank-W	Datastream
Colombia	Interbank overnight-middle rate	Other Studies**	Datastream
Denmark	Discount-middle rate	Central Bank-W	Datastream
Finland	Key tender-middle rate	Central Bank-W	Datastream
France	Intervention rate-middle rate	Central Bank-W	Datastream
Indonesia	SBI 90 day-middle rate	Central Bank-W	Datastream
Korea	Call overnight-middle rate	Central Bank-W	Datastream
Mexico, 1994:5	Cetes 28-day min. auction-middle rate	Central Bank-W	Datastream
Mexico, 1994:12	Cetes 28-day min. auction-middle rate	Central Bank-W	Datastream
Mexico, 1998:9	Cetes 28-day avg. auction-middle rate	Central Bank-W	Datastream
Norway, 1986:5	Daily interbank nominal-middle rate	Central Bank-W	Datastream
Norway, 1992:12	Sight deposit nominal-middle rate	Central Bank-W	Datastream
Philippines	Interbank call loan rate-middle rate	Other Studies***	Datastream
Portugal	Central bank reference rate	Central Bank-W	Datastream
Russia	Discount (refinancing)-middle rate	Central Bank-W	Datastream
Slovakia	Basic NBS interest rate	Central Bank-W	Central Bank
South Africa	Prime overdraft-middle rate	Central Bank-W	Datastream
Spain	Intervention-middle rate	Central Bank-W	Datastream
Sweden	Repo-middle rate	Central Bank-W	Datastream
Thailand	Repo 14-day-middle rate	Central Bank-W	Datastream
Turkey	Interbank overnight-middle rate	Central Bank-W	Datastream
United Kingdom	Base rate	Central Bank-W	Central Bank
Venezuela	Discount Rate	Central Bank-W	IFS

Notes: Central Bank-W = Central Bank Website; Central Bank-C = Central Bank Contact by Email.
* Furman and Stiglitz (1998); ** Uribe (1998); *** Caporale, Cipollini and Demetriades (2005).

Table 3: Indicators of Monetary Policy

Panel 1: Correlations

	MP_1	$DISC_1$	MP_2	$DISC_2$	$\widetilde{MP}_1$	$\widetilde{DISC}_1$	$\widetilde{MP}_2$	$\widetilde{DISC}_2$
MP_1	1.00							
$DISC_1$	0.97	1.00						
MP_2	0.98	0.54	1.00					
$DISC_2$	0.60	0.28	0.98	1.00				
$\widetilde{MP}_1$	0.36	0.42	0.31	0.14	1.00			
$\widetilde{DISC}_1$	0.41	0.39	0.11	0.16	0.77	1.00		
$\widetilde{MP}_2$	0.17	0.02	0.26	0.53	0.38	0.03	1.00	
$\widetilde{DISC}_2$	0.04	0.07	0.30	0.40	0.05	0.60	0.72	1.00

Panel 2: Summary statistics

	mean	st. dev.	min	max
MP_1	0.07	0.56	-0.70	3.61
$DISC_1$	-0.01	0.12	-0.55	0.28
MP_2	0.08	0.56	-0.70	3.61
$DISC_2$	0.01	0.14	-0.55	0.30
$\widetilde{MP}_1$	0.38	1.91	-1.90	9.96
$\widetilde{DISC}_1$	1.45	5.22	-3.10	27.61
$\widetilde{MP}_2$	1.06	3.04	-4.64	12.08
$\widetilde{DISC}_2$	2.20	6.46	-6.80	27.61

Panel 3: Monetary policy and the outcome of a speculative attack

	Successful		Failed	
	Number	Tightening	Number	Tightening
MP_1	19	0.53	25	0.56
$DISC_1$	17	0.53	29	0.45
MP_2	19	0.53	25	0.64
$DISC_2$	17	0.53	29	0.66
$\widetilde{MP}_1$	19	0.53	25	0.57
$\widetilde{DISC}_1$	17	0.53	29	0.45
$\widetilde{MP}_2$	19	0.53	25	0.64
$\widetilde{DISC}_2$	17	0.53	29	0.66

