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Are Currency Crises Predictable?[1]

Prepared by Ilan Goldfajn and Rodrigo O. Valdés[2]

Authorized for distribution by Donald J. Mathieson

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Abstract

This paper studies whether exchange rate expectations and overvaluations are predictors of currency crises. The results suggest that overvaluation has predictive power in explaining crises. However, although expected depreciation obtained from survey data partially takes different measures of exchange rate misalignment into consideration, expectations fail to anticipate currency crises.

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E-mail: igoldfajn@imf.org.

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[2]Address: Research Department, Central Bank of Chile, Agustinas 1180, Santiago, Chile. E–mail: rvaldesx@condor.bcentral.cl.

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SUMMARY

Using survey data for 26 countries in the past 13 years, this paper studies whether exchange rate expectations and overvaluations are predictors of currency crises.

It is found that exchange rate expectations from survey data take into consideration real exchange rate misalignment estimates. When expectations of depreciation from survey data are regressed against alternative misalignment measures, the coefficients are positive and significant. This result is at odds with the belief that the real exchange rate is an equilibrium relative price and by definition is not misaligned and, therefore, that market expectations should not take misalignment measures into account. The clearest results arise when the simplest way of calculating misalignment is used--only detrending and taking out the average of consumer price index-based real exchange rates.

The analysis concentrates on the role of the real exchange rate in expectations, arguing that it is a summary variable and, therefore, an important leading indicator of currency crises. The results suggest that overvaluation has predictive power in explaining such crises, since it shows that real exchange rate misaligment is a good predictor even out of sample (that is., using only past information to predict crises).

The possible role of the real exchange rate as a summary variable notwithstanding, expectations should incorporate all information available, including other leading indicators, when predicting crises. However, the results show that expectations cannot predict crises. Indeed, the negative results encountered for the Mexican and Thailand cases are confirmed for the whole sample of crises and expectations. In a panel logit regression of a crises indicator on expected depreciation, the coefficient is close to zero and insignificant. Therefore, from the perspective adopted in this paper, exchange rate crises are largely unpredictable events.

I. INTRODUCTION

Are currency crises predictable events? The renewed interest in leading indicators of crises suggests that the profession believes there is more to be learned from interpreting economic variables and also that crises are potentially predictable. Existing anecdotal evidence, however, indicates that markets are unable to foresee exchange rate crises or devaluations.

In fact, when one examines expectations of devaluation obtained from survey data for the currency crises in Mexico and Thailand, the picture that emerges is one of surprised forecasters (see Figures 1 and 2).[1] In Mexico, three months before the currency crisis, forecasters predicted that the peso would stay at 3.4 per U.S. dollar in January 1995 (contrasted with the actual rate of 5.7 pesos per dollar). Similarly, in Thailand expectations three months ahead were that the bath rate would stay at 25.8 per dollar in July 1997 rather than at the post-crisis rate of 31.2.

These facts have to be contrasted with the evidence on leading indicators. Several indicators have proven to be particularly useful in anticipating crises, e.g., the real exchange rate, international reserves and domestic credit (Kaminsky, Lizondo and Reinhart, 1997). Although one could argue that these results are essentially a *post factum* analysis based on *in-sample* empirical work, there is some scattered evidence to support that they are in fact *leading* indicators with ex-ante predictive power. For example, with respect to the real exchange rate indicator, there is evidence that medium-sized and large overvaluations lead to future devaluations even when the starting point is a broader sample of appreciations rather than the usual devaluations or currency crises sample (Goldfajn and Valdés, 1996). Moreover, as a by-product, this paper shows that the real exchange rate is a good predictor *out-of-sample*. Using only past information to determine real exchange misalignment the paper finds it has a positive effect on a crisis indicator.

Given this evidence, a natural first question is *does the market incorporate overvaluation measures when it forms expectations of devaluation?* If one believes in the above evidence, then one should expect the market to take this information into account. Section 3 shows this to be the case. When regressing expectations of depreciation from survey data for 26 countries in the last 13 years against alternative misalignment measures the coefficients are positive and significant. This result is at odds with the belief that the real exchange rate is an equilibrium relative price and by definition not misaligned and, therefore, market expectations should not take

[1]The forecasts used here and in the rest of the paper are obtained from the *Financial Times Currency Forecaster* which surveys monthly 45 professional firms for forecasts on 30 different currencies.

