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Evaluating Historical CGER Assessments: How Well Have They Predicted Subsequent Exchange Rate Movements?

Abdul Abiad, Prakash Kannan, and Jungjin Lee

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Prepared by Abdul Abiad, Prakash Kannan, and Jungjin Lee

Authorized for distribution by Gian Maria Milesi-Ferretti

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Abstract

The IMF's Consultative Group on Exchange Rate issues (CGER) has been conducting exchange rate assessments as part of the surveillance process since 1997. This paper evaluates CGER assessments from 1997 to 2006, by comparing these to subsequent movements in real effective exchange rates (REER). We find that CGER's estimated misalignments have predictive power over future REER movements, especially over longer horizons and after changes in fundamentals are accounted for. But while CGER misalignments frequently predict the direction of currency movements correctly, misalignments have tended to be persistent, resulting in systematic errors—overprediction for undervalued currencies and underprediction for overvalued currencies.

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Authors' E-Mail Address: aabiad@imf.org; pkannan@imf.org; jlee4@imf.org

Contents Page

I. Introduction

Exchange rate assessments—estimates of whether or not a country's exchange rate is broadly in line with fundamentals—play a central role in IMF surveillance. The recent 2007 Decision on Bilateral Surveillance has renewed the IMF's mandate in this area, placing particular emphasis on the role of exchange rate policies in achieving external stability (IMF, 2007). Since 1997, the IMF Consultative Group on Exchange Rate issues (CGER)—an internal working group—has been conducting biannual exchange rate assessments for a number of countries from a multilateral perspective. The initial exercise consisted of assessments for the G-7 economies: Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States. Coverage was expanded in 1998 to include six more industrial countries (Australia, Denmark, New Zealand, Norway, Sweden, and Switzerland), and more substantially in 2006 to cover 27 advanced and emerging market economies.

The notion of equilibrium that underpins the CGER exercise is one of internal and external balance.[1] Internal balance is associated with a zero output gap for the economy, while external balance is associated with an "equilibrium" current account balance (estimated as a function of economic fundamentals) and with a sustainable net external (asset or liability) position. Beyond this notion of equilibrium, reduced-form relationships between the real exchange rate and macroeconomic fundamentals have also been employed as a measure of misalignment. An overview of the different methodologies used by CGER in conducting its exchange rate assessments is provided in Box 1.

The objective of this paper is to evaluate the predictive power of the CGER assessments of exchange rate misalignments.[2] We carry out this exercise by comparing estimated misalignments, based on different vintages of CGER assessments, to subsequent movements in the respective countries' real effective exchange rate (REER). The degree to which these subsequent movements are in the direction of reducing the misalignment is used as the basic metric of how well the assessments have performed. The manner in which this comparison is made differs according to the length of the available sample. For assessments of advanced economies, for which we have the longest sample, a panel approach is used, where comparisons are made for both 3-year and 5-year horizons. For the wider set of advanced and emerging market economies that have been included in the CGER exercise since 2006, a cross-sectional analysis of exchange rate movements between 2006 and 2008 is performed instead.

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[1] A more detailed discussion is provided in Isard and Faruqee (1998), Isard et al. (2001), and Lee et al. (2008). For a survey of related methodologies used to estimate equilibrium exchange rates, see Williamson (1994) and Hinkle and Montiel (1999).

[2] CGER exchange rate assessments are classified by the IMF as "Strictly Confidential," due to potential market sensitivity of IMF views on exchange rate misalignments (although CGER assessments do not necessarily reflect the IMF's official view on exchange rates). As a result, this paper does not provide information on assessed misalignments for specific countries. However, the methodologies used by CGER are public (see, for example, Lee et al. 2008), and interested parties can produce similar misalignment estimates based on publicly available information.

Box 1: An Overview of CGER Exchange Rate Assessment Methodologies

CGER has used a number of complementary methodologies to assess exchange rates. The three methodologies currently in use—the macroeconomic balance approach, a reduced-form equilibrium real exchange rate approach, and an external sustainability approach—are summarized here, with further details including regression estimates, data sources, and robustness tests available in Lee et al. (2008). Earlier versions of the MB approach have been used since 1997 to provide assessments for a number of advanced economies, and a precursor of the ERER approach has been in place since 2000. Revised and extended methodologies were developed in late 2006 to provide assessments for a wider set of countries, covering both industrial and emerging market countries.

The **macroeconomic balance (MB) approach** calculates the difference between the current account balance projected over the medium term at prevailing exchange rates, and an estimated equilibrium current account balance or "CA norm." The latter is a function of medium-term determinants of the savings-investment balance, such as demographic factors (population growth and old-age dependency), the fiscal balance, and level and growth rate of output per capita. The exchange rate adjustment that would eliminate this difference over the medium term—a horizon over which domestic and partner-country output gaps are closed and the lagged effects of past exchange rate changes are fully realized—is obtained using country-specific elasticities of the current account with respect to the real exchange rate.

The reduced-form **equilibrium real exchange rate (ERER) approach** estimates an equilibrium, statistical, relationship between the real exchange rate for each country and macroeconomic fundamentals such as the net foreign asset (NFA) position of the country, relative productivity differentials between the tradable and nontradable sectors, and the terms of trade. The exchange rate misalignment is then calculated as the difference between the estimated equilibrium real exchange rate, based on medium-term projections of the fundamentals, and its current value.

The **external sustainability (ES) approach** calculates the difference between the current account balance projected over the medium term at prevailing exchange rates, and the balance that would stabilize the NFA position of the country at some benchmark level. Using the same elasticities as in the MB approach, this difference is translated into the real exchange rate adjustment that—over the medium term—would bring the current account balance in line with its NFA-stabilizing level.

The three misalignment estimates are then combined to give an **overall assessment**, using simple criteria. If the average of the three misalignments is within five percent of zero, or if all three misalignments are less than 10 percent in absolute value, then the currency is assessed to be broadly in line with fundamentals. Otherwise, the approximate midpoint of the three estimates (when all three estimates are within 10 percentage points of each other) or a range encompassing all three estimates (when the estimates are at least 10 percentage points apart) is used as the assessment.

The methodologies employed in this paper are based on standard tools used to assess forecasting models.[3] Several caveats should be noted, however. First, CGER assessments are not designed to be forecasts, especially over short horizons. Instead, they are assessments of the current value of the real exchange rate relative to an equilibrium that is based on medium-term projections of underlying economic fundamentals. Deviations from equilibrium can be, and often are, persistent. Second, misalignments can be closed or narrowed by movements in fundamentals, without any changes in the real exchange rate. Third, even for the G-7 countries for which we have the longest sample, we have at most only 18 usable observations per country, comprising the bi-annual assessments from 1997 to 2005 (when using a 3-year prediction window to 2008). Given these data limitations, caution should be exercised when interpreting the individual-country diagnostic statistics presented in this paper, especially those that rely on large-sample asymptotics. Despite these caveats, the usefulness of the assessments as a surveillance tool will be buttressed if they have some predictive power over medium-term real exchange rate movements, and it is for this purpose that we conduct this exercise.

In addition to evaluating the performance of CGER exchange rate assessments, we also test the predictive power of estimated deviations of current accounts from their equilibrium values. As mentioned earlier, the external equilibrium concept underlying CGER assessments involve a measure of an equilibrium current account based on medium-term forecasts of economic fundamentals.[4] Similar to the exercise conducted for exchange rate misalignments, we compare movements in current account balances over 3- and 5-year horizons with the initial deviation from the estimated current account norm.

