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Sylvester C.W. Eijffinger &
Benedikt Goderis

CESifo
Poschingerstr. 5, 81679 Munich, Germany
Phone: +49 (0) 89 9224-1410 - Fax: +49 (0) 89 9224-1409
office@CESifo.de
www.cesifo.de

The effect of monetary policy on exchange rates during currency crises; the role of short-term debt and institutions*

Sylvester C.W. Eijffinger and Benedikt Goderis

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Abstract

The literature on the impact of monetary policy on exchange rates during financial crises is divided. The traditional view argues that higher interest rates discourage capital outflows and appreciate the exchange rate. By contrast, the revisionist view argues that higher interest rates deteriorate corporate balance sheets, increase the likelihood of defaults and bankruptcies, and depreciate the exchange rate. Empirical evidence is mixed, suggesting that the effect of monetary policy may depend on country-specific characteristics. This paper tests two hypotheses. First, higher interest rates have larger adverse balance sheet effects and are therefore less effective in countries with high levels of short-term corporate debt. Second, higher interest rates are more credible and therefore more effective in countries with high-quality institutions. Using data for currency crisis episodes in the last two decades, we find strong evidence in favour of these hypotheses. A closer examination of the results shows that monetary policy is only effective in countries with both low corporate short-term debt and high-quality institutions.

Keywords: Currency Crises; Institutions; Monetary Policy; Short-Term Debt

JEL classification: E52; E58

*Eijffinger: Tilburg University, RSM Erasmus University, CESifo and CEPR, P.O. Box 90153, 5000 LE Tilburg, The Netherlands. Tel.: +31-13-4662411; Fax: +31-13-4663042; Email: s.c.w.eijffinger@uvt.nl. Goderis: Centre for the Study of African Economies, Department of Economics, University of Oxford, Manor Road, Oxford OX1 3UQ, UK. Tel.: +44-1865-271074; Fax: +44-1865-281447; Email: Benedikt.Goderis@economics.ox.ac.uk (corresponding author).

1 Introduction

The debate on the role of monetary policy during financial crises has gained attention over the last decade, especially in the aftermath of the Asian crisis. The large depreciations in Thailand, Korea, Indonesia, and the Philippines in 1997 and 1998 had detrimental effects on the balance sheets of banks and firms with outstanding US dollar loans. This resulted in large-scale banking sector distress and economic downturn. An important question that arose and has been subject to intense debates amongst policymakers and academics ever since, relates to the appropriate response of monetary authorities.

Many urged the desirability of tight monetary policy to limit the degree of depreciation. This 'traditional view', which also marked the position of the IMF, argues that higher interest rates make it more costly to shorten the domestic currency. This will discourage capital outflows and appreciate the exchange rate. Higher interest rates can also signal the monetary authorities' commitment to support the exchange rate in the future (Backus and Driffill (1985) and Drazen (2000, 2003)).

Although the traditional view seems to get broad support during 'normal' times, some economists, notably Feldstein (1998), Furman and Stiglitz (1998), and Radelet and Sachs (1998), have argued that monetary tightening during times of crisis can have the opposite effect of further depreciating the exchange rate. An extensive analysis of this argument, sometimes called the 'revisionist view', is provided in Furman and Stiglitz (1998). They argue that a higher interest rate, in addition to raising the promised return on investments, can have several adverse effects. First, it increases the probability of defaults and bankruptcies in the corporate sector by increasing debt service payments and deteriorating the balance sheets of firms and banks that are adversely exposed to short-term interest rate changes. Second, if investors are risk averse, the higher probability of default will increase the required risk premium on investments. If these two effects - a higher probability of default and a higher risk premium - more than offset the higher promised return on investments, then raising the interest rate makes the crisis country de facto less attractive for foreign investors. As a result, capital will continue to flee the country and the exchange rate will further depreciate.

Empirical evidence on the effect of higher interest rates on exchange rates during during crises is

mixed. Some studies find that monetary tightening appreciates the exchange rate (Basurto and Ghosh (2001), Caporale et al. (2005) for non-crisis periods, Dekle et al. (2002), Goderis and Ioannidou (2006) for countries with moderately indebted corporate sectors, Goldfajn and Gupta (2003) for countries with strong banking sectors, Tanner (2001), and Zettelmeyer (2004)). Others find that tighter monetary policy weakens the currency (Caporale et al. (2005) for crisis episodes, Furman and Stiglitz (1998) for low-inflation countries, and Goderis and Ioannidou (2006) for countries with highly indebted corporate sectors). Some other studies find that monetary policy does not affect the exchange rate (Goldfajn and Baig (2002), Gould and Kamin (2001), and Kraay (2003)).

The mixed results in the literature point at the possibility that the impact of monetary policy on the exchange rate depends on country-specific characteristics. Several studies have investigated this possibility by testing whether the effect of monetary tightening varies for different levels of economic fundamentals. Furman and Stiglitz (1998), for example, examine episodes of sustained high interest rates in nine developing countries in the nineties and find that higher interest rates depreciate the exchange rate but only in low-inflation countries. Goldfajn and Gupta (2003) find that in the aftermath of currency crises, tight monetary policy increases the probability that a real appreciation of the exchange rate occurs through a nominal appreciation rather than an increase in inflation. Hence, monetary tightening appreciates the nominal exchange rate. They test whether this effect is different for countries that also face a banking crisis and indeed find that for these countries the supportive effect of monetary tightening disappears. Kraay (2003) looks at whether high interest rates support fixed exchange rates during speculative attacks. He also allows the effect of monetary policy to depend on the presence of banking crises, as well as on four other country-specific fundamentals: exchange rate overvaluation, the level of international reserves, the external payments position, and the business cycle. He finds no impact of monetary policy, even when allowing this impact to vary for different levels of fundamentals. Goderis and Ioannidou (2006) extend the analysis of Kraay (2003) by allowing the effect of monetary policy to depend on a country's level of (corporate) short-term debt. They find that for relatively low levels of corporate short-term debt, raising interest rates lowers the probability that a speculative attack ends up in a currency crisis. This effect

decreases and eventually changes sign for higher levels of short-term debt.

This paper looks at the effect of monetary tightening during periods of currency crises. In particular, we consider two possible country-specific characteristics that could be important in determining whether monetary tightening appreciates the exchange rate. First, we consider a country's level of short-term corporate debt. As described above, Furman and Stiglitz (1998) argued that a higher interest rate causes a higher probability of corporate defaults and bankruptcies, and a higher risk premium, both of which could lead to a weaker exchange rate. Following Goderis and Ioannidou (2006), we argue that this monetary policy channel is likely to be more important for countries with higher levels of short-term corporate debt. The higher the level of corporate short-term debt, the larger the adverse effects of a higher interest rate, and the larger the probability that a higher interest rate leads to a depreciation of the exchange rate.

