Economic Modelling 28 (2011) 2622–2627

Contents lists available at SciVerse ScienceDirect

Economic Modelling

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

Sources of exchange rate fluctuations with Taylor rule fundamentals

Bernd Kempa *, Wolfram Wilde

Department of Economics, University of Muenster, Universitaetsstrasse 14-16, 48143, Muenster, Germany

ARTICLE INFO

Article history:
Accepted 1 August 2011

JEL Classification:
F31
E5
F41

Keywords:
Exchange rate fluctuations
Taylor rule
Structural VAR

ABSTRACT

This paper investigates the sources of exchange rate fluctuations when monetary policy follows a Taylor rule interest rate reaction function. We first present a simple dynamic exchange rate model with Taylor rule fundamentals which is triangular in the long-run impacts of shocks to the output market, the interest rate differential, and the Taylor rule. We then proceed to assess the relative importance of various shocks in exchange rate determination by estimating a structural VAR with long-run identification restrictions based on the triangular structure of the model. We find demand shocks to be less important than in earlier VAR studies, with both supply shocks and nominal shocks explaining a substantial part of real exchange rate fluctuations.

1. Introduction

Standard monetary models of exchange rate determination have long been discredited by their failure to explain, let alone predict, exchange rate behavior, as forcefully documented by Meese and Rogoff (1983) and Flood and Rose (1995). A new strand of literature identifies one of the major shortcomings of traditional exchange rate models in paying too little attention to the market's expectations of future values of the macroeconomic fundamentals (Bacchetta and van Wincoop, 2006; Engel and West, 2004, 2005). In particular, most extant exchange rate models fail to incorporate the endogeneity of monetary policy. But if exchange rates are primarily driven by expectations, then correctly modeling monetary policy is crucial (Engel et al., 2007). Changes in current economic fundamentals may have little direct impact on exchange rates, but may nevertheless affect the latter strongly through their effect on changes in expectations regarding the monetary policy response.

The endogeneity of monetary policy can be modeled by means of a Taylor rule with the interest rate as the policy instrument. In such an environment, interest rates respond to inflation, the output gap and possibly the exchange rate as well. It turns out that models of the open economy with a Taylor rule display exchange rate behavior quite different from traditional exchange rate models. For example, whereas in standard flexible-price monetary models an increase in the current inflation rate depreciates the exchange rate, in Taylor rule models the exchange rate appreciates because higher inflation induces expectations of tighter future monetary policy (Clarida and Waldman, 2007).

The emerging evidence on the empirical performance of Taylor rule models of the open economy is quite encouraging. Engel and West (2006) and Mark (2009) use the forecasts from VAR models for the fundamentals and compare the properties of exchange rates generated from such models with actual German–US bilaterals. Both are shown to be highly volatile and persistent, and the Taylor rule exchange rate turns out to be substantially more strongly correlated with the actual data than exchange rates generated by traditional models. Molodtsova and Papell (2009) analyze the out-of-sample predictability of exchange rates with Taylor rule fundamentals by employing an error-correction formulation for the Taylor rule model. They find that the predictability of exchange rates in the short run improves compared to conventional models.

In this paper, we present a simple dynamic exchange rate model incorporating a Taylor rule monetary reaction function in the spirit of Engel and West (2006). In contrast to the related literature cited above, our model can be solved in closed form and features a complete specification of the model dynamics. Although we consider the model to be primarily illustrative, its triangular structure in the long-run impacts of shocks to the output market, the interest rate differential, and the Taylor rule can be utilized for empirical analysis without having to rely on the structural form of the model itself. To this end, we use a structural VAR in which we utilize the long-run properties of the model as identification restrictions to empirically identify the relative contributions of nominal and real shocks in accounting for the variability of exchange rates. In contrast to similar VAR variance decompositions such as Lastrapes, 1992; Clarida and Galí, 1994, or Farrant and Peersman, 2006, we explicitly rely on Taylor rule fundamentals as determinants of exchange rate behavior. We focus on the time-series evidence of Canada, the Euro area, Japan and the UK, all relative to the US, in order to

---

* Corresponding author at: Department of Economics, University of Muenster, Universitaetsstrasse 14-16, 48143, Muenster, Germany.
E-mail address: bernd.kempa@uni-muenster.de (B. Kempa).

