Department Socioeconomics

Forecasting the Brazilian Real and the Mexican Peso: Asymmetric Loss, Forecast Rationality, and Forecaster Herding

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Abstract

Using forecasts of the Brazilian real and the Mexican peso, we analyze the shape of the loss function of exchange-rate forecasters and the rationality of their forecasts. We find a substantial degree of cross-sectional heterogeneity with respect to the shape of the loss function. While some forecasters seem to forecasts under an asymmetric loss function, symmetry of the loss function cannot be rejected for other forecasters. An asymmetric loss function does not necessarily make survey data of exchange-rate forecasts look rational, and the loss function seems to depend not only on the forecast error.

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1 Introduction

Since Meese and Rogoff (1983) reported a lack of explanatory power of exchange rate models, economic studies frequently show that it is notoriously difficult to forecast exchange rate fluctuations by means of structural economic models. This is especially true with regard to exchange rates of emerging market countries. A characteristic features of exchange rates of emerging market countries is that they witness large fluctuations and often eruptive jumps. Large fluctuations and eruptive jumps of exchange rates constitute a major challenge to policymakers, international investors, and international firms in emerging countries. Given the poor forecasting performance of structural economic models, survey data of exchange rate forecasts of professional economists have widely been studied as an alternative source of information for forecasting exchange rates. Many researchers, however, have reported that survey data of exchange rate forecasts violate traditional criteria of forecast rationality (for a survey, see MacDonald 2000). Violation of traditional criteria of forecast rationality, in turn, gives rise to doubts as to the usefulness of survey data for forecasting exchange rates.

Traditional criteria of forecast rationality are based on the assumption that forecasters have a symmetric (quadratic) loss function. Patton and Timmermann (2007) argue that invoking the assumption of a symmetric loss function could be problematic for traditional rationality tests if, in fact, forecasters have an asymmetric loss function. It has been well-known for quite a while that there are good reasons to argue that loss functions are not symmetric (Granger 1969; Granger and Newbold 1986; Zellner 1986; Christoffersen and Diebold 1997, among others). Recent research provides ample evidence indicating that deviations from a symmetric loss function may be quite common (Elliott et al. 2005; Christodoulakis and Mamatzakis 2008a; Döpke et al. 2010; among others). Research on asymmetric loss functions estimated on survey data of exchange rate forecasts, however, has started only recently. Christodoulakis and Mamatzakis (2008b) study the exchange rates of the G10 countries. While they report evidence in favor of an asymmetric loss function, they derive their finding using forward exchange rates to measure exchange rate expectations. Another recent study by Pierdzioch et al. (2012), in contrast, uses survey data of exchange rate forecasts that contain information on the yen/dollar exchange rate forecasts of individual forecasters. Research on asymmetric loss functions that analyzes the properties of survey data of forecasts of emerging market countries at the microeconomic level of individual forecasters is, to the best of our knowledge, not available. The research by Baghestani and Marchon (2012) is an exception insofar as they analyze an asymmetric loss function using forecasts of the Brazilian real, an important emerging market exchange rate. They study forecasts collected from a survey conducted by the Brazilian Central Bank. They do not study, however, exchange rate forecasts at the level of individual forecasters. Rather, their study is restricted to the mean (that is, the consensus) forecast and hence studies the time series characteristics of the survey. Their study does not take the cross-sectional dimension and the cross-sectional heterogeneity of forecasts at the microeconomic level into account.

Our research is a first step to close this gap in the literature. Following Christodoulakis and Mamatzakis (2008b), Baghestani and Marchon (2012), and Pierdzioch et al. (2012), we shape our empirical analysis in terms of an approach recently developed by Elliott et al. (2005) to recover the shape of exchange rate forecasters' loss function. This approach is easy to implement, it informs about the type of a potential asymmetry in forecasters' loss function, and it allows the rationality of forecasts under an asymmetric loss function to be tested. We apply the approach advanced by Elliott et al. (2005) to study survey data of forecasts of the Brazilian real and the Mexican peso vis-à-vis the U.S. dollar for the time period 1995 – 2009. Our empirical results show a substantial degree of heterogeneity across exchange rate forecasters' with respect to the shape of forecasters' loss function. While a symmetric loss function seems to fit the forecasts of some forecasters, an asymmetric loss function seems to be consistent with forecasts of other forecasters. In line with results reported by Pierdzioch et al. (2012), our empirical results further show that assuming an asymmetric loss function does not necessarily make survey data of exchange rate forecasts look rational. While, in some cases, an asymmetric loss function remedies apparent deviations from rationality that obtain under a symmetric loss function, this is not a general feature of the data. Importantly, whether an asymmetric loss function makes forecasts look rational in many cases depends on the shape of the assumed loss function. In other words, a single loss function does not fit equally well the forecasts of all forecasters.

Given that the assumed parametrization seems to affect the results of the rationality test advanced by Elliott et al. (2005), we proceed by analyzing the survey data of exchange rate forecasts using an alternative test that has recently been suggested by Patton and Timmermann (2007). Their test is more general than the test developed by Elliott et al. (2005) because it does not rest on a specific parametrization of the loss function. The test only assumes under the null hypothesis of forecast rationality that the loss function either only depends on the forecast error or is homogeneous in the forecast error. The test yields sound rejections of the null hypothesis for the majority of forecasters. The test also yields the result that if the exchange rate forecast exceeds (falls short of) the current exchange rate, then the probability that the exchange rate forecast also exceeds (falls short of) the future exchange rate increases. We argue that this result can be interpreted in terms of recent research on forecaster (anti-) herding in foreign exchange markets (Pierdzioch and Stadtmann 2010).

We organize the reminder of this paper as follows. In Section **??**, we briefly outline the approach developed by Elliott et al. (2005) and the rationality test suggested by Patton and Timmermann (2007). In Section **??**, we describe our data and our empirical results. In Section **??**, we offer some concluding remarks.

2 The Empirical Model: Estimation and Testing

In Section **??**, we describe how we estimated the shape of the loss function. In Section **??**, we describe how we tested for forecast rationality under the assumption of a specific parametrization of the loss function and under the assumption of an unknown loss function.