Figure 1. Mexican Peso Actual and Forecast

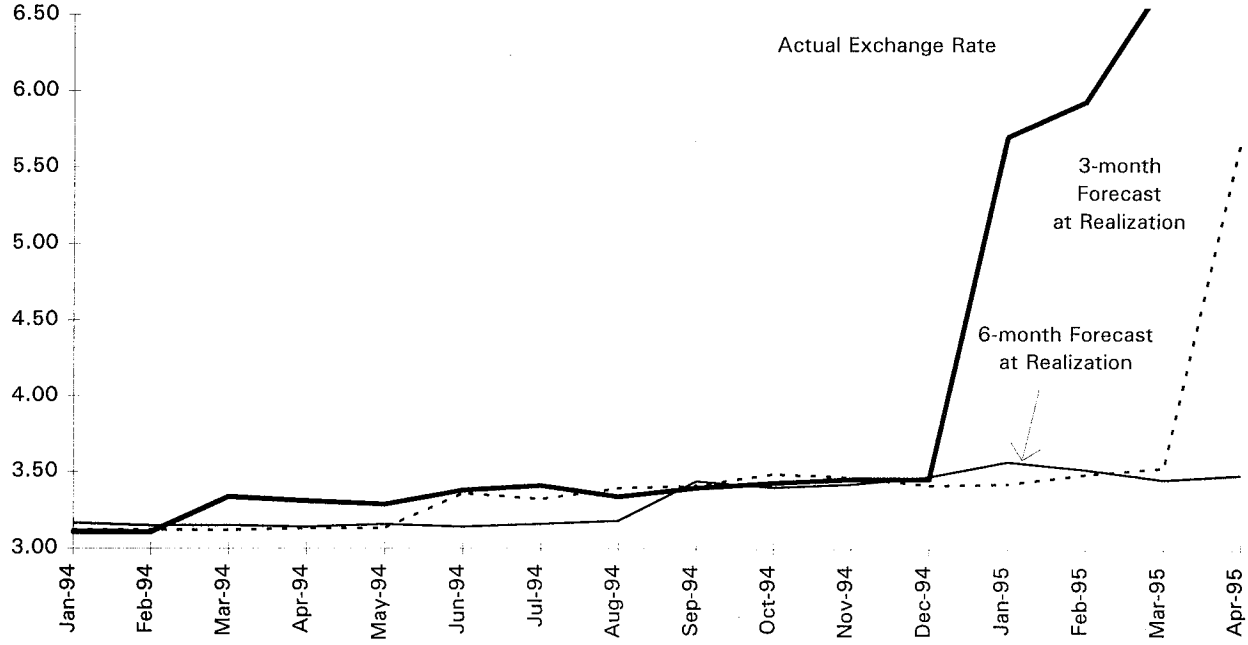
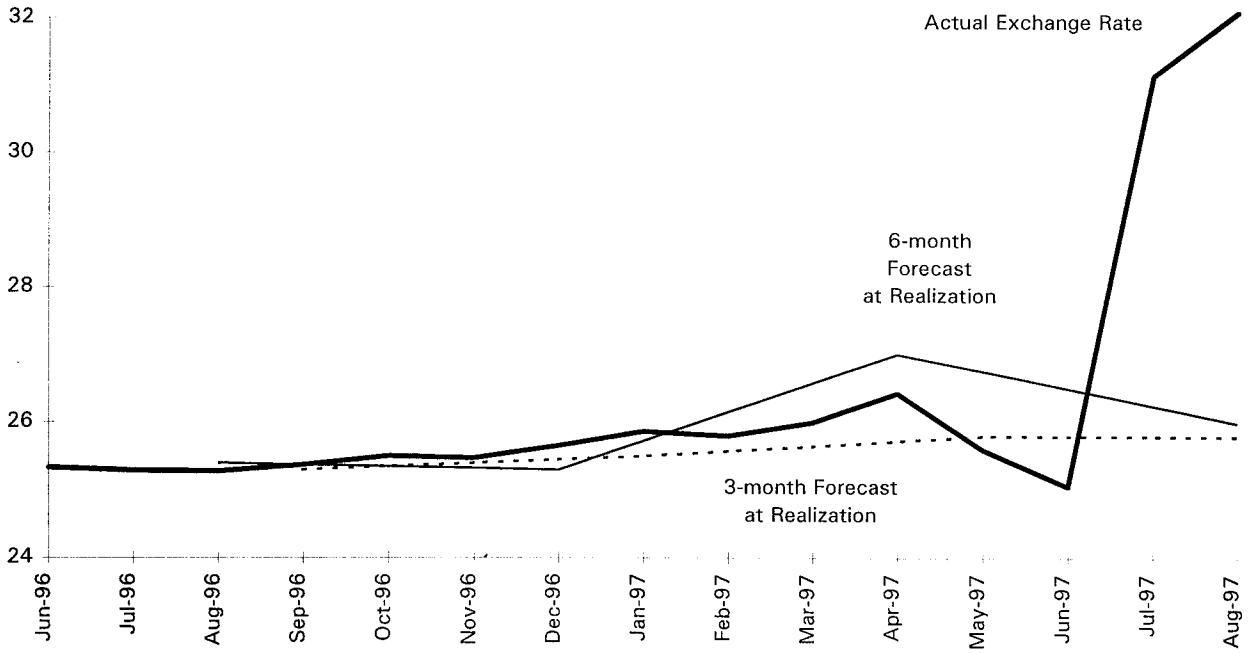