Secondly, we consider the quality of a country's institutions as a possible determinant of whether higher interest rates support the exchange rate. The role of institutions has recently gained recognition in the currency crisis literature. Institutions can affect the likelihood of currency crises by affecting macroeconomic fundamentals and driving market expectations about future fundamentals (Li and Inclan, 2001). Shimpalee and Breuer (2006) empirically assess the importance of a wide range of institutional factors in explaining the occurrence of currency crises. They find strong evidence that corruption, government instability, and a lack of law and order increase the probability of a crisis. This paper looks at a different role of institutional quality by asking whether the effect of monetary policy on exchange rates differs for different levels of institutional quality. Our hypothesis is that high-quality institutions contribute to the credibility of monetary policy, and therefore make monetary policy a more effective policy instrument. The better a country's institutions, the higher the probability that a tighter monetary policy stance will be maintained in the future, and hence the larger the supportive effect of a tighter monetary policy on the exchange rate.

To test the impact of short-term debt and institutions on the efficacy of monetary policy, we collected data for a group of countries that experienced one or more periods of currency crises in the period between 1986 and 2004. As an indicator of a country's corporate short-term debt, we use an aggregate measure

of debt, constructed by Goderis and Ioannidou (2006). As an indicator for institutional quality we use a composite index that includes a range of institutional measures used in recent literature. Finally, following Goderis and Ioannidou (2006), we use a country-specific monetary policy indicator to allow for the possibility that different countries have different key interest rates.

Our findings reveal that short-term debt and institutional quality are important determinants of the success or failure of higher interest rates to support the exchange rate during currency crises. In particular, we find that everything else equal, a higher level of corporate short-term debt *lowers* the efficacy of monetary policy in supporting the exchange rate. By contrast, a higher level of institutional quality *increases* the efficacy of monetary policy. These results provide a possible explanation for the mixed findings in the literature and imply that the traditional and revisionist views on the efficacy of monetary policy are not mutually exclusive.

It should be noted that the empirical analysis in this paper is closely related to Goderis and Ioannidou (2006) and Kraay (2003). We use Kraay's methodology to identify the onset of currency crises (successful speculative attacks in Kraay's terminology). We also use his control variables, supplemented by the ones used in Goderis and Ioannidou (2006). Furthermore, we follow Goderis and Ioannidou in the construction of monetary policy indicators. This paper differs from the two above in several ways. Most importantly, the other two assess the effect of monetary policy *in the run to* a crisis, that is during episodes of speculative attacks against fixed exchange regimes. These attacks will either succeed or fail in ending these regimes and the papers ask whether monetary tightening can diminish the probability of success. By contrast, this paper looks at the effect of monetary tightening *during currency crises*, i.e. in the aftermath of a collapse of a fixed exchange rate regime. In addition, this paper allows for an additional source of non-linearity by testing the importance of institutional quality as a determinant of policymakers' success in supporting their exchange rate.

2 Methodology and Data

Following Kraay (2003) we identify the onset of currency crises as large nominal depreciations or devaluations preceded by relatively fixed nominal exchange rates:

$$(i,t)\,|de_{i,t} > k_i \text{ and } \overline{de}_{i,t} < \overline{k}_i \tag{1}$$

where $de_{i,t}$ is the monthly percentage change in the nominal exchange rate vis-a-vis the anchor currency[1] in country i between period t and period t-1. k_i is the threshold determining the minimum size of the devaluation. $\overline{de}_{i,t}$ is the average absolute percentage change in the exchange rate in country i in the 12 months prior to period t. $\overline{k}_i$ is the threshold determining the maximum size of the "allowable" exchange rate volatility prior to the devaluation. Following Kraay (2003), k_i is set to 5% for OECD countries and 10% for non-OECD countries, while $\overline{k}_i$ is set to 1% for non-OECD countries and 2.5% for non-OECD countries. To prevent double-counting, we eliminate episodes that were preceded by episodes in the preceding 12 months.

This yields a list of episodes that mark the beginning of a crisis. We identify the end of crisis periods as the first month after the onset of a crisis in which speculative pressures have substantially diminished compared to their earlier crisis peaks. More formally, for crises starting in month t, we define endings as the first month $t+s$ $(s>0)$ for which the following condition is satisfied:

$$s_{i,t+s+j} \; < \bar{s}_{i,t} \; + \; 0.25 * (s_{i,t}^{MAX} - \bar{s}_{i,t}), \text{ where } j = 0,1,2 \tag{2}$$

where $s_{i,t+s+j}$ is the nominal money market interest rate[2] spread over the US Federal Funds rate in country i and month $t+s+j$ where t and s denote the starting month and the length of the crisis, respectively. $\bar{s}_{i,t}$ is the average spread[3] in the 24 months preceding month t, and $s_{i,t}^{MAX}$ is the mean of the

[1] Historically European countries typically pegged to the German mark whereas non-European countries often pegged to the US dollar. Hence, we use the monthly average local currency price of the German mark for European countries and the local currency price of the US dollar for all other countries (International Financial Statistics line rf).

[2] IFS line 60b.

[3] In some cases this 24-month average might be heavily influenced by episodes of distress, related to the upcoming crisis. Since we will use the average as an indicator of the level of spreads in 'normal' times, we exclude observations that lie more than 2 standard deviations above the 24-month mean.

3 highest levels of spreads in month t and the 5 succeeding months. In order to eliminate periods in which a relatively fixed exchange rate was abandoned without substantial financial turmoil, we exclude periods for which the difference between $s_{i,t}^{MAX}$ and $\bar{s}_{i,t}$ does not exceed three percentage points, as they exhibit only a limited degree of speculative pressure. As a result, 6 episodes[4] are dropped. Table 1 shows the resulting panel of 18 currency crisis periods for which we have data.