Table 4: Benchmark Regressions

	Kraay's timing				Alternative timing			
	change		% change		change		% change	
	$DISC_1$	MP_1	$\widetilde{DISC}_1$	$\widetilde{MP}_1$	$DISC_2$	MP_2	$\widetilde{DISC}_2$	$\widetilde{MP}_2$
Monetary policy	0.27	0.11	0.06	0.06	0.36	0.07	0.04	-0.02
	(1.82)	(0.42)	(0.04)	(0.13)	(1.59)	(0.38)	(0.03)	(0.08)
	0.01	0.03	0.11	0.05	0.02	0.01	0.09	-0.02
Initial level of spread			-0.35	1.41			-0.29	3.12
			(1.69)	(1.50)			(2.48)	(2.10)
			-0.02	0.11			-0.01	0.23
Debt to total assets	0.53	2.75	-0.04	3.80	0.60	2.77	0.96	3.90
	(5.03)	(4.82)	(5.03)	(5.48)	(4.89)	(4.82)	(5.09)	(5.08)
	0.01	0.05	-0.00	0.08	0.01	0.06	0.02	0.08
Exchange rate growth	30.90	11.16	31.36	15.26	31.56	11.41	32.66	-8.92
	(32.65)	(31.04)	(34.83)	(35.77)	(32.94)	(30.96)	(37.09)	(33.69)
	0.09	0.03	0.09	0.05	0.09	0.03	0.10	-0.03
Reserves to imports	0.04	-0.08	0.05	-0.12	0.04	-0.07	0.06	-0.11
	(0.10)	(0.09)	(0.10)	(0.08)	(0.09)	(0.08)	(0.10)	(0.08)
	0.03	-0.09	0.04	-0.14	0.03	-0.09	0.04	-0.13
IMF loans to quota	1.09**	0.42*	1.08**	0.44*	1.12**	0.43*	1.18**	0.32
	(0.46)	(0.25)	(0.45)	(0.26)	(0.54)	(0.24)	(0.54)	(0.24)
	0.27**	0.17*	0.26**	0.18*	0.27**	0.17*	0.29**	0.13
Deviations from GDP trend	-7.43	-3.14	-5.05	-5.94	-7.91	-3.30	-7.62	-2.35
	(8.60)	(5.91)	(8.52)	(5.89)	(8.61)	(5.77)	(8.12)	(6.87)
	-0.09	-0.05	-0.06	-0.10	-0.10	-0.05	-0.09	-0.04
Current account to GDP	-8.06	-3.30	-7.56	1.40	-8.12	-3.31	-8.09	-2.01
	(5.09)	(4.43)	(4.88)	(4.85)	(5.05)	(4.44)	(5.10)	(4.40)
	-0.14*	-0.07	-0.13*	0.03	-.014*	-0.07	-0.14*	-0.04
Growth rate of exports	0.63	-0.79	0.81	0.10	0.74	-0.75	1.19	0.07
	(3.16)	(3.13)	(3.38)	(3.61)	(3.14)	(3.12)	(3.17)	(3.89)
	0.02	-0.02	0.02	0.00	0.02	-0.02	0.03	0.00
Goodness of fit								
Pseudo R-Squared	0.16	0.10	0.18	0.12	0.16	0.10	0.17	0.15
Predicted=1, Actual=1	52.9	47.4	47.1	47.4	52.9	47.4	52.9	52.6
Predicted=1, Actual=0	10.3	12.0	6.9	21.7	10.3	12.0	10.3	20.0
Predicted=0, Actual=0	89.7	88.0	93.1	78.3	89.7	88.0	89.7	80.0
Predicted=0, Actual=1	47.1	52.6	52.9	52.6	47.1	52.6	47.1	47.4
Observations	46	44	46	42	46	44	46	44
P_0	0.35	0.43	0.36	0.46	0.35	0.43	0.36	0.44

For each regressor we report the estimated coefficient from the probit model, the robust standard error of the estimated coefficient, and the change in probability of a successful attack if a regressor increases by 1-standard deviation from its sample mean. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. P_0 is the probability of a successful attack if all regressors are evaluated at their sample mean. To determine whether the model predicts a successful attack (i.e., predicted=1), we use 0.5 as a cut-off point.

