Economic Modelling 40 (2014) 42–51

Contents lists available at ScienceDirect

Economic Modelling

journal homepage: www.elsevier.com/locate/ecmod

Money demand instability and real exchange rate persistence in the monetary model of USD–JPY exchange rate

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ARTICLE INFO

Article history:
Accepted 13 March 2014
Available online 12 April 2014

Keywords:
Cointegration
Exchange rates
Monetary model
Weak exogeneity

ABSTRACT

This paper proposes a hybrid monetary model of the dollar–yen exchange rate that takes into account factors affecting the conventional monetary model's building blocks. In particular, the hybrid monetary model is based on the incorporation of real stock prices to enhance money demand stability and also, productivity differential, relative government spending, and real oil price to explain real exchange rate persistence. By using quarterly data over a period of high international capital mobility and volatility (1980:01–2009:04), the results show that the proposed hybrid model provides a coherent long-run relation to explain the dollar–yen exchange rate as opposed to the conventional monetary model.

1. Introduction

Since the collapse of the Bretton Woods fixed exchange rate system in 1971, much attention has been paid towards finding a meaningful explanation of exchange rates. A wide range of models have been proposed to understand movements in the exchange rate, one of which is the monetary model (see Bilson, 1978; Frankel, 1979). Despite its rigorous theoretical underpinnings by linking the nominal exchange rate to its monetary fundamentals (e.g., money, income, and interest rates), the resulting reduced form has had limited empirical success until now.

For example, although MacDonald and Taylor (1994) provided evidence of a long-run relation between monetary fundamentals and nominal exchange rates, the signs and magnitudes of estimated coefficients did not support the related monetary theories. Groen (2000), and Mark and Sul (2001) among others also found some evidence in a panel context, but this was under the assumption of a high order of heterogeneity across the country models. Similarly, Rapach and Wohar (2002) found some support for the theory using long time series, but this was related to different exchange rates and macro regimes, with some evolution in the composition of products in price indices. Taylor and Peel (2000) applied nonlinear methods to model a nominal exchange rate and monetary fundamentals (relative money supply and relative income), but such results are often sensitive to a small number of observations and become less robust as the sample evolves. Frömmel et al. (2005) estimated the real interest differential (RID) model of Frankel (1979) applying the Markov switching approach. However, the model was shown to relate to only one regime.

Furthermore, the empirical failure of this model has been specifically found in regard of the US dollar–Japanese yen exchange rate. The evolution of this exchange rate has been much debated over the recent years with no consensus over the factors that drive the dynamics. For instance, Caporale and Pittis (2001) were unable to find a stable relation based on a monetary model of this exchange rate. Chinn and Moore (2011) also failed to find a long-run relation between the nominal dollar–yen exchange rate and its monetary fundamentals (money, industrial production, and interest rate differentials) even when they included cumulative order flow as opposed to the dollar–euro exchange rate. By contrast, MacDonald and Nagayasu (1998) only found that a simplified version of the RID model of Frankel (1979), that excluded the money demand functions, held for the yen–dollar exchange rate for the period 1975:Q3–1994:Q3. Tellingly, in a recent paper, Obstfeld (2009, p.1) comments that 'the determinants of the yen's short- and even longer-term movements remain mysterious in light of the development of Japan's macro economy'.

A possible explanation for the empirical failure of the dollar–yen exchange rate monetary model is perhaps the breakdown of its underlying building blocks; that is, stable money demand and purchasing power parity (PPP). Indeed, Hendry and Ericsson (1991) found that the conventional money demand equation for the US was not stable. Whereas, Friedman (1988) and McCornac (1991) confirmed the need for real stock prices to stabilise money demand equations using data from the United States and Japan, respectively.[1] Sarno and Taylor (2002), on the other hand, found little support for the conventional notion of PPP by surveying a range of empirical studies. This corresponds well with the classic findings of

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[1] The conclusion of the seminal article of Friedman (1988) has also been confirmed by Choudhry (1996) for the US and Canada and Caruso (2001) for Japan, the UK, Switzerland and Italy, as well as for a panel of 25 (19 industrial and 6 developing) countries.

http://dx.doi.org/10.1016/j.econmod.2014.03.019
0264-9993/

Balassa (1964) and Samuelson (1964), which indicate that persistent deviations from PPP arise from productivity differentials. Chinn (1997, 2000), and Wang and Dunne (2003) among others showed that fluctuations in the nominal and real dollar–yen exchange rate are due to the impact of differentials in productivity and government expenditure along with real oil prices.

This paper contributes to the existing literature by proposing a hybrid monetary model of the dollar–yen exchange rate that takes into account the breakdown of the aforementioned building blocks. That is, the proposed model captures both the monetary and the real aspects of the economy, thereby circumventing some of the potential pitfalls associated with earlier studies. More specifically, we examine the empirical performance of the standard RID model, developed by Frankel (1979), against this proposed hybrid version by employing the Johansen (1995) methodology and quarterly data from 1980:01 to 2009:04, a period characterised by high international capital mobility and volatility.

The RID model has been widely used as it combines aspects of the sticky-price approach with the flexible-price one. Furthermore, this variant of the monetary approach is chosen because it is a realistic description when variation in the inflation differential is moderate as is the case between the US and Japan over the period under examination.[2] Particularly, the theory underlines the role of expectations in different inflationary environments and the associated rapid adjustment in capital markets. The hybrid version, by contrast, is devised by using domestic and foreign money demand equations based on broader asset classes and also accounting for the factors that cause PPP to fail. That is, we incorporate real stock prices in the money demand equations,[3] while we use the productivity differential, relative government spending, and real oil price to explain the persistence in the real dollar–yen exchange rate.