Using this panel of crisis periods, we analyze the effect of monetary policy on the exchange rate using the following empirical specification:

$$Y_{i,t} = \beta_0 + \beta_1 X_{i,t-1} + \beta_2 Z_{i,t-k} + \beta_3 X'_{i,t-1} Z_{i,t-k} + \epsilon_{i,t}, \tag{3}$$

where $Y_{i,t}$ is an indicator that captures the change in the exchange rate in month t for country i.[5] $X_{i,t-k}$ is an indicator that captures changes in the stance of monetary policy. $Z_{i,t-k}$ is a vector that includes episode-specific fundamentals that are expected to affect the exchange rate (e.g. international reserves, business cycle, etc.), where $k = 0, 1, ..n$. Finally, the interaction term of $X_{i,t-1}$ and $Z_{i,t-k}$ captures how the effect of monetary policy changes for different levels of fundamentals. The interaction terms of monetary policy with short-term debt and institutional quality are used to assess the importance of debt and institutions for the effect of monetary policy on exchange rates.

Table 2 provides an overview of the variables used in estimation and their their definitions, frequencies, and sources. We use two measures for the change in the exchange rate, $Y_{i,t}$. The first measure denotes the percentage change in the *nominal* exchange rate vis-a-vis the anchor currency. After the collapse of a fixed exchange rate, monetary authorities typically remain concerned about the nominal value of the currency. Domestic banks and companies are often exposed to nominal depreciations through foreign currency liabilities. Large depreciations also tend to lead to high levels of inflation through exchange-rate passthrough. Hence, monetary authorities may want to limit nominal depreciation to avoid costly defaults and excessive inflation. Using the change in the nominal exchange rate allows us to test whether they can effectively do so.

[4] Denmark 1993, Ireland 1993, Korea 2000, Spain 1995, Sweden 1992, and United Kingdom 1992.
[5] The change in month t refers to the change between month t and month t-1.

The second measure we use is the percentage change in the *real* exchange rate vis-a-vis the anchor currency. If monetary authorities are more concerned about bringing the real exchange rate back to its equilibrium level rather than just controlling nominal depreciation, the question arises whether monetary policy can effectively support the currency in real terms. Using the change in the real exchange rate allows us to provide an answer to this question. Our indicators of the changes in the nominal and real exchange rate are denoted NE and RE, respectively.

We turn next to our indicator of monetary policy change, $X_{i,t-k}$. Several measures have been proposed in the literature. Kraay (2003) uses the discount rate as this interest rate is to a large extent controlled by the monetary authorities and therefore provides a better measure of monetary policy than short-term money market interest rates that are also affected by market conditions. By contrast, Goldfajn and Gupta (2003) prefer money market interest rates because these interest rates better reflect short-term changes in monetary policy. Discount rates often tend to remain flat, as was for example the case during the Swedish interest rate defense in 1992 that made money market interest rates shoot up to 500%. Goderis and Ioannidou (2006) point out that the best available indicator of monetary policy is not necessarily the same across countries or time and therefore collect information on the most appropriate indicator of monetary policy for each episode in their sample.

In this paper we will use two alternative indicators of monetary policy. Our preferred indicator is based on the country-specific interest rates collected in Goderis and Ioannidou (2006).[6] For comparison, we use a second indicator which is based on the discount rate. We collected daily data on both indicators for the periods in our sample and constructed monthly averages of these series.[7] These monthly averages were then expressed as spreads over the anchor country's monetary policy interest rates to eliminate changes in monetary policy that result from changes in the monetary policy of the anchor country. We then calculated the percentage change in these spreads from one month to another. Finally, we take the first lag of the percentage change in the spread to get our two monetary policy indicators MP and $DISC$, based on the country-specific interest rate and the discount rate, respectively. Lagging the monetary policy indicator

[6] Table 3 reports the names of these country-specific interest rates, the way in which they were identified, and the data source, all taken from Goderis and Ioannidou (2006).

[7] This accounts for possible intra-monthly fluctuations, which are ignored when using end-of-month data.

allows the transmission of monetary policy to take some time and avoids measuring the monetary policy reponse to changes in the exchange rate. For both measures of monetary policy, we also include the initial level of the spread as a control variable.

Next to monetary policy, we include a vector of episode-specific fundamentals, $Z_{i,t-k}$, and interactions of monetary policy with these fundamentals. Six fundamentals are taken from Kraay (2003) and/or Goderis and Ioannidou (2006). First, as an indicator of real exchange rate overvaluation, we include the average growth rate of the real exchange rate vis-a-vis the anchor currency during the previous 12 months, expressed as a percentage. An average real appreciation implies a deterioration of a country's international competitiveness and increases the likelihood of a depreciation in the near future to restore competitiveness. Secondly, we include the level of non-gold reserves as a percentage of total imports in the previous month. This reflects the degree to which monetary authorities can support the exchange rate in the face of speculation against the currency or a sudden reversal of capital flows. The higher the level of international reserves, the higher the probability that the exchange rate will appreciate, everything else equal. Thirdly, as an indicator of a country's external payments position, we include the average of a country's outstanding IMF loans as a percentage of a country's IMF quota in the previous twelve months. A high level of external debt might discourage international investors to lend to a country or persuade those already present to leave the country, which depreciates the exchange rate. Fourth, we include the deviation of the real per capita GDP growth in the previous calendar year from the average of the five years before, expressed in percentage points. Lower economic growth might lower international investors' expectations of future returns. Also, it might make it more difficult for a country to meet its external debt service obligations. Again, this could lead to a decrease in demand for the domestic currency, causing a depreciation of the exchange rate. Fifth, we include the monthly percentage change in real exports. An increase in exports implies an increase in the supply of foreign currency which, everything else equal, appreciates the exchange rate. Sixth, we include the monthly percentage change in real imports. A higher level of imports increases demand for foreign currency and depreciates the exchange rate.

In order to test the hypotheses described in the introduction of this paper, we also include measures

of corporate short-term debt and institutional quality. Our measure of debt is taken from Goderis and Ioannidou (2006). In particular, we use their data on short-term debt and total assets for a large number of publicly listed companies in developed and emerging markets, obtained from the Thomson Financial's Worldscope database. We construct an aggregate measure of a country's short-term debt by taking the mean of the individual short-term debt to total assets ratios in the calendar year before the year of the exchange rate change.

To capture the quality of a country's institutions we use the International Country Risk Guide (ICRG) rating, which is a weighted index of 22 variables in three subcategories of risk: political (50%), financial (25%), and economic (25%). The index includes measures of for example the quality of a country's bureaucracy, the degree of corruption, the degree of democratic accountability, the stability of the government, and the degree of law and order. The index ranges from 0 for very bad institutions to 100 for very good institutions.

