Banco Central de Chile
Documentos de Trabajo

Central Bank of Chile
Working Papers

N° 126

Noviembre 2001

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BANCO CENTRAL DE CHILE

CENTRAL BANK OF CHILE

Documentos de Trabajo del Banco Central de Chile
Working Papers of the Central Bank of Chile
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OVERSHOOTINGS AND REVERSALS: THE ROLE OF MONETARY POLICY

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Resumen

Este trabajo brinda evidencia sobre la relación entre política monetaria y el tipo de cambio en las postrimerías de una crisis cambiaria tomando en cuenta el rol de un sistema bancario frágil. Se analiza un conjunto grande de crisis cambiarias que llevaron a subvaloraciones del tipo de cambio real para una muestra de 80 países en el período de 1980 a 1998. Primero, el trabajo evalúa si una política monetaria restrictiva incrementa sustancialmente más la probabilidad de revertir la subvaloración a través de la apreciación nominal del tipo de cambio que de una mayor tasa de inflación. Segundo, usando datos de panel, el trabajo estima la relación entre tipos de cambio reales y tasas de interés reales. Encontramos que políticas monetarias restrictivas facilitan más la reversión del tipo de cambio real a través de apreciaciones nominales que de tasas de inflación. En contraste, cuando la economía enfrenta al mismo tiempo una crisis bancaria, una política monetaria restrictiva puede no tener el mismo efecto.

Abstract

This paper provides evidence on the relationship between monetary policy and the exchange rate in the aftermath of currency crises taking into account the role of a fragile banking system. It analyzes a large set of currency crises that led to real exchange rate undervaluations from a sample of 80 countries in the period 1980 to 1998. First, the paper evaluates whether tight monetary policy increases substantially the probability of reversing the undervaluation through nominal appreciation of the exchange rate rather than through higher inflation. Second, using panel data, the paper estimates the relationship between real exchange rates and real interest rates. We find that tight monetary policy facilitates the reversal of the real exchange rate through nominal appreciation rather than inflation. In contrast, when the economy is also facing a banking crisis, tight monetary policy may not have the same effect.

This paper is a chapter of the forthcoming book Banking, Financial Integration, and International Crises, edited by Leonardo Hernández and Klaus Schmidt-Hebbel, Banco Central de Chile, Santiago, 2002.
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Overshootings and Reversals: The Role of Monetary Policy

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Does tight monetary policy stabilize the currency after a collapse? Does the effect of high interest rates on the exchange rate depend on the condition of the banking system? The East Asian crises and other recent currency crises have put these questions at the center of economic policymaking decisions.

There is a lively debate on the effect of tight policies on the exchange rate. The traditional approach stresses that tight monetary policy is necessary to support the exchange rate and curb inflationary pressures. In the short run, higher interest rates make speculation more expensive by increasing the cost of borrowing (shorting) the domestic currency. Also, higher interest rates increase the return from investing in the country. In the long run, higher interest rates may affect the exchange rate by reducing absorption and improving the current account. However, in the current discussion of the role of monetary policy in the Asian crises, several economists have raised the possibility that an increase in interest rates would have a negative effect on the exchange rate. Radelet and Sachs (1998, p. 31), for

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The authors would like to thank Andrew Berg, David Goldsbrough, Paul Masson, Jonathan Ostry, David Robinson, Mark Stone, Christopher Towe, and seminar participants at the Asian Pacific Department of the International Monetary Fund and the Central Bank of Chile. The views expressed are those of the authors and do not necessarily represent those of the International Monetary Fund.

example, have argued that high interest rates would not stabilize currencies in the Asian case: "Despite sharply higher interest rates, currencies have not appreciated so the supposed benefits of this policy are in question. It is entirely possible that in the unique conditions of the midst of a financial panic, raising interest rates could have the perverse effect of weakening the currency." On the opposite side of this debate, Krugman (1998a, b), also referring to the Asian crisis, writes, "I have heard some people propose what amounts to a sort of foreign exchange–interest rate Laffer curve: if you cut interest rates this will strengthen the economy, and the currency will actually rise. This is as silly as it sounds."

When one observes the relationship between the real exchange rate (RER) and real interest rates in the countries affected by the Asian currency crisis, the evidence is mixed. In the crisis period, from July 1997 to May 1998, a fairly positive correlation exists for Hong Kong (0.56), Indonesia (0.62), Malaysia (0.54), and the Philippines (0.58). In contrast, we observe a negative correlation in Korea (–0.45) and Thailand (–0.47).

This paper attempts to shed light on this debate by analyzing a large set of large depreciations in the aftermath of currency crises in the period 1980-98. The analysis of the effect of tight monetary policy on the exchange rate proceeds in three main steps. The first step is to evaluate whether the exchange rate overshot during the crisis, or in other words, whether the currency became undervalued in real terms and needed to be brought back to equilibrium. The second step is to identify the mechanisms through which the RER could be corrected if there is an undervaluation. There are two ways to reverse an undervaluation: through nominal currency appreciation or through higher inflation at home than abroad (or a combination of the two). If avoiding an inflation buildup is an important concern, or if nominal appreciation is desirable for the benefit of domestic corporate and banking balance sheets, the extent to which the reversal occurs through nominal appreciation is fundamental. The third step is to identify through which policies and under which circumstances the reversal occurs through nominal appreciation. In particular, it is important to evaluate whether nominal appreciations occur mainly in cases where interest rates are kept high. In addition, it is important to evaluate whether other economic conditions, for example the state of the banking system, influence the relationship between interest rates and exchange rates.

