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Can international macroeconomic models explain low-frequency movements of real exchange rates?☆

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ABSTRACT

Real exchange rates exhibit important low-frequency fluctuations. This makes the analysis of real exchange rates at all frequencies a more sound exercise than the typical business cycle one, which compares actual and simulated data after the Hodrick-Prescott filter is applied to both. A simple two-country, two-good, international real business cycle model can explain the volatility of the real exchange rate when all frequencies are studied. The puzzle is that the model generates too much persistence of the real exchange rate instead of too little, as the business cycle analysis asserts. We show that the introduction of input adjustment costs in production, cointegrated productivity shocks across countries, and lower home bias allows us to reconcile theory and this feature of the data.

1. Introduction

This paper challenges the conventional wisdom that a baseline international real business cycle (IRBC) two-country, two-good model cannot generate either enough volatility or enough persistence in the real exchange rate (RER) when compared to the data. When the object of interest is RER fluctuations at all frequencies, instead of business cycle (BC) frequencies only, this model can explain the standard deviation of the U.S. dollar RER. However, the model implies a higher persistence of the RER than in the data.

We advocate that analyzing RER fluctuations at all frequencies is a more compelling exercise than just studying the BC ones. Spectral analysis shows that most of the variance of the RER in the data can be assigned to low-frequency movements (about 70%), while movements at BC frequencies account for only a small share of the RER fluctuations (just 25%). The baseline IRBC model accounts for the area below the spectrum of the RER, i.e., its standard deviation, but not for its shape, since it places a larger share of fluctuations of the RER in low-frequency movements than occurs in the data. We call this shortcoming of the model the "excess persistence of the RER" puzzle. We show that extending the model to consider adjustment costs in the composition of domestic and imported intermediate inputs and lower home bias helps to solve this puzzle (i.e., replicating the shape of the spectrum) while still explaining the standard deviation of the RER (i.e., the area below the spectrum).

Since the seminal works of Backus et al. (1992) and Baxter and Crucini (1995), the IRBC literature has been preoccupied with explaining

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the international transmission of shocks, the cyclical comovement of variables across countries, and the behavior of international relative prices. As in the real business cycle (RBC) literature, the IRBC literature mainly concentrates on explaining the BC fluctuations of the data. The success of the model is measured by its ability to reproduce selected second moments of Hodrick–Prescott (HP) filtered data, which removes trends and low-frequency movements. Other papers use instead the band-pass filter, as described in Baxter and King (1999) or Christiano and Fitzgerald (2003). The researcher compares the second moments of actual data with those implied by the artificial data generated by the model after the same detrending procedure has been applied to both. One of the most relevant facts in the HP-filtered data is that international relative prices are more volatile than output and highly persistent. IRBC models with reasonable calibrations have a hard time reproducing these features. In earlier work Backus et al. (1994) and Stockman and Tesar (1995) showed that IRBC models cannot match the volatility of the (HP-filtered) terms of trade, while, in a more recent contribution, Heathcote and Perri (2002) have pointed out the standard IRBC model's inability to explain the volatility and persistence of the (HP-filtered) RER.

In this paper, we first argue that analyzing only the BC fluctuations of the RER leads researchers to miss a large part of the story. The reason is as follows. The top panel in Fig. 1 plots the (log) U.S. dollar RER along with its implied HP-filtered "trend" using a bandwidth of 1600. Just from eyeballing, it is evident that most of the fluctuations in the U.S. dollar RER have been low-frequency movements. This observation is confirmed by the spectral analysis that we perform in Section 2: most of the variation of the RER in the data is at frequencies lower than BC fluctuations (it is 75% for the U.S. dollar, and between 60 and 76.5% depending on the currency we examine). These low-frequency movements are removed by HP-filtering.[1]

Second, motivated by the argument above, we propose to analyze the fluctuations of the RER at all frequencies instead. Therefore, we need to consider a model able to generate low-frequency fluctuations in the RER. Our baseline model is an extension of the two-country, two-good model of Heathcote and Perri (2002) in which stochastic processes for total factor productivity (TFP) are non-stationary but cointegrated across countries.[2] We show that the model can explain about 80% of the standard deviation of the RER in the data while closely matching the volatility of output growth when we use a benchmark calibration of the model, including a value of 0.85 for the elasticity of substitution between intermediate inputs in the production of the final good. However, in the model, the RER is too persistent and the spectrum places too much weight on low-frequency fluctuations (in the model 85% of the variance is caused by low-frequency fluctuations while it is 70% in the data). In order to solve this shortcoming, we extend the model with adjustment costs in the use of intermediate imported inputs for the production of the final good (see Erceg et al. (2006)). The presence of these costs allows us to combine a low short-run elasticity of substitution between imported and domestic intermediate goods, which is needed to increase the volatility of the RER at BC frequencies, with a higher long-run elasticity, which is needed to reduce the excessive volatility of the RER at low frequencies. We show how these input adjustment costs, together with lower home bias, help to solve the puzzle by increasing the impact response of the RER in the short run while reducing it at long-run horizons in the model. The calibration of a lower home bias is consistent with recent data that show more trade openness for the U.S.

