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Evaluating exchange rate forecasts along time and frequency



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ABSTRACT

A key puzzle in international macroeconomics is the proposition by Meese and Rogoff (1983) that no model can outperform the random walk in predicting the exchange rate. This paper contributes to this literature by performing an evaluation of exchange rate forecasts of reference models in time and frequency. While the literature has usually addressed the performance of exchange rate models relative to the random walk in time only, this paper studies whether this relative performance is uniform along different frequencies or whether it is driven by certain frequencies. The main finding of this paper is that the predictability of exchange rates varies along the different frequencies. Furthermore, the absence of the high frequency component leads to many cases in which the random walk is outperformed.

1. Introduction

Ever since the seminal contribution by Meese and Rogoff (1983) proposed the so-called Meese-Rogoff puzzle, i.e. that no model can surpass the random walk in forecasting the exchange rate, there has been a continuous effort to address the puzzle via various models and techniques. More than 40 years after this puzzle was formulated, we can still confidently state that exchange rates are basically not forecastable, except for particular cases, see the recent review by Rossi (2013).

There is a wide body of literature that tries to outperform the random walk in forecasting the exchange rate using various methods, and which is almost impossible to summarize. Recent research, see Rossi (2013), has found that predictability depends on several key factors: that the predictors are the Taylor rule and/or net foreign assets, that the model is linear and that the model is small (consisting of only a few parameters).

So far, the findings in the literature tend to suggest that the role of frequency in forecasting the exchange rates is negligible. However, until now the research has considered the role of frequency relative only to the issue of data selection. Rossi (2013) underlines that there are no significant differences with respect to the forecasting accuracy of daily and monthly data, but only due to using in-sample versus out-of-sample. A potential exception to this general trend might be the study by Ferraro, Rogoff, and Rossi (2011); however, as Rossi (2013) again underscores, the difference accounting for its superior predictability might be its use of both daily data and commodity prices.

This paper addresses the issue of exchange rate forecastability through a new methodology, with a focus on the frequency components. I propose the use of wavelets in the context of forecasting exchange rates. Wavelets have rarely been used in the context of economic forecasts, notable exceptions being the studies by Michis (2014) or Rua (2011). While a more detailed presentation is postponed to the section dedicated to wavelets, I will underline here that the key advantage of wavelets is the possibility of estimating

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and forecasting with the models along both time and frequency. By performing estimations and forecasts of economic models along different frequencies, I am able to compare whether the predictability of exchange rates is influenced in any way by the frequency dimension.

While some contributions have been made with respect to the use of wavelets in the context of forecasting, see [Michis \(2014\)](#) or [Rua \(2011\)](#), their studies are rather limited by the fact that they do not take into account the double-side filtering property of wavelets, which can lead to a distortion of estimation and forecasts.

At the same time, the paper is related to a growing literature pointing to the fact that, under certain conditions related to filtering the data in an appropriate manner, wavelets can be confidently used to forecast economic time series, see [Aussem, Campbell, and Murtagh \(1998\)](#), [Renaud, Starck, and Murtagh \(2005\)](#), [Soltani, Boichu, Simard, and Canu \(2000\)](#), or [Zheng, Starck, Campbell, and Murtagh \(1999\)](#).

That the frequency components of exchange rate do not have uniform effects has not been a central issue in the literature until very recently. [Rabanal and Rubio-Ramrez \(2015\)](#) have shown that the low frequency component of the real exchange rate is more important in shaping the dynamics of unfiltered real exchange rates than the usually analyzed business cycle component.

Though a bit less strictly related, the paper also indirectly touches on how the structural relationships and/or causality relationships look differently when examining the shocks affecting the variables in question, see [Caraiani \(2016\)](#), for a study on the causality between money, on one hand, and output and inflation on the other hand. It nevertheless contributes to a growing literature showing that aggregate macroeconomic relationships can be broken using structural decompositions like above, or wavelet decompositions, see [Gallegati, Gallegati, Ramsey, and Semmler \(2011\)](#).

The main contributions of this paper are as follows. I propose and discuss alternative methodologies to assess forecasting accuracy through the use of wavelets filtering in time and frequency. Second, I perform a wavelet filtering that addresses the double-sided nature of wavelets, a key issue in forecasting. Third, I estimate and forecast with various models along the different frequencies, comparing whether the forecasting accuracy of exchange rates is influenced in any way by the frequency dimension. Fourth, I contribute to the new results in the literature regarding the role of frequency components in shaping the dynamics of the exchange rate, see [Rabanal and Rubio-Ramrez \(2015\)](#) for a recent result. Finally, the comparison is conducted across a wide range of countries, data series, models, and tests for forecast accuracy, further strengthening the main findings.

The key finding of the paper is that, in contrast to what is found in previous literature on exchange rate forecasting, there are evidences that the frequency dimension does matter for the accuracy of exchange rate forecasts. Not only does each frequency considered alter forecasting accuracy, there are also stark differences between the high frequency components and the low frequency components. When the high frequency component is removed, the random walk is outperformed for several countries and models, while removing the low frequency component drastically weakens exchange rate predictability.

2. Models

Following [Rossi \(2013\)](#), I focus on the most widely-used models in the literature, selecting those for which quarterly data was available. There are several reasons to follow this approach. First of all, it is one of the best summaries of the literature to date. Second, in contrast to most previous studies, it includes only the best-performing and widely-used models in its comparison. Lastly, it allows a focus on the role of frequency for a dataset and models already used in a previous study.

I focus on two classes of models, univariate linear models as well as multivariate linear models. I exclude nonlinear models, since, as [Rossi \(2013\)](#) suggests, their performance in the literature to date is rather modest.

Dating back to [Fisher \(1896\)](#), the Uncovered Interest Parity (UIRP, hereafter) model has been widely used in the literature. I use a standard specification:

$$E_t(s_{t+h} - s_t) = \alpha + \beta \left(i_{t+h} - i_{t+h}^* \right) \quad (1)$$

Here s_t stands for the logarithm of the nominal bilateral exchange rate S_t , i.e., $s_t = \ln(S_t)$; i_t is the domestic nominal interest rate, while i_t^* is the foreign nominal interest rate; the parameter $\alpha = 0$ while $\beta = 1$, while h stands for the horizon.

Unfortunately, to date there are scarce evidences favoring the UIRP model, with some limited positive results in [Clark and West \(2006\)](#) at short horizons and [Molodtsova and Papell \(2009\)](#) for a sample of countries.

An equally frequently used model in forecasting the exchange rate is based on Purchasing Power Parity (PPP, hereafter). In its standard form, the PPP model can be written as:

$$s_t = \alpha + \beta (p_t - p_t^*) + \varepsilon_t \quad (2)$$

Here p_t stands for the logarithm of the domestic commodity price CP index, p_t^* is the logarithm of the foreign commodity price index, the parameter $\alpha = 0$ and $\beta = 1$, while h stands for the horizon.

The evidence does not favor the PPP model either, see the reference study by [Cheung, Chinn, and Pascual \(2005\)](#), although some limited evidence has been found for this model at long horizons, which is not, however, significantly better statistically.

A third single equation model to be used is the monetary model. This model dates back to the contributions by [Frenkel \(1976\)](#) and [Mussa \(1976\)](#) and builds on a very basic real demand for money, which can be written as:

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