The results in this paper show that exchange rate misalignment assessments for advanced economies based on CGER methodologies contain predictive power over subsequent movements in real exchange rates, especially over a 5-year horizon. The results are more pronounced once changes in fundamentals over the prediction horizon are controlled for. At an individual country level, the CGER assessments outperform a benchmark random-walk model for roughly half of the countries in the sample. As documented in much of the academic literature beginning with Meese and Rogoff (1983), the random walk model is an exceptionally difficult benchmark to beat and the fact that the CGER assessments perform better in a large proportion of the sample is promising. On the other hand, assessments are shown to have very high systematic errors, which indicates that estimated misalignments have been very persistent. On average, currencies that were assessed to be undervalued tend to remain undervalued, and currencies that were assessed to be overvalued tend to remain overvalued, even over a 5-year horizon.

[3] See, for example, Timmerman (2007). The purpose of this paper is not to perform robustness tests of a specific model; extensive tests of the current CGER models were performed, and are reported in Lee et al. (2008). Rather, we are evaluating the predictive performance of CGER assessments, which are based not only on several exchange rate models, but also reflect subjective views of IMF staff, e.g., medium-term projections of macroeconomic variables that are inputs into the CGER assessments.

[4] See Debelle and Faruqee (1996) for details on earlier versions of the estimation procedure. A description of the updated methodology and estimates is provided in Lee et al. (2008).

The results are also supportive of predictions regarding movements in current account balances of countries—that is, changes in current account balances have been in the direction towards eliminating the gaps with their estimated norm values. As in the case of the exchange rate assessments, the results are more promising over longer time horizons and after controlling for changes in fundamentals.

In the case of the wider set of advanced and emerging market countries that constitute the updated CGER assessment methodology, a cross-sectional analysis of misalignment estimates produces encouraging results. Given the short horizon being considered, it is crucial to control for potential short-run determinants of exchange rate movements, particularly interest rate differentials, as well as for the possibility that fundamentals and hence the equilibrium REER may have adjusted. We find that short-term interest rates have indeed been strong drivers of recent exchange rate movements, and that changes in fundamentals have also moved currencies. Once these factors are controlled for, exchange rates move in the direction predicted by CGER, closing about two-thirds of the estimated gap over the past two years. We also find that the midpoint of the CGER assessment range (which is based on the three methodologies described in Box 1) does better than the individual misalignment estimates, underscoring the value of using a complementary set of methodologies.

The rest of the paper is organized as follows: Section II evaluates CGER's exchange rate assessments for advanced economies for which we have the longest sample. In Section III, we carry out a cross-sectional analysis based on the expanded set of countries and the most recent CGER exchange rate assessment methodologies. Finally, Section IV concludes.

II. Evaluating Misalignment Assessments for Advanced Economies

Between 1997 and 2006, assessments of exchange rate misalignments using CGER methodologies were only conducted for a subset of advanced countries. The eleven economies that comprised the sample are Australia, Canada, Denmark, the euro area, Japan, New Zealand, Norway, Sweden, Switzerland, the United Kingdom, and the United States.

The assessments carried out during this period were based on two methodologies—the MB approach, and a reduced-form econometric estimation that was a precursor of the current ERER methodology (see Box 1 for details). Assessments of misalignments were presented as either a point estimate using the MB approach, or as a range encompassing both methodologies. In the empirical exercise that follows, we use both the MB point estimate as well as the midpoint of the assessment range.

A. Mean Prediction Error

We begin the evaluation by examining the mean prediction error. If one were to use CGER misalignments to predict subsequent REER changes, the expected change would be given by the *negative* of the misalignment—e.g., if a currency is assessed to be 20 percent overvalued, the expected REER change would be –20 percent. We can define the prediction error for period t as

$$e_{it} = \left(\ln\left(REER_{i,t+3/5}\right) - \ln\left(REER_{i,t}\right)\right) - (-Misalignment_{i,t}) \quad (1)$$

where $REER_{i,t+3/5}$ refers to country i's REER either 3 years or 5 years after the assessment period,[5] and $REER_{i,t}$ refers to the REER at the time the assessment was made; as a result, only assessments up to 2005 (for the 3-year horizon) and up to 2003 (for the 5-year horizon) are included in these evaluations. $Misalignment_{i,t}$ is the estimated REER misalignment (either the midpoint of the CGER assessment range or the MB misalignment) for country i at time t. Running a regression of e_t on a constant,

$$e_t = \alpha + \varepsilon_t \quad (2)$$

and evaluating whether $\alpha = 0$ generates the mean prediction error and provides an evaluation of the bias of CGER misalignments. We do this for the full sample, as well as for individual country subsamples.

The top bars in Figures 1(a) and 1(b) show mean prediction errors for the full sample, at the 3- and 5-year horizon. The magnitude of the full-sample mean prediction error ranges between +0.6 percent and -3.2 percent, and is not significantly different from zero (using a simple Student's t-test). At first glance this would suggest the lack of systematic prediction errors, but this is not the case—the rest of Figures 1(a) and 1(b) show that mean prediction errors are large and positive for some countries and large and negative for others.[6]

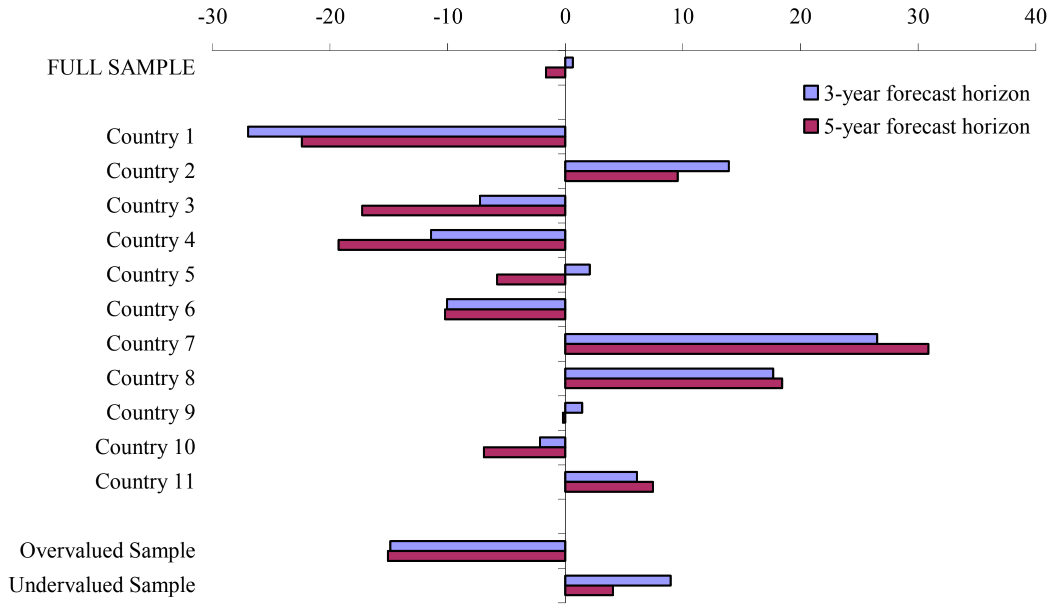
Further examination reveals that these systematic (country-specific) prediction errors arise because misalignments are persistent. If one divides the sample based on whether currencies are assessed to be over- or undervalued (bottom bars of Figures 1(a) and 1(b)), one finds that CGER misalignments tend to underpredict for overvalued currencies (the subsequent depreciation is less than the assessed overvaluation) and overpredict for undervalued currencies (the subsequent appreciation is less than the assessed undervaluation). Put differently, "predictions" based on CGER misalignments get the magnitudes wrong—the magnitude of subsequent real exchange rate changes is often smaller than the assessed misalignments. As noted in the introduction, however, CGER assessments are not meant to be optimal forecasts, but estimates of where a currency is relative to its equilibrium level.