2.1 Estimation

The approach developed by Elliott et al. (2005) rests on the assumption that the loss function, $\mathcal{L}$, of an exchange rate forecaster can be described in terms of the following general functional form:

$$\mathcal{L} = [\alpha + (1-2\alpha)I(s_{t+1} - f_{t+1} < 0)]|s_{t+1} - f_{s+t}|^p, \tag{1}$$

where s_{t+1} denotes the realization of the exchange rate, f_{t+1}, denotes the forecast formed in period t of the realization of the exchange rate in period $t+1$, I denotes the indicator function, $p = 1$ for a lin-lin loss function and $p = 2$ for a quad-quad loss function, and $\alpha \in (0, 1)$ governs the degree of asymmetry of the loss function. In the case of $\alpha = 0.5$, the loss function is symmetric. For $\alpha = 0.5$ and $p = 2$, the loss a forecaster incurs increases in the squared forecast error. For $\alpha = 0.5$ and $p = 1$, the loss increases in the absolute forecast error. A value of $\alpha > 0.5$ represents the case of forecasters' tendency to issue optimistic forecasts (to overpredict relative to the symmetric case). The opposite case – $\alpha < 0.5$ stands for the case of pessimistic forecasts.

Elliott et al. (2005) show that, for a given parameter p, which defines the general functional form of the loss function, the asymmetry parameter, α, can be consistently estimated as

$$\hat{\alpha} = \frac{\left[\frac{1}{T}\sum_{t=\tau}^{T+\tau-1} v_t |s_{t+1} - f_{t+1}|^{p-1}\right]' \hat{S}^{-1} \left[\frac{1}{T}\sum_{t=\tau}^{T+\tau-1} v_t I(s_{t+1} - f_{t+1} < 0)|s_{t+1} - f_{t+1}|^{p-1}\right]}{\left[\frac{1}{T}\sum_{t=\tau}^{T+\tau-1} v_t |s_{t+1} - f_{t+1}|^{p-1}\right]' \hat{S}^{-1} \left[\frac{1}{T}\sum_{t=\tau}^{T+\tau-1} v_t |s_{t+1} - f_{t+1}|^{p-1}\right]}, \tag{2}$$

where $\hat{S} = \frac{1}{T}\sum_{t=\tau}^{T+\tau-1} v_t v_t' (I(s_{t+1} - f_{t+1} < 0) - \hat{\alpha})^2 |s_{t+1} - f_{t+1}|^{2p-2}$ denotes a weighting matrix, v_t denotes a vector of instruments, T denotes the number of forecasts available, starting at $\tau + 1$. Elliott et al. (2005) define conditions for optimality of forecasts, which, in turn, deliver the moment conditions for an IV estimation procedure (more specifically: a GMM estimation). The optimality conditions refer to the fact, that all outside information (the IV vector) are included in the forecast and therefore orthogonal to the forecast error. Because the resulting weighting matrix of the GMM estimator depends on $\hat{\alpha}$, estimation is done iteratively. Testing whether $\hat{\alpha}$ differs from α_0 is done by using the following z-test

$\sqrt{T}(\hat{\alpha}-\alpha_0) \to \mathcal{N}(0, (\hat{h}'\hat{S}^{-1}\hat{h})^{-1})$, where $\hat{h} = \frac{1}{T}\sum_{t=\tau}^{T+\tau-1} v_t|s_{t+1}-f_{t+1}|^{p-1}$. Testing whether $\hat{\alpha}$ differs from α_0 is done by using the following z-test $\sqrt{T}(\hat{\alpha}-\alpha_0) \to \mathcal{N}(0, (\hat{h}'\hat{S}^{-1}\hat{h})^{-1})$, where $\hat{h} = \frac{1}{T}\sum_{t=\tau}^{T+\tau-1} v_t|s_{t+1}-f_{t+1}|^{p-1}$.

We considered as instruments a constant (Model 1), and a constant and lagged exchange rate (Model 2). Because the survey data that we shall describe in Section **??** below contains forecasts for an unbalanced panel of forecasters, we did not follow Elliott et al. (2005) in using lagged published forecasts as another instrument.

2.2 Testing

For the specific parametrization of the loss function outlined in Section **??**, Elliott et al. (2005) further prove that a test for rationality of exchange rate forecasts, given a loss function of the lin-lin or a quad-quad type ($p = 1, 2$), can be performed by computing

$$J(\hat{\alpha}) = \frac{1}{T}\left(x_t'\hat{S}^{-1}x_t\right) \sim \chi^2_{d-1}, \tag{3}$$

where $x_t = \sum_{t=\tau}^{T+\tau-1} v_t[I(s_{t+1}-f_{t+1} < 0) - \hat{\alpha}]|s_{t+1}-f_{t+1}|^{p-1}$ and d denotes the number of instruments. This is similar to the usual test of over-identifying restrictions in the GMM framework. In the case of a symmetric loss function, the rationality test is given by $J(0.5) \sim \chi^2_d$. The statistic $J(0.5)$ answers the question of whether forecasters under the maintained assumption of a quadratic (symmetric) loss function form rational exchange rate forecasts. The statistic $J(\hat{\alpha})$, answers the question of whether forecasters form rational forecasts, given an asymmetric loss function (lin-lin or quad-quad). A comparison of $J(\hat{\alpha})$

with $J(0.5)$ shows whether an asymmetric loss function helps to remedy a potential failure of rationality of forecasts observed under a symmetric loss function.

Patton and Timmermann (2007, Proposition 3) show that if the loss only depends on the forecast error (and the exchange rate has dynamics only in the conditional mean) or the loss function is homogenous in the forecast error (and the exchange rate has dynamics in the conditional mean and variance), a simple quantile test can be used to analyze the rationality of exchange rate forecasts. The quantile test stipulates that, under the null hypothesis of forecast rationality, it should not be possible to forecast the sign of the forecast error using data that are in the information set of forecasters at the time a forecast is made.