Operationally, the paper selects a set of currency crises that led to large undervaluations in terms of the RER and investigates how the

subsequent reversal occurred. We define as successful those reversals that occurred primarily through nominal appreciation rather than through higher inflation, and we calculate the probability of successful cases in the overall sample. We also calculate the probability that a tight monetary policy, defined as a case in which real interest rates in the aftermath of the crisis are higher than the average real interest rate during the twenty-four months preceding the crisis, is successful. We then compare that result with the overall probability of success. The traditional approach would suggest that the probability of being successful is higher in cases where tight monetary policy was implemented. Then the whole exercise is replicated using only cases of "twin crises," that is, cases in which currency crises coincided with banking crises. Again the probability of success is compared with the conditional probability of success when tight monetary policy is implemented. In principle, one would expect tight monetary policies to be less successful when a country is also experiencing a banking crisis.

In addition, we report results of a panel regression of RERs and real interest rates in the aftermath of currency crises. We also report results of an equivalent panel regression using only twin crisis cases.

The results indicate that tight monetary policy substantially increases the probability of success. For example, for real undervaluations greater than 15 percent, the probability of success increases from 26 percent to 37 percent when tight monetary policy is implemented. In contrast, tight monetary policies reduce the probability of success when the country is also experiencing problems in the banking sector.

The panel regression results show that the real interest rate is positively correlated with the RER for the entire sample as well as for some regional subsamples, but not for the Asian subsample. The results are mixed when we consider only the twin crises cases. Real interest rates are found to affect the RER positively in the African and European countries, but not in the Asian and Latin American countries.

The exercise in this paper differs from previous studies in a few important aspects. First, it analyzes the relationship between interest rates and exchange rates in crisis episodes, which are crucial periods for policymakers. This leaves out several interesting issues but allows us to concentrate on the role of monetary policy in reestablishing currency stability after a collapse. Previous studies have looked at the general relationship between interest rates and exchange rates, but few have concentrated their analysis on crisis episodes. Second, the paper studies a large set of currency crises and therefore can offer more

general results. Previous studies have concentrated on specific currency crisis cases, offering more limited results.[1] Third, the paper studies the relationship between *real* interest rates and *real* exchange rates using monthly data, as opposed to studying the relationship between the respective nominal variables using daily data. The availability of a sufficient number of monthly observations from the pooling of countries allows us to avoid having to extract the relevant information from more noisy daily data. In addition, the objective of the paper is to evaluate the relationship between tight monetary policy and currency stabilization: both, in our view, are more precisely defined using the real rather than the nominal variables. Finally, the recent research and availability of data on banking crises allow us to evaluate the relationship between real interest rates and real exchange rates in cases where currency and banking crises have occurred simultaneously.

This paper is organized as follows. Section 1 describes the theoretical arguments that would justify different correlations between interest rates and exchange rates in the aftermath of a currency crisis. Section 2 explains the methodology and the data used in the paper. Section 3 characterizes the undervaluation cases, looking at their duration and frequency. Section 4 characterizes the reversals and evaluates the effect of monetary policy, providing the essential results in the paper. Section 5 presents the econometric analysis, and section 6 concludes.

1. Theoretical Considerations

In the midst of an exchange rate crisis, interest rates are raised to make speculation against the currency more costly. If borrowing (shorting) the domestic currency to invest in the foreign currency is allowed, raising the interest rate directly increases the costs of speculation. Even if shorting the domestic currency is not allowed, the increase in interest rates affects the opportunity cost of an investor deciding whether to invest in the domestic economy.

The expected return on investing in the country depends on the promised interest rate and the expected depreciation. The interest

1. For example, the Asian crises and the debate on the role of monetary policy have motivated a few studies on the relationship between exchange rates and interest rates in the five or six countries most affected. See Ghosh and Phillips (1998), Goldfajn and Baig (1998), and Kaminsky and Schmukler (1998).

differential with respect to the rest of the world should allow for both an exchange rate risk premium and a probability of default:[2]

$$\mathrm{E}[i] = i^* + \mathrm{E}[\Delta e] + R, \tag{1}$$

where $\mathrm{E}[\Delta e]$ is the expected depreciation, $\mathrm{E}[i]$ is the expected return on an investment in the domestic economy, i^* is the safe return on an equivalent international asset, and R is the risk premium demanded by risk-averse foreign investors faced with exchange rate volatility.[3] In principle, increases in interest rates should increase the expected return, making investing in the domestic economy more attractive relative to investing abroad (in other words, making the right-hand side of the above equation larger than the left-hand side) and inducing capital inflows. This would increase the supply of dollars and immediately cause the currency to appreciate to the point where equation (1) again holds (in the Dornbusch, 1976, model, the exchange rate should actually overshoot its target so that agents will expect a future depreciation).