[5] We use 3- and 5-year horizons—as opposed to a shorter horizon of, say, one year—because evidence from error-correction models (e.g., Ricci et al. 2008) suggests slow convergence of the actual REER to the equilibrium REER, with an estimated convergence half-life of about 2½ years.

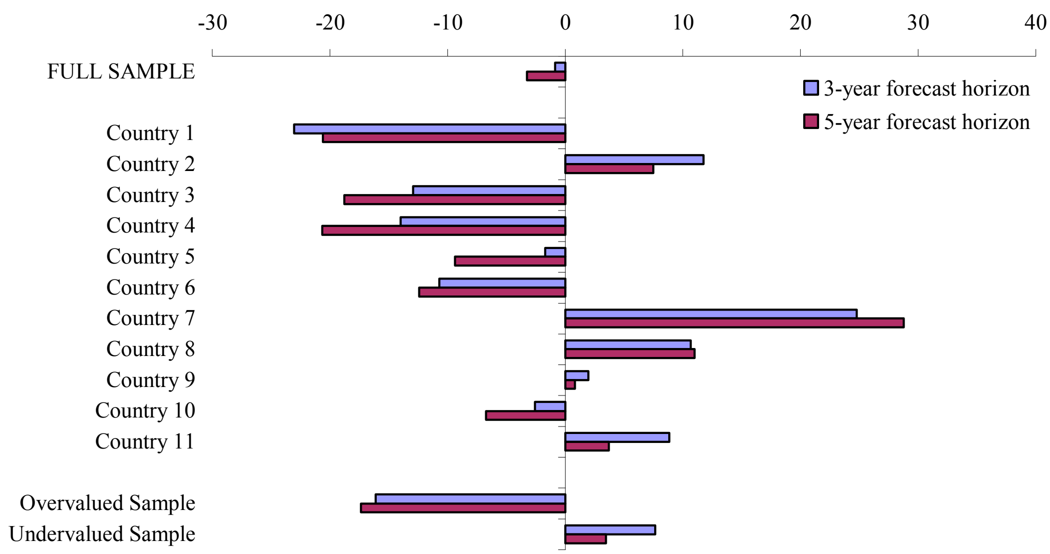
[6] Countries are not identified, for reasons described in footnote 2.

Figure 1. Mean Prediction Error (in percent)

a. Using the CGER MB Misalignment



b. Using the Midpoint of the CGER Assessment Range



Note: The bars show the mean prediction error (defined as actual REER change minus predicted REER change), for the full sample and for individual countries, using 3- and 5-year forecast horizons. The top panel uses the negative of the MB misalignment as the prediction, while the bottom panel uses the negative of the CGER assessment midpoint as the prediction. Countries are not identified, for reasons described in footnote 2.

B. Panel Regressions

We now turn to evaluating CGER misalignments using a panel regression framework. The basic specification that we use to evaluate the misalignment estimates is as follows:

$$\ln\left(REER_{i,t+3/5}\right)-\ln\left(REER_{i,t}\right)=\beta_1\cdot Misalignment_{i,t}+\upsilon_i+\varepsilon_{i,t} \qquad (3)$$

In light of the systematic differences across countries documented in Figure 1, country-specific fixed effects are estimated.[7] Some readers, however, may be interested in seeing the pooled regression results, so for completeness these are reported in Appendix I.

The slope coefficient, β_1, measures the sensitivity of subsequent exchange rate changes to variations in CGER misalignments. A negative value for β_1 would imply that more highly overvalued (undervalued) currencies tend to experience larger depreciations (appreciations) of their real exchange rate over the specified horizon.

As mentioned in the introduction, misalignments in exchange rates can also be narrowed or eliminated through changes in fundamentals, reducing the required adjustment in exchange rates.[8] To control for this, we include as a regressor the change in fundamentals over the 3- or 5-year horizon, as proxied by the change in the estimated equilibrium exchange rate. The modified specification of the regression equation is as follows:

$$\ln\left(REER_{i,t+3/5}\right)-\ln\left(REER_{i,t}\right)=\beta_1\cdot Misalign_{i,t}+\beta_2\cdot\Delta Fundamentals_{i,t+3/5}+\upsilon_i+\varepsilon_{i,t} \qquad (4)$$

where the coefficient β_2 captures the effect of changes in fundamentals on changes in exchange rates. The change in fundamentals in this context is measured by the change in the estimated equilibrium exchange rate. We should expect that an improvement in fundamentals (i.e. a more appreciated equilibrium real exchange rate) should be associated with an appreciation of the actual real exchange rate, other things equal. As such, β_2 is expected to have a positive sign.

The results based on panel regression estimates of equations (3) and (4) are presented in Tables 1 and 2.[9] Table 1 shows the results using the midpoint of the assessments while Table

[7] The Hausman (1978) test that the error term is uncorrelated with the regressors rejects the null hypothesis for many of the regressions below, suggesting that fixed-effects estimation is more appropriate than random-effects estimation. Similar results obtain when using random-effects estimation (not reported).

[8] The "fundamentals" used to calculate the equilibrium exchange rate at time *t* reflects not just current macroeconomic conditions at time *t*, but also projections of future macroeconomic conditions made at time *t*. To the extent that changes between time *t* and *t+k* were in line with these projections, there is no "change in fundamentals;" it is only when realizations are different from the projected path, or there is a shift in projections, that we have a "change in fundamentals."

[9] Robust standard errors are computed to address the serial correlation induced by the use of overlapping observations, as noted in Hansen and Hodrick (1980). Country fixed effects are not reported in Tables 1 and 2,

(continued…)

2 shows the results using the point estimates of the MB approach. The following aspects of the results are noteworthy:

- First, the coefficient β_1 is significantly negative in all specifications. Higher assessments of exchange rate overvaluation (undervaluation) are associated with larger subsequent depreciations (appreciations).
- Second, for both the midpoint of the assessments and the point estimate of the MB approach, the magnitude of β_1 is higher at the 5-year horizon than at the 3-year horizon specifications. This suggests a greater (though not significantly greater) tendency for the real exchange rate to move towards its estimated equilibrium over a longer horizon. This is a reassuring result, as the CGER methodologies employ a medium-term perspective in formulating its assessments, where the medium-term is often thought of as five years, the forecast horizon of the World Economic Outlook.
- Third, the coefficient β_2 is positively signed, as expected, indicating that improvements in fundamentals are associated with more appreciated exchange rates. Once this is controlled for, the effect of higher misalignments on exchange rates are more pronounced.

Table 1. Panel Regression Results using Midpoint of CGER Assessment

	Dependent Variable: Actual Change in REER			
	Over a 3-year horizon		Over a 5-year horizon	
Misalignment from Midpoint of Assessment (β_1)	-0.55	-0.70	-0.80	-0.82
	[5.48]***	[7.22]***	[4.13]***	[5.12]***
Change in MB Fundamentals		0.52		0.38
		[4.32]***		[6.01]***
$H_0: \beta_1 = -1$	P = 0.0013	P = 0.0124	P = 0.3167	P = 0.2750
Observations	165	165	121	121
R-squared	0.14	0.44	0.27	0.47

Robust t statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 2. Panel Regression Results using MB Misalignment Estimate

	Dependent Variable: Actual Change in REER			
	Over a 3-year horizon		Over a 5-year horizon	
Misalignment from MB estimates (β_1)	-0.47	-0.86	-0.83	-1.07
	[2.76]**	[8.71]***	[3.14]**	[5.69]***
Change in MB Fundamentals		0.63		0.52
		[6.41]***		[7.97]***
$H_0: \beta_1 = -1$	P = 0.0013	P = 0.0124	P = 0.3167	P = 0.2750
Observations	185	185	141	141
R-squared	0.09	0.50	0.29	0.63

Robust t statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

but follow a pattern very similar to the mean prediction errors reported in Figure 1; the correlation between them is 0.98.