In order to implement the quantile test, we define $I_{t+1} = 1$ if $s_{t+1} - f_{t+1} < 0$, and $I_{t+1} = 0$ otherwise. As for the information set of forecasters at the time a forecast is made, we consider the wedge between the current exchange rate and the forecast, $s_t - f_{t+1}$, that is, the forecast of the relative change in the exchange rate. The resulting quantile test can be implemented by estimating the following equation:

$$I_{t+1} = \beta_0 + \beta_1(s_t - f_{t+1}) + \epsilon_{t+1}, \tag{4}$$

where β_0 and β_1 are coefficients to be estimated, and ϵ_{t+1} is a disturbance term. Estimation can be done by ordinary least squares, or by using a qualitative response model.[1] If $\beta_1 < 0$,

[1]Because of the limited number of observations per forecaster, we shall present estimation results for a model estimated by means of the ordinary least squares technique. Results for a qualitative response model, however, are similar to those we shall present in the vast majority of cases and are available upon request. When estimation is done using ordinary least squares, Equation (**??**) is similar to standard tests of market timing. Market timing tests are widely studied in the empirical finance literature to explore

then the model implies that the future exchange rate tends to fall short of the forecast if the current exchange rate falls short (exceeds) of the forecast, $s_t < f_{t+1}$. Conversely, if $\beta_1 > 0$, the future exchange rate tends to fall short of the forecast if the current exchange rate exceeds (falls short) the forecast, $s_t < f_{t+1}$.

3 Empirical Analysis

In order to recover a potential asymmetry in forecasters' loss function, we use survey data on one-month-ahead and three-months-ahead forecasts of the Brazilian real and the Mexican peso vis-à-vis the U.S. dollar. The survey data are from Consensus Forecasts Inc. The survey data contain information on individual exchange rate forecasts issued by forecasters who work for institutions such as investment banks, large international corporations, economic research institutes, and at universities. Because not all forecasters participated in all surveys, the survey data are available in the form of an unbalanced panel. For our empirical analysis, we only consider the forecasts of those forecasters who participated at least 15 times in the survey. In total, we use 1,120 forecasts for our empirical analysis, with approximately half of the forecasters being one-month-ahead forecasts and the other half three-months-ahead forecasts. The survey data are irregularly spaced in time and are conducted on average on a quarterly frequency for the period 1995/1−2009/12.

– Please insert Figure **??** about here. –

whether forecasts of excess returns predict the sign of future actual returns. In the context of our survey data of exchange rate forecasts, the test can be interpreted as a "test of forecast-error timing".

Figure ?? shows the exchange rate (solid line) and the cross-sectional maximum and minimum of exchange rate forecasts (circles and triangles). Both exchange rates substantially fluctuated over time, experiencing occasional sudden jumps and trend reversals. The cross-sectional maximum and minimum of exchange rate forecasts further recovers, at the microeconomic level of individual forecasters, the kind of cross-forecaster heterogeneity reported in earlier literature (MacDonald and Marsh 1996, Benassy-Quere et al. 2003).

– Please insert Table ?? about here. –

Under a symmetric loss functions, rational forecasts should be unbiased, that is, forecast errors should exhibit no systematic component, hovering around zero. As a test for bias, we use the non-parametric Wilcoxon signed rank test with the null hypothesis that the median of the forecast errors is equal to zero. According to Campbell and Ghysels (1995), such a non-parametric test is preferable to parametric tests for small samples.[2] The results (Table ??) yield evidence of a systematic component in the forecast errors for some forecasters, but not for all forecasters. For example, the forecasts delivered by Forecaster No. 11 seem to be biased both in the case of one-month-ahead and three-months-ahead forecasts. For Forecaster No. 4, in turn, forecasts seem to be biased on the three-months, but not at the one-month forecast horizon. In total, approximately one-third of all forecasters deliver forecasts that result in a significant test outcome. It is, thus, interesting to explore in more detail whether asymmetries in forecasters' loss functions account for their biased forecasts.

[2]See also Dufor (1981) and Campbell and Ghysels (1995) for further details. A non-parametric test has the advantage of avoiding restrictive assumptions on well-behaved residuals as in the case of most of the regression-based tests.

Tables **??** (lin-lin) and **??** (quad-quad) summarize the estimated asymmetry parameter, $\hat{\alpha}$, the corresponding standard error, and the results of the z-test for one-month-ahead forecasts. Tables **??** and **??** show the results for three-months-ahead forecasts. The results of the z-test recover statistically significant deviations from a symmetric loss function for some (but not all) forecasters, where $\hat{\alpha} > 0.5$ for some forecasters, and $\hat{\alpha} < 0.5$ for others. An estimated asymmetry parameter of $\hat{\alpha} > 0.5$ implies that exchange rate forecasters incur a higher loss when they underestimate the future exchange rate than when they overestimate the future exchange rate. An estimated asymmetry parameter of $\hat{\alpha} < 0.5$, in contrast, implies that overestimations are more costly than underestimations. The cross-sectional heterogeneity with respect to the estimated asymmetry parameter, $\hat{\alpha}$, holds under a lin-lin and under a quad-quad loss function.

– Please include Tables **??** − **??** about here. –

Table **??** − **??** summarize the results of the J test of an asymmetric loss function and forecast rationality. As for one-month-ahead forecasts, the test results indicate, for example, deviations from rationality under an asymmetric loss function for Forecasters No. 6, 7, 12, 15, 16, 18, and 22 on a ten percent significance level (lin-lin). Interestingly, for Forecasters No. 5, 11, 13, 14, and 17 forecast rationality can be rejected for symmetric loss but not for asymmetric loss (lin-lin). Table **??** reports that for the three-months ahead forecasts forecast rationality under an asymmetric lin-lin loss function can only be rejected for four forecasters. For a quad-quad loss function, we observe that forecast rationality can be rejected for 15 forecasters at the one-month horizon and for eight forecasters at a three-month-horizon. Hence, the rejection of forecast rationality depends on the assumed shape of the loss function. The general impression that emerges, thus, is that, in many cases, whether an asymmetry in the shape of the loss function makes forecasts of exchange rate look rational depends on the specific functional form of the assumed loss function.

– Please include Tables **??** – **??** about here. –

We, therefore, study the quantile test for forecast rationality analyzed by Patton and Timmermann (2007), which does not depend on any specific functional form of the loss function. For many forecasters, test results (Tables **??** – **??**) reject the rationality of forecasts. Alternatively, the dynamics of exchange rates may violate the assumptions of the test under the null hypothesis. If so, the loss function may not only depend on the forecast error if exchange rates have dynamics only in the conditional mean, or the loss function is not homogenous in the forecast error if the exchange rate has dynamics in the conditional mean and variance.

