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Out-of-sample exchange rate predictability with Taylor rule fundamentals

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ABSTRACT

An extensive literature that studied the performance of empirical exchange rate models following Meese and Rogoff's [Meese, R.A., Rogoff, K., 1983a. Empirical Exchange Rate Models of the Seventies: Do They Fit Out of Sample? Journal of International Economics 14, 3–24.] seminal paper has not convincingly found evidence of out-of-sample exchange rate predictability. This paper extends the conventional set of models of exchange rate determination by investigating predictability of models that incorporate Taylor rule fundamentals. We find evidence of short-term predictability for 11 out of 12 currencies vis-à-vis the U.S. dollar over the post-Bretton Woods float, with the strongest evidence coming from specifications that incorporate heterogeneous coefficients and interest rate smoothing. The evidence of predictability is much stronger with Taylor rule models than with conventional interest rate, purchasing power parity, or monetary models.

1. Introduction

The failure of open-economy macro theory to explain exchange rate behavior using economic fundamentals has prevailed in the international economics literature since the seminal papers by Meese and Rogoff (1983a,b), who examine the out-of-sample performance of three empirical exchange rate models during the post-Bretton Woods period and conclude that economic models of exchange rate determination of the 1970's vintage do not perform better than a random walk model. While, starting with Mark (1995), a number of studies have found evidence of greater predictability of economic exchange rate models at longer horizons, these findings have been questioned by Kilian (1999). The recent comprehensive study by Cheung, Chinn and Pascual (2005) examines the out-of-sample performance of the interest rate parity, monetary, productivity-based and behavioral exchange rate models and concludes that none of the models consistently outperforms the random walk at any horizon.

There is a disconnect between most research on out-of-sample exchange rate predictability, which is based on empirical exchange rate models of the 1970s, and the literature on monetary policy evaluation, which is based on some variant of the Taylor (1993) rule. A recent literature uses Taylor rules to model exchange rate determination. The Taylor rule specifies that the central bank adjusts the short-run nominal interest rate in response to changes in inflation and the output gap. By specifying Taylor rules for two countries and subtracting one from the other, an equation is derived with the interest rate differential on the left-hand-side and the inflation and output gap differentials on the right-hand-side. If one or both central banks also target the purchasing power parity (PPP) level of the exchange rate, the real exchange rate will also appear on the right-hand-side. Positing that the interest rate differential equals the expected rate of depreciation by uncovered interest rate parity (UIRP) and solving expectations forward, an exchange rate equation is derived.

Engel and West (2005) use the Taylor rule model as an example of present value models where asset prices (including exchange rates) will approach a random walk as the discount factor approaches one. Engel and West (2006) construct a "model-based" real exchange rate as the present value of the difference between home and foreign output gaps and inflation rates, and find a positive correlation between the "model-based" rate and the actual dollar-mark real exchange rate. Mark (2007) considers Taylor rule interest rate reaction functions for Germany and the U.S. and estimates the real dollar-mark exchange rate path assuming that the exchange rate is priced by uncovered interest rate parity. He provides evidence that the interest rate differential can be modeled as a Taylor rule differential and the real dollar-mark exchange rate is linked to the Taylor rule fundamentals, which may provide a resolution for the exchange rate disconnect puzzle. Groen and Matsumoto (2004) and Gali (2008) embed Taylor rules in open economy dynamic stochastic general equilibrium models and trace out the effects of monetary policy shocks on real and nominal exchange rates, respectively.

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In this paper, we examine out-of-sample exchange rate predictability with Taylor rule fundamentals. The starting point for our analysis is the same as for the Taylor rule model of exchange rate determination, the Taylor rule for the foreign country is subtracted from the Taylor rule for the United States (the domestic country). There are a number of different specifications that we consider. While each specification has the interest rate differential on the left-hand-side, there are a number of possibilities for the right-hand-side variables.

1. In Taylor's (1993) original formulation, the rule posits that the Fed sets the nominal interest rate based on the current inflation rate, the inflation gap – the difference between inflation and the target inflation rate, the output gap – the difference between GDP and potential GDP, and the equilibrium real interest rate. Assuming that the foreign central bank follows a similar rule, we construct a *symmetric* model with inflation and the output gap on the right-hand-side. Following Clarida, Gali, and Gertler (1998), (hereafter CGG), we can also posit that the foreign central bank includes the difference between the exchange rate and the target exchange rate, defined by PPP, in its Taylor rule and construct an *asymmetric* model where the real exchange rate is also included.
2. It has become common practice, following CGG, to posit that the interest rate only partially adjusts to its target within the period. In this case, we construct a model with *smoothing* so that the lagged interest rate differential appears on the right-hand-side. Alternatively, we can derive a model with *no smoothing* that does not include the lagged interest rate differential. Models with and without smoothing can be symmetric or asymmetric.[1]
3. If the two central banks respond identically to changes in inflation and the output gap and their interest rate smoothing coefficients are equal, so that the coefficients in their Taylor rules are equal, we derive a *homogeneous* model where relative (domestic minus foreign) inflation, the relative output gap, and the lagged interest rate differential are on the right-hand-side. If the response coefficients are not equal, a *heterogeneous* model is constructed where the variables appear separately. The homogeneous and heterogeneous models can be either symmetric or asymmetric, with or without smoothing.
4. If, in addition to having the same inflation response and interest rate smoothing coefficients, the two central banks have identical target inflation rates and equilibrium real interest rates, there is *no constant* on the right-hand-side. Otherwise, there is a *constant*. The models with and without a constant can be either symmetric or asymmetric, with or without smoothing.