Figure 2. Thai Baht Actual and Forecast



misalignment measures into account.

A second natural question is whether markets anticipate currency crises or devaluations. Given that expectations incorporate information on misalignments (which in turn are correlated with devaluations), *is the market able to predict crises?* Section 4 shows that market participants fail to anticipate crises. Indeed, negative results encountered for the Mexican and Thailand cases are confirmed for the whole sample of crises and expectations. In a panel logit regression of a crises indicator on expected depreciation, the coefficient is close to zero and insignificant.

The paper is organized as follows. Section 2 summarizes the results of the literature on leading indicators and the effect of misalignment measures on future devaluations and crises. Section 3 analyses whether the market incorporates misalignment measures in its expectations and, also, studies which of the misalignment measures (CPI or WPI, fundamentals or not) is more correlated with market expectations. Section 4 tests if market expectations anticipate crises. Finally, in Section 5 the paper concludes with a summary of the results.

II. OVERVALUATION PREDICTS CRISES

There has been a renewed effort in the literature to understand the empirical determinants of currency crises. Some models of leading indicators have been derived, in particular, the one in Kaminsky, Lizondo, and Reinhart (1997). The latter includes several variables divided into six categories: the external sector, financial sector, real sector, public finance, institutional variables, and political variables.

This paper concentrates on the real exchange rate as a leading indicator variable. Most empirical studies have shown that the real exchange rate (RER), deviations from its trend, or other forms of calculating RER misalignments, are important variables in predicting a crisis. In fact, out of twelve studies surveyed by Kaminsky, et al. (1997) that consider the RER as a crisis indicator, ten find that it is statistically significant. In addition, in their study they find the real exchange rate to be the most reliable indicator (in terms of their noise to signal ratio and the longest lead time).[2]

The fact that the real exchange rate has systematically proven to be an important determinant of currency crises will be interpreted here as a sign that this relative price is a key summary variable of several other underlying fundamentals rather than the unique determinant of currency crises. This reading of the data is further justified by some

[2]See also Dornbusch, Goldfajn and Valdés (1995), and Sachs, Tornell and Velasco (1996) for further discussion about the role of the RER.

results in the literature that do not find an effect of the RER on future crises when the analyses include a sufficiently large number of other explanatory variables (Meese and Rose, 1996).

One limitation of some empirical studies is that the sample is restricted to crisis episodes. This restriction prevents detection of "false signals:" when the explanatory variable predicts a crisis that does not actually occur. This argument calls for setting the sample large enough to include both crisis and noncrisis episodes to guarantee the neutrality of the results. Of course, setting up a "neutral" sample requires extensive data and diversity of countries which may not always be immediately available.