– Please include Tables **??** – **??** about here. –

4 Concluding Remarks

Our empirical results recover a substantial degree of heterogeneity across forecasters of the Brazilian real and the Mexican peso with respect to the shape of their loss function and the rationality of their forecasts. We have shown that neither an asymmetric loss function nor congruence of forecasts with the criterion of forecast rationality are general features of forecasts. While some forecasters' loss function seems to be quadratic, other forecasters seem to have an asymmetric loss function. Accounting for an asymmetric loss function does not necessarily imply that the hypothesis of rational forecasts cannot be rejected. Of course, violation of forecast rationality need not reflect that forecasters indeed form irrational forecasts. It may simply be the case that the process of forecasting exchange rates is more complex than implied by the lin-lin or quad-quad loss functions that we have considered in our empirical analysis. For example, strategic interactions among forecasters may lead them to publish forecasts that intentionally deviate from the forecasts of others.

In this respect, it is instructive to interpret the results of the quantile test of forecast rationality in terms of a test of forecaster (anti-)herding recently developed by Bernhardt et al. (2006). In order to sketch the logic of the test developed by Bernhardt et al. (2006), it is useful to consider a forecaster who forms an "efficient" (that is, rational) private forecast of the future exchange rate. In terms of Equation (**??**), a rational private forecast implies that the forecast of the rate of change in the exchange rate should have no explanatory power with respect to the ex-post forecast error, such that we should have $\beta_1 = 0$. Conversely, a parameter $\beta_1 \neq 0$ indicates forecast inefficiency.

Such forecast inefficiency arises if the eventually published forecast differs from the rational private forecast. One reason for a potential wedge between the private forecast and the published forecast is that the latter is influenced by public information as embedded in, for example, the current exchange rate. In the case of forecaster herding, a forecaster publishes a forecast that "mimics" public information, implying that the published forecast is tilted towards the current exchange rate. If the private forecast exceeds the current exchange rate, $s_t > f_{t+1}$, the probability increases that the published forecast turns out to be smaller ex post than the actual future exchange rate, $s_{t+1} - f_{t+1} < 0$, requiring $\beta_1 > 0$. In contrast, if a forecaster anti-herds, the published forecast scatters farther away from the current exchange rate, and the probability that the actual future exchange rate undershoots the forecast, $s_{t+1} - f_{t+1} < 0$, will increase, requiring $\beta_1 < 0$, as in our empirical analysis.

In terms of a suggested interpretation, our results thus provide some evidence that forecasters tend to anti-herd. Forecaster anti-herding in foreign exchange markets has also been reported by Pierdzioch and Stadtmann (2010). Forecaster-anti-herding may reflect that forecasters do not only take into account the accuracy of their forecasts, but that they also try to differentiate their forecasts from the forecasts of others. Such forecast differentiation is likely to result in "extreme" forecasts, which may be a source of the cross-sectional heterogeneity of forecasts that we have observed in our empirical analysis. Attempts to differentiate forecasts, in turn, may reflect that forecasters are paid according to their relative forecasting success, as in the model suggested by Laster et al. (1999). If so, forecast accuracy is not the only argument in forecasters' loss function, implying that the kind of asymmetric loss functions underlying the estimation approach developed by Elliott et al. (2005) may not suffice to model how forecasters form their forecasts. We leave it to future research to explore in detail the links between forecaster anti-herding and empirical tests of asymmetries in forecasters' loss functions.

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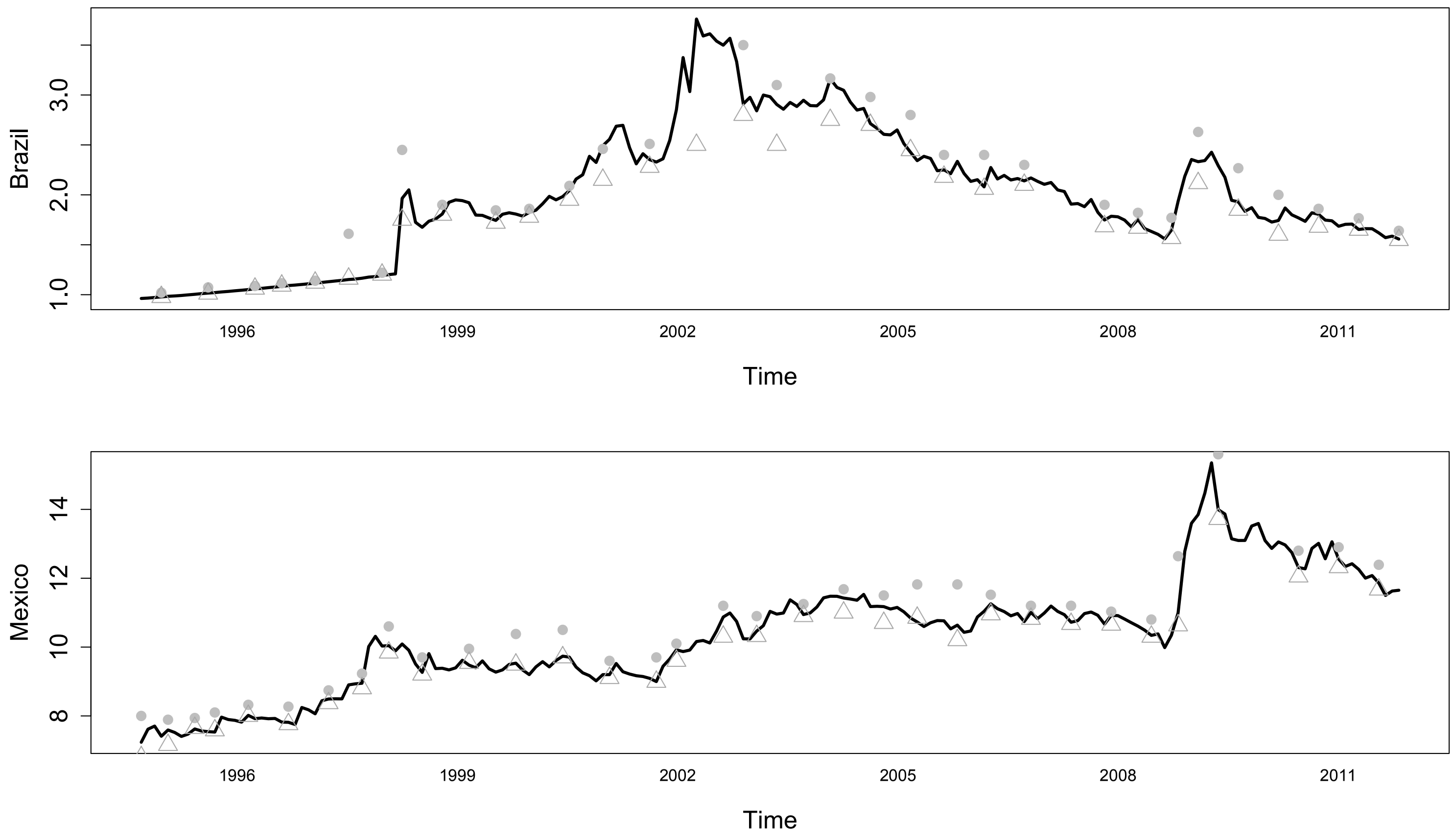
Figure 1: The Data



Note: The solid line shows the exchange rate vis-à-vis the U.S. dollar. The circles and the triangles show the range of one-month-ahead forecasts (maximum and minimum). We coded up this figure and all other empirical results that we report in this research in the software R (R Development Core Team 2009).