0264-9993/$ – see front matter © 2011 Elsevier B.V. All rights reserved.
doi:10.1016/j.econmod.2011.08.004

compare our results generated on the basis of Taylor-rule fundamentals with those from these earlier studies.

The remainder of the paper is structured as follows: Section 2 lays out the model, analyzes its dynamics, and illustrates its long-run neutrality properties. Section 3 motivates the structural VAR setup and reports on the empirical findings, while Section 4 offers concluding remarks.

2. The model

We consider an open-economy model where monetary policy is described by Taylor rules of the form

$$i_t^h = \overline{i_t^h} + \gamma_q q_t + \gamma_\pi \pi_t^h + \gamma_y y_t^h + u_{mt}^h \tag{1}$$

$$i_t^* = \overline{i_t^*} + \gamma_\pi \pi_t^* + \gamma_y y_t^* + u_{mt}^* \tag{2}$$

for the home and the foreign economies, respectively. In Eqs. (1) and (2), i_t^h and i_t^* are the home and foreign interest rates in time period t, with $\overline{i_t^h}$ and $\overline{i_t^*}$ the corresponding natural interest rates. π_t^h and π_t^* denote the inflation rates at home and abroad, y_t^h and y_t^* stand for the domestic and foreign deviations of log output from trend, and u_{mt}^h and u_{mt}^* capture shocks to the home and foreign monetary policy rules. Assuming all coefficients of the policy rules to be positive and identical at home and abroad, the only difference arises with the inclusion of the log current real exchange rate q_t in the Taylor rule of the home country. The log real exchange rate is defined as $q_t = s_t - p_t$, with s_t the log nominal exchange rate as the home currency price of foreign exchange, and p_t the log domestic price level. A positive coefficient $\gamma_q > 0$ implies that the domestic monetary authority is assumed to raise the interest rate whenever the real exchange rate depreciates. The Taylor rule of the domestic economy can thus alternatively be viewed as a monetary conditions index (MCI).[1] However, the qualitative characteristics of the model developed below do not critically depend on the MCI specification, and the long-run neutrality results obtain even when γ_q is set equal to zero.

We follow Engel and West (2006) in expressing all variables of the model in relative terms as the difference between the respective variables in the home and foreign countries. Subtracting Eq. (2) from Eq. (1) results in a composite Taylor rule of the form

$$i_t = \overline{i_t} + \gamma_q q_t + \gamma_\pi \pi_t + \gamma_y y_t + u_{mt}, \tag{3}$$

where $i_t = i_t^h - i_t^*$, $\overline{i_t} = \overline{i_t^h} - \overline{i_t^*}$, $\pi_t = \pi_t^h - \pi_t^*$, $y_t = y_t^h - y_t^*$, and $u_{mt} = u_{mt}^h - u_{mt}^*$. The difference between the nominal and real interest rates is determined by the Fisher parity condition given by

$$\overline{r_t} = \overline{i_t} - E_t \pi_{t+1}, \tag{4}$$

with E_t denoting conditional expectations as of period t. Substituting (4) into (3) yields

$$i_t = \overline{r_t} + E_t \pi_{t+1} + \gamma_q q_t + \gamma_\pi \pi_t + \gamma_y y_t + u_{mt},$$

implying that the Taylor principle is satisfied whenever $\gamma_\pi > 0$. Exchange rate expectations enter the model via an interest rate parity condition. As the evidence regarding uncovered interest rate parity is rather weak, we augment it by a time-varying risk premium shock u_{st}

$$i_t = E_t s_{t+1} - s_t + u_{st},$$

which may be rewritten in terms of the real exchange rate as

$$i_t = E_t \pi_{t+1} + E_t q_{t+1} - q_t + u_{st}. \tag{5}$$

The aggregate demand equation describing the domestic-to-foreign output gap differential is given by

$$y_t = \theta q_t - (i_t - E_t \pi_{t+1}) + u_{yt}, \tag{6}$$

where $i_t - E_t \pi_{t+1}$ is the ex-ante real interest rate differential, $\theta > 0$ represents the expenditure switching effect associated with a normal reaction of the balance of payments, and u_{yt} can be interpreted as a differential output market disturbance. Eq. (6) is consistent with an open-economy dynamic IS curve and can be derived from first principles as in Gali and Monacelli (2005).