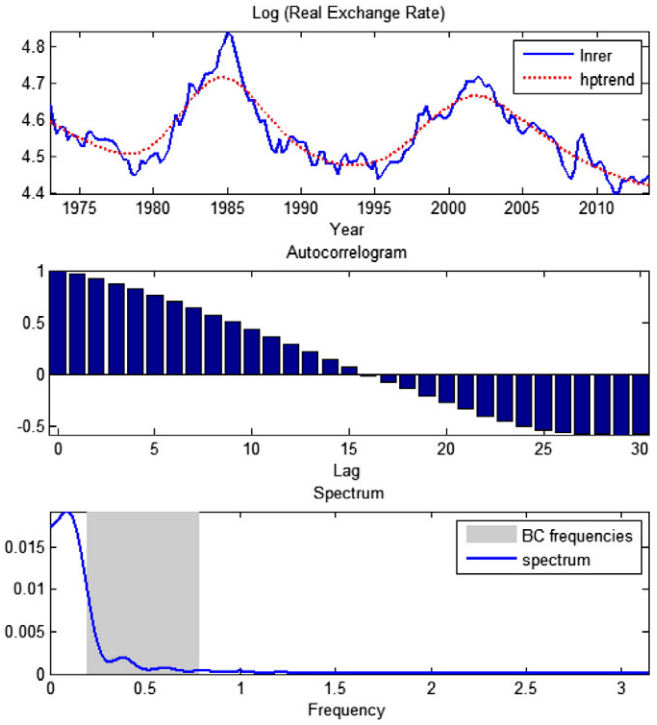

Fig. 1. Log RER, autocorrelation function, and spectral density of the U.S. dollar.

Moreover, our model can explain an important fact in international macroeconomics at several frequencies. Since the seminal paper by Backus and Smith (1993), the literature has been preoccupied with matching the correlation between the ratio of the relative consumption of two countries and the RER at BC frequencies. This correlation tends to be close to one in the standard model, even under cointegrated shocks, while it is negative in the data. Corsetti et al. (2008a) were the first ones to propose a solution to this puzzle under different specifications of international asset markets, elasticities of substitution between types of goods, and persistence of the underlying productivity shocks. However, their analysis focused on HP-filtered data. Recently, an empirical paper by Corsetti et al. (2012) has confirmed the Backus and Smith (1993) results at low, BC and high frequencies for a large sample of countries. The extended model in this paper is in fact able to explain the negative correlation at all frequencies. However, it should be noted that this mechanism is at odds with existing VAR evidence, as presented in Corsetti et al. (2014).

The paper is organized as follows: Section 2 presents the spectral analysis of the U.S. dollar RER as well as that of other main currencies. Section 3 discusses the related literature, while Section 4 presents a baseline IRBC model. Section 5 presents the calibration and the results of the baseline model. In Section 6, we present the extensions to the model and show how they help reconcile theory and evidence. Section 7 concludes.

2. Spectral analysis of the RER

In this section we study the spectrum of the RER of six main currencies: the U.S. dollar, the euro, the U.K. pound sterling, the Japanese yen, and the Canadian and Australian dollars. In order to find the longest possible time series for each currency, we choose between the IMF's International Financial Statistics (IFS) database, the measure constructed from national central banks, or other measures. We verify that for the period during which both measures overlap the correlation is very high, denoting that all sources use similar methodologies to construct the RER series.

The sample period is 1973Q1–2013Q3 unless otherwise noted. Our data sources are as follows: for the U.S. dollar we obtain the real effective exchange rate (REER) series from the Federal Reserve's Real Broad

[1] The RER in emerging markets can have a trend, in particular in those emerging economies that experience higher productivity growth rates than advanced economies. In that case, the use of a trend/cycle decomposition would be justified. However, most of the IRBC literature focuses on explaining the RER of the U.S. dollar vis-a-vis the currencies of other industrialized countries. In that case RERs are a highly persistent series, but they do not have a trend.

[2] In a related work, Rabanal et al. (2011) show that cointegrated TFP shocks improve the model's ability to explain certain features of the HP-filtered data, including RER volatility.