Table 1: Wilcoxon rank sum test

	Horizon	One-Month-Ahead			Three-Months-Ahead		
No.	Country	Obs.	Test	p	Obs.	Test	p
1	Brazil	23	114	0.4654	23	115	0.5009
2	Brazil	18	93	0.7660	21	120	0.8917
3	Brazil	22	172	0.1465	22	150	0.4552
4	Brazil	25	152	0.7915	25	96	0.0755
5	Brazil	20	31	0.0042	20	58	0.0826
6	Brazil	19	74	0.4180	19	61	0.1819
7	Brazil	22	144	0.5879	23	125	0.7090
8	Brazil	28	162	0.3505	28	148	0.2146
9	Brazil	27	101	0.0340	27	94	0.0214
10	Brazil	22	173	0.1375	24	162	0.7469
11	Brazil	17	32	0.0348	17	34	0.0448
12	Mexico	28	110	0.0337	28	118	0.0534
13	Mexico	21	64	0.0760	28	116	0.0477
14	Mexico	25	127	0.3525	25	139	0.5424
15	Mexico	28	160	0.3386	28	161	0.3502
16	Mexico	16	9	0.0010	16	58	0.6322
17	Mexico	25	87	0.0422	25	112	0.1817
18	Mexico	18	59	0.2645	18	76	0.7019
19	Mexico	16	51	0.4037	16	78	0.6322
20	Mexico	26	136	0.3276	26	120	0.1651
21	Mexico	21	75	0.1644	21	69	0.1111
22	Mexico	31	165	0.1066	31	156	0.0727
23	Mexico	31	133	0.0233	31	138	0.0305
24	Mexico	24	125	0.4908	25	130	0.3957

Table 2: Asymmetry parameter, one-month-ahead forecasts, lin-lin loss function

No.	Country	Obs.	$\hat{\alpha}_{Model1}$	se	z-test	$\hat{\alpha}_{Model2}$	se	z-test
1	Brazil	23	0.6522	0.0993	1.5323	0.6534	0.0992	1.5458
2	Brazil	18	0.5000	0.1179	0.0000	0.5000	0.1179	0.0000
3	Brazil	22	0.5000	0.1066	0.0000	0.5000	0.1066	0.0000
4	Brazil	25	0.5600	0.0993	0.6044	0.5600	0.0993	0.6044
5	Brazil	20	0.8000	0.0894	3.3541	0.8340	0.0832	4.0148
6	Brazil	19	0.6842	0.1066	1.7274	0.8193	0.0883	3.6169
7	Brazil	22	0.5909	0.1048	0.8673	0.6479	0.1018	1.4524
8	Brazil	28	0.5714	0.0935	0.7638	0.5907	0.0929	0.9764
9	Brazil	27	0.7037	0.0879	2.3180	0.7039	0.0879	2.3210
10	Brazil	22	0.4091	0.1048	-0.8673	0.3870	0.1038	-1.0883
11	Brazil	17	0.8235	0.0925	3.4991	0.8909	0.0756	5.1690
12	Mexico	28	0.7857	0.0775	3.6845	0.9007	0.0565	7.0907
13	Mexico	21	0.7619	0.0929	2.8179	0.7759	0.0910	3.0317
14	Mexico	25	0.7200	0.0898	2.4499	0.7258	0.0892	2.5303
15	Mexico	28	0.6429	0.0906	1.5776	0.7118	0.0856	2.4747
16	Mexico	16	0.8125	0.0976	3.2026	0.9220	0.0670	6.2937
17	Mexico	25	0.7200	0.0898	2.4499	0.7237	0.0894	2.5009
18	Mexico	18	0.6111	0.1149	0.9670	0.8382	0.0868	3.8968
19	Mexico	16	0.6875	0.1159	1.6181	0.7147	0.1129	1.9019
20	Mexico	26	0.6154	0.0954	1.2093	0.6266	0.0949	1.3351
21	Mexico	21	0.6667	0.1029	1.6202	0.6710	0.1025	1.6679
22	Mexico	31	0.6774	0.0840	2.1132	0.7144	0.0811	2.6426
23	Mexico	31	0.6774	0.0840	2.1132	0.6800	0.0838	2.1487
24	Mexico	24	0.6667	0.0962	1.7321	0.6800	0.0952	1.8908

Note: se = standard error, z-test = test of the null hypothesis that $\hat{\alpha} = 0.5$. The instruments used are the following: a constant (Model 1), a constant and the lagged exchange rate (Model 2).

Table 3: Asymmetry parameter, three-months-ahead forecasts, lin-lin loss function

