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Why Are Exchange Rates So Difficult to Predict?

by Jian Wang

A quarter-century quest hasn't found the elusive links between economic fundamentals and currency values.

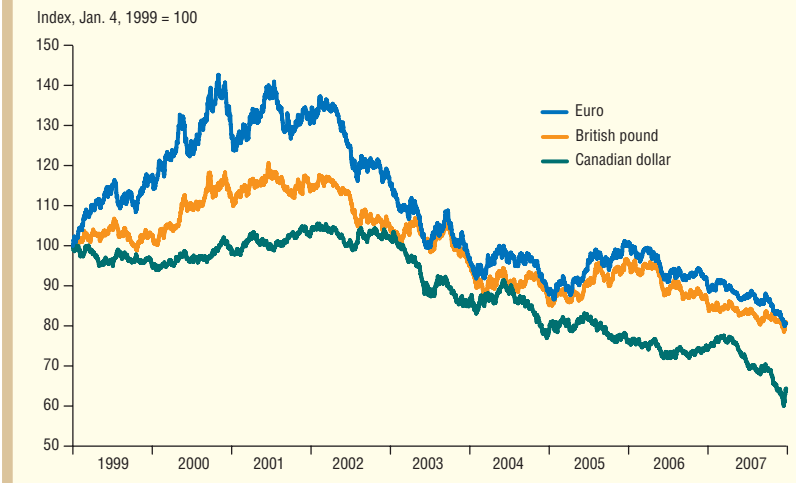
The U.S. dollar has been losing value against several major currencies this decade. Since 2001–02, the U.S. currency has fallen about 50 percent against the euro, 40 percent against the Canadian dollar and 30 percent against the British pound (*Chart 1*).

These steep, prolonged depreciations have brought a new urgency to understanding the factors that move exchange rates. Some way of forecasting them would allow businesses, investors and others to make better, more-informed decisions. Unfortunately, exchange rates are very difficult, if not impossible, to predict — at least over short to medium time horizons.

Economic differences between countries — in such areas as national income, money growth, inflation and trade balances — have long been considered critical determinants of currency values.[1] However, there's no definitive evidence that any economic variable can forecast exchange rates for currencies of nations with similar inflation rates.

Chart 1

Dollar Drops Against Key Foreign Currencies



NOTES: Exchange rates are units of foreign currency per dollar.

SOURCE: Federal Reserve Board of Governors.

A "random walk" model is just as good at predicting exchange rates as models based on fundamentals.

Economists continue to seek the keys to predicting currency values. Some recent research supports the idea that exchange rates behave like financial assets, whose price movements are primarily driven by changes in expectations about future economic fundamentals, rather than by changes in current ones. These studies suggest that the real contribution of standard exchange rate models may not lie in their ability to forecast currency values. Instead, the models imply predictability runs in the opposite direction: Exchange rates can help forecast economic fundamentals.

The Disconnect Puzzle

Supply and demand hold sway on currency exchanges, just as they do in most other markets. Exchange rates ebb and flow depending on the shifting needs of the individuals, firms and governments that buy foreign goods and services, invest abroad, and seek profit or protection through speculation.

The fundamentals that economists link to exchange rates shape the forces of supply and demand. It seems logical, for example, that countries with large trade deficits would see their currencies decline, and countries with strong growth and low inflation would see their currencies rise in value.

But what may be logical in theory hasn't been easy to prove. In 1983, Richard Meese and Kenneth Rogoff challenged the long-held idea that economic fundamentals determine relative currency values.[2] The economists compared existing models to an alternative in which fundamentals are excluded and any exchange rate changes are purely random. They found a "random walk" model just as good at predicting exchange rates as models based on fundamentals.

