Engel, Charles

Article
Exchange-rate models

NBER Reporter Online

Provided in Cooperation with:

Suggested Citation: Engel, Charles (2006) : Exchange-rate models, NBER Reporter Online, NBER, Cambridge, Mass, Iss. Fall 2006, pp. 17-20

This Version is available at:
http://hdl.handle.net/10419/61886

Terms of use:
Documents in EconStor may be saved and copied for your personal and scholarly purposes.
You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

---

**Exchange-Rate Models**

Charles Engel*

Recent research that my co-authors and I have undertaken, as well as related research by other NBER researchers, suggests that theoretical models of foreign exchange rates are “not as bad as you think.” Since the 1970s, models have emphasized the role of exchange rates as asset prices. The new work, looking at present-value models of exchange rates, highlights the role of expectations in determining exchange rate movements. In this article, I briefly summarize some of the work that I have been involved with, along with a few related papers by other researchers. I also report on some research that has drawn the implications of this new work on exchange rates for open-economy macroeconomic policy.

---

*Engel is a Research Associate in the NBER’s Program on International Finance and Macroeconomics and a Professor in the Departments of Economics and Finance at the University of Wisconsin.

**Should Exchange Rate Models Out-predict the Random Walk Model?**

For many years, the standard criterion for judging exchange rate models has been, do they beat the random-walk model for forecasting changes in exchange rates? This criterion was popularized by the seminal work of Meese and Rogoff. They found that the empirical exchange rate models of the 1970s that seemed to fit very well in-sample tended to have a very poor out-of-sample fit. The mean-squared error of the model’s prediction of the exchange rate (using realized values of the explanatory variables) tended to be lower than the mean-squared error of the naive model that predicts no change in the exchange rate. While Meese and Rogoff’s exercise was not strictly speaking “forecasting” (because it used realized explanatory variables to “predict” the exchange rate), subsequent work has evaluated exchange rate models by the criterion of whether they produce forecasts with a lower mean-squared error than the simple random walk forecast of no change. Mark’s (1995) paper was important in reviving interest in empirical exchange rate models. He found that the models were helpful in predicting exchange rates at long horizons. Subsequent work has cast doubt on whether exchange rates can be forecast at long horizons, so there is a weak consensus that the models are not very helpful in forecasting. (It is worth noting that there is a contingent that believes that non-linear models have forecasting power. When exchange rates are far out of line with the fundamentals, the models are useful in predicting that the exchange rate will return to its fundamental level.)

West and I question the standard criterion for judging exchange rate models. Many exchange rate models can be writ-
tant fundamentals — errors in money 

ers acknowledge that some of the impor-
exchange rate models because all research-
value models should not be applied to

demand, foreign-exchange risk premiums,
exchange rates are nearly a random walk.

This type of model can be solved for-
toward to express the exchange rate as the
expected present discounted value of cur-
rent and future fundamentals. West and I
demonstrate the following result for this
class of models: if the fundamentals are
integrated of order 1 (that is, their first
difference is stationary), and the discount
factor is close to one, then the exchange
rate will approximately follow a random
walk. One important implication of this
result is that the standard criterion used
in evaluating exchange rate models -- can
the models out-forecast a random walk? -
is not useful here. The Engel-West result
shows that the models actually imply that
the exchange rate will approximately fol-
low a random walk. Evidence that they do
not perform better than a random walk in
forecasting exchange rates cannot be taken
as evidence against the models. In prac-
tice for typical exchange rate models, West
and I show that — given the value of dis-
count factors measured in previous studies
and the empirical properties of the funda-
mentals — the models indeed imply that
exchange rates are nearly a random walk.

Other Means of Evaluating Exchange Rate Models

We argue that the Campbell-
Shiller\(^1\) technique for evaluating present-
value models should not be applied to
exchange rate models because all research-
ers acknowledge that some of the impor-
tant fundamentals — errors in money
demand, foreign-exchange risk premiums,
the equilibrium real exchange rate — are
not observed by the econometrician. The
Campbell-Shiller technique implicitly
requires that we know and observe all of
the relevant fundamentals that determine
the asset price.