No.	Country	Obs.	$\hat{\alpha}_{Model1}$	se	z-test	$\hat{\alpha}_{Model2}$	se	z-test
1	Brazil	23	0.6522	0.0993	1.5323	0.6573	0.0990	1.5898
2	Brazil	21	0.4762	0.1090	-0.2185	0.4653	0.1088	-0.3192
3	Brazil	22	0.5455	0.1062	0.4282	0.5482	0.1061	0.4541
4	Brazil	25	0.6400	0.0960	1.4583	0.6402	0.0960	1.4604
5	Brazil	20	0.7500	0.0968	2.5820	0.8016	0.0892	3.3822
6	Brazil	19	0.7368	0.1010	2.3444	0.8843	0.0734	5.2384
7	Brazil	23	0.6957	0.0959	2.0392	0.8278	0.0787	4.1627
8	Brazil	28	0.7143	0.0854	2.5100	0.7218	0.0847	2.6191
9	Brazil	27	0.7778	0.0800	3.4718	0.8585	0.0671	5.3457
10	Brazil	24	0.4583	0.1017	-0.4097	0.4565	0.1017	-0.4278
11	Brazil	17	0.7647	0.1029	2.5730	0.7648	0.1029	2.5736
12	Mexico	28	0.6786	0.0883	2.0233	0.6994	0.0867	2.3008
13	Mexico	28	0.6429	0.0906	1.5776	0.6520	0.0900	1.6891
14	Mexico	25	0.6000	0.0980	1.0206	0.6025	0.0979	1.0474
15	Mexico	28	0.5714	0.0935	0.7638	0.5716	0.0935	0.7660
16	Mexico	16	0.4375	0.1240	-0.5040	0.4136	0.1231	-0.7016
17	Mexico	25	0.5600	0.0993	0.6044	0.5620	0.0992	0.6246
18	Mexico	18	0.5000	0.1179	0.0000	0.5000	0.1179	0.0000
19	Mexico	16	0.3750	0.1210	-1.0328	0.3655	0.1204	-1.1173
20	Mexico	26	0.7308	0.0870	2.6528	0.7312	0.0869	2.6592
21	Mexico	21	0.6190	0.1060	1.1234	0.6276	0.1055	1.2092
22	Mexico	31	0.7097	0.0815	2.5719	0.7427	0.0785	3.0906
23	Mexico	31	0.6774	0.0840	2.1132	0.7077	0.0817	2.5427
24	Mexico	25	0.5200	0.0999	0.2002	0.5200	0.0999	0.2002

Note: se = standard error, z-test = test of the null hypothesis that $\hat{\alpha} = 0.5$. The instruments used are the following: a constant (Model 1), a constant and the lagged exchange rate (Model 2).

Table 4: Asymmetry parameter, one-month-ahead forecasts, quad-quad loss function

No.	Country	Obs.	$\hat{\alpha}_{Model1}$	se	z-test	$\hat{\alpha}_{Model2}$	se	z-test
1	Brazil	23	0.5570	0.1399	0.4075	0.7479	0.1193	2.0785
2	Brazil	18	0.4277	0.1511	-0.4783	0.3619	0.1464	-0.9432
3	Brazil	22	0.1901	0.1026	-3.0211	0.1833	0.0897	-3.5301
4	Brazil	25	0.4610	0.1281	-0.3042	0.4511	0.1229	-0.3980
5	Brazil	20	0.8106	0.1512	2.0543	0.9811	0.0149	32.372
6	Brazil	19	0.5785	0.1440	0.5452	0.8341	0.0948	3.5241
7	Brazil	22	0.3411	0.1344	-1.1824	0.3555	0.1323	-1.0923
8	Brazil	28	0.6095	0.1303	0.8403	0.7902	0.1062	2.7337
9	Brazil	27	0.7994	0.0921	3.2515	0.9465	0.0401	11.128
10	Brazil	22	0.3511	0.1665	-0.8946	0.1647	0.0916	-3.6599
11	Brazil	17	0.8559	0.0950	3.7476	0.9994	0.0010	515.44
12	Mexico	28	0.6894	0.1226	1.5449	0.8812	0.0977	3.9006
13	Mexico	21	0.7195	0.1179	1.8623	0.7972	0.1034	2.8746
14	Mexico	25	0.4673	0.1490	-0.2196	0.4519	0.1418	-0.3396
15	Mexico	28	0.5191	0.1281	0.1488	0.6316	0.1322	0.9955
16	Mexico	16	0.9377	0.0457	9.5771	0.9976	0.0026	190.72
17	Mexico	25	0.6498	0.1773	0.8448	1.0428	0.1071	5.0668
18	Mexico	18	0.5660	0.1783	0.3699	1.0187	0.0449	11.549
19	Mexico	16	0.4447	0.2054	-0.2691	0.8861	0.1053	3.6673
20	Mexico	26	0.5529	0.1251	0.4228	0.5587	0.1253	0.4687
21	Mexico	21	0.7409	0.1084	2.2213	0.7324	0.1083	2.1467
22	Mexico	31	0.6364	0.1247	1.0941	0.7726	0.1125	2.4221
23	Mexico	31	0.6297	0.1596	0.8127	0.6703	0.1542	1.1046
24	Mexico	24	0.3920	0.1361	-0.7931	0.3767	0.1301	-0.9481

Note: se = standard error, z-test = test of the null hypothesis that $\hat{\alpha} = 0.5$. The instruments used are the following: a constant (Model 1), a constant and the lagged exchange rate (Model 2).

Table 5: Asymmetry parameter, three-months-ahead forecasts, quad-quad loss function

No.	Country	Obs.	$\hat{\alpha}_{Model1}$	se	z-test	$\hat{\alpha}_{Model2}$	se	z-test
1	Brazil	23	0.4528	0.1480	-0.3190	0.6942	0.1338	1.4519
2	Brazil	21	0.4055	0.1518	-0.6228	0.5742	0.1540	0.4819
3	Brazil	22	0.2132	0.0954	-3.0052	0.1784	0.0825	-3.8992
4	Brazil	25	0.6038	0.1512	0.6869	0.6050	0.1484	0.7074
5	Brazil	20	0.5449	0.1779	0.2522	0.9184	0.0933	4.4864
6	Brazil	19	0.6264	0.1511	0.8360	0.8710	0.0852	4.3546
7	Brazil	23	0.3824	0.1326	-0.8865	0.3894	0.1333	-0.8293
8	Brazil	28	0.5196	0.1378	0.1418	0.6306	0.1283	1.0175
9	Brazil	27	0.6967	0.1236	1.5907	0.8709	0.0791	4.6920
10	Brazil	24	0.3422	0.1344	-1.1740	0.3365	0.1283	-1.2741
11	Brazil	17	0.8185	0.1023	3.1141	0.9558	0.0483	9.4343
12	Mexico	28	0.6479	0.1454	1.0170	0.9566	0.1172	3.8976
13	Mexico	28	0.5751	0.1644	0.4568	0.5664	0.1626	0.4082
14	Mexico	25	0.4455	0.1547	-0.3521	0.4972	0.1542	-0.0181
15	Mexico	28	0.5069	0.1341	0.0512	0.5023	0.1335	0.0173
16	Mexico	16	0.4806	0.2175	-0.0890	0.7971	0.1521	1.9531
17	Mexico	25	0.5932	0.1638	0.5689	0.5852	0.1623	0.5249
18	Mexico	18	0.5386	0.1656	0.2329	0.5380	0.1656	0.2297
19	Mexico	16	0.3799	0.1890	-0.6356	0.3150	0.1687	-1.0967
20	Mexico	26	0.6102	0.1422	0.7749	0.6303	0.1421	0.9169
21	Mexico	21	0.7221	0.1091	2.0352	0.7300	0.1081	2.1280
22	Mexico	31	0.6200	0.1305	0.9201	0.6497	0.1317	1.1364
23	Mexico	31	0.6041	0.1493	0.6974	0.7470	0.1482	1.6667
24	Mexico	25	0.4616	0.1391	-0.2758	0.4822	0.1406	-0.1264

Note: se = standard error, z-test = test of the null hypothesis that $\hat{\alpha} = 0.5$. The instruments used are the following: a constant (Model 1), a constant and the lagged exchange rate (Model 2).