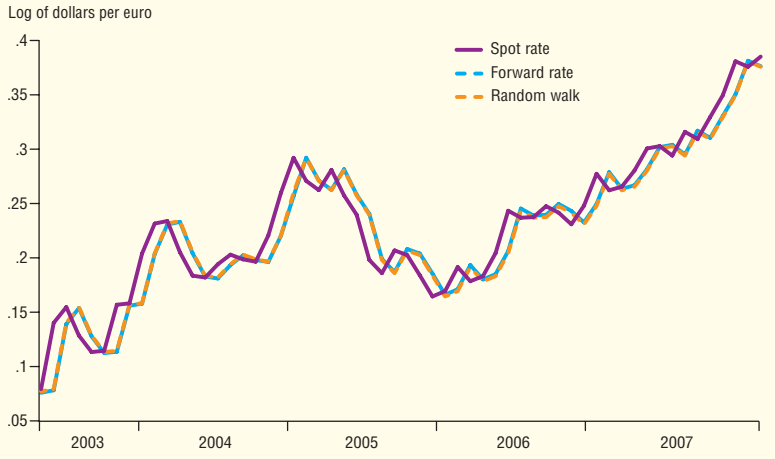
In short, their findings suggest economic fundamentals—like trade balances, money supply, national income and other key variables—are of little use in forecasting exchange rates between countries with roughly similar inflation rates.[3] This result has been labeled the "exchange rate disconnect puzzle."

This disconnect can be illustrated by comparing the one-month forward exchange rate forecast and a random walk, using data for the U.S. dollar against the euro from March 2003 to January 2008 (*Chart 2*). There's no evidence that the forward rate follows the spot rate more closely than a random walk. The results are similar for three other currencies—the British pound, the Canadian dollar and the Japanese yen. Indeed, for the euro, pound and yen, the random walk has smaller prediction errors than forward rates (*Table 1*).[4]

Economists have offered several reasons for the inability to find clear links between exchange rates and economic fundamentals, starting with the inherent limitations of economic models. A typical model relies on coefficients that specify the relationship between exchange rates and fundamentals. Estimates of these parameters are based on historical data, but their predictive power stems from their abil-

Chart 2

Dollar, Euro Take a Random Walk



NOTE: Spot and forward exchange rates are logarithms of spot and one-month forward exchange rates from March 2003 to January 2008.

SOURCE: *Financial Times* data compiled by Haver Analytics.

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Table 1

Forward Rate Forecast vs. Random Walk

(Mean Squared Prediction Errors)

	Euro	British pound	Canadian dollar	Japanese yen
Forward rate	2.143%	2.044%	2.029%	2.112%
Random walk	2.138%	2.023%	2.040%	2.102%
Ratio	100.23%	101.03%	99.45%	100.50%

NOTES: Ratios are calculated using the mean squared prediction errors of forward exchange rates and the random walk. If the ratio is greater than 100 percent, the random walk is more accurate than forward rates in predicting exchange rates.

ity to determine currency values from new data or projections (*see box on page 4*).

In their disconnect-puzzle paper, Meese and Rogoff conjecture that these parameters may vary over time. They note that monetary and other policies in many countries have been in flux since the early 1970s, when the fixed exchange rate regimes of the Bretton Woods system collapsed.

Model misspecification could also be a factor in the exchange rate disconnect puzzle.[5] If the coefficient values are skewed from their true values, forecasts based on these "wrong" parameters can be more off base than those generated by a random walk.

In addition to being difficult to forecast, exchange rates are far more volatile than the economic fundamentals that supposedly determine them. Over a 30-year period, for example, swings in the exchange rate between the U.S. dollar and the British pound have been far wider than the countries' differences in output and inflation (*Chart 3*). The high volatility of

Modeling Exchange Rates

How do economists model exchange rates and economic fundamentals? Actual models may be complex, but a relatively simple one might assume that the exchange rate at time t (s_t) is a linear function of some economic fundamental (f_t) and some error term (ε_t):

$$s_t = \alpha + \beta f_t + \varepsilon_t.$$

We have data for the exchange rate (s_t) and the economic fundamental (f_t) up to time t. The true values of coefficients α and β are unknown, but we can use historical data to estimate them. Let's denote these estimates with $\hat{\alpha}$ and $\hat{\beta}$.