But how closely linked are the
“observed” fundamentals to exchange rates? West and I\(^5\) note that, since the exchange
rate is supposed to be the expected present
value of current and future fundamentals,
perhaps the exchange rate is useful in fore-
casting some of the observed fundamen-
tals. In that paper we indeed find (weak)
evidence to confirm the hypothesis. Note
that since the exchange rate also moves
with news about future “unobserved” funda-
mentals, we should not expect it to be
an excellent forecaster of the observed
fundamentals alone.

How Much of the Volatility of Exchange Rates is Accounted for by the “Observed
Fundamentals”?

A separate criticism of the present
value models of exchange rates is that the
volatility of the present value is smaller in
practice than the volatility of the exchange
rate. That is actually the opposite of the
way it should be. Calculating the present
value requires making a forecast of future
fundamentals. Researchers do not have
all the information that the markets use
in constructing forecasts, so their fore-
casts should have higher variance than the
markets’.

An implication of the Campbell-
Shiller technique is that if researchers
used the asset price to forecast the funda-
mentals, they would have all the informa-
tion that markets use, because that infor-
mation is reflected in the asset price. But
the exchange rate reflects information
only about the true fundamental, not the
component of the fundamental observed
by the econometrician. Still, West and
I\(^6\) demonstrate that, again when the dis-
count factor is near one, the variance in
innovations of the discounted sum of
current and expected future fundamen-
tals calculated by the researcher with his
inferior information set is approximately
equal to the variance in innovations of the
present value when forecasts are based on
the market’s information.

With that result in hand, we are able
to ask how the conditional variance of the
discounted present value of expected
observed fundamentals compares with the
conditional variance of the exchange
rate. The answer is that the observed
fundamentals for a few commonly used
exchange rate models account for, on
average, about 40 percent of exchange
rate volatility. While this still means that
either left-out fundamentals account for
much of the volatility, or that there is
excess volatility, it is encouraging rela-
tive to previous work. It no longer seems
so hopeless that an improved exchange
rate model can account for exchange rate
volatility.

Indeed, perhaps such a model can be
developed out of the new line of macro-
economic research that has emphasized
that monetary policy is set as a Taylor
rule: interest rates are set to respond to
inflation, the output gap, and perhaps
other economic variables. West and I\(^7\)
provide some favorable evidence for such
models. We\(^8\) show that the Taylor-rule
model, when expressed as a present value
relationship, has a modest positive cor-
relation with the actual real dollar/DM
rate over the 1979–98 period. An inter-
esting implication of the model is that
an increase in expected future inflation
in a country actually causes the currency
to appreciate. The reason for this is that
under the Taylor rule, the policymaker
raises interest rates more than the increase
in expected inflation. This aspect of the
model plays an important role in tracking
the actual dollar/DM rate.

Mark’s paper is closely related.\(^3\) There
are a few differences, two of which merit
mention here. The first is a minor point
conceptually, but seems to have impor-
tant empirical implications. In modeling
the Taylor rule, Mark allows for sluggish
adjustment in the nominal interest rate,
which is a feature of actual interest rate
behavior that is well known in the lit-
erature. This modification appears to be
partly responsible for the fact that Mark’s
empirical model produces an exchange
rate that is much more volatile than
Engel and West’s — indeed, the model’s exchange rate is slightly more volatile than the actual exchange rate. The second point is important conceptually, but seems to have modest empirical implications. Mark allows for the possibility that agents do not know central bank policy and learn about it over time. While in Mark’s formulation, this modification does not play a large role in explaining movements in exchange rates, I believe it is an important step in trying to get a handle on the formation of expectations.

Another important step in this direction is the contribution of Bacchetta and van Wincoop. They examine exchange rate determination in a simple model in which agents have different information about future economic fundamentals. Perhaps it is most plausible to think of this as different forecasters using different techniques to analyze the future evolution of the economy. They emphasize how agents must try to infer the information that other agents have from the movements in exchange rates. Agents must forecast the forecasts of others — that is, they must form “higher-order beliefs”. Kasa, Walker, and Whiteman have drawn an interesting link between this line of research and my paper with West on volatility. They show that introducing higher-order beliefs into a standard exchange rate model works like an “unobserved fundamental”.

Since expectations are the prime mover of exchange rates and expectations change only when there is news, we can ask whether exchange rates respond to news in the way the models predict. That is exactly the exercise undertaken by Clarida and Waldman. As noted above, Taylor-rule models imply that a country’s currency will appreciate when there is news of higher inflation. Clarida and Waldman examine announcements of inflation rates, compared to survey expectations of what the announced inflation rate will be. They find that when the announcement is that inflation is unexpectedly high, the currency tends to appreciate. That relationship is strong in countries that explicitly target inflation and is weaker or non-existent in countries that do not target inflation.