However, increases in interest rates may reduce the expected return by increasing the probability of default. Higher interest rates may affect the probability of default by increasing the borrowing costs of corporations, by depressing the economy and reducing profits, by altering the net worth of corporations adversely exposed to interest rate changes, and, finally, by affecting the health of the banking system, which tends to be naturally exposed to interest rate changes. The last of these factors has a compounding effect on the economy, since problems in the banking system lead to credit crunches, disintermediation, and poor allocation of credit. Formally, the expected return on the domestic asset $\mathrm{E}[i]$ can be written as the product of the domestic interest rate, I, and the probability of repayment, ρ:$\mathrm{E}[i] = \rho(I)I$. The equation can be rewritten in the following way:

$$\rho(i)\,i = i^* + \mathrm{E}[\Delta e] + R,$$

where $\rho' < 0$, $\rho'' < 0$.

At some point, additional increases in interest rates do not raise the expected return from investing in the domestic economy.

2. Default here is defined in general terms to include partial payment, delay of payments, or the introduction of exchange controls.

3. The risk premium must also include a component for the uncertainty induced by the probability of default.

Therefore, even though one should expect increases in interest rates to attract capital, there must be cases where additional increases in interest rates reduce the expected return and generate capital outflows. In these cases, raising interest rates paradoxically destabilizes the exchange rate.[4]

Proponents of tighter monetary policy argue that higher interest rates need only be temporary. Once the exchange rate has been defended (or the currency has appreciated), interest rates can be allowed to decline. This argument is important given that the costs of a persistent period of high interest rates could be substantial.

However, the question is then, Why should a temporary increase in interest rates bring about permanent, positive effects on the exchange rate? After all, the objective is to stabilize the exchange rate permanently. One answer is that the temporarily tight policies signal the determination of the monetary authorities to pursue exchange rate stability and low inflation. Temporary policies may then change the beliefs of investors, so that even when the tight policies are withdrawn, the exchange rate will stabilize at a higher level than it would have otherwise.

Tight monetary policies do not always serve as a credible signaling device. Drazen and Masson (1994) have shown that if the costs of implementing the tight policies are too high, the temporary policy will actually reduce credibility, because investors will know that the policy cannot be sustained and will expect a future devaluation. Under this theory, the relationship between interest rates and the exchange rate could be negative. When there are doubts about the determination of the authorities, and signaling is very important, the effect of raising interest rates should be positive, but when there are structural problems that are severely exacerbated by raising interest rates, the effect may be negative.

2. Methodology and Data

This paper analyzes all episodes of currency collapses that resulted in large undervaluations from a sample of eighty countries between

4. Notwithstanding the negative effect of interest rates on exchange rates in these cases, it is not immediately evident that a tight monetary policy will lead to an explosive path. One should still expect a reversal in the long run, since a deep enough recession and a large enough depreciation would eventually generate a surplus in the current account and an appreciation of the currency.

January 1980 and January 1998. It also studies the role of tight monetary policy in reversing the undervaluation through nominal appreciation of the currency rather than through higher inflation. This exercise requires the definition of four different concepts. First, one needs to define the term *undervaluation* and specify the threshold that defines a "large" undervaluation. Second, the exercise requires the definition of what constitutes a successful reversal; that is, it requires a threshold for the proportion of the reversal to equilibrium that is due to nominal appreciation of the currency. For example, is a reversal that is 50 percent driven by nominal appreciation a successful case? Third, there is a need to define "tight" monetary policy. Finally, one needs to specify how to evaluate whether tight monetary policy has helped stabilize the exchange rate.

2.1 Definition of Undervaluation and Identification of Cases

In this paper an undervaluation episode is defined in terms of the departure of the actual RER from an estimated equilibrium RER. We define the undervaluation series in terms of the deviation of the actual exchange rate from a Hodrick-Prescott-filtered series. The filtered series captures stochastic trends in the series and allows us to concentrate on the cyclical behavior of potentially nonstationary RER series. The filtered series represents the predicted equilibrium RER and captures the permanent changes in relative prices between countries, whereas the estimated undervaluation series represents the cyclical component of the RER movements, since, as a misalignment, an undervaluation must eventually correct itself. This approach will also net out from the undervaluation measure any trend in the equilibrium RER, for example that due to a Balassa-Samuelson effect.[5]

The paper defines the equilibrium RER as the predicted value of a cointegrating regression of the actual RER on a set of fundamentals: the terms of trade, openness of the economy, government size, and the international interest rate. We then calculate the undervaluations as deviations from this equilibrium value (see Goldfajn and Valdés, 1998). Since the sample for which measures of

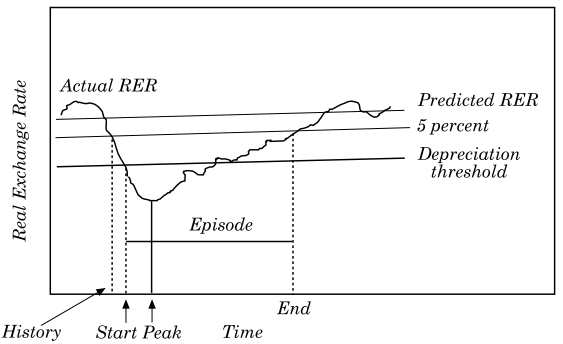
5. The Balassa-Samuelson effect occurs when the productivity of a country's tradables sector grows faster than that in its trading partners, and this differential growth is smaller in the nontradables sector. Then the (cross-country) relative price of nontradables increases, and therefore the currency appreciates in terms of the RER over time. See Rogoff (1992).

the fundamentals are available is more restricted, we will use these RER series to test the robustness of the results.