Table 6: J-test, one-month-ahead forecasts, lin-lin loss function

No.	Country	Obs.	$J(0.5)$	p	$J(\hat{\alpha})$	p
1	Brazil	23	2.1818	0.3359	0.0914	0.7624
2	Brazil	18	0.8793	0.6443	0.8793	0.3484
3	Brazil	22	0.0118	0.9941	0.0118	0.9134
4	Brazil	25	0.3601	0.8352	0.0001	0.9906
5	Brazil	20	7.8812	0.0194	1.1856	0.2762
6	Brazil	19	5.1014	0.0780	6.3602	0.0117
7	Brazil	22	5.2799	0.0714	4.5520	0.0329
8	Brazil	28	3.5814	0.1668	3.0209	0.0822
9	Brazil	27	4.4905	0.1059	0.0145	0.9043
10	Brazil	22	3.0169	0.2213	2.1963	0.1383
11	Brazil	17	7.2308	0.0269	2.2578	0.1329
12	Mexico	28	11.5652	0.0031	8.1592	0.0043
13	Mexico	21	5.9841	0.0502	0.5554	0.4561
14	Mexico	25	5.1486	0.0762	0.3236	0.5695
15	Mexico	28	5.6278	0.0600	5.2072	0.0225
16	Mexico	16	6.8544	0.0325	4.7421	0.0294
17	Mexico	25	4.9718	0.0832	0.2067	0.6494
18	Mexico	18	5.4201	0.0665	12.890	0.0003
19	Mexico	16	2.6471	0.2662	1.0717	0.3006
20	Mexico	26	2.2265	0.3285	1.1699	0.2794
21	Mexico	21	2.5941	0.2733	0.2683	0.6045
22	Mexico	31	5.7430	0.0566	2.8806	0.0897
23	Mexico	31	4.1503	0.1255	0.2251	0.6352
24	Mexico	24	3.3397	0.1883	0.9109	0.3399

Note: p = p-value. $J(0.5)$ denotes the J-test for a symmetric loss function. $J(\hat{\alpha})$ denotes the J-test for an estimated (unconstrained) loss function. The instruments used are a constant and the lagged exchange rates.

Table 7: J-test, three-months-ahead forecasts, lin-lin loss function

No.	Country	Obs.	$J(0.5)$	p	$J(\hat{\alpha})$	p
1	Brazil	23	2.3680	0.3061	0.3795	0.5379
2	Brazil	21	3.5788	0.1671	3.3140	0.0687
3	Brazil	22	0.7552	0.6855	0.6230	0.4299
4	Brazil	25	1.9733	0.3728	0.0163	0.8983
5	Brazil	20	6.7423	0.0343	2.0458	0.1526
6	Brazil	19	6.6327	0.0363	7.6875	0.0056
7	Brazil	23	9.1572	0.0103	7.4500	0.0063
8	Brazil	28	5.4952	0.0641	0.4821	0.4875
9	Brazil	27	9.4242	0.0090	4.4906	0.0341
10	Brazil	24	0.6683	0.7159	0.5062	0.4768
11	Brazil	17	4.7651	0.0923	0.0015	0.9696
12	Mexico	28	4.3854	0.1116	1.5183	0.2179
13	Mexico	28	3.0701	0.2154	0.8566	0.3547
14	Mexico	25	1.3029	0.5213	0.3074	0.5793
15	Mexico	28	0.6066	0.7384	0.0405	0.8405
16	Mexico	16	2.8966	0.2350	2.2497	0.1336
17	Mexico	25	0.7166	0.6989	0.4002	0.5270
18	Mexico	18	1.0117	0.6030	1.0117	0.3145
19	Mexico	16	1.7226	0.4226	0.5722	0.4494
20	Mexico	26	5.5487	0.0624	0.0244	0.8759
21	Mexico	21	1.9157	0.3837	0.7078	0.4002
22	Mexico	31	6.8860	0.0320	2.2835	0.1308
23	Mexico	31	5.5363	0.0628	2.3976	0.1215
24	Mexico	25	0.0427	0.9789	0.0027	0.9582

Note: p = p-value. $J(0.5)$ denotes the J-test for a symmetric loss function. $J(\hat{\alpha})$ denotes the J-test for an estimated (unconstrained) loss function. The instruments used are a constant and the lagged exchange rates.

Table 8: J-test, one-month-ahead forecasts, quad-quad loss function

No.	Country	Obs.	$J(0.5)$	p	$J(\hat{\alpha})$	p
1	Brazil	23	4.0416	0.1326	6.0986	0.0135
2	Brazil	18	4.0914	0.1293	4.3623	0.0367
3	Brazil	22	3.7125	0.1563	0.0274	0.8684
4	Brazil	25	0.2215	0.8952	0.0984	0.7538
5	Brazil	20	4.8138	0.0901	132.67	0.0000
6	Brazil	19	5.3331	0.0695	10.383	0.0013
7	Brazil	22	1.1471	0.5635	0.2778	0.5981
8	Brazil	28	4.0350	0.1330	7.1601	0.0075
9	Brazil	27	4.9235	0.0853	16.764	0.0000
10	Brazil	22	2.8607	0.2392	5.4022	0.0201
11	Brazil	17	3.4945	0.1743	21936	0.0000
12	Mexico	28	5.4043	0.0671	7.8421	0.0051
13	Mexico	21	3.8903	0.1430	2.0860	0.1487
14	Mexico	25	0.2595	0.8783	0.1846	0.6674
15	Mexico	28	4.7074	0.0950	6.0203	0.0141
16	Mexico	16	9.2949	0.0096	529.13	0.0000
17	Mexico	25	1.5025	0.4718	16.200	0.0001
18	Mexico	18	2.2757	0.3205	104.41	0.0000
19	Mexico	16	1.5566	0.4592	19.295	0.0000
20	Mexico	26	1.1949	0.5502	1.0867	0.2972
21	Mexico	21	2.5945	0.2733	0.3146	0.5749
22	Mexico	31	3.0666	0.2158	5.6655	0.0173
23	Mexico	31	1.4772	0.4778	0.5084	0.4758
24	Mexico	24	0.8741	0.6459	0.2957	0.5866

Note: p = p-value. $J(0.5)$ denotes the J-test for a symmetric loss function. $J(\hat{\alpha})$ denotes the J-test for an estimated (unconstrained) loss function. The instruments used are a constant and the lagged exchange rates.