We follow Clarida and Waldman (2007) in assuming a high degree of inflation inertia where the change in expected relative inflation, rather than its level, is increasing in the output gap differential, such that the composite aggregate supply equation takes the form

$$E_t \pi_{t+1} = \pi_t + \kappa y_t. \tag{7}$$

The model consists of Eqs. (3) to (7), which can be condensed into two difference equations describing the laws of motion of relative inflation and the real exchange rate. Substituting Eqs. (4) and (6) into Eq. (3) and using (5) results in the difference equation for the real exchange rate

$$\begin{aligned} E_t q_{t+1} - q_t = \frac{1}{1+\gamma_y} [\overline{r_t} &+ \gamma_\pi \pi_t + \left(\theta \gamma_y + \gamma_q\right) q_t \\ &+ \gamma_y u_{yt} + u_{mt} - \left(1 + \gamma_y\right) u_{st}], \end{aligned} \tag{8}$$

while substituting Eqs. (5) and (6) into (7) and using (8) yields the difference equation for inflation dynamics

$$E_t \pi_{t+1} - \pi_t = \frac{1}{1+\gamma_y} \left[\kappa\left(\theta - \gamma_q\right) q_t - \kappa \overline{r_t} - \kappa \gamma_\pi \pi_t + \kappa\left(u_{yt} - u_{mt}\right)\right]. \tag{9}$$

The Appendix characterizes the dynamic system given by Eqs. (8) and (9). The model turns out to be saddle-point stable, which allows for a simple graphical exposition of the dynamic adjustment paths in a diagram with relative inflation and the real exchange rate on the axes. Dropping the time index and setting $\Delta q = E_t q_{t+1} - q_t = 0$ as well as $\Delta\pi = E_t \pi_{t+1} - \pi_t = 0$, the two difference equations appear respectively as the downward and upward sloping schedules in Figs. 1–3, with the convergent saddle path indicated by a broken line. The Δq schedule shows all combinations of relative inflation and the real exchange rate at which the composite Taylor rule yields a zero interest rate differential. In contrast, the $\Delta\pi$ schedule displays all combinations of the endogenous variables at which the output gap differential is closed.

All figures display the initial equilibrium as point A, and the post-shock impact and long-run equilibria as points B and C. In Fig. 1, the implementation of a more restrictive monetary policy stance in the domestic relative to the foreign economy ($u_m > 0$) shifts both the $\Delta q = 0$ and $\Delta\pi = 0$ schedules downwards in equal proportions such that the steady-state effect on the real exchange rate is exactly zero. Fig. 2 displays an expansionary shock to the output gap differential ($u_y > 0$) associated with either an increase in aggregate demand or a contraction in aggregate supply. The $\Delta\pi = 0$ schedule shifts up and the $\Delta q = 0$ schedule shifts down such that the new steady state is characterized by a higher rate of inflation and a lower level of the real exchange rate relative to the initial equilibrium. Finally, Fig. 3 shows the dynamic adjustment following a shock to the risk premium on home bonds ($u_s > 0$). The shock shifts the $\Delta q = 0$ schedule to the right, and the new steady-state features a higher relative inflation rate and a depreciated real exchange rate.

For the subsequent empirical analysis we separately consider shocks to aggregate supply and aggregate demand. In the model an expansionary demand shock and a contractionary supply shock both generate a positive output gap. The only difference arises with respect

---

[1] MCIs have been analyzed extensively in the recent literature both as a theoretical concept (see, e.g. Ball, 1999;Svensson, 2000;Batini et al., 2003) and as an empirical approximation to the actual conduct of monetary policy, particularly for small open economies (see e.g. Freedman, 1994;Clarida et al., 1998;Gerlach and Smets, 2000).