Stressing the usefulness of concentrating on a summary variable for this "neutral" exercise, Goldfajn and Valdés (1996) analyzed a large set of real exchange rate appreciations derived from an initial sample of monthly real exchange rates for 93 countries from 1960 to 1994. The objective was to evaluate whether real exchange rate misalignments lead to future crisis or nominal devaluations—being the alternative correction mechanism a domestic inflation lower than abroad's. Figure 3 shows a typical result. The graph shows the probability of eliminating the misalignment without nominal devaluations (smooth returns) for different degrees of misalignment is extremely low. For misalignments larger than 35 percent there is not a single case of return to equilibrium through nominal devaluations. These results are robust to different definitions of misalignments and to different definitions of smooth returns to equilibrium.

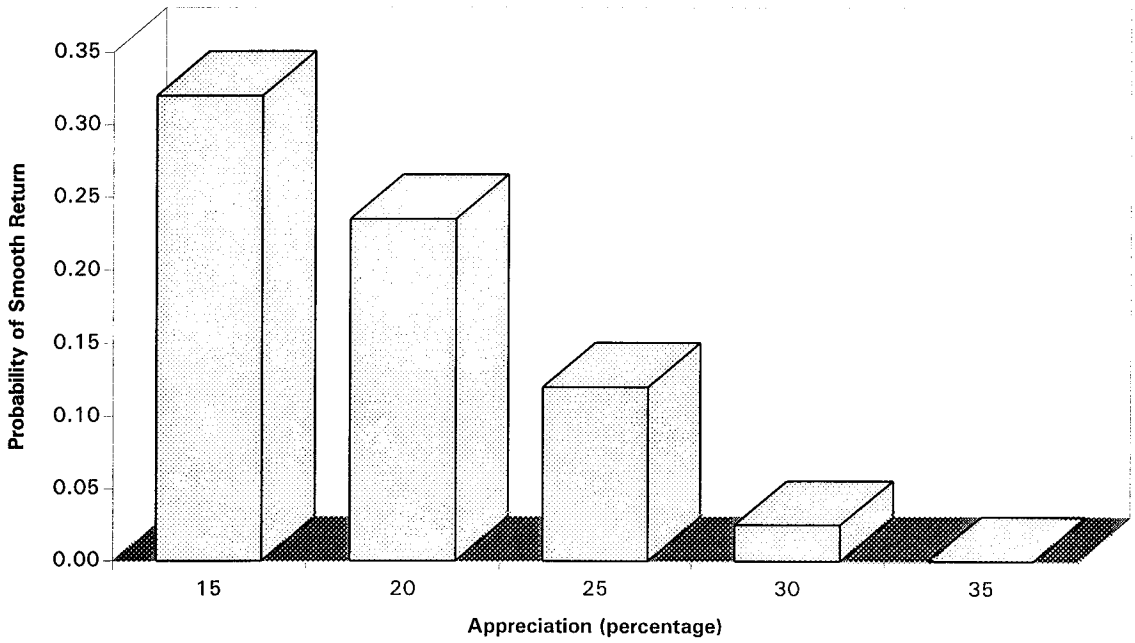
The exercise in Goldfajn and Valdés shows a close relation between nominal and real exchange rates. A real overvaluation is invariably corrected through nominal devaluation rather than inflation differentials. Therefore, in what follows, the paper associates real misalignments with nominal corrections.

III. DOES THE MARKET CONSIDER OVERVALUATION?

The previous section concluded that the real exchange rate is an important summary variable to predict future changes in the nominal exchange rate. This conclusion is robust to specifying the initial sample as cases of overvaluation rather than the narrower sample of currency crises.

This section investigates whether the market incorporates into its expectations the strong correlation between overvaluation and subsequent depreciation. One would expect agents to anticipate future devaluations once they realize the real exchange rate is overvalued. If this is the case, one further interesting question is whether there is any misalignment measure that is more correlated to market expectations.

Figure 3. Probability of Smooth Return



This paper estimates a fixed effect panel regression of expected devaluation against different overvaluation measures. The expected devaluation measures used are the n-month ahead expectation of the nominal exchange rate with respect to the U.S. dollar divided by the equivalent current spot rates. It includes three, six and twelve months ahead expectations of devaluation for 17 developed and 9 developing countries (Appendix A presents the list of countries).