C. Individual Country Diagnostics

We now assess the performance of CGER misalignment estimates at an individual country level. Data limitations become an important issue here. For each country, we have at most 18 observations comprising the biannual assessments from 1997 to 2005. Given the limited data sample, we rely on a different set of diagnostic tools from the regression specifications in equations (3) and (4).

Three basic diagnostic statistics are used to assess the CGER misalignment estimates at an individual-country level: mean square error (MSE), the "direction of change" statistic, and Theil's U-Statistic.[10]

MSE, a standard metric of predictive performance, in this instance measures the squared distance between the estimated misalignment and the subsequent movement in the real exchange rate. We decompose the MSE into three components—bias, variance and covariance—that allow us to identify the main components of the errors. The "bias" component of the MSE reflects systematic error, in the sense that it captures the degree to which the deviation between the average values of the misalignment estimate and the subsequent exchange rate movements contribute to the overall MSE. The "variance" component of the error instead reflects the ability of the misalignment estimates to replicate the degree of variability in subsequent movements of the exchange rate. The portion of the MSE that is not explained by the bias and the variance component will, by construction, be attributed to the "covariance" component. Ideally, we would like the "covariance" component to be the main driver of the MSE for a particular country. A high "bias" component instead implies that misalignments are persistent—exchange rates that are overvalued or undervalued tend to remain so even after 3 or 5 years.

The direction of change statistic, on the other hand, gives us the proportion of instances where the realized change in the REER was in the same direction as the change predicted in the misalignment estimates. A ratio that is significantly greater than ½ would tell us that the model has been more successful in predicting the sign of the change in the REER than the flip of a fair coin. In the exercise that follows, we measure significance based on a binomial distribution with $p = 0.5$.

Ever since Meese and Rogoff (1983), the standard benchmark against which the MSE of an exchange rate model is compared to is that of a random walk. To subject the CGER assessments to the same test, the third diagnostic that we employ is Theil's (1966) U-statistic, which is the ratio of the MSE of the CGER "prediction" to that of the random walk. A value less than 1 indicates that the model has a lower MSE than the random walk. The Diebold and Mariano (1995) statistic is used to provide an assessment of whether the difference vis-à-vis the random walk is significantly different from one. This statistic, however, relies on an asymptotic variance measure, which may not be appropriate for small samples.

[10] Details of the various diagnostic statistics are given in Appendix II.

Table 3 presents the diagnostics for the point estimates of the MB approach for the individual countries, at 3- and 5-year horizons.[11] The reported mean-squared errors display a large variance across countries, with estimates for the Danish krone and the Canadian dollar occupying the low end of the distribution of errors, and estimates for the Japanese yen and the U.S. dollar being at the high end. The decomposition of the MSE indicates that the bias component accounts for a significant share of the error for majority of the currencies, including the U.S. dollar and the yen, even at a 5-year horizon, indicating that misalignments in these currencies tend to be persistent.

Table 3. Evaluation Diagnostics Using MB Estimates

a. 3-year Horizon

Currency	MSE	Decomposition of MSE: Bias	Variance	Covariance	Direction of Change 1/	U-Statistic	Diebold-Mariano 2/
Australian Dollar	283.3	46%	1%	53%	0.50	1.17	Equal
Canadian Dollar	44.0	10%	50%	40%	**0.74**	0.50	CGER
Danish Krone	31.6	7%	1%	93%	0.56	1.12	Equal
Euro	218.2	2%	15%	83%	0.50	1.10	Equal
Japanese Yen	847.5	83%	5%	12%	**0.26**	1.93	RW
Norwegian Krone	161.0	23%	0%	77%	**0.85**	1.52	Equal
New Zealand Dollar	190.0	28%	24%	48%	0.50	0.89	Equal
Swedish Krona	253.1	76%	4%	20%	0.38	1.98	RW
Swiss Franc	340.6	92%	0%	8%	0.44	3.78	RW
Pound Sterling	150.3	67%	0%	33%	**0.16**	2.25	RW
U.S. Dollar	811.5	90%	0%	10%	0.58	3.13	RW

b. 5-year Horizon

Currency	MSE	Decomposition of MSE: Bias	Variance	Covariance	Direction of Change	U-Statistic	Diebold-Mariano
Australian Dollar	426.9	87%	0%	13%	0.58	0.91	Equal
Canadian Dollar	106.5	32%	60%	9%	**1.00**	0.50	CGER
Danish Krone	11.8	0%	7%	93%	**0.92**	0.60	CGER
Euro	102.7	46%	8%	46%	**0.83**	0.73	CGER
Japanese Yen	984.0	97%	1%	3%	**0.07**	1.97	RW
Norwegian Krone	125.9	44%	0%	56%	**0.78**	1.58	Equal
New Zealand Dollar	334.9	89%	4%	8%	**0.75**	0.83	CGER
Swedish Krona	116.6	78%	2%	19%	0.58	2.35	RW
Swiss Franc	398.4	85%	0%	14%	0.50	3.92	RW
Pound Sterling	141.9	74%	0%	26%	**0.13**	1.95	RW
U.S. Dollar	573.2	87%	2%	10%	**0.73**	2.01	RW

1/ The direction of change statistic gives the proportion of observations where the change in the REER was in the direction predicted by the misalignment. Bold values indicate statistics significantly different from 0.5 at the 5 percent level, based on the appropriate Binomial distribution.

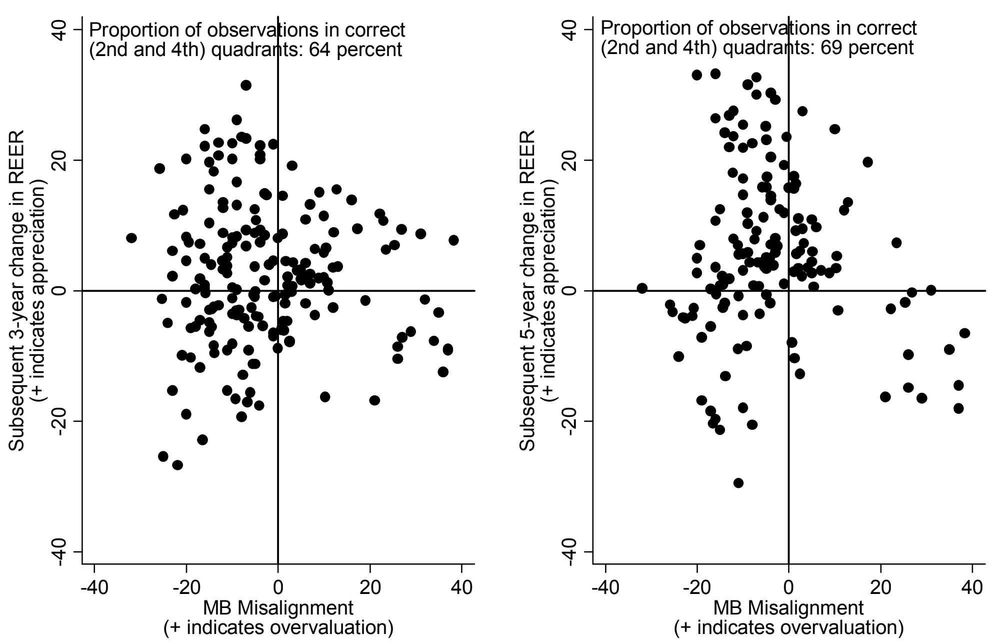
2/ The Diebold-Mariano statistic is computed using MSE as the loss function and evaluated at the 10 percent significance level. We use both a maximum lag of 1 period and the automatic lag selection using the Schwarz criterion. Both lag specifications gave the same results. The benchmark for the Diebold-Mariano statistic is the random walk. "Equal" indicates that the difference between the two MSEs is not significant, "CGER" indicates that CGER misalignment has a significantly lower MSE, and "RW" indicates that the random walk model has a significantly lower MSE.