Table 4 reports summary statistics for the variables used in estimation. On average, the nominal and real exchange rates depreciated during the episodes in our sample, while monetary policy on average tightened.[8] The standard deviation of $DISC$ is lower than the standard deviation of MP, which is consistent with the argument above that discount rates tend to remain flatter than other monetary policy indicators.[9]

3 Estimation results

Table 5 reports pooled OLS estimation results for six alternative specifications of equation 3.[10] Column (1) shows results when using the monetary policy indicator $DISC$ and fundamentals but no interaction terms. Monetary policy enters with a positive sign, indicating that everything else equal an increase in interest rates leads to a depreciation of the nominal exchange rate. However, the coefficient is not statistically significant, which is consistent with Kraay (2003) who also uses the discount rate and finds no statistically

[8] We dropped January 1998 for Indonesia from our sample as the nominal and real exchange rate depreciation in this episode (96.8% and 84.5% respectively) represents a clear outlier.

[9] The correlation between the two indicators of monetary policy is 0.49.

[10] We performed Hausman tests, F-tests, and Lagrange multiplier tests to compare fixed effects, random effects, and pooled OLS estimation. The results did not reject the use of pooled OLS.

significant impact of monetary policy on the outcome of speculative attacks.

Only half of the control variables enter with expected signs but all variables are statistically insignificant so should be viewed with caution. In particular, exchange rate overvaluation enters with a negative sign, indicating that a lower level of this variable (higher overvaluation) leads to a depreciation of the nominal exchange rate. The external payments position of a country enters with a positive sign, indicating that higher levels of external debt lead to a depreciation of the nominal exchange rate. Also, the growth rate of exports enters with a negative sign, suggesting that a higher level of exports appreciates the nominal exchange rate. Finally, the initial level of the monetary policy interest rate spread enters positive, suggesting that higher levels of the spread correspond to nominal exchange rate depreciations. The level of debt to assets, reserves to imports, deviations of GDP growth, and the growth rate of imports do not have the expected signs.

Column (2) shows the results when using our preferred monetary policy indicator MP. We again find that everything else equal an increase in interest rates depreciates the nominal exchange rate. This effect is now statistically significant at the 5% level and supports the revisionist view that higher interest rates weaken the home currency during currency crises. The coefficients of the control variables have slightly changed but remain statistically insignificant, except for the level of the spread which is now significant at the 1% level.

In columns (3) and (4) we add interaction terms of monetary policy and all fundamentals except institutional quality to test whether the effect of monetary policy depends on these fundamentals. The first hypothesis of this paper - increasing the interest rate to support the exchange rate has larger adverse effects and is therefore less effective in countries where the corporate sector is more short-term indebted - is tested using the interaction term of monetary policy and short-term debt to assets.

Column (3) shows results when using the monetary policy indicator $DISC$. Monetary policy again enters positive and statistically insignificant. The interaction of monetary policy and short-term debt also enters statistically insignificant and moreover with the counterintuitive sign. A higher level of short-term debt to total assets makes monetary policy more effective in supporting the exchange rate. The

fundamentals enter with the same signs as in column (1), except for GDP growth. They all remain statistically insignificant except for debt, which now enters statistically significant at the 5% level but with the 'wrong' sign. The interaction terms of monetary policy with the other fundamentals enter statistically insignificant except for the interaction with GDP growth, which enters marginally significant at the 10% level. However, the sign is again counterintuitive. A higher level of relative GDP growth makes monetary policy less effective. These results do not provide evidence of any relationship between interest rates and exchange rates. This is again consistent with the findings in Kraay (2003), who also fails to find any evidence of a linear or non-linear effect of monetary policy.

As argued by Goldfajn and Gupta (2003), discount rates often fail to reflect important changes in the monetary policy stance. Moreover, using a universal monetary policy interest rate fails to recognize that different countries use different key interest rates as part of their monetary policy strategy. It is therefore interesting to investigate if and how our findings change when using our preferred country-specific monetary policy indicator MP. Column (4) shows the results. Monetary policy now enters negative and statistically significant at the 5% level. The interaction of monetary policy and short-term debt to total assets enters positive and is also statistically significant at 5 percent. This indicates that the effect of monetary policy on the nominal exchange rate is non-linear and non-monotonic: for low levels of debt, higher interest rates appreciate the nominal exchange rate while for higher levels of debt, this effect becomes weaker and eventually changes sign. The control variables and the other interaction terms enter statistically insignificant except for the initial level of the spread, which again enters positive and strongly significant.

We next allow for a second possible source of non-linearity. In addition to a country's corporate short-term debt, we consider a country's institutional quality as a possible determinant of whether monetary policy is effective in supporting the exchange rate. Column (5) reports the results when adding the interaction of monetary policy and institutional quality to the regression equation. The interaction terms other than the ones for debt and institutional quality are left out because of multicollinearity.[11] The interaction of monetary policy and short-term debt remains positive and enters statistically significant at the 10% level. Moreover, the interaction of monetary policy with institutional quality enters negative and

[11] We tested for multicollinearity by calculating variance inflation factors (VIF) for all regressors.

statistically significant at 5 percent. This indicates that monetary policy is more effective in countries with good institutions. Whereas monetary policy was negative and significant in column (4), it now enters positive although statistically insignificant. The change in the coefficient of monetary policy shows that the negative and significant effect in column (4) can be attributed to the institutional quality of countries. Once we control for institutional quality as a determinant of the efficacy of monetary policy, the coefficient of monetary policy becomes statistically insignificant and even changes sign. Institutional quality by itself enters positive but statistically insignificant, which is reassuring as it shows that the coefficient of the interaction of monetary policy with institutional quality does not reflect a general effect of institutional quality on the nominal exchange rate. The sign and statistical significance of the coefficients of the other fundamentals are identical to column (4).

Column (6) reports results when substituting the nominal exchange rate change in column (5) with the *real* exchange rate change as the dependent variable. The results are very similar. In particular, the evidence of non-linear effects of monetary policy on the exchange rate is robust to using the real exchange rate instead of the nominal exchange rate. The coefficients of the interactions of monetary policy with short-term debt and institutional quality are almost unchanged and slightly more significant than before.

Summarizing, the results in table 5 provide strong evidence that the efficacy of monetary policy in supporting the exchange rate depends on a country's corporate short-term debt and institutional quality. Everything else equal, monetary policy will be more effective in countries with lower levels of corporate short-term debt or higher levels of institutional quality.

