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Web Essay

The failure of empirical exchange rate models: Room for optimism?

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Is there any room for optimism when assessing the empirical performance of exchange rate models? Surprisingly, there is – in spite of countless surveys showing that at horizons less than two years the explanatory power of empirical exchange rate models is essentially zero. (The seminal finding dates back to Dick Meese and Ken Rogoff's 1983 paper in the *Journal of International Economics*, with recent surveys including the 1995 chapter in the *Handbook of International Economics* by Jeff Frankel and Andy Rose and the 2002 *Economic Policy* Web Essay by Ken Rogoff.) How can this be?

There's a sense in which the Meese-Rogoff "puzzle" has been resolved, and there's a sense in which it hasn't. There are two versions of the puzzle:

(1) Macro variables cannot account for exchange rates empirically.

(2) No well-specified model can account for exchange rates empirically.

The first version of the puzzle does indeed remain unresolved. (Read "exchange rates" as referring to major floating rates against the U.S. dollar and "account for" as referring to horizons less than two years.) I take this first version to be the most faithful interpretation of both the original Meese-Rogoff work and the subsequent surveys: these authors are careful to refer to the relevant class of models as "structural macro," or "traditional macro," or "canonical macro."

On the other hand, the second version of the puzzle continues to trouble many people who are not specialists in this area – yet this puzzle *has* been recently resolved. Further-

more, its resolution may help us to understand why macro variables alone can't do the job, so the first version of the puzzle may not be such a puzzle after all.

The Broad Puzzle Resolved

In what sense, then, do we have a well-specified model that can account for exchange rates empirically? The answer to this question requires a bit of background (because the empirical approach is not from the tradition of macro econometrics). There is a large micro-empirical literature (mostly in finance journals) that addresses the mechanism by which security prices change. Important early papers in this line include the 1988 article by Larry Glosten and Larry Harris, the 1991 article by Joel Hasbrouck, and the 1991 article by Ananth Madhavan and Seymour Smidt. These papers, and a long line of subsequent empirical papers, use transaction-level data to sort out exactly what is moving prices. Is it public information that gets into price independently of trading? Or is price moving as a function of trading itself, perhaps because trades convey information that is not observable any other way (at least in the short run)? Importantly, these empirical techniques are firmly grounded in the theoretical breakthroughs of the mid 1980s by Pete Kyle, Larry Glosten, and Paul Milgrom. They have strong micro-foundations, and these include a precise account of causality.

A 2002 paper by Martin Evans and myself applies this same micro-empirical approach to the two largest floating exchange rate markets (dollar/DM and dollar/yen). Though we use transaction-level data (newly available due to the advent of electronic trading in FX), we estimate our micro-empirical model at the daily frequency. Unlike intraday nominal rates, which display mean reversion, daily exchange rates are essentially a random walk, meaning that past changes do not forecast subsequent changes. This means our explanations are as relevant to the long horizons that interest macroeconomists as they are to short horizons.

What do we find? The flow of buy and sell transactions (namely the running tally of buyer-initiated trades minus seller initiated trades) explains about two-thirds of the daily variance in the dollar/DM rate and about one-half of the daily variance in the dollar/yen rate. These results compare quite favorably to the macro-econometric models of exchange rate determination, which generally explain less than five percent of exchange rate variation. Other empirical work within this micro-empirical approach (such as that by Richard Payne and Dagfinn Rime) finds broadly similar results. It is in this sense, then, that one can disagree with the view that we have no well-specified models that can account for exchange rates.

Though these results are consistent with the micro-foundations of the motivating micro theory, they are not consistent with the micro-foundations of traditional macro theory. Why not? In traditional macro exchange rate theory, all information relevant to exchange rates ("fundamentals") is publicly available, and the implications of that information for market-clearing exchange rates are common knowledge. In this information environment, the trading process (the flow of transacted buy and sell orders) cannot convey incremental information about the appropriate level of the exchange rate, so transacted order flow should not be relevant to price determination. (Thus, order flow is not equivalent to demand:

in macro models, good news raises demand, which raises price, but rational agents are not willing to *transact* at interim prices.) In the micro theory underlying our empirical approach, in contrast, some types of information that are relevant to exchange rates are dispersed throughout the economy, and are not immediately available to any one individual (or subset of individuals) in aggregated form. In this information environment, market participants are continually aggregating signals of dispersed information, and some of these signals take the form of transacted orders in foreign exchange. The transacted orders, then, convey information that needs to be aggregated in the price, which is why the trading process per se is so important for price determination. (Does the FX market aggregate dispersed information? Surely it does—that is a natural function of all securities markets.)