[11] Countries are named in Table 3 because no information is provided on country-specific misalignments. Diagnostics using the midpoint of the CGER assessment range produce similar results, and are not reported here. In particular, there was no systematic difference in either the MSE or the direction of change statistic between using the midpoint and the MB estimate.

With regard to the direction of change statistic, the MB estimates correctly predict the direction of subsequent exchange rate changes for 4 of the 11 countries at the three-year horizon, and for 8 of the 11 countries at the five-year horizon. The limited number of observations makes a rejection of the null hypothesis of 0.5 difficult. Even then, at the five-year horizon, there are six currencies for which the direction of change statistic is significantly larger than 0.5. CGER gets the direction of change wrong significantly less than half the time for the yen and the pound sterling. Very recent large movements in these two currencies were in the direction predicted by CGER misalignments, but are only reflected in the last observation of the sample. If the REERs for the yen and the pound sterling were to remain at current levels for the next three years, the diagnostic statistics for these two currencies would improve considerably: the direction-of-change statistic would increase from 26 percent to 44 percent for the yen, and from 16 percent to 36 percent for the pound sterling.

A visualization of the direction of change statistic can be obtained from a scatterplot of the actual changes in real exchange rates against their estimated misalignments, which is shown in Figure 2. The horizontal axis measures the MB misalignment estimate, with positive numbers indicating overvaluation, while the vertical axis measures the subsequent change in the real exchange rate over the following three or five years, with positive numbers indicating real effective appreciation. Ideally, observations should lie in the fourth (upper-left) and second (lower-right) quadrants, which would be consistent with an appreciation of undervalued currencies and a depreciation of overvalued currencies. In Figure 2, 64 percent of all observations lie in either the second or the fourth quadrants when observations are made at a 3-year horizon. This number increases to 69 percent when using a 5-year horizon.

Figure 2. Scatterplots of Realized vs. Predicted Changes in REER



We now turn our attention back to Table 3, in particular to the computation of the U-statistic, which measures the ratio of the mean square error based on CGER misalignment assessments to the mean-square error of the random walk model. At the 5-year horizon, we note that CGER misalignment estimates outperform the random walk model (a value of the U-statistic that is less than one) for 5 out of the 11 currencies. The random walk benchmark has typically proved to be a difficult benchmark to beat, so it is somewhat comforting that the CGER exercise manages to outperform it for about half the countries in the sample. It is noteworthy that most of these currencies are "commodity currencies", as analyzed in Chen and Rogoff (2003) and Cashin et al. (2004). Of these five currencies, four are found to have U-statistics that are significantly different from one based on the Diebold-Mariano test.

D. Evaluating Current Account Movements

As part of the estimation of exchange rate misalignments under the MB approach, a measure of the deviation of the current account of a country from the value consistent with its medium-term fundamentals (its "norm") is also computed. In this section, we analyze whether current account balances in countries have tended to move towards their "norm" values. The mean prediction errors for the current account are not reported here, but follow a pattern very similar to the mean prediction errors for the REER documented in Figure 1. A small overall mean prediction error masks substantial individual-country mean prediction errors, which arise because gaps between the actual current account and the estimated equilibrium current account tend to be persistent: subsequent current account movements are often smaller in magnitude than CGER's assessed "current account gap."

Analogous to the evaluation procedure used in the previous section, the basic equation used to evaluate the performance of the current account norm is as follows:

$$\left(CA_{i,t+3/5} - CA_{i,t}\right) = \beta_1\left(CA_{i,t} - \overline{CA}_{i,t}^{norm}\right) + \beta_2 \cdot \Delta\overline{CA}_{i,t+3/5}^{norm} + \upsilon_i + \varepsilon_{i,t} \qquad (5)$$

where $CA_{i,t}$ refers to the current account to GDP ratio for country i at time t , and $\overline{CA}_{i,t}^{norm}$ is the norm for country i estimated at time t. $\Delta\overline{CA}_{i,t+3/5}^{norm}$ is the change in the estimated current account norm that, as in the previous section, captures changes in fundamentals that occur over the 3 or 5 year horizon. As in equations (3) and (4), we are interested in tests of whether β_1 is (i) significantly negative and (ii) close to –1 in value. Table 4 below show the results from this regression.

Table 4. Panel Regression Results using CA Norm

	Dependent Variable: Actual Change in CA			
	Over a 3-year horizon		Over a 5-year horizon	
Deviation from CA Norm (β_1)	-0.76	-1.03	-0.68	-0.85
	[6.88]***	[14.08]***	[4.03]***	[4.99]***
Change in CA Norm		0.61		0.42
		[11.65]***		[2.99]**
$H_0 : \beta_1 = -1$	P = 0.0548	P = 0.7254	P = 0.0930	P = 0.4042
Observations	163	163	130	130
R-squared	0.39	0.56	0.54	0.69

Robust t statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Estimates of the coefficient on the current account gap variable presented in Table 4 show that current accounts that are away from their norm values tend to move in the direction towards eliminating the gap, and that they do so more for longer horizons than for shorter ones. As in the case for the REER misalignment assessments, the effect is also more pronounced once changes in fundamentals are accounted for.

III. Cross-Section Analysis of the Fall 2006 CGER Estimates

In the fall of 2006, the CGER exercise was substantially expanded and overhauled. In recognition of the growing importance of emerging markets in world trade and financial integration, CGER's country coverage was expanded to 27 advanced and emerging market economies (Table 5), representing 90 percent of world GDP and 80 percent of world trade (compared to 70 percent and 60 percent, respectively, using only the 11 advanced economies). The assessment methodologies were also overhauled: the MB and ERER methodologies are now based on estimates using a larger set of countries, and the ES methodology was added (see Lee et al. (2008) for details on the updated methodologies and Box 1 for a summary).

This section analyzes whether REERs have converged towards the equilibrium values estimated in the Fall 2006 CGER exercise, i.e., whether currencies assessed as overvalued have depreciated and currencies assessed as undervalued have appreciated. We start by examining the unconditional relationships between the Fall 2006 CGER assessments and exchange rate movements between July 2006 (the reference period for the Fall 2006 exercise) and September 2008 (the reference period for the Fall 2008 exercise). Throughout the section, we will analyze not just the midpoint of the CGER assessment range, but also the three individual misalignment estimates used by CGER.