Figure 1 presents the definition of an undervaluation episode and its phases. We define the start of an undervaluation episode as the time when the difference between the actual RER and our estimate of the steady-state RER is equal to or higher than a certain threshold (for example, 15 percent or 25 percent). The episode ends when this difference hits a second threshold (5 percent) associated with the absence of undervaluation. In order to control for data blips, an episode has to be sustained for more than two consecutive months to be classified as such.

We define four points in the course of an undervaluation episode. The *start* occurs when the undervaluation hits the threshold. The *end* occurs when the undervaluation disappears (that is, when the RER returns to the 5 percent threshold). The *peak* occurs when the undervaluation is at its highest. And the *history* occurs when the undervaluation first reaches 5 percent. An undervaluation episode is then defined as the period between the start and the end. Associated with each episode there are also two phases: from history to peak, representing the buildup of the overshooting, and from peak to end, representing reversion to a "normal" level.

Figure 1. Definition of Cases and Phases



2.2 Definition of Successful Reversals

As noted above, there are two ways to reverse an undervaluation: through nominal currency appreciation or through higher inflation at home than abroad (or a combination of the two). If avoiding an inflation buildup is an important concern, or if nominal appreciation is desirable for the benefit of domestic corporate and banking balance sheets, the extent to which the reversal occurs through nominal appreciation is fundamental.

In order to decompose the real appreciation that occurs during the return to equilibrium, we calculate the total appreciation in terms of the actual RER during the peak-end phase and the total nominal appreciation during that same period. Successful reversals can then be defined as episodes that return to equilibrium with nominal appreciation of the currency above a certain threshold.

Letting Δ denote percentage change, we have the identity

$$\Delta RER = \Delta E + \Delta(P - P^*) ,$$

where E and RER are the nominal and real effective exchange rate indices, respectively, and P and P^* are the price indices at home and abroad, respectively. We can then calculate

$$S = \frac{\Delta E}{\Delta RER}$$

as our success index. As a starting point we define a successful case as occurring when S is greater than 50 percent. In the next section we test the sensitivity of our results to different thresholds for S.

2.3 Definition of Tight Monetary Policy

Ideally, one would like to have exogenous shocks to monetary policy in all the crisis episodes. Clearly, however, there are no such data available. This paper therefore identifies a country as experiencing tight monetary policy when the average real interest rate r during the period of undervaluation exceeds a threshold real interest rate. The latter is calculated as the average real interest rate during the twenty-four months preceding the crisis and is denoted by u_r , plus x times the standard deviation of the series, σ_r . In other words,

$$r > u_r + x\sigma_r .$$

As a starting point, we have set x equal to zero in the benchmark case, but sensitivity analyses are also performed for different values of x.

There are several possible ways of calculating real interest rates, depending on how expected inflation is proxied.[6] In this paper we calculate expected inflation by taking the following month's inflation and use it to find the real interest rate. The real interest rate in period t is then calculated as the moving average of real interest rates for the three months centered at t. We also evaluate the results under alternative definitions of the real interest rate and of monetary tightness.

2.4 Determining the Effectiveness of Tight Monetary Policy

We define monetary policy as effective if we find that the conditional probability of reversing an undervaluation through nominal appreciation using tight policy is higher than the unconditional probability (or higher than the probability conditional on not using tight policy). In other words, we consider that monetary policy has been effective if, in the cases that had tight monetary policies, we observe a larger proportion of successes than in the overall sample.

The main tables of the paper compare the conditional probabilities of success under tight and nontight policies for different thresholds and definitions. In particular, we evaluate the probability of success of tight monetary policy with and without a banking crisis.

2.5 Data

Our sample consists of monthly data for eighty countries (see appendix for a list) during the period January 1980 to January 1998.[7] The monthly data on nominal interest rates were obtained from the International Monetary Fund's *International Financial Statistics*. Depending on data availability, one of the following series is used for the nominal interest rate: the money market rate, the treasury bill rate, or the discount rate. In a few cases where none of these series were available, the deposit rate was used.

Data on the seasonally adjusted consumer price index, the nominal effective exchange rate, and the real effective exchange rate

6. See Goldfajn and Baig (1998).

7. We started with the same set of ninety-three countries as in Goldfajn and Valdés (1998); however, because of data unavailability some countries had to be dropped.

were obtained from the IMF's Information Notice System (INS).[8] The use of the INS real effective exchange rate should, in principle, consider the effect of "competitive devaluations" in third markets.

The existence of banking crises is summarized by a dummy variable. The dates of banking crises were obtained from Lindgren, Garcia, and Saal (1996), Caprio and Klingebiel (1996), and Demirgüç-Kunt and Detragiache (1997).[9] Since these studies provide only annual data, monthly data were interpolated by assuming that the crisis lasted from January of the year in which it started until December of the year in which it ended.