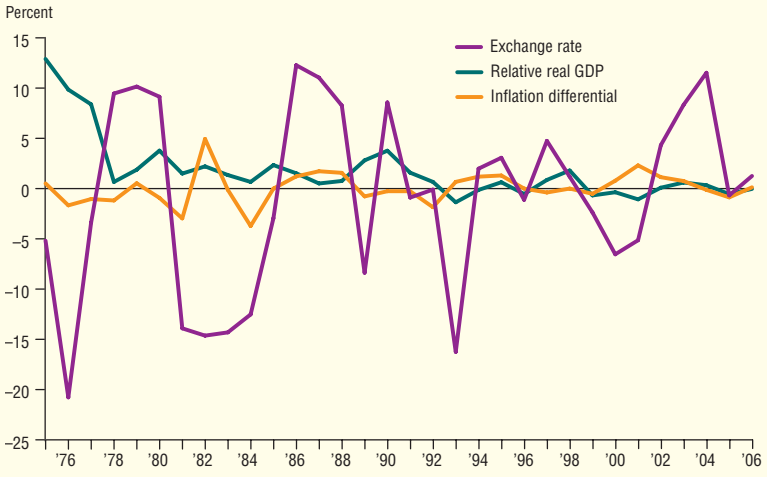
If we have a forecast of the fundamental at time $t + 1$ ($\hat{f}_{t+1}$), we can project the exchange rate at time $t+1$ (s_{t+1}):

$$\hat{s}_{t+1} = \hat{\alpha} + \hat{\beta}\hat{f}_{t+1}.$$

If α and β are constant over time and they capture the true relationship between exchange rates and fundamentals, the model will predict future currency values. If the parameters vary from time to time, or if the parameter estimates are seriously biased, the model may yield incorrect results.

With the longer horizons, fundamentals can outperform a random walk at forecasting long-term changes in exchange rates.

Chart 3
Exchange Rates Vary More Than Key Fundamentals



NOTES: The chart shows percentage changes in the nominal exchange rate (the pound relative to the U.S. dollar), U.K. GDP per capita relative to U.S. GDP per capita, and the inflation differential between the U.K. and U.S.

SOURCE: Haver Analytics.

exchange rates relative to economic fundamentals is very difficult to replicate in a model without introducing arbitrary disturbances.

The fact that standard, fundamentals-based models can't outperform a random walk casts serious doubt on their ability to explain exchange rate fluctuations. The random walk itself does a mediocre job predicting exchange rate movements. It's surprising we can't find some economic

variables to help us beat this poor predictor.

Beyond the Disconnect

Researchers have been probing the relationship between economic fundamentals and exchange rates since Meese and Rogoff first posed the disconnect puzzle.

Various combinations of economic variables and econometric methods have been tried in an attempt to predict exchange rates.[6] These models haven't wholly disproved the idea of a disconnect, but they've found evidence that economic fundamentals matter—at least under some conditions.

For example, longer time frames improve predictability in standard exchange rate models.[7] Models that rely on the money supply, real incomes and other fundamentals do a better job tracking the dollar's movements against the deutsche mark over eight or 12 quarters than one quarter (*Chart 4*).

With the longer horizons, fundamentals can outperform a random walk at forecasting long-term changes in exchange rates. The practical value of these results is limited, however, because of the short-term nature of many decisions affected by currency values.