Table 5: Benchmark Regressions plus interaction of monetary policy and debt

	Kraay's timing				Alternative timing			
	change		% change		change		% change	
	$DISC_1$	MP_1	$\widetilde{DISC}_1$	$\widetilde{MP}_1$	$DISC_2$	MP_2	$\widetilde{DISC}_2$	$\widetilde{MP}_2$
Monetary policy	2.24	-2.26	0.12	-0.39	-3.48	-12.38	-0.58*	-2.19***
	(4.35)	(2.55)	(0.19)	(0.55)	(5.33)	(9.99)	(0.31)	(0.61)
	0.11	-0.36*	0.24	-0.26	-0.16	-0.48***	-0.35***	-0.33***
Debt to total assets	0.83	2.51	0.46	2.73	-0.32	-0.20	-4.25	-9.63
	(5.01)	(4.80)	(5.43)	(5.52)	(4.72)	(4.99)	(6.82)	(6.61)
	0.02	0.05	0.01	0.06	-0.01	-0.00	-0.07	-0.15*
Monetary policy*debt	-18.89	17.49	-0.47	2.42	35.40	90.65	5.70**	15.14***
	(37.37)	(17.98)	(1.58)	(2.65)	(44.52)	(70.99)	(2.89)	(4.30)
	-0.08	0.45	-0.11	0.32	0.20	0.52***	0.65***	0.67***
Exchange rate growth	30.21	10.92	31.11	19.16	34.64	11.25	28.68	-7.26
	(32.90)	(30.12)	(35.07)	(34.18)	(32.32)	(27.49)	(34.46)	(30.93)
	0.09	0.03	0.09	0.06	0.10	0.03	0.08	-0.02
Reserves to imports	0.03	-0.07	0.05	-0.08	0.07	-0.03	0.05	0.01
	(0.10)	(0.09)	(0.10)	(0.09)	(0.10)	(0.08)	(0.11)	(0.09)
	0.02	-0.08	0.04	-0.10	0.06	-0.04	0.04	0.01
IMF loans to quota	1.18**	0.35	1.10**	0.47*	0.99*	0.20	0.89**	0.05
	(0.55)	(0.25)	(0.45)	(0.27)	(0.52)	(0.25)	(0.46)	(0.25)
	0.29**	0.15	0.27**	0.19*	0.24*	0.08	0.22*	0.02
Deviations from GDP trend	-6.81	-3.43	-4.89	-5.76	-8.86	0.91	-9.64	2.24
	(8.78)	(5.81)	(8.60)	(5.74)	(8.58)	(6.26)	(7.88)	(8.34)
	-0.08	-0.05	-0.06	-0.09	-0.11	0.01	-0.11	0.03
Current account to GDP	-8.67	-3.15	-7.94	1.20	-8.10*	-5.24	-5.00	-6.59
	(5.29)	(4.41)	(4.91)	(4.77)	(4.91)	(4.47)	(4.82)	(5.49)
	-0.15*	-0.06	-0.14*	0.02	-0.14*	-0.11	-0.09	-0.11
Growth rate of exports	0.27	-0.28	0.68	0.53	1.95	1.10	6.57	9.73*
	(3.38)	(3.24)	(3.49)	(3.62)	(3.65)	(3.41)	(4.21)	(5.26)
	0.01	-0.01	0.02	0.02	0.05	0.03	0.19	0.27*
Initial level of spread			-0.42	1.27			1.88	4.18
			(1.70)	(1.46)			(2.68)	(3.30)
			-0.02	0.10			0.08	0.31
Goodness of Fit								
Pseudo R-squared	0.16	0.11	0.18	0.14	0.17	0.16	0.29	0.37
Predicted=1, Actual=1	41.2	47.4	47.1	52.6	47.1	52.6	58.8	73.7
Predicted=1, Actual=0	10.3	12.0	6.9	8.7	10.3	8.0	6.9	20.0
Predicted=0, Actual=0	89.7	88.0	93.1	91.3	89.7	92.0	93.1	80.0
Predicted=0, Actual=1	58.8	52.6	52.9	47.4	52.9	47.4	41.2	26.3
Observations	46	44	46	42	46	44	46	44
P_0	0.35	0.43	0.36	0.46	0.36	0.48	0.35	0.33