3. Characterizing Undervaluations and Crises

In this section we present several characteristics of the undervaluation episodes in our sample. In particular, we analyze the number of episodes with different magnitudes of undervaluation, the average duration of the undervaluation episodes, the proportion of cases in which banking problems were also experienced (the twin crises cases), and the proportion of cases in which monetary policy was tight.

3.1 Number of Cases

The number of episodes clearly depends on the cutoff used to define an undervaluation. We identified ninety-nine cases of undervaluation using a 10 percent cutoff: that is, there are ninety-nine cases in our sample where the RER overshot by at least 10 percent. When the definition is made stricter by raising the cutoff, the number of undervaluation cases declines. Thus, the number of cases with more than a 15 percent undervaluation declines to seventy-seven, and there are just twenty-eight cases in which the RER is found to be undervalued by more than 30 percent. These results are presented in table 1.

Table 1 also shows the proportion of banking crises in the sample. We identified about 45 to 55 percent of the undervaluation cases to be twin crises cases; in other words, about half of the undervaluation

8. The nominal and real exchange rates have been defined such that an increase is an appreciation.

9. Problems in the banking sector may take either or both of the following forms. First, the banks may be unsound, that is, they may have a high share of nonperforming assets in their portfolio; second, there may be a run on the banks. We include both types of cases to define a fragile banking sector.

Table 1. Composition of Undervaluation Episodes

Threshold for RER overshooting (percent)	*No. of episodes above threshold*	*Proportion with concurrent banking crises (percent)*	*Proportion of all episodes with tight monetary policy (percent)*
10	99	...	32.3
15	77	45.4	29.2
20	49	46.9	22.5
25	36	50.0	17.2
30	28	57.1	13.6

Source: Authors' calculations.

cases are accompanied by a fragile banking sector.[10] This confirms previous results in the literature finding strong evidence for the simultaneous occurrence of banking and currency crises. The proportion of these cases increases for larger undervaluation thresholds. This means that once the degree of undervaluation reaches 15 percent, further undervaluation alters the likelihood of having a banking crisis.

We find monetary policy to be tight in nearly one-third of the cases with more than a 10 percent undervaluation. The percentage of such cases declines when the threshold used to define undervaluation is increased.

3.2 Duration of Undervaluations

We also examined the average duration for which an undervaluation in terms of the RER persisted after a currency crisis. The average duration was found to be about thirty months for cases with more than a 15 percent undervaluation. The average buildup phase (the history-to-peak phase) is 9.5 months, which is considerably shorter than the reversal phase (the peak-to-end phase), which averages about 20.4 months. These results are summarized in table 2. We also present in figure 2 a frequency histogram of the duration of the buildup phase and the reversal phase.

As can be seen from figure 2, there is a marked asymmetry in the durations of the two phases. On one hand, in more than 45 percent of the cases the buildup takes only one to three months, and in almost 80 percent of the cases it takes less than a year. On the other hand, reversal takes much longer: in only 35 percent of the cases does reversal take less than a year.

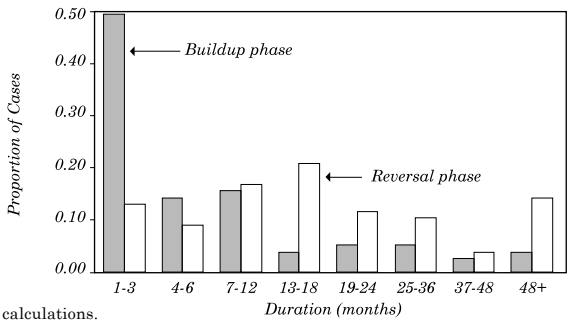
10. See Kaminsky and Reinhart (1998) and Gupta (1997) for evidence on the existence of twin crises and various explanations of why such crises may arise.

Table 2. Average Duration of Undervaluation Episodes

Phase of episode	*Months*
Buildup	9.5
Reversal	20.4
Total	29.9

Source: Authors' calculations.

Figure 2. Phases Duration Histogram



Source: Authors' calculations.

4. Characterizing Reversals

In this section we address the main questions raised in this paper. What is the probability that a reversal will occur through nominal appreciation rather than through higher inflation? What is the effect of a tight monetary policy on the probability of a successful reversal? Does the condition of the banking system alter the effectiveness of monetary policy?

We first analyze the proportion of success cases. Then we identify the proportion of successes among cases in which interest rates were kept high. In light of the recent debate on how the state of the banking system may influence the relationship between interest rates and exchange rates, we analyze the effect of the health of the banking sector on the probability of successful reversal.

4.1 Unconditional Reversals: Proportion of Nominal Appreciation versus Inflationary Returns

We first analyze the success cases among cases of undervaluation of at least 15 percent. We consider several alternative definitions of

success by varying the percentage of reversal that is required to be brought about through nominal appreciation. The results are presented in table 3 and figure 3. The number of success cases declines when a stricter definition is used.