Table 5. Country Coverage of the Expanded CGER Exercise (Fall 2006 onwards)

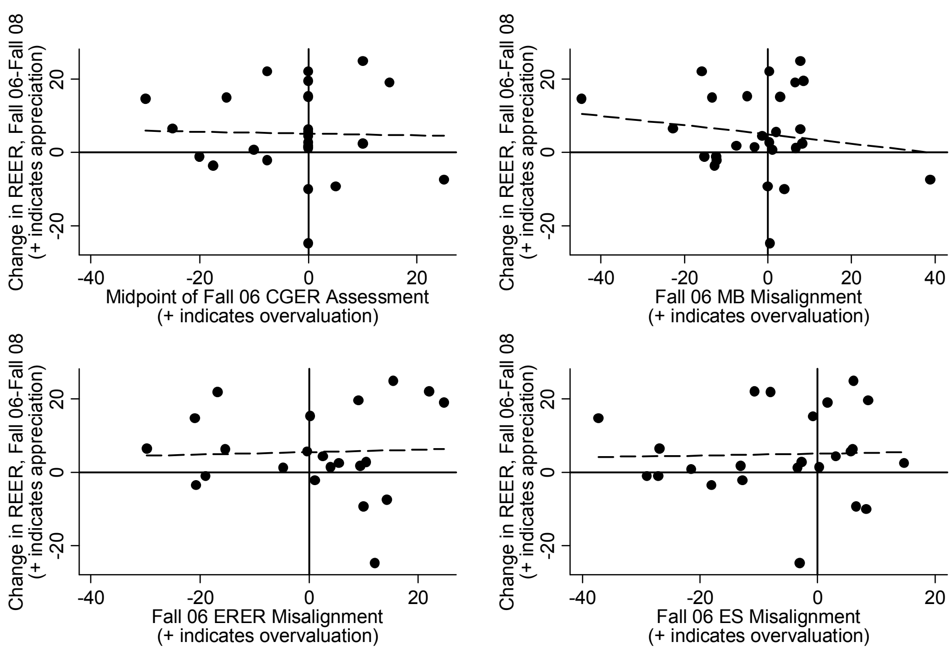
Three Largest Economies	**Emerging Latin America**	**Emerging Asia**
United States	Argentina	China
Euro Area	Brazil	India
Japan	Chile	Indonesia
	Colombia	Korea
Other Advanced Economies	Mexico	Malaysia
Australia		Thailand
Canada	**Emerging Europe**	
Sweden	Czech Republic	**Other Emerging Economies**
Switzerland	Hungary	Israel
United Kingdom	Poland	Pakistan
	Russia	South Africa
		Turkey

An initial comparison of CGER assessments against REER movements between July 2006 and September 2008 does not support unconditional convergence toward CGER's estimated equilibrium (Figure 3). As in Figure 2, the horizontal axis measures the CGER assessment—

either the midpoint of the CGER range or each of the three misalignment estimates—with positive numbers indicating overvaluation, and the vertical axis measures the change in the REER between July 2006 and September 2008, with positive numbers indicating real effective appreciation. The unconditional best-fit lines are mostly flat.

There are obvious caveats regarding these unconditional correlations. First, we are examining REER movements over a two-year horizon, while CGER's focus is on the medium term that is typically defined as five years, the forecast horizon of the World Economic Outlook. Second, the much shorter time horizon makes it essential to control for possible short-run determinants of exchange rate movements, such as interest rates. Third, as in Section II one also needs to control for the possibility that fundamentals—and hence the equilibrium REER—may have adjusted since the Fall 2006 assessments, since changes in fundamentals affect the equilibrium real exchange rate and the size of the required exchange rate adjustment.

Figure 3. Unconditional scatterplots, 27 CGER countries



As in Section II, we control for changes in fundamentals as measured by the change in the estimated equilibrium real exchange rate. We also control for the interest rate differential as of July 2006, measured as a country's short-term interest rate less a world interest rate, the latter proxied by the average of short-term interest rates in the U.S., the euro area, and Japan. Uncovered interest parity would suggest a negative correlation with REER changes, but most empirical evidence, e.g., Burnside et al. (2007) has found a positive correlation.[12] We thus estimate three different specifications:

A. Unconditional

$$\ln(REER_{i,Fall08}) - \ln(REER_{i,Fall06}) = \beta_0 + \beta_1 \cdot Misalignment_{i,Fall06}$$
$$= \beta_0 + \beta_1 \cdot [\ln(REER_{i,Fall06}) - \ln(\overline{REER}_{i,Fall06})] \quad (6)$$
$$[\text{expect } \beta_0 \approx 0, \beta_1 < 0]$$

B. Controlling for changes in fundamentals

$$\ln(REER_{i,Fall08}) - \ln(REER_{i,Fall06}) = \beta_0 + \beta_1 \cdot Misalignment_{i,Fall06}$$
$$+ \beta_2 \cdot [\ln(\overline{REER}_{i,Fall08}) - \ln(\overline{REER}_{i,Fall06})] \quad (7)$$
$$[\text{expect } \beta_0 \approx 0, \beta_1 < 0, \beta_2 > 0]$$

C. Controlling for fundamentals and interest rates

$$\ln(REER_{i,Fall08}) - \ln(REER_{i,Fall06}) = \beta_0 + \beta_1 \cdot Misalignment_{i,Fall06}$$
$$+ \beta_2 \cdot [\ln(\overline{REER}_{i,Fall08}) - \ln(\overline{REER}_{i,Fall06})] \quad (8)$$
$$+ \beta_3 \cdot [IntRate_{i,Fall06} - IntRate_{G-3,Fall06}]$$
$$[\text{expect } \beta_0 \approx 0, \beta_1 < 0, \beta_2 > 0]$$

Regression results using the midpoint of the CGER assessment (Table 6 and Figure 4) suggest that changes in fundamentals, short-term interest rates, *and* the CGER assessment all help predict exchange rate movements during the period under consideration. The first column is the unconditional regression, and merely replicates the unconditional scatterplot result in Figure 3. The second column controls for changes in fundamentals, as measured by the changes in the equilibrium real exchange rates under the MB and ERER approaches.[13] Changes in fundamentals are positively related to changes in the actual REER, with the change in ERER fundamentals being more significant. Once changes in fundamentals are controlled for, the coefficient on the CGER assessment becomes much more negative, and is

[12] In additional regressions (not reported) we also controlled for changes in interest rates over the forecast horizon, in case changes in monetary policy might have influenced the behavior of the exchange rate, but this had no significant influence on the results.

[13] There are two reasons why the change in ES fundamentals was not included in the regression. First, unlike the MB and ERER approaches, the ES approach is not based on a regression and, as such, has no explicit fundamental determinants. The "fundamentals" implicit in the NFA-stabilizing CA are medium-term growth and the NFA position, both of which change very slowly. Second, changes in ES fundamentals are dominated by changes to the underlying medium-term CA, which is already captured in the change in MB fundamentals. In fact, the correlation between the changes in MB and ES fundamentals is extremely high (0.93), so that when one also includes the change in ES fundamentals, both it and the change in MB fundamentals are insignificant.

significant at the 5 percent level. When initial interest rates are added as a control (third column), the coefficient is significantly positive: high interest rate currencies have tended to appreciate, while low interest rate currencies have tended to depreciate. When interest rate differentials are controlled for the coefficient on the CGER assessment becomes even more negative, and is now significant at the 1 percent level. The size of the coefficient gives an indication of the speed of convergence toward equilibrium: for each percentage point of assessed overvaluation, currencies depreciated by 0.7 percentage points on average over the past two years, controlling for other factors.