Figure 1 illustrates the marginal effect of an increase in the monetary policy interest rate for different levels of short-term debt and institutional quality, based on the estimation results in column (5) of Table 5. Panel (A) shows marginal effects in countries with weak institutions[12] (institutional quality = 0.48) for different levels of short-term debt to total assets. The upward sloping solid line shows how the marginal effect increases with debt. For all debt levels in our sample the marginal effect is positive and for debt levels above 0.11 this effect is statistically significant at the 5% level. This shows that for countries with weak

[12]For weak and strong institutions and low and high debt, we use the 10th and 90th percentile of the distributions of institutional quality and debt, respectively.

institutions, monetary tightening depreciates the nominal exchange rate. For most debt levels this effect is also economically relevant. For example, the marginal effect of an interest rate increase in countries with weak institutions and a sample average debt level of 0.18, is equal to 0.15. This indicates that a tightening of monetary policy by 1 percentage point leads to an increase in the nominal depreciation by 0.15 percentage points.

Panel (B) shows marginal effects in countries with strong institutions (institutional quality = 0.87). The marginal effect again linearly increases with debt but the sign of the effect is no longer positive for all debt levels. In particular, for countries with strong institutions and debt levels below 0.20, the marginal effect is negative, which indicates that a higher interest rate appreciates the exchange rate. For debt levels below 0.13, this effect is marginally significant at the 10% level. For debt levels above 0.20, the marginal effect of monetary policy turns positive again.

Panels (C) and (D) show the marginal effects of monetary policy in countries with low and high debt for different levels of institutional quality. Panel (C) confirms that monetary policy is effective in countries with low debt (debt to assets = 0.06) and high institutional quality, but countereffective in countries with low debt and low institutional quality. For countries with high levels of debt (debt to assets = 0.30), monetary policy is always countereffective, although the degree depends on the quality of institutions.

Summarizing panels (A) to (D), monetary tightening seems to be countereffective except in countries with both low short-term debt to total assets and strong institutions.

Panel (E) shows combinations of debt and institutional quality for which the marginal effect of monetary policy equals zero, illustrated by the solid line. The line is upward sloping as for higher levels of debt, the negative effects of monetary policy increase, which can only be offset by higher levels of institutional quality. In addition, panel (E) shows the combinations of debt and institutional quality for all the crisis episodes in our sample. For countries that lie above the solid line, monetary tightening appreciates the exchange rate whereas this effect is opposite for countries below the solid line. As can be seen from the location of the markers, raising the interest rate depreciates the exchange rate in most of the countries in our sample. Only during the crisis episodes in Ireland (1986), Finland (1991), Mexico (1998), Norway

(1986), and South Africa (1998), monetary policy could have been used to support the exchange rate. This observation is consistent with the results in column (2) of Table 5, where we did not allow for any non-linearities and found that on average an increase in interest rates depreciated the nominal exchange rate.

4 Sensitivity Analysis

We next address two possible concerns that could be of importance when interpreting the results in Table 5. First, the empirical specification in equation 3 is a static one and hence does not allow for the possibility that past levels of the dependent variable have an affect on the current level. Allowing for dynamics may be important for the consistency of the other regressors (Bond (2002)). We therefore add the lagged exchange rate change to the specification in column (5) of Table 5.[13] The results are reported in column (1) of Table 6. The lagged exchange rate change enters positive and statistically significant at the 10% level. The coefficients of the other regressors are very similar to the ones in column (5) of Table 5. In particular, the coefficients of monetary policy and the interactions of monetary policy with debt and institutional quality are almost unchanged, which indicates that our earlier results are robust to the inclusion of the lagged dependent variable.

A second possible concern when interpreting the results in Table 5 relates to the possible endogeneity of monetary policy. Monetary policy could be correlated with some omitted variable(s) that also affect the exchange rate change (omitted variable bias) or could be affected by the exchange rate change through the expectations of monetary authorities (reverse causation). In both cases, our estimated coefficients will be biased as monetary policy will be correlated with the error term in equation 3. Several instrumental variables have been proposed in the literature. Kraay (2003) uses the percentage change in real reserves as an instrument for monetary policy. Goderis and Ioannidou (2006) instead use the turnover rate of central bank governors. In our sample, however, both instruments are poor predictors of monetary policy.

In the absence of other strictly exogenous instruments, we use an alternative instrumental variables

[13] We also tried adding additional lags of the dependent variable but found that only the first lag is important.

technique first suggested by Anderson and Hsiao (1981). This technique proposes to first transform the model by first-differencing to eliminate possible individual effects and then apply instrumental variables. In particular, endogenous variables in first differences are instrumented with suitable lags of their own levels and first differences. Aside from monetary policy, the lagged dependent variable in column (1) of Table 6 could also suffer from endogeneity if the error term in equation 3 contains a country-specific unobservable fixed effect. Using the Anderson and Hsiao two-stage least squares estimator eliminates this potential endogeneity bias. Although consistent, the estimator is not efficient for panels with more than three periods, as for the later periods in the sample additional instruments are available. Holtz-Eakin, Newey, and Rosen (1988) and Arellano and Bond (1991) applied the generalised method of moments (GMM) approach developed by Hansen (1982) to use all available instruments. Arellano and Bover (1995) extended this difference-GMM estimator by adding the equations in levels to the system, creating what is often called the system-GMM estimator. This addition increases the number of moment conditions, thereby increasing the efficiency of the estimator. Blundell and Bond (1998) showed that exploiting these additional moment conditions provides dramatic efficiency gains.[14]

We use the system-GMM estimator[15] to deal with the potential endogeneity of the regressors in our model, including the lagged dependent variable. In particular, we instrument all regressors with lags of their own levels and differences, starting from period $t-2$. For example, to explain the exchange rate change in period t we instrument monetary policy at time $t-1$[16] with levels and differences of monetary policy and the other regressors at time $t-2$, $t-3$, etc. The lagged dependent variable and all the other regressors are instrumented in the same way. The results are reported in columns (2) and (3) in Table 6. In column (2) we use exactly the same variables as in column (1). Results are very similar to column (1). In particular, we find that the coefficients of the interactions of monetary policy with debt and institutions are identical although the statistical significance slightly changes. Given that the model is overidentified, we can use the Sargan test of overidentifying restrictions to test the validity of the instruments. The p-value of the Sargan test is reported at the bottom of column (2) and indicates that the null hypothesis that

[14] For an introduction to the GMM estimators for dynamic panel data, see Bond (2002).
[15] We use the xtabond2 procedure in Stata, written by David Roodman.
[16] Recall that our monetary policy indicators are already lagged by one period.