The Driving Variables: Fundamentals = Macro?

Though these micro-empirical results resolve the broad puzzle, they are not fully satisfying. Only when one has uncovered what is driving transacted order flow will this approach be complete. (Order flow is a proximate cause, not the underlying cause, of exchange rate movements.) Uncovering the drivers would also resolve the narrow puzzle of macro variables' inability to account for exchange rates. So let me offer some perspective on the current direction of research.

Understanding order flow amounts to understanding what information it conveys. Within asset pricing more broadly, there are two basic types of information: information about expected *payoffs* to holding the asset (dividends in a dividend-discount model of stock prices, or interest differentials in FX, for example) and information about *discount rates* (sometimes referred to as information about expected returns, or, more recently, as information about pricing kernels). Disentangling these two drivers of asset-price changes is the focus of much recent empirical work (by John Campbell and Bob Shiller, for example). A punch line of that empirical work is that most (e.g., 70 percent) of variation in (aggregate) equity values appears to be due to changes in discount rates rather than to changes in expected payoffs.

Now, in foreign exchange, it is important to recognize that the macro models addressed empirically by Dick Meese and Ken Rogoff are all models that define the term "fundamentals" narrowly to include only drivers of expected payoffs; this notion of fundamentals does not include any drivers of equilibrium discount rates. (Put differently, the narrow category of fundamentals in traditional macro models would affect price even in a risk neutral world, whereas fundamentals related to discount rates play a role only in a world where risk affects prices.) If foreign exchange is similar to equity in that changing expectations of payoffs (narrow fundamentals) are not driving much monthly variation in prices, then empirical models based on those narrow fundamentals would be expected to do poorly. Consistent with this, if the information that transacted order flows are helping the market to aggregate is largely discount rate information, then order flows would be expected to perform favorably in similar regressions, as they do.

Though conceptually reasonable, this explanation for the ability of order flow to account for exchange rates requires different-currency assets to be imperfect substitutes. As an empirical matter, imperfect substitutability across different-currency assets is still an open issue. Though increasingly used as a basis for theoretical work (see recent papers by Cavallo et al. and Martin and Rey), there is still the nagging reality of poor empirical performance by models of imperfect substitutability (see a long line of tests of the portfolio balance model of exchange rates). Without more confirming evidence that substitutability is imperfect, the theoretical possibility that order flow is conveying dispersed information relevant to discount rates remains just that, a possibility. (The large literature documenting home-country bias in portfolios is suggestive of imperfect substitutability, but the bias may be due to other factors.)

Is there any way to understand why order flow conveys information without having to appeal to a broadened set of fundamentals (i.e., discount-rate-related variables)? Yes. Suppose market participants draw different insights about future payoffs from common macroeconomic data—narrow fundamentals. (Those with superior ability, we might imagine, would likely be managing international assets in a hedge fund, mutual fund, bank proprietary trading desk, etc.) In this setting, the orders of high-ability participants convey information about their changing expectations, which is then impounded in price. If this story were true, then one would expect order flow to forecast future narrow fundamentals (relative interest rates, money supplies, output levels, etc.). Moreover, to be consistent with the Meese-Rogoff findings, the narrow fundamentals that order flow is forecasting would have to be largely beyond the one-year horizon. This is conceivable, but not so likely

Measured Optimism for the Next Step

What are the next steps toward resolving, potentially, the Meese-Rogoff puzzle in its narrow form? Within the micro-empirical approach, three strategies are emerging. The first strategy addresses the story of the previous paragraph (different insights about payoffs) by examining whether order flow has the predicted forecasting power over macro fundamentals. (Under this story, the exchange rate is informationally very *efficient*: order flow serves to "telescope" dispersed information about distant payoffs into current price.) Only recently have data on FX order flow of sufficient length for this analysis become available. (See related survey results by Gehrig and Menkhoff.)

The second strategy within the micro-empirical approach that may shed light on the Meese-Rogoff puzzle in its narrow form relies on disaggregation. That is, a nice property of order flow (relative to price) is that one can split it into pieces and ask whether some of the pieces have more price impact, dollar for dollar, and if so, whose orders are the most informationally potent. Evidence along these lines suggests that the price impact of orders does indeed depend on the source: the trades of financial institutions have much greater price impact, dollar for dollar, than the trades of non-financial institutions (see the 2001 book by Lyons). This casts new light on the underlying information structure: who has the information and what type of information that is likely to be.