The measure of currency expectation is obtained from the survey conducted on a monthly basis by the *Financial Times Currency Forecaster*. The market expectations used in this paper are geometric averages of 45 individual forecasters, therefore, reducing the effect of outliers. Use of these measures avoids relying on estimates of expectation that are inferred from either the interest differential or from actual depreciation (assuming rational expectations). There is some evidence that interest rate differentials are not useful in predicting crises (Kaminsky, et al., 1997). More importantly for the case being studied, Werner (1996) shows that inferences based on interest differentials (without correction for relative asset supplies) did not increase prior to the Mexican peso crisis of 1994. One possible reason for this poor performance is that interest differentials do not adequately reflect expected depreciation. Changes in interest rate differentials may reflect short-run monetary policies that increase domestic interest rates or changes in the risk premium. These factors may produce enough noise that prevents the extraction of reliable expected depreciation measures.

The period of estimation extends from May 1984 to May 1997, but the actual sample for different countries depends on the availability of data and, therefore, the panel regression is unbalanced. The regressors include the average devaluation of the previous three months, $\hat{e}^e_{i,t-1}$, expressed in units consistent with the dependent variable and the misalignment of the dollar, M_{US}.[3] Thus, we estimate equations of the form:

$$\hat{e}^e_{i,t} = \alpha_i + \alpha_1 \mathrm{M}_{i,t} + \alpha_2 \hat{e}_{i,t-1} + \alpha_3 \mathrm{M}_{US} + \varepsilon_{i,t} \qquad (1)$$

where $\hat{e}^e_{i,t}$ is expected devaluation (n-month ahead) at time t in country i, M denotes the misalignment (overvaluation) measure and $\varepsilon_{i,t}$ is a random error.

This paper uses various measures of real overvaluation in different regressions. All are based on multilateral real exchange rates, and calculated using rolling regressions. The information for calculating a month t overvaluation includes

[3]Including the average devaluation of previous three months in the regressors controls for large devaluations in high inflation countries and including the dollar misalignment controls for changes in the forecasts that are due to expected movements of the dollar against other large currencies.

information up to that same month. Six alternative measures of overvaluation are considered. The first division is the price data used to construct RERs:

- **Wholesale Price Index** based multilateral RER (from the JP Morgan database, January 1970 to May 1997).
- **Consumer Price Index** based multilateral RER (from the IMF's effective exchange rate database, January 1970 to March 1997).

The second division includes three different ways of calculating overvaluation:

- **Trends**: Misalignments calculated as the deviations of the actual series from a predicted series based on a regression of the RER usingtrends and a constant.
- **H-P Filter**: Misalignments calculated as the deviations of the actual series from a Hodrick-Prescott filtered series.
- **Fundamentals**: Misalignments calculated as the deviations of the actual series from a predicted series based on a regression of the RER on the permanent values (filtered with H-P) of productivity (when available), terms of trade, government spending and openness.

The results of the regressions are presented in Table 1. The main conclusions are as follows. First, larger misalignments result in higher devaluation prospects. For almost all the horizons (in columns) and all the different misalignment measures (in rows), the coefficient on overvaluation is positive and significant. Only on the 12-months ahead horizon is the coefficient occasionally not significant. These results provide evidence against the view that the real exchange rate is continuosly in equilibrium and, therefore, could not provide information about future changes in the exchange rate. Quite the opposite, market expectations do take into consideration real exchange rate misalignments.

Second, there is no *clear* pattern in the R-squareds of the different regressions that could indicate whether a specific misalignment is more correlated to market expectations. However, there is a slight tendency for the R-squareds to be higher when misalignments are calculated using CPI based real exchange rates or when using fundamentals. Our preferred results are the ones obtained under the CPI real exchange rate and misalignment calculated using only trends. The coefficients are large—an additional overvaluation of 1 percent increases expected devaluation by 0.8 percent in the next 12 months—and increases almost proportionally with the horizon —the

Table 1. Overvaluation and Expected Devaluation
Dependent Variable: Expected Devaluation