these moment conditions are valid cannot be rejected. In addition, we report the p-value of the Difference Sargan test, which tests the validity of the additional moment conditions used in the system-GMM by adding the levels equations. In particular, the system-GMM assumes that the regressors are uncorrelated with a possible unobservable fixed effect. The Difference Sargan test can be used to test the validity of this assumption. Again, the p-value of the test statistic suggests that the null of valid instruments cannot be rejected. A second underlying assumption of the system-GMM is the absence of serial correlation in the error terms of the original model, i.e. the model before first-difference transformation. If the error terms are serially uncorrelated, then the differenced-error terms in the differenced equations should show negative first-order serial correlation and no second-order serial correlation. The presence of this first- and second-order serial correlation can be tested using the Arellano and Bond AR(1) and AR(2) tests. The Arellano and Bond AR(1) test statistic confirms the presence of negative serial correlation, as the test statistic is negative and statistically significant at the 10% level. The Arellano and Bond AR(2) test statistic shows that there is no evidence of second-order serial correlation as the test statistic is relative small and statistically insignificant. These test results are reassuring as they are consistent with the assumption of no serial correlation in the error terms of the original model. Column (3) in Table 6 reports estimation results when adding the interactions of monetary policy with the other fundamentals. Again, most of the coefficients do not change much and the coefficients of the variables of interest are robust to adding the interaction terms. The coefficients on the interactions of monetary policy with debt and institutional quality even increase in absolute size and gain statistical significance. The Sargan and Difference Sargan tests again fail to reject the validity of the moment conditions and the Arellano and Bond AR(1) and AR(2) test statistics do not reject the absence of serial correlation in the error terms of the original model, although the AR(2) test statistic is somewhat higher than in column (2).

Columns (4), (5), and (6) check the robustness of the results in columns (1), (2), and (3) to using the *real* exchange rate change instead of the nominal exchange rate change as the dependent variable. Again, results are very similar. In particular, the evidence of non-linear effects of monetary policy on the exchange rate is robust to using the real exchange rate instead of the nominal exchange rate. The coefficients of the

interactions of monetary policy with short-term debt and institutional quality are almost unchanged and slightly more significant than before. Sargan, Difference Sargan, and Arellano and Bond AR(1) and AR(2) test statistics again support the validity of the instruments and the assumption of no serial correlation in the error terms.

5 Conclusions

This paper has examined whether the efficacy of monetary policy in supporting the exchange rate after a fixed exchange rate collapse depends on the level of a country's corporate short-term debt and on a country's institutional quality. The first hypothesis of the paper is that raising the interest rate to support the exchange rate has larger adverse balance sheet effects and is therefore less effective in countries where the corporate sector is more short-term indebted. The second hypothesis of the paper is that raising the interest rate to support the exchange rate is more effective in countries with high-quality institutions.

Our results strongly support the hypotheses. Using data for a number of currency crisis episodes over the period 1986 till 2004, we find that everything else equal, a higher level of corporate short-term debt *lowers* the efficacy of monetary policy in supporting the exchange rate while a higher level of institutional quality *increases* the efficacy of monetary policy. A closer examination of the results showed that monetary policy is only effective in countries with both low corporate short-term debt and high-quality institutions. This evidence provides a possible explanation for the mixed findings in the literature. It also suggests that the traditional and revisionist views on raising the interest rate during times of crises are not mutually exclusive. In some cases monetary tightening appreciates the exchange rate, supportive of the traditional view. In other cases monetary tightening depreciates the exchange rate, supportive of the revisionist view.

Our results have important policy implications. Countries that experience a currency crisis and wish to support their exchange rate can only use this instrument effectively if corporate short-term debt is low and institutional quality is high. From a more long-term perspective, the ability of countries to withstand severe speculation against their currencies depends crucially on their ability to keep corporate short-term debt under control and build strong institutions. As for the former, the development of equity markets

and prudent supervision might be helpful strategies.

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Table 1: Episodes of currency crises

Country	Start	End
Argentina	2002:1	2002:10
Brazil	1999:1	1999:5
Finland	1991:11	1993:2
Indonesia	1986:9	1989:2
Indonesia	1997:8	1999:6
Ireland	1986:8	1987:5
Korea	1997:11	1998:7
Mexico	1994:12	1996:8
Mexico	1998:9	1999:4
Norway	1986:5	1988:8
Philippines	1997:9	1997:12
Russia	1998:9	1998:11
Slovakia	1998:10	1999:12*
South Africa	1998:7	1999:3
South Africa	2001:12	2004:6**
Thailand	1997:7	1998:7
Venezuela	1995:12	1996:6*
Venezuela	2002:2	2003:7

*Due to lack of data on money market interest rates in Slovakia (1998-99) and Venezuela (1995-96), we used real non-gold reserves as an alternative indicator of speculative pressure, analogues to the methodology for interest rate spreads. The end date for Venezuela (1995-96) can be explained by Venezuela's Stand-By Arrangement with the IMF in July 1996, which caused a substantial rise in reserves.

**As this episode has not ended yet, we use the most recent month in which data were available.

Note: Slovakia 1993:7 was identified as the beginning of a crisis. This episode is excluded since it is due to the separation of Czechoslovakia into the Czech and Slovak Republic.

Table 2: Variables, Definitions, Frequency, and Source

Variables	Definitions	Frequency/Source
A. Dependent variable		
NE	Percentage change in the monthly average local currency price of the German mark for European countries,and the local currency price of the US dollar for all other countries (%).	Monthly IFS[1] line rf
RE	Analogues to NE but corrected for domestic and German/US price levels (%).	Monthly IFS line rf/64
B. Independent variables: Indicators of Monetary Policy		
MP	based on country-specific interest rates (%)	Monthly, Table 3
$DISC$	based on discount rate (%)	Monthly, IFS line 60
C. Independent variables: Fundamentals		
Debt to total assets	Ratio of short-term debt to total assets in previous calendar year; mean of individual companies (%)	Annual WS[2]
Institutional quality	Weighted index of 22 political, financial, and economic risk variables	Annual WDI[3]
Exchange rate overvaluation	Average growth rate of the real exchange rate during the previous 12 months (%)	Monthly IFS line RF/64
Reserves to imports	Non-gold reserves as percentage of total imports in the previous month (%)	Monthly IFS line 1L.D/71.D
External payments position	IMF loans as percentage of a country's quota, averaged over the previous twelve months (%)	Monthly IFS line 2TL/2F.S
Deviation GDP growth	Deviation of the real per capita GDP growth in the previous calendar year from the average of the five years before (%)	Annual WDI[3]
Exports growth	Monthly percentage change of merchandise exports in constant US dollars in the previous month (%)	Monthly IFS line 70..D
Imports growth	Monthly percentage change of merchandise imports in constant US dollars in the previous month (%)	Monthly IFS line 71..D
Level of MP/DISC at $t-2$	Initial level of the monetary policy spread at $t-2$	Monthly Table 3/IFS line 60

