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The out-of-sample forecasting performance of nonlinear models of real exchange rate behavior ☆

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Abstract

We analyze the out-of-sample forecasting performance of nonlinear models of U.S. dollar real exchange rate behavior from the extant empirical literature. Our analysis entails a comparison of point, interval, and density forecasts generated by nonlinear and linear autoregressive models. Using monthly data from the post-Bretton Woods period, there is little evidence to recommend either band-threshold or exponential smooth transition autoregressive models over simple linear autoregressive models in terms of out-of-sample forecasting performance at short horizons. Nonlinear models appear to offer more accurate point forecasts at long horizons for some countries. Overall, our results suggest that any nonlinearities in monthly real exchange rate data from the post-Bretton Woods period are quite "subtle" for band-threshold and exponential smooth transition autoregressive model specifications. Further evidence of this is provided by in-sample comparisons of the conditional densities implied by nonlinear and linear autoregressive models.

JEL classification: C22; C52; C53; F31; F47

Keywords: Real exchange rate; Transaction costs; Band-threshold autoregressive model; Exponential smooth transition autoregressive model; Point forecast; Interval forecast; Density forecast

1. Introduction

There is growing interest in nonlinear models of real exchange rate behavior in the empirical international finance literature. This is not surprising, as nonlinear model specifications of real exchange rate behavior are well motivated by theoretical models incorporating transaction costs.[2] Transaction costs can be broadly defined to include transportation costs, tariffs and nontariff barriers, as well as any other costs

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that agents incur in international trade (Obstfeld & Rogoff, 2000). Intuitively, transaction costs give rise to a band of inactivity where arbitrage is not profitable, so that nominal exchange rate deviations from purchasing power parity (real exchange rate fluctuations) are not corrected inside the band. However, if the real exchange rate moves outside the band, arbitrage works to bring the real exchange rate back to the edge of the band.

Motivated by theoretical models incorporating transaction costs, two recent studies estimate nonlinear autoregressive (AR) models for U.S. dollar real exchange rates over the post-Bretton Woods period. Obstfeld and Taylor (1997) estimate band-threshold AR (Balke & Fomby, 1997; Band-TAR) models for a large number of U.S. dollar real exchange rates based on both broad and disaggregated consumer price indices. In line with the theoretical models cited above, the Band-TAR model is characterized by unit-root behavior in an inner regime and reversion to the edge of the unit-root band in an outer regime. A second study, Taylor, Peel, and Sarno (2001), considers exponential smooth transition AR (Granger & Teräsvirta, 1993; ESTAR) models of U.S. dollar real exchange rate behavior. In contrast to the discrete regime switching that characterizes the Band-TAR model, the ESTAR model allows for smooth transition between regimes.[3] As Taylor et al. (2001) pointed out, Bertola and Caballero (1990), Dumas (1994), and Teräsvirta (1994) suggest that time aggregation and non-synchronous adjustment by heterogeneous agents is likely to lead to smooth regime switching, rather than discrete switching, and this is especially likely to be the case for real exchange rates based on broad price indices. Using monthly data for the U.S. dollar real exchange rate vis-à-vis the U.K., Germany, France, and Japan over the post-Bretton Woods era, Taylor et al. (2001) estimate a parsimonious ESTAR model for each country. For their ESTAR models, the real exchange rate follows a random walk in the extreme inner regime near the long-run equilibrium, while the speed of reversion to the long-run equilibrium increases the farther the real exchange rate deviates from the long-run equilibrium. Taylor et al. (2001) conclude that the real exchange rates they consider are well characterized by nonlinear mean reversion.[4]

Obstfeld and Taylor (1997) and Taylor et al. (2001) report evidence of nonlinear behavior in U.S. dollar real exchange rates. All of the evidence reported in these well-known and oft-cited papers is based on in-sample tests. In the present paper, we add to the existing empirical literature on nonlinear real exchange rate behavior by undertaking an extensive evaluation of the out-of-sample forecasting performance of the nonlinear AR models from these papers. Tests of out-of-sample forecasting performance are widely viewed as an important component of model evaluation and a way of guarding against model overfitting. In our evaluation, we simulate the situation of a forecaster who uses the fitted nonlinear AR models from Obstfeld and Taylor (1997) and Taylor et al. (2001) to forecast real exchange rate observations that have become available since the models were originally estimated.[5] We compare the out-of-sample real exchange rate forecasts generated by these fitted nonlinear AR models to out-of-sample forecasts generated by fitted linear AR models. If the forecasts generated by nonlinear AR models are superior to those generated by simple linear AR models, this can be construed as strong empirical evidence in favor of nonlinear model specifications.

We first compare the out-of-sample forecasting performance of nonlinear and linear AR models in terms of mean squared forecast error (MSFE), and we test whether the nonlinear AR model forecasts are significantly superior to the linear AR model forecasts

[2] Theoretical models incorporating transaction costs include Benninga and Protopapadakis (1988), Williams and Wright (1991), Dumas (1992), Coleman (1995), Sercu, Uppal, and Van Hulle (1995), Ohanian and Stockman (1997), O'Connell (1998), and Obstfeld and Rogoff (2000).

[3] Like the Band-TAR model, the ESTAR model is characterized by symmetric adjustment.

[4] Sarantis (1999) also estimates ESTAR models for real exchange rates using monthly data from the post-Bretton Woods period. However, he estimates ESTAR models under the assumption that real exchange rate levels are nonstationary, while theoretical models suggest estimating nonlinear models under the assumption that real exchange rate levels are globally stationary.

[5] Michael, Nobay, and Peel (1997) also estimate ESTAR models for U.S. dollar real exchange rates using the Lothian and Taylor (1996) annual data that cover more than two centuries. We do not consider this study in detail in the present paper, as there are only a relatively small number of annual observations that have become available since the models were originally estimated.