The models we have specified all have the interest rate differential on the left-hand-side. If UIRP held with rational expectations, an increase in the interest rate would cause an immediate appreciation of the exchange rate followed by forecasted (and actual) depreciation in accord with Dornbusch's (1976) overshooting model. Empirical research on the forward premium and delayed overshooting puzzles, however, is not supportive of UIRP in the short run. Gourinchas and Tornell (2004) propose an explanation for both puzzles based on a distortion in beliefs about future interest rates, and use survey data to document the extent of the distortion. We assume that investors use this theoretical and econometric evidence for forecasting, so that an increase in inflation and/or the output gap will increase the country's interest rate, cause immediate exchange rate appreciation, and produce a forecast of further exchange rate appreciation.

The relevant literature on exchange rate predictability compares out-of-sample predictability of two models (linear fundamental-based model and a random walk) on the basis of different measures. The most commonly used measure of predictive ability is mean squared prediction error (MSPE). In order to evaluate out-of-sample performance of the models based on the MSPE comparison, tests for equal predictability of two non-nested models, introduced by Diebold and Mariano (1995) and West (1996), are often used (henceforth, DMW tests).

While the DMW tests are appropriate for non-nested models, it is by now well-known that, when comparing MSPE's of two nested models, mechanical application of the DMW procedures leads to non-normal test statistics and the use of standard normal critical values usually results in very poorly sized tests, with far too few rejections of the null.[2] This is a problem for out-of-sample exchange rate predictability because, since the null is a random walk, all tests with fundamental-based models are nested and the typical result is that the random walk null cannot be rejected in favor of the model-based alternative. In addition to being severely undersized, the standard DMW procedure demonstrates very low power, which makes this statistic ill-suited for detecting departures from the null. Rossi (2005) documents the existence of size distortions of the DMW tests by revisiting the Meese and Rogoff puzzle. While her paper suggests a possible way to solve this problem by adjusting critical value of the tests, the resulting statistic has low power.

We apply a recently developed inference procedure for testing the null of equal predictive ability of a linear econometric model and a martingale difference model proposed by Clark and West (2006, 2007), which we call the CW procedure. This methodology is preferable to the standard DMW procedure when the two models are nested. The test statistic takes into account that under the null the sample MSPE of the alternative model is expected to be greater than that of the random walk model and adjusts for the upward shift in the sample MSPE of the alterative model. The simulations in Clark and West (2006) suggest that the inference made using asymptotically normal critical values results in properly-sized tests for rolling regressions.[3]

There is an important distinction, emphasized by Inoue and Kilian (2004) and Rogoff and Stavrakeva (2008), between forecasting and predictability. If we were evaluating forecasts from two non-nested models, we could compare the MSPE's from the two models by the DMW statistic and determine whether one model forecasts better than the other. In our case, however, the null hypothesis is a random walk, all alternative models are nested, and we use the CW adjustment of the DMW statistic to achieve correct size. Predictability, whether the vector of coefficients on the Taylor rule fundamentals is jointly significantly different from zero in a regression with the change in the exchange rate on the left-hand-side, is therefore not equivalent to forecasting content, whether the MSPE from the alternative model is significantly smaller than the MSPE from the null model. Put differently, we are using out-of-sample methods to evaluate the Taylor rule exchange rate model, not investigating whether the model would potentially be useful to currency traders.

We evaluate the out-of-sample exchange rate predictability of models with Taylor rule fundamentals using the CW statistic for 12 OECD countries vis-à-vis the United States over the post-Bretton Woods period starting in March 1973 and ending in December 1998 for the European Monetary Union countries and June 2006 for the others. In order to construct Taylor rule fundamentals, we need to define the output gap, and we use deviations from a linear trend, deviations from a quadratic trend, and the Hodrick–Prescott filter.

[1] Benigno (2004) shows that, in the context of a model incorporating a Taylor rule, real exchange rate persistence requires interest rate smoothing.

[2] McCracken (2007) shows that using standard normal critical values for the DMW statistic results in severely undersized tests, with tests of nominal 0.10 size generally having actual size less than 0.02.

[3] An alternative strategy, used by Mark (1995) and Kilian (1999), is to calculate bootstrapped critical values for the DMW test to construct an accurately sized test. While this solves the most egregious problems with the application of the DMW test to nested models, the advantage of the CW test is that it has somewhat greater power. West (2006) provides a summary of recent literature on asymptotic inference about forecasting ability.