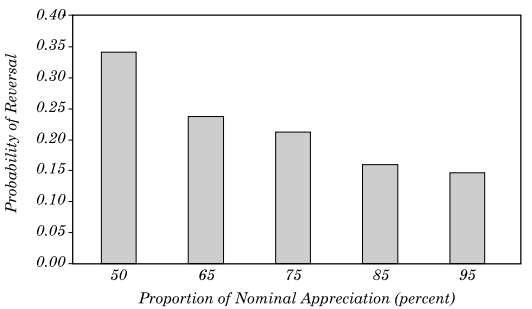
Figure 4 presents the probability of reversal through nominal appreciation for varying degrees of undervaluation. Here we define successful cases as those in which nominal appreciation is responsible for at least 50 percent of the reversal in the RER. We find that in a significant number of cases the reversal comes about through a nominal appreciation of the currency: 35 percent of cases of more than 10 percent undervaluation were found to be success cases. The percentage of success cases declines for undervaluations of greater magnitude, but not significantly: about 29 percent of undervaluations of greater than 30 percent were reversed through nominal appreciation. This implies that the magnitude of the overshooting does not significantly affect the probability of reversing the undervaluation through nominal appreciation.

Table 3. Probability of Success at Alternative Success Thresholds[a]

Minimum share of reversal achieved through nominal appreciation (percent)	*Probability of success (unconditional)*
50	0.32
65	0.22
75	0.19
85	0.14
95	0.13

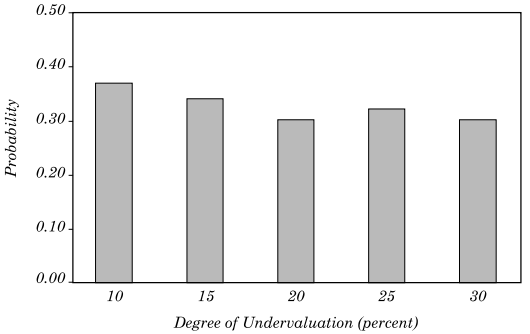
Source: Authors' calculations.
a. Only episodes of undervaluations greater than 15 percent are included.

Figure 3. Probability of Reversing Undervaluations as a Function of Success Definition



Source: Authors' calculations.

Figure 4. Probability of Reversing Undervaluations Through Nominal Appreciation



Source: Authors' calculations.

4.2 Conditional Reversals: Proportion of Successful Cases with Tight Monetary Policy

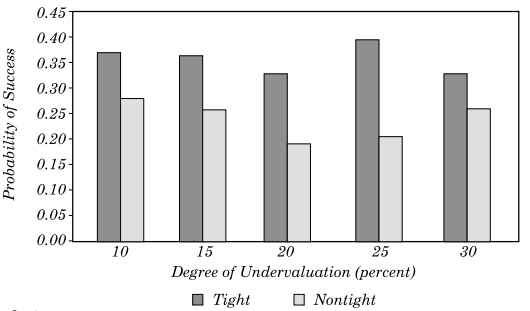
Table 4 and figure 5 address one of the main questions of the paper, namely, What is the effect of tight monetary policy in bringing about the reversal of an undervaluation through nominal appreciation? The probability of success conditional on using tight monetary policy is substantially higher than the probability of success conditional on nontight policy. Thus, whereas the probability of success is only 26 percent for undervaluations of at least 15 percent for the nontight sample, that probability increases to 37 percent when tight monetary policy is used. This result is confirmed for all degrees of undervaluation.

Table 4. Unconditional versus Conditional Probabilities of Success

Threshold for RER overshooting (percent)	*Probability of success*[a]			
	Unconditional	*Tight monetary policy*	*Nontight monetary policy*	*Result of significance test*[b]
10	0.35	0.38	0.28	Significant
1	0.32	0.37	0.26	Significant
20	0.29	0.33	0.19	
25	0.31	0.40	0.21	
30	0.29	0.33	0.26	Significant

Source: Authors' calculations.
a. Success is defined as a greater than 50 percent reversal of undervaluation achieved through nominal appreciation.
b. "Significant" indicates that the probabilities are different at a significance level greater than 85 percent.

Figure 5. Probability of Success with Tight and Nontight Monetary Policy



Source: Authors' calculations.

These results may lend support to the use of tight monetary policy to correct an undervaluation of the currency. However, one has to interpret the results with caution. Since there is no truly exogenous policy variable in this exercise, the higher incidence of successes under high real interest rates could be driven by a third factor.

Nonetheless, the fact that our results do show a positive correlation between tight policies and nominal appreciations is interesting. A typical "endogeneity" argument is that interest rates and exchange rates are both driven by a deterioration in investors' confidence during a crisis. This increases the risk premium and consequently raises interest rates and at the same time depresses the exchange rate. This would typically generate a negative correlation, not a positive correlation as obtained here.