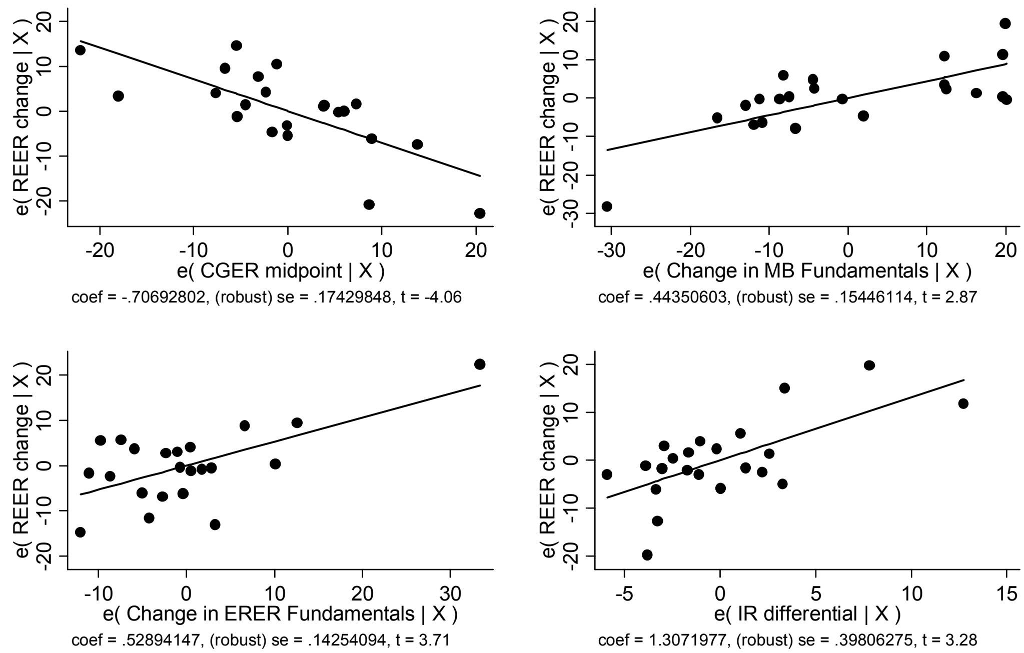
The significant coefficient on the interest rate variable warrants some further discussion. As mentioned earlier, uncovered interest rate parity predicts a negative coefficient—higher interest rate currencies are expected to depreciate and vice-versa. The positive coefficient that we find here reflects the "forward premium puzzle" that has been widely documented in the literature, and which has made carry trade strategies profitable. Does the significant coefficient suggest that CGER assessment should incorporate information from interest rate differentials? The main argument against this is that the CGER exercise, as mentioned before, is not meant to be a forecasting exercise, but rather is an assessment of whether exchange rates are broadly in line with medium-term fundamentals. Short-run interest rate differentials need not—and often do not—reflect these medium-term fundamentals. In addition, the recent unwinding of carry trades suggests caution in interpreting these forward premium puzzle as a stable relationship.

Table 6. Regression Results using Midpoint of CGER Assessment

	Dependent Variable: Change in REER, July 06-Sep 08		
Midpoint of Assessment, Fall 06 CGER	-0.02	-0.47	-0.71
	[0.14]	[2.65]**	[4.06]***
Change in MB fundamentals		0.34	0.44
		[1.74]*	[2.87]**
Change in ERER fundamentals		0.61	0.53
		[3.55]***	[3.71]***
IR differential vis-a-vis G-3, July 06			1.31
			[3.28]***
Constant	5.15	1.39	-2.64
	[2.04]*	[0.54]	[1.22]
Observations	27	22	22
R-squared	0.00	0.50	0.72

Robust t statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Figure 4. Conditional Scatterplots
Using Midpoint of CGER Assessment



Results using individual CGER misalignment estimates are similar to, though not as strong as, the results from using the midpoint of the range (Table 7). The results are qualitatively similar, but the size and significance of the coefficient on misalignment is often smaller than when the midpoint is used.

How much of the reversion toward equilibrium was the result of the substantial exchange rate movements in the fall of 2008? To answer this, we ran the same regression as in column 3 of Table 6, but using REER changes over different horizons (Table 8). If one uses REER changes between July 2006 and July 2008 (second column), one actually finds a larger and more significant coefficient on the CGER assessment. Not surprisingly, the coefficient drops substantially in magnitude and significance as the forecast horizon is reduced to 20 or 14 months (third and fourth columns), but nevertheless stays negative and significant.

Table 7. Regression Results using Individual CGER Methodologies

Using MB Misalignment Estimate	Dependent Variable: Change in REER, July 06-Sep 08		
MB Misalignment, Fall 06 CGER	-0.13	-0.32	-0.45
	[1.15]	[2.03]*	[3.08]***
Change in MB fundamentals		0.48	0.56
		[3.32]***	[4.96]***
IR differential vis-a-vis G-3, July 06			1.18
			[4.48]***
Constant	4.90	4.44	0.14
	[2.08]**	[2.24]**	[0.07]
Observations	27	27	27
R-squared	0.02	0.39	0.59

Robust t statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Using ERER Misalignment Estimate	Dependent Variable: Change in REER, July 06-Sep 08		
ERER Misalignment, Fall 06 CGER	0.03	-0.46	-0.55
	[0.18]	[2.28]**	[2.56]**
Change in ERER fundamentals		0.90	0.87
		[4.52]***	[4.34]***
IR differential vis-a-vis G-3, July 06			0.79
			[2.16]**
Constant	5.50	1.26	-0.93
	[2.14]**	[0.50]	[0.34]
Observations	22	22	22
R-squared	0.00	0.39	0.48

Robust t statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Using ES Misalignment Estimate	Dependent Variable: Change in REER, July 06-Sep 08		
ES Misalignment, Fall 06 CGER	0.03	-0.14	-0.25
	[0.18]	[1.29]	[2.36]**
Change in ES fundamentals		0.61	0.70
		[4.99]***	[6.80]***
IR differential vis-a-vis G-3, July 06			1.15
			[4.63]***
Constant	5.10	5.99	2.07
	[1.78]*	[3.52]***	[1.30]
Observations	24	24	24
R-squared	0.00	0.61	0.79

Robust t statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 8. Regression Results using Midpoint of CGER Assessment, Different Horizons

	Dependent Variable: Change in REER, July 06 to:			
	Sep-08	Jul-08	Mar-08	Sep-07
Midpoint of Assessment, Fall 06 CGER	-0.71	-0.77	-0.43	-0.18
	[4.06]***	[4.70]***	[2.70]**	[1.99]*
Change in MB fundamentals	0.44	0.48	0.36	0.32
	[2.87]**	[4.36]***	[2.65]**	[3.22]***
Change in ERER fundamentals	0.53	0.61	0.32	0.36
	[3.71]***	[4.25]***	[1.93]*	[2.34]**
IR differential vis-a-vis G-3, July 06	1.31	1.32	0.82	0.77
	[3.28]***	[3.64]***	[2.23]**	[3.68]***
Constant	-2.64	-3.33	0.21	-0.28
	[1.22]	[1.54]	[0.10]	[0.23]
Observations	22	22	22	22
R-squared	0.72	0.76	0.53	0.71

Robust t statistics in brackets

* significant at 10%; ** significant at 5%; *** significant at 1%

IV. Conclusion

There is a broad consensus in the economics literature that predicting exchange rates is a daunting endeavor. In this context, the overall findings in this paper are generally supportive of the CGER exchange rate assessments. Estimated REER misalignments and current account gaps have predictive power over future movements in real exchange rates and current accounts, especially over longer horizons and after changes in fundamentals are accounted for. The cross-sectional analysis of the latest CGER methodologies and expanded set of countries also produce encouraging results in spite of a relatively short forecast horizon. Once short-term determinants and changes in fundamentals are accounted for, exchange rates for these countries move in the direction towards reducing their assessed misalignments.

