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Rational expectations, changing monetary policy rules, and real exchange rate dynamics

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ABSTRACT

This paper reexamines the explanatory power of Taylor rule fundamentals for real exchange rate determination. We assume the agents know the time-varying parameters in central bank policy rules. The empirical results suggest that a monetary policy rule with regime switching is better able to explain the real Deutschemark/dollar exchange rate from 1976 to 1998 compared with a fixed-regime monetary policy rule. The findings show the importance of accounting for the expectation formation effect in changing policy rules as emphasized by the Lucas critique. Ignoring these effects can undermine the value of the rational expectations models.

1. Introduction

Models incorporating Taylor rule fundamentals, as proposed by Engel and West (2005), have recently gained some prominence as a means of explaining movements in the exchange rate. For instance, Engel and West (2006) derive the present-value expression from a Taylor rule model, and find a positive correlation between the model-based exchange rate and the actual real exchange rate between the US dollar and the Deutschemark. Mark (2009) examines the role of Taylor rule fundamentals for exchange rate determination in a model that assumes agents use least-square learning rules to acquire information about the numerical values of the model's coefficients. He finds the model is able to capture major swings in the real mark/dollar exchange rate from 1976 to 2007. Molodtsova and Papell (2009) show significant short-horizon, out-of-sample predictability of exchange rates with Taylor rule fundamentals for 11 out of 12 currencies vis-à-vis the US dollar during the post-Bretton Woods era. Molodtsova et al. (2008) find evidence of out-of-sample predictability for the dollar/mark nominal exchange rate with forecasts based on Taylor rule fundamentals using real-time dataset.

Moreover, theoretical frameworks such as Benigno (2004) and Benigno and Benigno (2008) show that a New Keynesian model with Taylor rules and a Calvo-type price adjustment between firms well characterizes the dynamic properties of real exchange rates. In their models, nominal interest rate differentials between the home and foreign countries generate persistence in real exchange rates rather than the speed of adjustment of nominal prices. Under a plausible parameters setting, these studies show that real exchange rates can be both highly persistent and volatile, and this helps solve the purchasing power parity puzzle remarked upon by Rogoff (1996).

Engel and West (2006) and Mark (2009) show that, the real exchange rate under Taylor rule fundamentals can be written as the present value of future macroeconomic fundamentals. Under an endogenous monetary policy rule, expected future inflation, the output gap, and associated parameters of the monetary policy rule determine the real exchange rate. As noted by Engel et al. (2007), correctly modeling monetary policy is critical if real exchange rates are primarily driven by expectations. This is because changes in the expectations of monetary policy may induce changes in current economic fundamentals, and this may amplify the impact on real exchange rates. Engel et al. (2007) measure the forecasts of current and future inflation and output based on survey data to capture the effects of expectations. They then examine the long-run relationship between the real exchange rate and the present value of changes in inflation and the output gap. However, Engel et al. (2007) do not discuss the impact directly arising from changes in the deep parameters of the monetary policy rule. As assumed in conventional rational expectations models, the reaction parameters of monetary policy are fixed. This implies that agents in the models

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naively believe that the regime will prevail indefinitely, but this may be inconsistent with the assumption of rational expectations in which agents form expectations based on all available information.

In an economy where past changes in monetary policy rules are observable and future changes in policies are likely to occur, the information set of rational agents should include a probability distribution over possible policy shifts in the future. Leeper and Zha (2003) denote the impact arising from expectations of possible future regimes as the expectation formation effect. It is worth noting that the above definition of the expectation formation effect is also related to the aspects of expectation formation in the Lucas critique. Leeper and Zha (2003) argue that, a natural way to judge whether the Lucas critique is quantitatively important is to examine the magnitude of the expectation formation effect. If the expectation formation effect is not negligible, then predictions based on a fixed regime model could be misleading.

Putting aside the theoretical importance of the expectation formation effect, the empirical evidence also suggests that monetary policies in the US and Germany exhibit regime switching. For example, Clarida et al. (2000) and Lubik and Schorfheide (2004) show that the change in monetary policy in the US from a passive policy rule to an active rule led to the great economic moderation of the early 1980s. Moreover, Kuzin (2006) finds the inflation aversion of the Bundesbank was not constant over time, but rather exhibited some sudden and large shifts because the bank was following an "opportunistic approach" to disinflation. That is, the Bundesbank was fighting against any incipient rise in inflation, but held its policy rules unchanged until the next favorable inflation shock appeared to lower inflation toward the inflation target. The Bundesbank is argued not to have actively lowered inflation in a manner that pushed the unemployment rate higher.

By assuming that market participants know the Taylor rule coefficients, Engel and West (2006) show that the correlation of the model real exchange rate and actual real exchange rate is around 0.32. Even though this is not too bad and represents a promising start in this strand of literature, this paper aims to investigate whether we can improve the fit of the Taylor rule model of real exchange rate determination when the agents account for possible changes in the monetary policy regimes. We use a modified version of the exchange rate models with Taylor rule fundamentals proposed by Engel and West (2006) and Mark (2009). In particular, we propose a time-varying Taylor rule that evolves according to an exogenous Markov process. In the modified model, interest rates can be more or less reactive to inflation rates, i.e., the so-called "active" and "passive" regimes in the literature. By assuming the nominal exchange rate is priced by uncovered interest parity and the inflation rates and output gap are generated by a bivariate vector autoregression (VAR), we then solve the implied real exchange rates of the regime-switching model by using the method of undetermined coefficients proposed by Davig and Leeper (2007).