	3 Months	6 Months	12 Months
Wholesale Price Index RER - JP Morgan Database			
		Trends	
Estimate	0.094	0.167	0.050
T-test	(1.57)	(1.71)	(0.18)
R^2	0.314	0.403	0.283
		H-P Filter	
Estimate	0.173	0.242	0.080
T-test	(2.68)	(2.28)	(0.27)
R^2	0.314	0.402	0.282
		Fundamentals	
Estimate	0.216	0.250	–0.156
T-test	(2.76)	(1.95)	(–0.44)
R^2	0.316	0.405	0.284
Consumer Price Index RER - IMF Database			
		Trends	
Estimate	0.218	0.491	0.785
T-test	(3.68)	(5.04)	(2.89)
R^2	0.317	0.411	0.290
		H-P Filter	
Estimate	0.165	0.234	0.154
T-test	(3.91)	(3.37)	(0.80)
R^2	0.318	0.407	0.286
		Fundamentals	
Estimate	0.426	0.570	0.880
T-test	(6.18)	(5.04)	(2.79)
R^2	0.322	0.411	0.288

Fixed-effects unbalanced panel estimation. Reported coefficient on overvaluation measure
Overvaluation measure is rolling. All regressions include lagged actual devaluation and US Overvaluation.

coefficient on the 12-months ahead prediction is 4 times larger than the coefficient on the 3-months ahead. Interestingly, these results occur in the simplest method to calculate misalignment.

IV. DOES THE MARKET PREDICTS CRISES?

Considering that the real exchange rate is an important determinant of the likelihood of a balance-of-payments crisis and that market participants do consider overvaluation in their formation of expectations, a natural question is *whether market participants are able to anticipate crises*. More specifically, we want to analyze the contribution of market expectations to the forecast of crises.

Defining the occurrence of an exchange crisis is no trivial task. While large devaluations are common in high inflation regimes, they may not imply any special external distress. Sometimes a devaluation is small, but the cost of a speculative attack in terms of reserves can be large, in turn changing the country's external position.

In order to define crisis episodes, this paper follows three alternative procedures. First, in the spirit of the methodology of Frankel and Rose (1996) and Meese and Rose (1996), we define a currency crisis (a *crash* for these authors) as a large devaluation, but larger than the previous nominal devaluation.[4] In this case we define the threshold in the following way: devaluation is a crisis when it is larger than (i) 1.96 times the standard deviation of the country's nominal exchange rate devaluation rate, *and* (ii) 2 percent plus 1.5 times the devaluation rate of the previous month. We require the crises to be 2 months apart.[5] In the sample of 26 countries, this index produces 61 crisis episodes (and 2,890 episodes with no crisis).

Second, we define an alternative crisis indicator based upon the evolution of the real exchange rate. Given downward price rigidity we associate large jumps in the RER as a crisis (larger than 2 standard deviations from the mean). This measure has the advantage of controlling directly the high inflation episodes. The total number of crisis cases under this definition is 55 (and 2,896 with no crisis).

Third, we use the crisis episodes reported in Kaminsky and Reinhart (1996). They define a currency crisis according to an indicator that combines both the

[4]Frankel and Rose (1996) and Meese and Rose (1996) use annual data with a threshold of 25 percent with at least a 10 percent increase from the devaluation rate of the previous year. They also require crises to be 2 years apart. They use the U.S. bilateral exchange rate.

[5]The first condition approximately isolates the largest 5 percent devaluation of each country (1.96 times the standard deviation). The second condition drops from the sample both devaluations that are just crawling pegs and insignificant exchange rate movements (lower than 2 percent).

devaluation rate and reserve losses. Because the countries in their sample are not the same as the ones defined above, the total number of episodes also changes. In this case there are 20 crises with 1469 "tranquil" months.

In order to evaluate whether expected devaluation and overvaluation help anticipate crises, this paper estimates a logit specification using both countries with and without crisis episodes. The overvaluation measure considered is the one calculated with CPI and trends (the other measures of overvaluation yield similar results). As before we use a rolling estimation, which means that we do not use any future information that the market does not posses at the time. The paper concentrates on expected devaluations 3-months ahead, the results being robust to other horizons. In order to control for high inflation countries we also consider the lagged actual devaluation rate as an explanatory variable. More specifically, we estimate:

$$Pr(\text{Crisis}_{i,t}) = \frac{exp(\beta X_{i,t} + \epsilon_{i,t})}{1 + exp(\beta X_{i,t} + \epsilon_{i,t})} \tag{2}$$

where $Pr(\text{Crisis}_{t,i})$ denotes a probability of crisis in month t and in country i, the vector $X_{i,t}$ includes a lagged overvaluation measure, lagged expected depreciation, and lagged actual depreciation, and $\epsilon_{i,t}$ is a normally distributed random error. The regression controls for the effect of lagged actual devaluation because in crawling pegs only accelerations in the devaluation rate are associated with crises.