The results in this paper also show, however, that exchange rate misalignments and current account gaps tend to be very persistent. CGER misalignments are good predictors of the direction of subsequent exchange rate movements, i.e., currencies that are assessed to be above (below) their equilibrium value tend to depreciate (appreciate). But the magnitudes of subsequent REER movements are often smaller than the misalignments, so that currencies tend to stay overvalued or undervalued even over a 5-year horizon. As a result, the prediction errors have a substantial systematic bias at the individual country level. Why misalignments are very persistent, even over the medium-term, is a subject we leave for future research.

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Appendix I. Pooled Regression Results

A. Pooled Regression Results using Midpoint of CGER Assessment (Table 1)

	Dependent Variable: Actual Change in REER			
	Over a 3-year horizon		Over a 5-year horizon	
Misalignment from Midpoint of Assessment (β_1)	-0.06	-0.17	-0.18	-0.24
	[0.59]	[3.41]***	[0.79]	[3.09]**
Change in MB Fundamentals		0.59		0.69
		[4.63]***		[5.02]***
Constant	2.50	2.11	4.88	4.39
	[1.43]	[1.88]*	[1.48]	[2.40]**
Observations	165	165	121	121
R-squared	0.01	0.37	0.03	0.48

Robust t statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

B. Pooled Regression Results using MB Misalignment Estimate (Table 2)

	Dependent Variable: Actual Change in REER			
	Over a 3-year horizon		Over a 5-year horizon	
Misalignment from MB estimates (β_1)	-0.03	-0.14	-0.12	-0.22
	[0.28]	[2.82]**	[0.52]	[2.87]**
Change in MB Fundamentals		0.57		0.70
		[4.86]***		[5.33]***
Constant	2.11	1.45	4.96	3.91
	[1.43]	[1.45]	[1.59]	[2.07]*
Observations	185	185	141	141
R-squared	0.00	0.35	0.02	0.45

Robust t statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

C. Pooled Regression Results using CA Norm (Table 4)

	Dependent Variable: Actual Change in CA			
	Over a 3-year horizon		Over a 5-year horizon	
Deviation from CA Norm (β_1)	0.09	0.02	0.31	0.17
	[1.20]	[0.23]	[1.81]	[0.98]
Change in CA Norm		0.28		0.34
		[2.53]**		[1.46]
Constant	0.24	0.27	0.33	0.34
	[0.57]	[0.63]	[0.60]	[0.61]
Observations	163	163	130	130
R-squared	0.01	0.04	0.10	0.14

Robust t statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Appendix II. Description of Diagnostic Statistics

1. Mean square error (MSE)

The MSE is a measure of the deviation of the expected change in the real exchange rate from the actual realized change. It's computed as

$$MSE = \frac{1}{T}\sum_{t=1}^{T}\left(\Delta REER_t^{\exp} - \Delta REER_{t+k}^{actual}\right)^2$$

where $\Delta REER^{\exp}$ refers to the misalignment estimate at time t (with the sign reversed), and $\Delta REER^{actual}$ refers to the realized change in the REER $t+k$ periods ahead ($k = 3$ or 5).

2. Theil's U-Statistic

This statistic is the ratio of the MSE of the model and the MSE of the random walk model.

$$U = \frac{\frac{1}{T}\sum_{t=1}^{T}\left(\Delta REER_t^{\exp} - \Delta REER_{t+k}^{actual}\right)^2}{\frac{1}{T}\sum_{t=1}^{T}\left(\Delta REER_{t+k}^{actual}\right)^2}$$

3. Decomposition of Mean Squared Error

It can be shown that the mean squared error can be decomposed into three terms:

$$U^M = \frac{\left(\bar{Y}^e - \bar{Y}^a\right)^2}{\frac{1}{T}\sum_{t=1}^{T}\left(\Delta REER_t^{\exp} - \Delta REER_{t+k}^{actual}\right)^2}$$

$$U^S = \frac{\left(\sigma^e - \sigma^a\right)^2}{\frac{1}{T}\sum_{t=1}^{T}\left(\Delta REER_t^{\exp} - \Delta REER_{t+k}^{actual}\right)^2}$$

$$U^C = \frac{2(1-\rho)\sigma^e\sigma^a}{\frac{1}{T}\sum_{t=1}^{T}\left(\Delta REER_t^{\exp} - \Delta REER_{t+k}^{actual}\right)^2}$$

where $\bar{Y}^e$ and $\bar{Y}^a$ are the average expected and actual change in the REER respectively. σ^e and σ^a are the standard deviations of the expected and actual changes in the REER and ρ their correlation coefficient.

The proportions U^M, U^S and U^C are called the *bias*, the *variance*, and the *covariance* proportions, respectively, and they are a useful as a means of breaking the prediction error down into its characteristic sources.

The proportion U^M is an indication of systematic error, since it measures the extent to which the average values of the predicted and actual series deviate from each other. The variation proportion U^S indicates the ability of the model to replicate the degree of variability in the variable of interest. If U^S is large, it means that the actual series has fluctuated considerably while the predicted series shows little fluctuation and vice versa. Finally, the covariance proportion measures unsystematic error. Ideally, we would like the source of the prediction error to all be from the correlation component, U^C.

4. Direction of Change Statistic

This statistic computes the proportion of instances where the realized change in the REER was in the same direction as the expected change. As a benchmark for comparison, we would like this ratio to be greater than 0.5, which would be the ratio if the points were scattered randomly. Exact p-values based on the appropriate Binomial (n,k,0.5) distribution are shown in parentheses.

5. Diebold-Mariano Statistic

The Diebold-Mariano statistic compares the predictive accuracy between two competing predictions. It is an asymptotic test and is robust to alternative loss specifications, and both contemporaneous and serial correlation. The three main choices that one needs to make when using this statistic are (i) the competing model, (ii) the loss function and (iii) the maximum lag for the window in which the autocovariances are computed. In this exercise, we have used (i) the random walk as the competing model, (ii) the MSE as the loss function and (iii) both 1 lag and the automatic lag selection using the Schwarz criterion.

Relative to Theil's U-Statistic, the DM statistic can give us exact significance levels under the null that there is no difference between the MSEs of the two competing prediction models.

Appendix III. Data Appendix

- Exchange rate assessments, misalignment estimates, and current account norms are obtained from historical bi-annual CGER notes, which were presented to the managing director of the IMF biannually beginning in March 1997. From March 2001 onwards, the CGER notes were also circulated to the IMF Executive Board.

- Actual changes in the REER are constructed using monthly REER data from the IMF's Information Notice System (INS) database. The reference periods specified in each bi-annual CGER note are used to identify base months, and changes over a 3-year and 5-year horizon are calculated for the panel regressions, while changes between July 2006 and September 2008 (the reference periods for the Fall 2006 and Fall 2008 CGER notes, respectively) are used for the cross-section analysis.

- Changes in the current account to GDP ratio are constructed using the current account and nominal GDP in U.S. dollars from the IMF's World Economic Outlook (WEO) database. The first three observations for Norway are outliers that are dropped, as Norway's CA/GDP ratio increases from zero in 1998 to 15 percent in 2000; nevertheless, including it in the samples (not reported) produces qualitatively similar results.

- Changes in fundamentals used in both panel and cross-section analysis are calculated as differences in equilibrium REERs between two periods. Equilibrium REERs in each period are derived using corresponding MB (or ERER in the case of cross-section analysis) misalignment estimates and INS REER.

- Short-term interest rate differentials used in the cross-section analysis are obtained from the IMF Research Department's Global Data Source (GDS) database. For Pakistan and Poland, which do not have short-term interest rate data in GDS, data from the IMF's International Financial Statistics (IFS) database are used.