The third strategy that may shed light on the Meese-Rogoff puzzle in its narrow form uses an event-study approach focusing on macro announcements. As noted above, publicly observed macro announcements do not induce systematic buying or systematic selling under the information-economic assumptions of traditional macro models. (Though trading volume may occur in response to announcements in traditional models—perhaps due to idiosyncratic portfolio rebalancing—there is no reason to expect order flow, i.e., no reason to expect trades to be initiated systematically on the buy side or on the sell side.) Early work along these lines suggests instead that even at times when the market is digesting announcements, order flow plays a central role in price adjustment (perhaps because market participants do not agree on the implications of the commonly observed data for market-clearing exchange rates; see Evans and Lyons 2001).

Finally, a couple of limitations of the micro-empirical approach deserve note. First, order flow data are not yet as readily available as the macro data used to estimate structural macro models. And many of the order flow datasets that do exist reflect such a small share of the type of trading being analyzed that firm conclusions are difficult (for instance, data that cover a small percentage of trading may produce little evidence of flow effects on price only because errors in variables implies low statistical power). Second, empirical identification of order flow's information content depends, in essence, on an ability to identify for every transaction which of the two demand curves has shifted (the other counter-party's trade representing induced movement *along* a given demand curve; in the micro-empirical literature, the former is termed the "initiator" or the "aggressor".) This is sometimes difficult, depending on market structure (a dealer market versus an auction market, for example) and depending on the richness of the data available.

References

Campbell, J. (1991), 'A Variance Decomposition for Stock Returns,' *Economic Journal*, 101, 157-179.

Campbell, J., and J. Ammer (1993), 'What Moves the Stock and Bond Markets? A Variance Decomposition of Long-Term Asset Returns,' *Journal of Finance*, 48, 3-38.

Campbell, J., and R. Shiller (1988), 'The Dividend-Price Ratio and Expectations of Future Dividends and Discount Factors,' *Review of Financial Studies*, 1, 195-228.

Cavallo, M., F. Perri, N. Roubini, and K. Kissilev (2002), 'Exchange Rate Overshooting and the Costs of Floating,' typescript, New York University, March.

Evans, M., and R. Lyons (2001), 'Why Order Flow Explains Exchange Rates,' typescript, U.C. Berkeley, November, at <haas.berkeley.edu/~lyons/wp.html>.

Evans, M., and R. Lyons (2002), 'Order Flow and Exchange Rate Dynamics,' *Journal of Political Economy*, 110: 170-180.

Frankel, J., and A. Rose (1995), 'Empirical Research on Nominal Exchange Rates,' in G. Grossman and K. Rogoff (eds.), *Handbook of International Economics*, Elsevier Science: Amsterdam, 1689-1729.

Gehrig, T., and L. Menkhoff (2002), 'The Use of Flow Analysis in Foreign Exchange: Exploratory Evidence,' typescript, *Journal of International Money and Finance*, forthcoming.

Glosten, L., and L. Harris (1988), 'Estimating the Components of the Bid-Ask Spread,' *Journal of Financial Economics*, 21, 123-142.

Glosten, L. and P. Milgrom (1985), Bid, Ask, and Transaction Prices in a Specialist Market with Heterogeneously Informed Agents. *Journal of Financial Economics* 14, 71-100.

Hasbrouck, J., (1991), 'Measuring the Information Content of Stock Trades,' *Journal of Finance*, 46, 179-207.

Kyle, A. (1985), 'Continuous Auctions and Insider Trading,' *Econometrica* 53, 1315-1335.

Lyons, R. (2001), *The Microstructure Approach to Exchange Rates*, MIT Press: Cambridge, MA, published December, chapters at <haas.berkeley.edu/~lyons/NewBook.html>.

Madhavan, A. and S. Smidt (1991) 'A Bayesian Model of Intraday Specialist Pricing,' *Journal of Financial Economics* 30, 99-134.

Martin, P., and H. Rey (2002), 'Financial Globalization and Emerging Markets: With or Without Crash?' typescript, Princeton University, March.

Meese, R., and K. Rogoff (1983), 'Empirical Exchange Rate Models of the Seventies,' *Journal of International Economics*, 14, 3-24.

Payne, R. (2000), 'Informed Trade in Spot Foreign Exchange Markets: An Empirical Investigation,' typescript, London School of Economics, September, at <http:// fmg.lse.ac.uk/~payne>.

Rime, D., (2000), 'Private or Public Information in Foreign Exchange Markets? An Empirical Analysis,' typescript, University of Oslo, March, at <www.uio.no/~dagfinri>.

Rogoff, K. (2002), 'The Failure of Empirical Exchange Rate Models: No Longer New, but Still True,' Web Essay, *Economic Policy*, at <www.economic-policy.org/commentaries.asp>.