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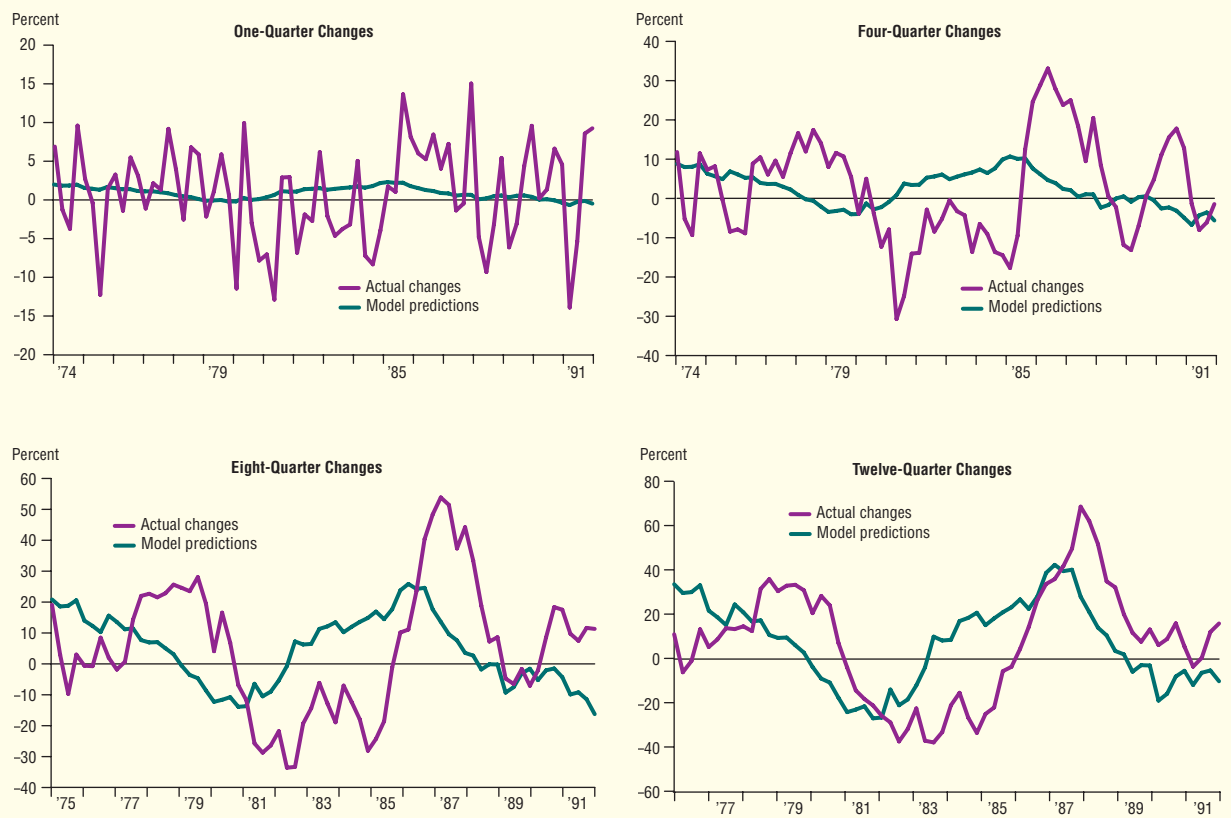
Introducing the possibility of monetary policy feedback can also improve predictability.

Chart 4

Exchange Rate Predictability Improves with Time Horizon



NOTES: Actual changes are in the dollar–deutsche mark exchange rate. Model predictions are from long-horizon regressions: $s_{t+k} - s_t = \alpha_k + \beta_k(f_t - s_t) + \varepsilon_{t+k,t}$, where fundamental f_t includes money supplies and real incomes in the U.S. and Germany.

SOURCE: "Exchange Rates and Fundamentals: Evidence on Long-Horizon Predictability," by Nelson C. Mark, *American Economic Review*, vol. 85, March 1995, pp. 201–18.

predictability. Some central banks take exchange rates into account when setting short-term interest rates. Models that incorporate this feedback from currency values to interest rates can replicate exchange rate data relatively well. One of them looks at the deutsche mark–dollar exchange rate from 1979 through 1998 (*Chart 5*).[8]

Evidence suggests that models incorporating central bank actions can beat a random walk in forecasting exchange rates.[9]

By extending time horizons and introducing central bank actions, researchers have shown links between economic fundamentals and exchange rates. They haven't, however, overturned the pivotal Meese and Rogoff finding that economic fundamentals can't predict exchange rates where it really counts—in the short term. A recent, comprehensive study concluded, "No model consistently outperforms a random walk…. Overall, model/specification/currency combinations that work well in one period will not necessarily work well in another period."[10]

Given the empirical results, should we decide that exchange rates are not determined by economic fundamentals? Probably not. Admittedly, currency values are difficult to predict, and economic fundamentals offer little help. But that doesn't necessarily mean that exchange rates are mainly driven by irrational noise. There are reasons economic fundamentals aren't very helpful in forecasting exchange rates, even if currency values are determined by these fundamentals.