[1] IFS: International Financial Statistics [2] WS: Worldscope [3] WDI: World Development Indicators

Table 3: 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
Finland	Key tender-middle rate	Central Bank-W	Datastream
Indonesia	SBI 90 day-middle rate	Central Bank-W	Datastream
Ireland	Discount rate	Central Bank-W	Datastream
Korea	Call overnight- 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	Daily interbank nominal-middle rate	Central Bank-W	Datastream
Philippines	Interbank call loan rate-middle rate	Other Studies**	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
Thailand	Repo 14 day-middle rate	Central Bank-W	Datastream
Venezuela	Discount Rate***	Central Bank-W	IFS

Central Bank-W = Central Bank Website; Central Bank-C = Central Bank Contact (email).

* From Furman and Stiglitz (1998)

** from Caporale, Cipollini, and Demetriades (2005)

*** End-of-month monthly series.

Table 4: Summary Statistics

Variables used in estimation				
	Mean	St. Dev.	Min	Max
A. Dependent variable				
NE	0.03	0.10	-0.24	0.45
RE	0.01	0.09	-0.23	0.41
B. Monetary Policy				
MP	0.06	0.33	-0.87	2.04
$DISC$	0.04	0.25	-0.50	2.00
C. Fundamentals				
Debt to total assets	0.17	0.09	0.04	0.45
Institutional quality	0.67	0.13	0.41	0.87
Exchange rate overvaluation	0.02	0.03	-0.04	0.14
Reserves to imports	6.09	4.48	0.68	22.14
External payments position	1.15	1.70	0.00	6.63
Deviation GDP growth	-0.02	0.05	-0.20	0.10
Exports growth	0.01	0.14	-0.71	0.43
Imports growth	-0.01	0.16	-0.52	0.54
Initial level of spread (MP)	0.25	0.42	0.05	4.60
Initial level of spread ($DISC$)	0.18	0.16	0.00	0.66

All percentages and percentage points were divided by 100 for convenience.

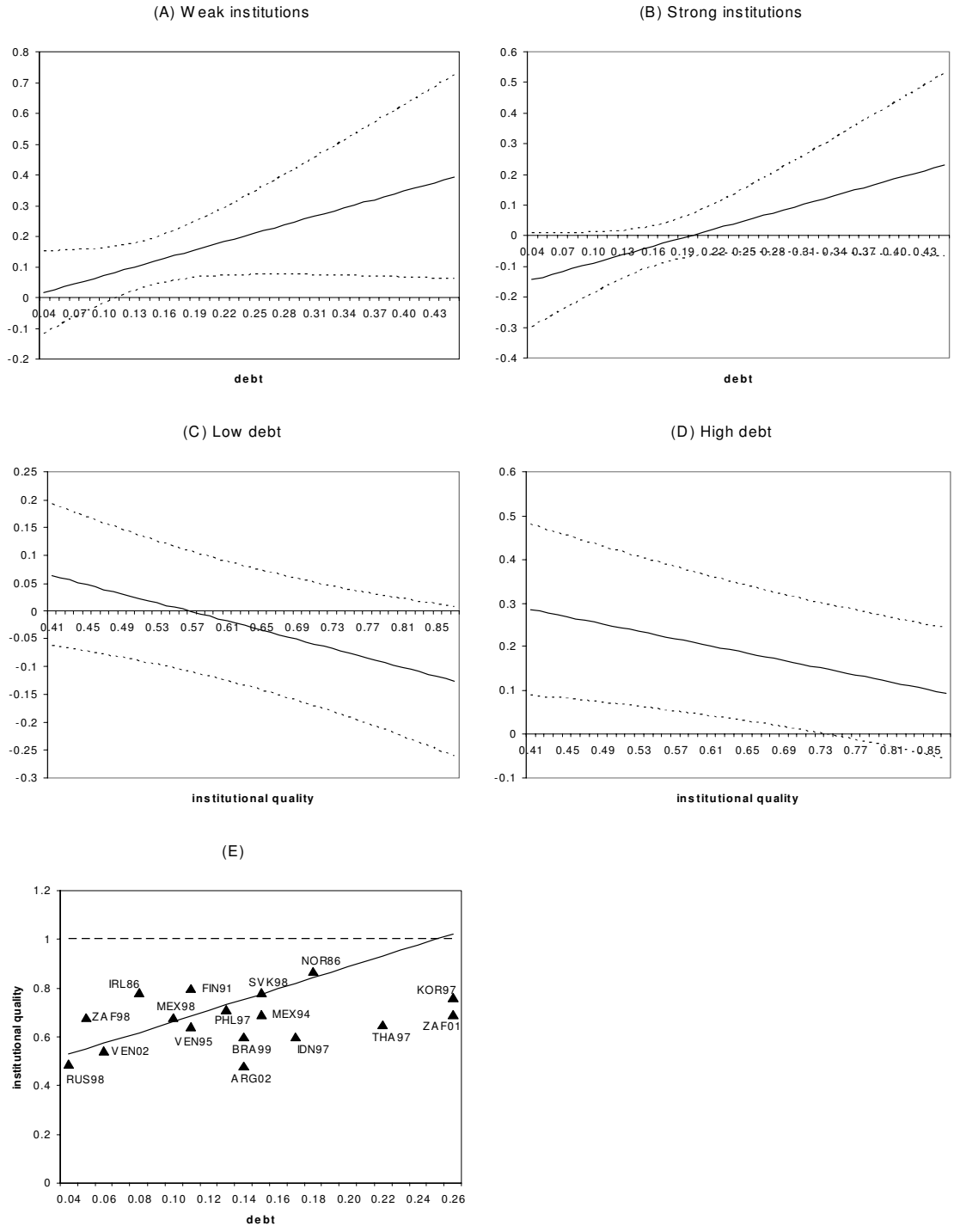
Hence, 0.03 refers to 3 percent or 3 percentage points.