The main findings of this paper can be summarized as follows. First, the correlation between the regime-switching model real exchange rate and the real mark/dollar exchange rate from 1976Q1 to 1998Q4 is higher than the correlation between the fixed-regime model real exchange rate and the real mark/dollar exchange rate. Second, the regime-switching model matches the persistence of the data better than the fixed-regime model, especially over long horizons. Finally, the calibrated paths generated from the regime-switching model more closely match the turning points in the real mark/dollar real exchange rate data than the paths generated from the fixed-regime model. The main contribution of the current paper is to show the importance of accounting for the expectation formation effect in changing policy rules on real exchange rate modeling. Moreover, the estimated parameters of the regime-switching monetary policy rules can also be used by the other researchers as the reference point for future research.

The remainder of the paper is organized as follows. Section 2 presents the basic model environment. Section 3 discusses the solution of the model with regime-switching monetary policy rules and Section 4 provides empirical evidence of the regime-switching monetary policy rules and assesses the empirical performance of the implied real exchange rates generated from the regime-switching model. Section 5 checks the robustness of the empirical results using alternative specifications. Section 6 concludes.

2. The model

The empirical model is based on Engel and West (2006), Engel et al. (2007) and Mark (2009). The economic environment is a two-country world, with Germany as the home country and the US as the foreign country. Subscripts "h" and "f" denote the home country and the foreign country, respectively. Following Engel and West (2006) and Mark (2009), we assume inflation and the output gap follow a vector autoregressive (VAR) process. The agents in the economy (including the foreign exchange market participants and the monetary authorities) take the monetary policy rules in conjunction with the VARs as the data-generating processes and use the VARs to forecast future inflation, the output gap and interest rates. The interest rate target $R^T_{h,t}$ of the Bundesbank is set by[1]:

$$R^T_{h,t} = \overline{R}_h + \gamma_h(E_t\pi_{h,t+1} - \overline{\pi}_h) + \theta_h x_{h,t}, \tag{1}$$

where $\overline{R}_h$ is the desired rate of the Bundesbank, $E_t\pi_{h,t+1}$ is the expected inflation rate at $t+1$, $\overline{\pi}_h$ is the inflation target and $x_{h,t}$ is the output gap. γ_h represents the policy parameters that measure the response of the deviation of the targeted interest rate $(R^T_{h,t} - \overline{R}_h)$ to the deviation of the expected inflation rate at $t+1$ from the inflation target $(E_t\pi_{h,t+1} - \overline{\pi}_h)$, and θ_h measures the response to the output gap.

The actual interest rate of the Bundesbank $R_{h,t}$ follows an interest rate smoothing behavior as follows:

$$R_{h,t} = (1-\rho_h)R_{h,t-1} + \rho_h R^T_{h,t} + u^m_{h,t}, \tag{2}$$

where $u^m_{h,t}$ is the monetary policy shock, which is assumed to be normally distributed with a zero mean and a finite variance $\sigma^2_{h,m}$.

Analogously, the target Federal funds rate is set by:

$$R^T_{f,t} = \overline{R}_f + \gamma_f(E_t\pi_{f,t+1} - \overline{\pi}_f) + \theta_f x_{f,t}. \tag{3}$$

Furthermore, the interest rate smoothing function of the Fed is:

$$R_{f,t} = (1-\rho_f)R_{f,t-1} + \rho_f R^T_{f,t} + u^m_{f,t}. \tag{4}$$

Substituting (1) into (2), and (3) into (4), we obtain the forward-looking monetary policy reaction functions of the Bundesbank and the Fed as follows:

$$R_{h,t} = \delta_h + (1-\rho_h)R_{h,t-1} + \rho_h(\gamma_h E_t\pi_{h,t+1} + \theta_h x_{h,t}) + u^m_{h,t}, \tag{5}$$

$$R_{f,t} = \delta_f + (1-\rho_f)R_{f,t-1} + \rho_f(\gamma_f E_t\pi_{f,t+1} + \theta_f x_{f,t}) + u^m_{f,t}, \tag{6}$$

where $\delta_h \equiv \rho_h(\overline{R}_h - \gamma_h\overline{\pi}_h)$ and $\delta_f \equiv \rho_f(\overline{R}_f - \gamma_f\overline{\pi}_f)$.

We assume the uncovered interest parity holds:

$$R_{h,t} = R_{f,t} + E_t s_{t+1} - s_t, \tag{7}$$

where s_t is the log of the nominal exchange rate. Define the log real mark/dollar exchange rate q_t as the nominal exchange rate s_t minus the log price differential between Germany and the US, $p_{h,t} - p_{f,t}$, i.e., $q_t \equiv s_t + p_{f,t} - p_{h,t}$. Upon subtracting the expected value of the

[1] In Clarida et al. (1998), the empirical results suggest that the Bundesbank reacts to the real exchange rates significantly. However, using the quarterly data, the estimation results of the Bundesbank's monetary policy reaction function in Mark (2009) yield insignificant estimates for the response coefficient to the real exchange rates. Following Mark (2009), we assume the Bundesbank does not respond to the real exchange rates because we use quarterly data as in Mark (2009).