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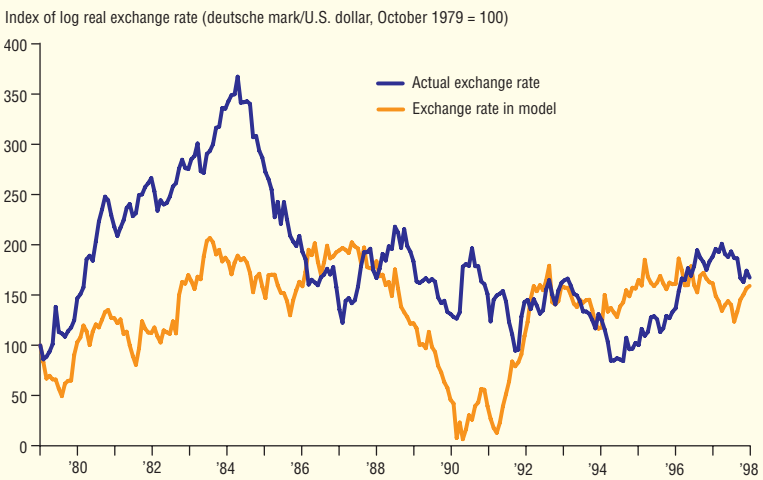
Currencies as Assets

Expectations are at the heart of recent explorations of the exchange rate disconnect.

Economists incorporate expectations into an economic model using an asset-pricing approach. In such models, current data receive far less weight than future factors in determining prices for long-lasting financial assets. For instance, recent dividends

Chart 5
Taking Central Bank Policies into Account



NOTES: Exchange rates in the model are less volatile than actual exchange rates and have been scaled to have the same mean and standard deviation as the actual exchange rate.

SOURCE: "Taylor Rules and the Deutschmark–Dollar Real Exchange Rate," by Charles Engel and Kenneth West, *Journal of Money, Credit and Banking*, vol. 38, August 2006, pp. 1175–94.

are a minor consideration when people buy stocks. More weight is given to expected future dividends and capital gains.

In asset-pricing exchange rate models, currency values are determined not only by current fundamentals but also by expectations of what the fundamentals will be in the future.[11] Current fundamentals receive very little weight in determining the exchange rate. Not surprisingly, they aren't useful in forecasting currency values, and the exchange rate approximately follows a random walk.

Under certain conditions, the asset-pricing approach can explain the greater predictability of exchange rates as time horizons lengthen.[12] Some fundamentals may behave like "noise" that drives exchange rates away from their long-run levels in the short term. As time passes, exchange rates gradually move back to their long-run levels, exhibiting long-horizon predictability.

The short-term noise may be related to fundamentals that aren't observable—for instance, the risk premium for holding a currency. Calculating the premium from survey data reveals that it has no long-run effect on exchange rate movements. In other words, it is stationary. In the short run, the premium can push exchange rates away from their long-run levels. However, they gradually move back over time. In this case, exchange rates can be predicted in the long run but not in the short run.

While the asset-pricing approach doesn't allow us to predict short-term exchange rates, it does lead to an interesting implication: Exchange rates should help forecast economic fundamentals. If the exchange rate is determined by expected future fundamentals, today's currency values should yield information about tomorrow's fundamentals.

Empirical evidence supports this prediction, although it's not uniformly strong. One study, for example, looks at exchange rates in Australia, Canada, Chile, New Zealand and South Africa—all countries where commodities account for a large portion of exports.[13] After allowing for parameter instability, the study finds that exchange rates help predict an economic fundamental—in this case, world commodity prices.

The asset-pricing approach gains further support from research that compares currency markets to other financial markets. One study, for example, examines opportunities arising from the *carry trade*—a term for borrowing in low interest rate currencies while lending in high interest rate ones. The return is positive if exchange rates don't move to offset gains from the rate differential. The results show excess returns are only compensation for the risks investors undertake in the carry trade, suggesting that in some ways exchange rates behave like other assets.[14]

The asset-pricing approach shows promise, but empirical work hasn't yet solved the exchange rate puzzle Rogoff and Meese introduced more than a quarter century ago. Economic models still do a poor job forecasting short-term exchange rates.