Table 5 Estimation Results

	(1)	(2)	(3)	(4)	(5)	(6)
Monetary policy						
MP		0.05**		-0.17**	0.18	0.16
		(0.02)		(0.08)	(0.13)	(0.10)
$DISC$	0.08		0.11			
	(0.06)		(0.23)			
Fundamentals						
Debt to total assets	-0.15	-0.10	-0.22**	-0.13	-0.13	-0.09
	(0.10)	(0.09)	(0.09)	(0.09)	(0.08)	(0.08)
Institutional quality					0.03	0.07
					(0.07)	(0.06)
Exchange rate overvaluation	-0.11	0.03	-0.17	-0.21	-0.09	-0.30
	(0.35)	(0.30)	(0.29)	(0.26)	(0.26)	(0.25)
Reserves to imports	0.00	0.00	0.00	0.00	0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
External payments position	0.01	-0.00	0.00	-0.00	-0.00	-0.00
	(0.02)	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)
Deviation GDP growth	0.08	-0.01	-0.05	-0.01	-0.03	-0.11
	(0.15)	(0.14)	(0.14)	(0.15)	(0.15)	(0.14)
Exports growth	-0.06	-0.06	-0.03	-0.06	-0.05	-0.05
	(0.05)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Imports growth	-0.05	-0.07	-0.07	-0.07	-0.07	-0.06
	(0.06)	(0.05)	(0.06)	(0.05)	(0.05)	(0.04)
Initial level of spread (MP)		0.08***		0.07***	0.10***	0.09***
		(0.01)		(0.02)	(0.01)	(0.01)
Initial level of spread ($DISC$)	0.02		0.00			
	(0.09)		(0.09)			
Monetary Policy×Fundamentals						
Monetary Policy×Debt to total assets			-0.92	1.23**	0.92*	0.95**
			(0.86)	(0.48)	(0.53)	(0.46)
Monetary Policy×Institutional quality					-0.41**	-0.40***
					(0.17)	(0.15)
Monetary Policy×Exchange rate overvaluation			0.55	0.96		
			(2.71)	(1.75)		
Monetary Policy×Reserves to imports			0.04	0.00		
			(0.03)	(0.01)		
Monetary Policy×External payments position			0.00	-0.02		
			(0.14)	(0.01)		
Monetary Policy×Deviation GDP growth			1.65*	-0.34		
			(0.86)	(0.42)		
Monetary Policy×Exports growth			-0.40	0.06		
			(0.62)	(0.50)		
Monetary Policy×Imports growth			0.16	0.38		
			(0.44)	(0.34)		
Number of observations	132	163	132	163	163	163
Adjusted R-squared	0.10	0.15	0.21	0.20	0.19	0.19

Notes: The dependent variable is NE (nominal exchange rate change) in columns (1) to (5) and RE (real exchange rate change) in column (6). ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. Robust standard errors in parentheses.

Figure 1: Marginal effect of an interest rate increase for different levels of debt and institutional quality



Notes: All graphs based on column (5) of Table 5. Panels (A) to (D): solid line represents marginal effect, dashed lines represent 95% confidence interval; weak institutions correspond to institutional quality=0.48, strong institutions correspond to institutional quality=0.87, low debt corresponds to debt to total assets=0.06, high debt corresponds to debt to total assets=0.30. Panel (E): solid line represents combinations of debt and institutional quality for which the marginal effect of monetary policy equals zero, dashed line denotes maximum value of institutional quality.

Table 6 Estimation Results: Sensitivity Analysis

	(1)	(2)	(3)	(4)	(5)	(6)
Lagged exchange rate change	0.13*	0.12**	0.12**	0.11	0.11	0.10
	(0.07)	(0.06)	(0.05)	(0.09)	(0.07)	(0.06)
Monetary policy						
MP	0.19	0.19	0.25	0.18*	0.18*	0.22
	(0.12)	(0.15)	(0.22)	(0.09)	(0.11)	(0.19)
Fundamentals						
Debt to total assets	-0.10	-0.10	-0.11	-0.08	-0.08	-0.09
	(0.08)	(0.06)	(0.08)	(0.08)	(0.06)	(0.08)
Institutional quality	0.04	0.03	0.03	0.06	0.06	0.06
	(0.07)	(0.07)	(0.07)	(0.06)	(0.06)	(0.07)
Exchange rate overvaluation	-0.25	-0.26	-0.34	-0.42*	-0.42	-0.49
	(0.27)	(0.28)	(0.31)	(0.25)	(0.29)	(0.31)
Reserves to imports	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
External payments position	-0.00	-0.00	0.00	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Deviation GDP growth	-0.04	-0.04	-0.05	-0.09	-0.09	-0.10
	(0.15)	(0.13)	(0.13)	(0.14)	(0.14)	(0.14)
Exports growth	-0.07	-0.07*	-0.06*	-0.06	-0.06*	-0.06
	(0.06)	(0.03)	(0.04)	(0.06)	(0.03)	(0.04)
Imports growth	-0.03	-0.03	-0.03	-0.04	-0.04	-0.04
	(0.05)	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)
Initial level of spread (MP)	0.08***	0.08***	0.07***	0.08***	0.08***	0.07***
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
Monetary Policy×Fundamentals						
Monetary Policy×Debt to total assets	0.89*	0.89**	1.03***	0.91**	0.92**	0.98***
	(0.52)	(0.45)	(0.33)	(0.46)	(0.45)	(0.29)
Monetary Policy×Institutional quality	-0.44***	-0.44*	-0.53**	-0.43***	-0.43**	-0.49**
	(0.17)	(0.23)	(0.26)	(0.15)	(0.19)	(0.24)
Monetary Policy×Exchange rate overvaluation			0.32			0.61
			(1.58)			(1.18)
Monetary Policy×Reserves to imports			-0.00			-0.00
			(0.01)			(0.01)
Monetary Policy×External payments position			-0.02**			-0.02*
			(0.01)			(0.01)
Monetary Policy×Deviation GDP growth			-0.35			-0.27
			(0.39)			(0.32)
Monetary Policy×Exports growth			0.03			0.10
			(0.52)			(0.44)
Monetary Policy×Imports growth			0.29			0.20
			(0.29)			(0.20)
Number of observations	163	163	163	163	163	163
Adjusted R-squared	0.22	-	-	0.20	-	-
P-value Sargan test	-	1.00	1.00	-	1.00	1.00
P-value Difference Sargan test	-	1.00	1.00	-	1.00	1.00
Arellano and Bond AR(1) test	-	-1.89*	-2.28**	-	-2.12**	-2.38**
Arellano and Bond AR(2) test	-	0.32	1.34	-	0.19	0.83

Notes: The dependent variable is NE (nominal exchange rate change) in columns (1) to (3) and RE (real exchange rate change) in columns (4) to (6). ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. Robust standard errors in parentheses.