Table 9: J-test, three-months-ahead forecasts, quad-quad loss function

No.	Country	Obs.	$J(0.5)$	p	$J(\hat{\alpha})$	p
1	Brazil	23	4.5194	0.1044	6.5555	0.0105
2	Brazil	21	4.0647	0.1310	4.9429	0.0262
3	Brazil	22	3.2124	0.2007	1.2651	0.2607
4	Brazil	25	0.5494	0.7598	0.0015	0.9693
5	Brazil	20	6.3811	0.0411	18.274	0.0000
6	Brazil	19	5.2803	0.0714	10.486	0.0012
7	Brazil	23	1.0765	0.5838	0.8012	0.3707
8	Brazil	28	2.4927	0.2876	2.5917	0.1074
9	Brazil	27	6.8084	0.0332	7.2545	0.0071
10	Brazil	24	1.1956	0.5500	0.0254	0.8733
11	Brazil	17	3.2191	0.2000	10.942	0.0009
12	Mexico	28	2.5455	0.2801	11.043	0.0009
13	Mexico	28	1.1116	0.5736	1.1068	0.2928
14	Mexico	25	0.7895	0.6739	0.9019	0.3423
15	Mexico	28	0.7151	0.6994	0.7211	0.3958
16	Mexico	16	1.5833	0.4531	5.7199	0.0168
17	Mexico	25	0.4364	0.8040	0.2575	0.6118
18	Mexico	18	1.1578	0.5605	1.2660	0.2605
19	Mexico	16	1.5565	0.4592	1.1070	0.2927
20	Mexico	26	1.2630	0.5318	1.0050	0.3161
21	Mexico	21	3.2982	0.1922	0.3916	0.5315
22	Mexico	31	2.9339	0.2306	3.0012	0.0832
23	Mexico	31	3.2636	0.1956	3.4016	0.0651
24	Mexico	25	1.0174	0.6013	1.0405	0.3077

Note: p = p-value. $J(0.5)$ denotes the J-test for a symmetric loss function. $J(\hat{\alpha})$ denotes the J-test for an estimated (unconstrained) loss function. The instruments used are a constant and the lagged exchange rates.

Table 10: Quantile test of forecast optimality, one-month-ahead forecasts

No.	Country	Obs.	β_1	p-value
1	Brazil	23	-1.3671	0.1860
2	Brazil	18	-2.2201	0.0412
3	Brazil	22	-1.3745	0.1845
4	Brazil	25	-2.4861	0.0206
5	Brazil	20	-3.2887	0.0041
6	Brazil	19	-3.4277	0.0032
7	Brazil	22	-3.9226	0.0008
8	Brazil	28	-3.3369	0.0026
9	Brazil	27	-2.1459	0.0418
10	Brazil	22	-2.2324	0.0372
11	Brazil	17	-0.8070	0.4323
12	Mexico	28	-0.5137	0.6118
13	Mexico	21	-0.0805	0.9367
14	Mexico	25	-2.5788	0.0168
15	Mexico	28	-1.3623	0.1848
16	Mexico	16	1.5047	0.1546
17	Mexico	25	-2.8091	0.0100
18	Mexico	18	-1.1411	0.2706
19	Mexico	16	-4.7531	0.0003
20	Mexico	26	-3.5144	0.0018
21	Mexico	21	-1.8992	0.0728
22	Mexico	31	-2.4773	0.0193
23	Mexico	31	-0.7365	0.4673
24	Mexico	24	-2.3534	0.0279

Note: OLS = ordinary least squares. The table summarizes coefficient estimates for the model $I_{t+1} = \beta_0+\beta_1(s_t-f_{t+1})+\epsilon_{t+1}$, where $I_{t+1} = 1$ if $s_{t+1} - f_{t+1} < 0$, and $I_{t+1} = 0$ otherwise.

Table 11: Quantile test of forecast optimality, three-months-ahead forecasts

No.	Country	Obs.	β_1	p-value
1	Brazil	23	-0.8602	0.3994
2	Brazil	21	-1.1723	0.2556
3	Brazil	22	-1.4357	0.1665
4	Brazil	25	-1.6412	0.1144
5	Brazil	20	-2.5623	0.0196
6	Brazil	19	-3.0546	0.0072
7	Brazil	23	-3.8517	0.0009
8	Brazil	28	-1.9357	0.0639
9	Brazil	27	-2.1695	0.0398
10	Brazil	24	-1.7497	0.0941
11	Brazil	17	-0.6999	0.4947
12	Mexico	28	0.1056	0.9167
13	Mexico	28	-0.7410	0.4654
14	Mexico	25	-2.7082	0.0125
15	Mexico	28	-1.8989	0.0687
16	Mexico	16	0.8227	0.4245
17	Mexico	25	-3.2032	0.0039
18	Mexico	18	-0.6232	0.5419
19	Mexico	16	-1.6987	0.1115
20	Mexico	26	-1.6675	0.1084
21	Mexico	21	-2.7048	0.0140
22	Mexico	31	-2.1931	0.0365
23	Mexico	31	-2.9123	0.0068
24	Mexico	25	-2.6099	0.0157

Note: OLS = ordinary least squares. The table summarizes coefficient estimates for the model $I_{t+1} = \beta_0 + \beta_1(s_t - f_{t+1}) + \epsilon_{t+1}$, where $I_{t+1} = 1$ if $s_{t+1} - f_{t+1} < 0$, and $I_{t+1} = 0$ otherwise.