Table 2 presents the results. The first row in each panel (rows 1, 4 and 7) shows that, indeed, overvaluation does help predict exchange rate crisis. In both real devaluation and Kaminsky and Reinhart's (1996) sample crises, the overvaluation coefficient is significantly positive. In the case of nominal devaluation, the coefficient is positive with a 10 percent significance. This finding is valuable in its own right because it shows that overvaluation is useful in predicting crises out-of-sample.[6]

The second row in each panel (rows 2, 5 and 8) answers the main question raised in this section-whether the market predicts crises. The coefficient of expected devaluation is not significantly different from zero in all three crisis definitions. The results show clearly that expectations fail completely to anticipate crises. This confirms the suspicion one obtains from observing the figures of expectations from the generally known cases of Thailand and Mexico, shown in the introduction.

In order to verify whether there is still information on the misalignment measures

[6]The results in the literature we reviewed in Section 2 are in-sample predictions.

that is not incorporated in expectations, both overvaluation and expected devaluation are considered together. The results in Table 2, third row of each panel show that overvaluation is no longer significantly different from zero, although the expected sign is kept. This is most likely a multicollinearity problem that arises because, as shown in Section 3, expectations are correlated to misalignment.

One could argue that although forecasters cannot predict the exact timing of crisis, they may have a good assessment of the possibility of a crisis within the next year. The paper repeats the exercise using the 12-month horizon one period before the crisis. The results are presented in Table 3 and are essentially equivalent to the ones encountered in Table 2. Indeed, the results are robust to using any of the horizons - 3, 6, or 12.

These results should be contrasted with existing crises (or devaluation) theories. First generation models of balance of payment crises model underlying fundamentals with a deteriorating trend that implies an inconsistency with the fixed or pegged exchange rate (Krugman (1979, 1996), Flood and Garber (1984)). Eventually, the exchange rate has to float or devalue. The devaluation or float occurs when it is first profitable to speculators to attack the currency. Rational agents incorporate the model into their expectations and anticipate the devaluation. This conclusion is valid even when one introduces stochastic elements. The expectation of crises (or devaluation) increases with the proximity of the attack (even if the date is not deterministic).

Second generation models give some role to self-fulfilling speculative attacks but have also elements that should help agents anticipate future devaluations. In the spirit of recent models (Cole and Kehoe (1996)), the economies are only *vulnerable* to self-fulfilling attacks when their fundamentals have already deteriorated to specific levels. In this region, agents should expect a higher probability of crisis.

The results show that market forecasters do not anticipate crises. This finding gives support to neither first or second generation models, although, admittedly, one should expect more difficulties anticipating crises when self-fulfilling attacks are possible.

These results do not necessarily imply that markets do not use efficiently all the information available since it is possible to conclude that *unanticipated* changes in fundamentals (shocks) are the main determinants of crises. But this conclusion will then cast doubts on the usefulness of the recent leading indicators literature that presumes that crises are potentially predictable.

Table 2. Crisis Prediction Using 12-Month Ahead Forecasts
Dependent Variable: Crisis Dummy

	CPI-Trend Overvaluation	3-Month Exp. Devaluation	Actual Lagged Deval.	Loglikelihood	Observations
		Crisis 1: Nominal Devaluation			
1	0.0164	–	-0.0007	295.67	2951
	(1.69)		(-1.15)		
2	–	0.0002	-0.0018	275.95	2687
		(0.05)	(-0.32)		
3	0.0161	0.0003	0.0033	240.95	2588
	(1.53)	(0.20)	(1.17)		
		Crisis 2: Real Devaluation			
4	0.0245	–	0.0037	269.71	2951
	(2.63)		(1.57)		
5	–	0.0013	0.0028	251.74	2687
		(0.69)	(1.15)		
6	0.0159	0.0009	0.0033	240.89	2588
	(1.51)	(0.43)	(1.28)		
		Crisis 3: Kaminsky and Reinhart (1996)			
7	0.0280	–	0.0046	103.18	1489
	(2.20)		(1.77)		
8	–	0.0011	0.0032	99.18	1358
		(0.45)	(1.24)		
9	0.0190	0.0007	0.0040	98.23	1350
	(1.36)	(0.25)	(1.45)		

T-tests in parenthesis. Logit specification with monthly data 1984.5-1997.5.

