

## BOOK REVIEWS

Francis Diebold, *Empirical Modeling of Exchange Rate Dynamics*, Lecture Notes in Economics and Mathematical Systems No. 303 (Springer-Verlag, Berlin, 1988) pp. 143, \$19.40.

Francis Diebold's book provides a unified summary of some prominent time series features of exchange rates between the United States and its major trading partners. The main message of this book is that although changes in exchange rates are not themselves predictable, the variances of these changes are. Moreover, according to Diebold's estimates, these conditional variances (that is, the variance of the change in the exchange rate over the next month, conditional on exchange rate data currently available) tend to change sharply over time.

Diebold's primary tool for ordering the information available in exchange rate data is Engle's (1982) notion of autoregressive conditional heteroskedasticity (ARCH). The ARCH model is an appealingly simple parameterization of the conditional variance of exchange rates as a regression of the current variance on past (squared) changes in exchange rates. There is currently a large literature on ARCH models of exchange rates (most of it subsequent to the writing of this book, so rapidly evolving is the field). Diebold's empirical investigation is one of the most thorough and careful.

Before embarking on the empirical investigation, Diebold develops some basic ideas about econometric inference with time series data that are conditionally heteroskedastic. Many of the conventional tools of time series analysis have distributions that change in the presence of heteroskedasticity, substantially reducing the value of these tools. Diebold addresses this problem by developing an alternative version of the Box–Pearce  $Q$  statistic used to test serial correlation that (unlike the usual  $Q$  statistic) is robust to conditional heteroskedasticity. In a small Monte Carlo experiment, this statistic performs as well as the usual  $Q$  statistic in the absence of conditional heteroskedasticity, but performs much better with moderate or severe conditional heteroskedasticity. This is one contribution that warrants close theoretical attention.

The empirical analysis examines monthly nominal exchange rates, quarterly nominal rates, and monthly real rates. A careful application of state-of-the-art econometric tools confirms the conventional wisdom: that past values of the exchange rate have no significant predictive content for future changes in the rate. In contrast, there is substantial predictability in the conditional

variances of both nominal and real exchange rates. As part of this investigation, Diebold examines the same exchange rate data for ARCH effects – first on the monthly level, then aggregated to the quarterly level by selecting every third month. As a matter of theory, ARCH effects will diminish as the sampling interval increases when an integrated process is point sampled: the errors are the accumulation of the errors between each observation, and these accumulated errors (jointly) converge to independent normal variates by the (functional) central limit theorem (as the ratio of the sampling interval to the sample size tends to a nonzero constant). Diebold demonstrates this effect in his data set. This provides a simple and convincing explanation for the relatively weaker ARCH effects others have found using quarterly rather than monthly data.

To interpret these results, it is useful to step back and consider why it might be of interest to consider ARCH models. We can think of three reasons. First, some inferences, e.g. tests of the proposition that the forward discount is an unbiased predictor of changes in the exchange rate, are asymptotically invalid if the series contains conditional heteroskedasticity: either robust procedures (such as Diebold's modified  $Q$ -statistic) need to be used, or the conditional heteroskedasticity should be modeled directly. The second use is as pure data description, to tell us empirical regularities that may be useful in the future development of realistic theories. ARCH models provide convenient parametric summaries of data-dependent variances. Third, the conditional heteroskedasticity can be examined in the context of an economic model in which uncertainty matters to agents' behavior.

The first of these reasons clearly motivates part of Diebold's study. Does the perceived lack of predictability of changes in exchange rates stand up to the closer scrutiny of tests that are robust to conditional heteroskedasticity? After much careful work, the important finding emerges that it does.

A strategy within the second motivation might be to summarize the conditional variance behavior of exchange rates in a way that elucidates the underlying sources of shocks to exchange rates, and therefore guide the way to improving our collective understanding of exchange rate determination. It is ultimately this latter goal to which Diebold, and indeed the literature on ARCH models of exchange rates in general, aspires; but it is here that these applications are the farthest from being fulfilled. Given the limited amount that existing theories of exchange rate determination have to say about conditional moments, it is the job of time series econometricians to ascertain what the important determinants of these conditional moments are. Is volatility in exchange rates predictable from volatility in interest rates? In the spread between foreign and domestic interest rates? In other financial variables? Are periods of instability in the prices of traded goods an important source of predictable variation in variances? Does the predictable variance come from the real side of the economy? Understanding these

simple correlations would have direct implications for the efficacy of attempts to stabilize exchange rates, and would serve as useful guides in developing more sophisticated theories of the evolution of exchange rates. Unfortunately, the ARCH models that populate the recent literature have little to say about these issues; all they tell us is that past volatility in the exchange rate is a useful predictor of future volatility. Plotting an estimated conditional variance series and making some suggestive remarks about international economic events that occurred roughly simultaneously with some of the movements in the conditional variance (which is what Diebold does at one point) does not even achieve the rigor of plotting an observed time series and doing the equivalent visual event study, because the conditional heteroskedasticity series is measured with considerable noise. The important questions about links among variables cannot be answered with univariate time series techniques.

The third use of conditional heteroskedasticity, in models where uncertainty matters for agents' behavior, has the most economic content. One well-specified goal for ARCH is to price options, which requires forecasting future variances. Another is to model the foreign exchange risk premium in the forward exchange market, which again requires a measure of risk. Such ARCH applications do not appear at all in this book, but they have been made in the literature (though they are much less common than the data description studies). One example is Charles Engel and Anthony Rodrigues, 'Tests of International CAPM with Time-Varying Covariances', NBER Working Paper No. 2303, July 1987; *Journal of Applied Econometrics*, 1989, forthcoming. (For further references on the connection between the risk premium, options prices and ARCH in the context of exchange rates, see Jeffrey Frankel, 'Recent Estimates of Time-Variation in the Conditional Variances and in the Exchange Risk Premiums', *Journal of International Money and Finance*, 7, 1988, pp. 115-125.)