The paper is organised as follows. Section 2 provides the theoretical framework for the exchange rate monetary model; Section 3 outlines the econometric technique used and describes the data; Section 4 explains the empirical results and the analysis; and finally Section 5 concludes.

2. Theoretical framework

The monetary model of the exchange rate is based on the assumptions that money demand equations are stable and that PPP holds. In this paper, we consider two forms of this model and place them under econometric scrutiny. The first is the RID model developed by Frankel (1979) and the second is a hybrid monetary model, proposed herein, that takes into account factors affecting the stability of the respective money demand equations and the validity of PPP.

In Frankel's (1979) RID model, the features of the fixed- and flexible-price models are amalgamated by incorporating short-term interest rates to capture the stance of monetary policy. In particular, the model asserts that the expected rate of depreciation of the exchange rate is a function of the gap between the current spot rate and the long-run equilibrium rate, as well as the expected long-run inflation differential between the domestic and foreign countries (see Pilbeam, 2013, Chapter 7); that is:

$$E(\Delta e) = \theta(\overline{e}-e) + \left(\Delta p^{e}-\Delta p^{*e}\right), \tag{1}$$

where θ is the speed of adjustment towards the equilibrium level and, Δp^e and Δp^{*e} denote the domestic and foreign expected long-run inflation rates, respectively. Note that throughout the paper all variables are expressed in natural logs (except interest rates), bars denote equilibrium values, and the asterisk denotes the foreign country (Japan) and the domestic country is the United States. It follows that Eq. (1) highlights that in the short-run the spot exchange rate e is expected to return to its long-run equilibrium value $\overline{e}$ at a rate equal to θ. However, in the long-run (since $\overline{e} = e$), changes in the exchange rate will be proportional to the expected long-run inflation differential ($\Delta p^e - \Delta p^{*\,e}$).

Assuming the uncovered interest parity (UIP) condition, $E(\Delta e) = i - i^*$, that postulates domestic and foreign bonds are perfect substitutes, then combining such a condition with Eq. (1) and rearranging for the spot exchange rate, we obtain:

$$e = \overline{e} - \frac{1}{\theta}\left[\left(i-\Delta p^{e}\right)-\left(i^{*}-\Delta p^{e*}\right)\right], \tag{2}$$

where i and i^* are defined as the domestic and foreign interest rates, respectively. Furthermore, conventional domestic and foreign money demand equations are given as follows:

$$m-p = a_1 y - a_2 i, \tag{3}$$

$$m^{*}-p^{*} = a_1 y^{*} - a_2 i^{*}, \tag{4}$$

where m (m^*), p (p^*), and y (y^*) are respectively domestic (foreign) money supply, price level, and real income. For simplicity, the income elasticity of money demand, a_1, and the interest rate semi-elasticity of money demand, a_2, are assumed to be identical across both domestic and foreign countries. Also, it is assumed that PPP holds in the long-run:

$$\overline{e} = \overline{p} - \overline{p^{*}}. \tag{5}$$

By extracting the expressions of relative prices in Eq. (5) from Eqs. (3) and (4) along with the view that $\left(\overline{i}-\overline{i}^{*}\right) = (\Delta p^e - \Delta p^{*e})$ in the long-run (since $\overline{e} = e$), the following is obtained with bars denoting equilibrium values:

$$\overline{e} = \left(\overline{m}-\overline{m}^{*}\right) - a_1\left(\overline{y}-\overline{y}^{*}\right) + a_2\left(\Delta p^{e}-\Delta p^{*e}\right). \tag{6}$$

By substituting Eq. (6) into Eq. (2), we obtain:

$$e = \left(\overline{m}-\overline{m}^{*}\right) - a_1\left(\overline{y}-\overline{y}^{*}\right) + a_2\left(\Delta p^{e}-\Delta p^{*e}\right) - \frac{1}{\theta}\left[\left(i-\Delta p^{e}\right)-\left(i^{*}-\Delta p^{*e}\right)\right]. \tag{7}$$

Frankel (1979) argued that it is common practice to estimate this equation empirically on the basis that short-term interest rates represent real interest rates (i.e., liquidity effects of monetary policy) and long-term interest rates capture the long-run expected inflation rates (see also MacDonald, 2007, Chapter 6). Thus, the baseline model is in the reduced form written as follows:

$$e_t = \beta_1\left(m_t - m_t^{*}\right) + \beta_2\left(y_t - y_t^{*}\right) + \beta_3\left(i_t^{s} - i_t^{s*}\right) + \beta_4\left(i_t^{l} - i_t^{l*}\right) + \varepsilon_t. \tag{8}$$

Otherwise, the RID model related to Eq. (8) hypothesises that an increase in the domestic money supply relative to the counterpart foreign one increases domestic prices and thus causes a one for one depreciation in the exchange rate ($\beta_1 = 1$). An increase in domestic income or a decline in the expected rate of domestic inflation (proxied by the long-term interest rate) relative to the foreign one raises the demand for money and thus causes an appreciation in the exchange rate ($\beta_2 < 0$, $\beta_4 > 0$). An increase in the domestic nominal interest rate relative to the foreign one induces capital inflows towards the domestic economy and thus causes an appreciation in the exchange rate ($\beta_3 < 0$). For further details the reader is directed to Frankel (1979).

[2] Bernanke (2000) and Taylor (2001) argued that the different inflationary environments in the US and Japan are due to the differences in the monetary policies in the two countries.

[3] Another motivation for incorporating real stock prices in the monetary model via money demand equations is that the financial press and financial market analysts advocate that there exists a relation between stock prices and exchange rates (see, for examples, Caporale et al., 2014; Phylaktis and Ravazzola, 2005).