Crises 1: $\hat{e}_{i,t} > 1.96\sigma_{\hat{e}_i}$ and $\hat{e}_{i,t} > 2\% + 1.5\hat{e}_{i,t-1}$.

Crises 2: $\hat{RER}_{i,t} > 1.96\sigma_{\hat{RER}_i}$.

Crises 3: Crisis months defined by Kaminsky and Reinhart (1996).

Table 3. Crisis Prediction Using 3-Month Ahead Forecasts
Dependent Variable: Crisis Dummy

	CPI-Trend Overvaluation	12-Month Exp. Devaluation	Actual Lagged Deval.	Loglikelihood	Observations
		Crisis 1: Nominal Devaluation			
1	0.0068	–	-0.0000	288.71	2809
	(1.66)		(-0.29)		
2	–	-0.0000	-0.0000	269.10	2550
		(-0.18)	(-0.30)		
3	0.0034	-0.0000	-0.0000	247.59	2451
	(0.74)	(-0.18)	(-0.27)		
		Crisis 2: Real Devaluation			
4	0.0042	–	0.0000	251.71	2809
	(2.61)		(0.41)		
5	–	0.0001	0.0000	234.09	2550
		(0.60)	(0.17)		
6	0.0072	0.0000	0.0000	223.12	2451
	(1.56)	(0.41)	(0.29)		
		Crisis 3: Kaminsky and Reinhart (1996)			
7	0.0112	–	0.0000	98.71	1412
	(2.05)		(0.04)		
8	–	0.0002	-0.0000	94.35	1281
		(0.84)	(-0.17)		
9	0.0075	0.0002	-0.0000	93.46	1281
	(1.29)	(0.80)	(-0.09)		

T-tests in parenthesis. Logit specification with monthly data 1984.5- 1997.5.

Crises 1: $\hat{e}_{i,t} > 1.96\sigma_{\hat{e}_i}$ and $\hat{e}_{i,t} > 2\% + 1.5\hat{e}_{i,t-1}$.

Crises 2: $R\hat{E}R_{i,t} > 1.96\sigma_{R\hat{E}R_i}$.

Crises 3: Crisis months defined by Kaminsky and Reinhart (1996).

V. CONCLUSIONS

This paper provides evidence that exchange rate expectations from survey data take into consideration real exchange rate misalignment estimates. Although there is no clear ranking of the exact measure of misalignment exchange forecasters use, a slight preference is given to CPI based estimates. Interestingly, the clearest results arise when the simplest way of calculating misalignment is used–only detrending and taking out the average of CPI-based real exchange rates.

The analysis concentrates on the role of the real exchange rate in expectations arguing that it is a summary variable and, therefore, an important leading indicator of crises. In fact, as a by-product, this paper shows that real exchange rate misaligment is a good predictor even out-of-sample (i.e., using only past information to predict crises). However, to generalize the conclusions, further work should repeat the exercise using other relevant indicators.

Independently of the possible role of the real exchange rate as a summary variable, expectations should incorporate all information available, including other leading indicators, when predicting crises. However, the results show that expectations cannot predict crises. This contrast with the positive results obtained with misalignment measures in the same regression. Therefore, from the perspective adopted in this paper, exchange rate crises are largely unpredictable events.

APPENDIX

Table A1: Country List

Argentina	Korea
Australia	Mexico
Belgium	Netherlands
Brazil	New Zealand
Canada	Norway
Colombia	Phillipines
Denmark	Singapore
France	South Africa
Germany	Spain
Hong Kong	Sweden
Ireland	Switzerland
Italy	United Kingdom
Japan	Venezuela

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