Conclusions and Implications

It is difficult to evaluate exchange rate models. Models of asset prices in general are difficult to test because asset price changes are driven by changes in expectations of future fundamentals. It is hard for the researcher to measure expectations. The problem is compounded in the case of exchange rates because we know that there are some components of the fundamentals that we cannot directly observe. Still, the recent research first refutes the notion that the failure of the models to predict exchange rate changes is strong evidence against the models. And, there is some favorable evidence: exchange rates contain news about future fundamentals; they are not so excessively volatile as the literature once accepted; Taylor-rule models show some promise; and, exchange rates respond to news in the way the models predict.

In closing I turn to my paper with Devereux, which explores the implications of the fact that exchange rates respond primarily to news about future fundamentals. An overly brief synopsis of the main lesson from the new Keynesian economics is that monetary policy should aim — to the extent it can — to eliminate the distortions introduced by sticky nominal prices. Ideally, monetary policy should try to reproduce the outcome that would be achieved if nominal prices were flexible. We show that, in an open economy there is a problem when we mix the fact that the nominal exchange rate of any country pair responds to news about the future with the fact that there are nominal goods prices that are set in the currency of each country. Then, relative prices – the prices of goods set in one currency relative to those set in another currency — will change when the nominal exchange rate changes. The problem is that those relative prices are changing when there is news about future fundamentals (monetary and real) that drive the nominal exchange rate. If goods prices were flexible, then relative goods prices would not be influenced by news about the future that is driving the nominal exchange rate. This is a distortion in relative prices caused by nominal price stickiness. Our paper argues that, since most of the variation in exchange rates comes from news about these future fundamentals, most exchange rate variation generates inefficient relative price movements. We argue that there is a case for monetary policy to target unexpected changes in nominal exchange rates in addition to targeting inflation.

10. P. Bacchetta and E. van Wincoop, “Can Information Heterogeneity Explain the


**NBER Profile: Torben G. Andersen**

Torben G. Andersen is a Research Associate in the NBER’s Program on Asset Pricing. He is also the Nathan S. and Mary P. Sharp Distinguished Professor of Finance at Northwestern University’s Kellogg School of Management, and is the chair of the International Business and Markets Program there.

Andersen, a native of Denmark, holds an M.S. in Economics and Mathematics from the University of Aarhus, Denmark, and a Ph.D. in economics from Yale University. He joined the Kellogg School faculty in 1991 as an Assistant Professor, was promoted to Associate Professor in 1997, and to full professor in 2000.

Andersen is serving as the editor of the Journal of Business and Economic Statistics for 2004 through 2006. He is currently also an associate editor of the Journal of Financial Econometrics and a member of the advisory editorial board of the Springer Series in Operations Research and Financial Engineering. He has previously served on the editorial board of five additional academic journals.

Andersen is married with three children and lives in Evanston, Illinois. In his free time he enjoys traveling, music, and sports.

**NBER Profile: Andrew B. Bernard**

Andrew Bernard is an NBER Research Associate in the Program on International Trade and Investment and the Jack Byrne Professor of International Economics at the Tuck School of Business at Dartmouth. Originally from New York City, he received his A.B. from Harvard University in 1985 and his Ph.D. in economics from Stanford University in 1991.

Bernard began his academic career in the economics department at MIT in 1991 before joining the Yale School of Management in 1997. In 1999, he left Yale for Tuck where he was promoted to full professor in 2003. At Tuck, Bernard also serves as Senior Associate Director of the Center for International Business.

Bernard’s research examines the role of heterogeneous firms in international trade and investment with an emphasis on how international activity and firm performance interact. His recent research has focused on decisions by multinationals on transfer pricing and the location of production, as well as on the extent and consequences of product switching by U.S. firms. He is an associate editor at the Review of Economics and Statistics and the Journal of International Economics.

Bernard lives in Hanover, New Hampshire with his wife, Corinne Fortune, and their two sons, Spencer and Henry. He enjoys seeing pileated woodpeckers outside his office window and quadrennially prognosticating about the summer Olympics using nothing more than economics.