For each regressor we report the estimated coefficient from the probit model, the robust standard error of the estimated coefficient, and the change in probability of a successful attack if a regressor increases by 1-standard deviation from its sample mean. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. P_0 is the probability of a successful attack if all regressors are evaluated at their sample mean. To determine whether the model predicts a successful attack (i.e., predicted=1), we use 0.5 as a cut-off point.

Table 6: Robustness checks and instrumental variable estimates

	Probit	Probit	OLS	IV Probit
Monetary policy	-1.16**	0.05		-2.62**
	(0.47)	(0.18)		(1.33)
	-0.38***	0.05		-0.35**
Percentage change in real reserves			-0.07**	
			(0.03)	
S-debt to total assets			5.97	-14.60
			(13.20)	(13.77)
				-0.22
L-debt to total assets		2.70		
		(2.80)		
		0.12		
T-debt to total assets	-2.23			
	(3.51)			
	-0.07			
Monetary policy*corresponding debt ratio	3.91**	-0.45		18.04**
	(1.59)	(1.14)		(8.22)
	0.62***	-0.08		0.65***
Exchange rate growth	-5.91	-11.09	-55.24	-15.35
	(31.54)	(34.84)	(36.67)	(56.84)
	-0.02	-0.03		-0.04
Reserves to imports	-0.07	-0.11	0.13	0.07
	(0.09)	(0.08)	(0.16)	(0.19)
	-0.07	-0.13		0.08
IMF loans to quota	0.27	0.30	-0.27	-0.09
	(0.24)	(0.25)	(0.41)	(0.46)
	0.11	0.12		-0.03
Deviations from GDP trend	0.82	-3.96	44.62***	8.14
	(8.43)	(7.34)	(13.31)	(25.23)
	0.01	-0.06		0.13
Current account to GDP	-3.32	-4.18	-8.28	-8.98
	(4.60)	(4.32)	(11.50)	(10.62)
	-0.06	-0.08		-0.16
Growth rate of exports	3.98	0.91	-20.00*	11.89
	(4.88)	(3.86)	(10.96)	(10.05)
	0.11	0.03		0.33
Initial level of spread	3.55	3.54	1.98	5.82
	(2.73)	(2.31)	(4.09)	(5.35)
	0.27	0.26*		0.38
Goodness of Fit				
(Pseudo) R-squared	0.24	0.16	0.38	0.15
Predicted=1, Actual=1	63.2	52.6	-	42.1
Predicted=1, Actual=0	12.0	12.0	-	8.0
Predicted=0, Actual=0	88.0	88.0	-	92.0
Predicted=0, Actual=1	36.8	47.4	-	57.9
Observations	44	44	41	41
P_0	0.38	0.45	-	0.35

The first two columns report results from a Probit model. The third column reports OLS results where the dependent variable is $\widetilde{MP}_2$. The fourth column reports GLS results from an instrumental variables Probit model. For each regressor we report the estimated coefficient and the robust standard error. In the first, second, and fourth columns we also report the change in the probability of a successful attack if a regressor increases by 1-st. deviation from its sample mean. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. S-debt, L-debt, and T-debt indicate short-term, long-term, and total debt, respectively. P_0 is the probability of a successful attack if all all regressors are evaluated at their sample mean. To determine whether the model predicts a successful attack (i.e., predicted=1), we use 0.5 as a cut-off point.