4.3 Proportion of Successful Cases among Cases Where Banking Problems Are Also Present

The presence of vulnerable banking and corporate sectors raises the often-mentioned trade-off between banking sector fragility and exchange rate stability that a policymaker faces when choosing monetary policy. Policymakers may be less willing to raise the interest rate to defend the currency when the banking sector or the corporate sector is exposed to interest rate increases.[11] This is compounded by the fact that interest rate increases may affect investors' expected

11. Other factors affecting monetary policy may include the stock of government debt and the increased burden of debt servicing.

return. Interest rates may affect the probability of default by increasing the debt-servicing burden of corporations, by depressing the economy and reducing profits, by altering the net worth of corporations adversely exposed to interest rate changes, or finally, by affecting the health of the banking system, which tends to be naturally exposed to interest rate changes.[12]

In fact, we find that policymakers are less likely to choose tight policies when they are simultaneously facing a banking crisis. In table 5 we find that, for higher undervaluation thresholds, the unconditional probability of choosing a tight monetary policy is higher than the probability of choosing a tight policy conditioned on having a banking crisis. For undervaluations of at least 15 percent, the probability of choosing tight monetary policy declines from 29 percent for the entire sample to 25 percent in the twin crises cases.

Moreover, when tight monetary policy is adopted in such cases, it diminishes the probability of a successful recovery. Table 6 and figure 6 show that the probability of success falls from 45 percent to 29 percent when tight monetary policies are adopted, for undervaluations greater than 15 percent. This means that the relationship between high interest rates and stable currencies hinges crucially on the state of the banking system.[13]

Table 5. Unconditional versus Conditional Probabilities of Choosing Tight Monetary Policy

Threshold for RER overshooting (percent)	*Probability of choosing tight monetary policy*	
	Unconditional	*Conditional on presence of banking crisis*
10	0.32	0.34
15	0.29	0.25
20	0.23	0.21

Source: Authors' calculations.

12. Ideally, one would like to analyze the effect of the health of the banking sector as well as of the corporate sector on the reversal process and on the relationship between real interest rates and the RER. However, because of data limitations we analyze only the effect of the banking sector.

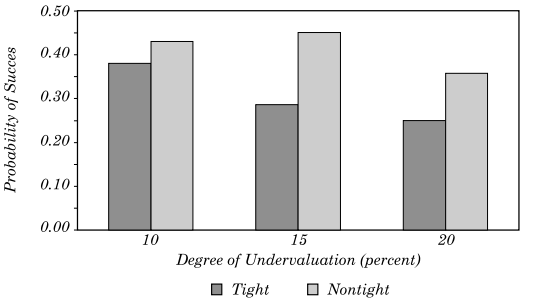
13. An important caveat is that there are very few cases in our sample in which tight policy was used in the presence of banking problems.

Table 6. Unconditional versus Conditional Probabilities of Success in Twin Crisis Cases

Threshold for RER overshooting (percent)	*Probability of success*[a]			*Result of significance test*[b]
	Unconditional	*Tight monetary policy*	*Nontight monetary policy*	
10	0.33	0.38	0.43	
15	0.34	0.29	0.45	Significant
20	0.30	0.25	0.36	Significant

Source: Authors' calculations.
a. Success is defined as a greater than 50 percent reversal of undervaluation achieved through nominal appreciation.
b. "Significant" indicates that the probabilities are different at a significance level greater than 85 percent.

Figure 6. Probability of Success under Twin Crises with Tight and Nontight Monetary Policy



Source: Authors' calculations.

5. Econometric Analysis

The analysis so far has treated each currency crisis as a single event and has not analyzed the time-series relationship between interest rates and exchange rates in the aftermath of currency crises. To fill this gap, we further analyze the effectiveness of monetary policy in correcting a real undervaluation by estimating a fixed-effects model using monthly panel data. We consider undervaluations greater than 15 percent and hence consider seventy-seven episodes of undervaluation in this exercise. The panel data consist of time-series observations for the cases of undervaluation. Since the duration of the undervaluation differed across cases, we estimated the model with an unbalanced panel.

We estimated the model by regressing the deviation of the RER from the equilibrium RER (which measures the extent of undervaluation) on the real interest rate, controlling for case-specific fixed effects. The model specification is given as

$$y_{it} = \alpha_i + \alpha x_{it} + u_{it},$$

where y is the deviation of the RER from equilibrium, and the subscript it refers to the ith case and the time period. Notice that t is different across cases. α is the constant term, which is assumed to differ across cases. The term x denotes the real interest rate, and u is an error term with a mean of zero and constant variance.

Table 7 presents the main results from this regression exercise. For the entire sample, the coefficient on the real interest rate is found to be positive and highly significant (at the 1 percent level; first column, first row), which implies that high real interest rates help in correcting an undervaluation.

In light of the recent debate on the effectiveness of monetary policy (see section 1) in the presence of a fragile banking sector, it is also interesting to see how the latter affects the relationship between the RER and the interest rate. Hence we divided the sample into two subsamples. One subsample included those observations for which, along with an undervaluation, the country is also experiencing a fragile banking sector (the twin crises cases). The second subsample included those observations for which the banking sector is supposedly healthy (the currency-crisis-only cases). We reestimated the model separately for each subsample. The results are presented in the second and third columns of the first row of table 7. The coefficient on the real interest rate is again positive and significant at the 1 percent level for the sample that excludes the twin crises cases. For the sample consisting of the twin crises cases only, we find that the coefficient of the real interest rate is still positive, but much smaller and significant only at the 5 percent level. This confirms our suspicion that banking sector problems may dampen the effect of higher interest rates on the exchange rate.