This issue has become more pressing. Globalization has made economies more integrated than ever, making exchange rates increasingly important for both businesses and policymakers. Making wise decisions when conducting international business and economic policies requires a better understanding and modeling of exchange rates.

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Notes

[1] For instance, see "A Monetary Approach to the Exchange Rate: Doctrinal Aspects and Empirical Evidence," by Jacob A. Frenkel, *Scandinavian Journal of Economics* 78 (2), 1976, pp. 200–24, and "The Exchange Rate, the Balance of Payments and Monetary and Fiscal Policy Under a Regime of Controlled Floating," by Michael Mussa, *Scandinavian Journal of Economics* 78 (2), 1976, pp. 229–48.

[2] "Empirical Exchange Rate Models of the Seventies: Do They Fit Out of Sample?" by Richard A. Meese and Kenneth Rogoff, *Journal of International Economics* 14, February 1983, pp. 3–24.

[3] This caveat acknowledges that inflation can forecast the exchange rate for countries with hyperinflation. Currencies experiencing hyperinflation will depreciate against currencies with more stable prices.

[4] The prediction errors are measured with mean squared prediction error

$$MSPE = \frac{\sum_{t=1}^{n} (s_t - \hat{s}_t)^2}{n},$$

where s_t is the logarithm of the exchange rate in the data and $\hat{s}_t$ is s_t predicted by a model.

[5] See "Testing Long-Horizon Predictive Ability with High Persistence, and the Meese–Rogoff Puzzle," by Barbara Rossi, *International Economic Review*, vol. 46, February 2005, pp. 61–92.

[6] For instance, see "Why Is It So Difficult to Beat the Random Walk Forecast of Exchange Rates?" by Lutz Kilian and Mark P. Taylor, *Journal of International Economics*, vol. 60, May 2003, pp. 85–107; "The Monetary Exchange Rate Model as a Long-Run Phenomenon," by Jan J. J. Groen, *Journal of International Economics*, vol. 52, December 2000, pp. 299–319; and "Nominal Exchange Rates and Monetary Fundamentals Evidence from a Small Post–Bretton Woods Panel," by Nelson C. Mark and Donggyu Sul, *Journal of International Economics*, vol. 53, February 2001, pp. 29–52.

[7] "Exchange Rates and Fundamentals: Evidence on Long-Horizon Predictability," by Nelson C. Mark, *American Economic Review*, vol. 85, March 1995, pp. 201–18.

[8] "Taylor Rules and the Deutschmark–Dollar Real Exchange Rate," by Charles Engel and Kenneth D. West, *Journal of Money, Credit and Banking*, vol. 38, August 2006, pp. 1175–94.

[9] "Out-of-Sample Exchange Rate Predictability with Taylor Rule Fundamentals," by Tanya Molodsova and David H. Papell, Working Paper, University of Houston, January 2008.

[10] See "Empirical Exchange Rate Models of the Nineties: Are Any Fit to Survive?" by Yin-Wong Cheung, Menzie D. Chinn and Antonio Garcia Pascual, *Journal of International Money and Finance*, vol. 24, November 2005, pp. 1150–75.

[11] "Exchange Rates and Fundamentals," by Charles Engel and Kenneth D. West, *Journal of Political Economy*, vol. 113, June 2005, pp. 485–517.

[12] "Can Long Horizon Data Beat Random Walk Under Engel–West Explanation?" by Charles Engel, Jian Wang and Jason Wu, Working Paper, University of Wisconsin, the Federal Reserve Bank of Dallas and the Federal Reserve Board, June 2008.

[13] "Can Exchange Rates Forecast Commodity Prices?" by Yu-chin Chen, Kenneth Rogoff and Barbara Rossi, February 2008, Working Paper, University of Washington, Harvard University and Duke University. In international commodity markets, the exports from each of these countries are small compared with total world supply. So the value of currencies in these countries has negligible effects on international commodity prices.

[14] "Common Risk Factors in Currency Markets," by Hanno Lustig, Nick Roussanov and Adrien Verdelhan, June 2008, Working Paper, University of California, Los Angeles, Wharton School and Boston University.

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