An important building block of a wide class of models of exchange rate determination is the proposition that the real exchange rate has a tendency to regress towards a constant (or trend), that there is a large autoregressive component to deviations from purchasing power parity. The last chapter of Diebold's book is devoted to testing movements in the real exchange rate. Like many others before him, the author concludes, 'that monthly real dollar spot exchange rates, like the monthly nominal rates upon which they are based, evolve as approximate random walks...'. More precisely, the finding is that the tests 'can detect no serial correlation' in changes in the real exchange rate.

One of the first lessons taught in any good undergraduate econometrics course is the principle that a statistical 'failure to reject' a null hypothesis like the random walk does not entitle the statistician to claim to have found the null hypothesis to be true, that low power of the test could always be the

explanation. This basic lesson is increasingly ignored in econometrics, at least as applied to modern macroeconomics.

It used to be that the goal in econometric work was to get results that were statistically significant, to reject the null hypothesis. In order for an author to stand up in front of a conference proudly, or to expect to publish his paper in a journal, he or she sought to get significant results. (This system was not without drawbacks, of course. Many econometricians adopted the shady practice of trying out many different functional forms, combinations of variables, and sample periods in their regressions, until they found results that appeared as statistically significant.)

It is difficult to get 'good' results in macroeconomics. The world is a complicated place; it is unlikely that the few key variables that emerge from the particular theory that one has developed will actually go far toward explaining a real-world time series. So what we have done – quite cleverly – is to redefine the rules. Now the goal is to *fail* to reject the null hypothesis, to get results that are statistically *insignificant* – in essence, to find *nothing*. It is far easier to find nothing than to find something. Typically one fails to reject many hypotheses every day, even in the shower or on the way to work.

The hypothesis that the real exchange rate follows a random walk is a favorite one to fail to reject. This is in part because it is easy to fail to reject this hypothesis. (In other words, it is in truth difficult to reject the hypothesis that the real exchange rate follows a random walk, or comes close to it.) A typical estimate is that the speed of adjustment of the real exchange rate to long-run equilibrium is 3 percent a month (an autoregressive coefficient of 0.97), or 30 percent a year (an autoregressive coefficient of 0.70). But the typical finding is also that this speed is not significantly greater than zero, which is consistent with Diebold's conclusion. This random-walk conclusion would be surprising from the viewpoint of standard theory. (Some economists claim to consider such empirical conclusions to be evidence *in favor* of an equilibrium condition or economic theory of some sort; but it is highly surprising that they make this claim.) Is the conclusion in fact justified by the evidence?

Our answer is that if the hypothesis of slow regression to PPP were correct, one *should not expect* to be able to reject a random walk on the mere 13-plus years of post-1973 data that Diebold and almost all of the other studies use. A formal way to make this point would be to note that the power of the unit root test against a stationary alternative is low. An informal calculation highlights this point. Consider the estimated speed of adjustment to PPP of 0.03 per month, or 0.30 per year. A simple calculation of the standard error reveals that one should not expect to be able to reject statistically the hypothesis that the coefficient is zero unless one has at least 49 years of data. If the observations are monthly, then 47 years of data will do. (This calculation and the test results for U.K.–U.S. data from 1869 to

1987 appear in Jeffrey Frankel, 'Quantifying International Capital Mobility in the 1980s', NBER Working Paper 2856, February 1989; in D. Bernheim and J. Shoven, eds., *Saving*, University of Chicago Press, Chicago, forthcoming.)

A long time series for the real exchange rate is available for the dollar/pound sterling rate. Tests of the speed of adjustment toward PPP give the following results. On post-1973 data, the speed is not statistically greater than zero. On post-1945 data, it still does not quite appear statistically greater than zero (using the correct Dickey-Fuller test). But, as we have noted, this is precisely what one would expect from 43 years of data if the true speed were 0.30 per year or less. On the complete data set of 1869-1987, the speed of adjustment is clearly statistically greater than zero. In our view this not only tends to vindicate the hypothesis of slow regression toward PPP, but also provides a neat illustration of the irrelevance of tests that 'find nothing' or 'fail to reject the null hypothesis', merely because they have not looked in the right places. (As this sample period mixes different exchange rate regimes, it would be desirable to allow for heteroskedasticity and for different speeds of adjustment during different sub-periods.)

Honing econometric tools is an important function of the econometrician, and by this criterion Diebold's study of the time-series properties of exchange rates is well executed and useful. But when one looks beyond the book to ask how these well-honed tools are being applied, one has to wonder whether the tools are not being studied as ends in themselves.

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Helen V. Milner, *Resisting Protectionism: Global Industries and the Politics of International Trade* (Princeton University Press, Princeton, New Jersey, 1988) pp. 329 + xiii, \$29.50.

*Resisting Protectionism* is a fascinating book. The author's thesis is that import penetration alone does not determine whether firms are protectionist: their advocacy of protection is also a function of their 'multinationality'.

Multinationality is defined as the extent of the firm's international involvement, in practice taken by the author to mean the fraction of its total investment which is in overseas plants. Professor Milner expounds the thesis, and then proceeds to examine the extent to which firm behavior conforms to her hypothesis through a series of case studies. They cover six American industries in the 1920s (woollen goods, watches and clocks, textile machinery, fertilizer, photographic equipment, and newsprint), six American industries in the 1970s (footwear, machine tools, semiconductors, radios and televisions,