To compare the relationship between real interest rates and the RER across regions, we estimated the panel regressions separately for subsamples consisting of each of four country groups: Latin America, Africa, Europe, and Asia. We performed the exercise three times for each set of countries: once taking the entire sample of currency crises, next including only the twin crises cases in the sample, and finally excluding those cases that had banking crises.

Table 7a. Panel Data Regressions of Deviations of the Real Exchange Rate from Equilibrium on Real Interest Rates[a]

Sample	*All cases*	*Twin crisis cases only*	*Cases with only a currency crisis*
Entire sample	0.05542* (8.02)	0.0236** (2.49)	0.0801* (8.37)
Latin American countries	0.04249* (5.18)	−0.0065 (−0.606)	0.1379* (10.6)
African countries	0.2169* (9.66)	0.2407* (8.518)	0.1350* (3.68)
European countries	0.06103** (2.26)	0.1706* (3.17)	0.0483 (1.45)
Asian countries	−0.0149 (−1.28)	−0.251* (−3.40)	−0.0162 (−1.45)

Source: Authors' calculations.
a. Numbers in parentheses are *t* statistics. * and ** denote statistical significance at the 1 percent and the 5 percent level, respectively.

Table 7b. Panel Data Regressions of Deviations of the Real Exchange Rate from Equilibrium on Real Interest Rates, New Set of Cases[a]

Sample	*All cases*	*Twin crisis cases only*	*Cases with only a currency crisis*
Entire sample	0.14674* (13.6)	0.1484* (9.01)	0.1531* (10.7)
Latin American countries	0.1531* (10.83)	0.0869* (3.374)	0.1972* (11.834)
African countries	0.1765* (8.39)	0.2190** (9.251)	0.1020* (2.611)
European countries	0.0566 (1.878)	0.1525** (2.116)	0.0483 (1.45)
Asian countries	−0.008 (−0.124)	−0.2768* (−3.45)	−0.108 (−1.16)

Source: Authors' calculations.
a. Numbers in parentheses are *t* statistics. * and ** denote statistical significance at the 1 percent and the 5 percent level, respectively.

Some interesting comparisons result from these panel regressions. For the Latin American countries, the coefficient on the real interest rate is positive and significant at the 1 percent level, both for the entire sample and for the sample that excludes banking crises. For this group of countries the coefficient is negative, but insignificant, when the sample consists of the twin crises cases only. This means that, for the Americas, monetary policy is effective in stabilizing the exchange rate provided there is no banking crisis.

For the African countries the coefficient on the real interest rate is positive and significant at the 1 percent level when all the cases are included in the sample. The coefficient remains positive and significant when only twin crises cases or only currency crisis cases are included. Thus, irrespective of the health of the banking sector, the real interest rate is found to affect the RER positively and significantly in Africa. The results for the European countries are somewhat similar to those for the African countries. The coefficient on the RER is positive for all three samples, but not significant when only currency crisis cases are included.

At the opposite end of the spectrum is the experience of the Asian countries: here the coefficient on the real interest rate is found to be negative, although insignificant, when all the cases are included in the sample. The coefficient becomes more negative and is significant at the 1 percent level when only the twin crises cases are included, thus providing evidence that the coexistence of a banking crisis dampens the effect of interest rates on the exchange rate. The coefficient remains negative but is insignificant when only currency crisis cases are included in the sample.

6. Conclusion

This paper provides empirical evidence for the debate about the effectiveness of tight monetary policies in stabilizing exchange rates in the aftermath of currency crises. Although exogenous monetary policy variables are not available, at least for a large set of countries, and true claims of causality cannot be made, the relationships encountered in this paper provide food for thought. We find that in a large set of undervaluations in the aftermath of currency crises, tight monetary policy substantially increases the probability of reversing an undervaluation through nominal appreciation rather than through higher inflation. However, the opposite is true when the country is also facing a banking crisis: tight policies then decrease the probability of a reversal through changes in the nominal exchange rate.

Even if one is willing to accept that tight monetary policy helps stabilize the exchange rate, and therefore that there may a benefit of this policy, one also has to take into account the costs involved in raising interest rates. A natural extension of this paper would be to look at the costs of tight policies by analyzing several variables, including output loss and higher debt service in the aftermath of currency crises.

Appendix

Argentina
Australia
Austria
Bahrain
Bangladesh
Belgium
Bolivia
Brazil
Burkina Faso
Burundi
Cameroon
Canada
Central African Republic
Chile
China, P.R.
Colombia
Costa Rica
Denmark
Ecuador
Egypt
El Salvador
Ethiopia
Finland
France
Gabon
Germany
Ghana
Greece
Guatemala
Haiti
Honduras
Hungary
India
Indonesia
Ireland
Israel
Italy
Jamaica
Japan
Jordan
Kenya
Korea
Madagascar
Malawi
Malaysia
Mexico
Morocco
Nepal
Netherlands, The
New Zealand
Nigeria
Norway
Pakistan
Papua New Guinea
Paraguay
Peru
Philippines
Poland
Portugal
Romania
Rwanda
Senegal
Sierra Leone
Singapore
South Africa
Spain
Sri Lanka
Sweden
Switzerland
Thailand
Togo
Trinidad and Tobago
Tunisia
Turkey
United Kingdom
United States
Uruguay
Venezuela
Zambia
Zimbabwe

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