A Review of Theoretical Model and Empirical Research on the Relationship Between Real Exchange Rate and Real Interest Rate

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Abstract. The research on the relationship between real exchange rate and real interest rate has been an important field of financial research. This paper sorted out, analyzed and summarized the main theoretical models and empirical studies on the relationship between real exchange rate and real interest rate by using method of literature analysis. It was found that the theoretical models reveals that there is a link between real exchange rate and real interest, however, the results of the empirical analysis is not the same, some empirical analysis found evidence of the link between real exchange rate and real interest rate, and other empirical analysis failed to find evidence of this.

Introduction

The relationship between interest rate and exchange rate has always been one of the important issues that economists have been concerned about by countries in the world. Considering the influence of price difference of various countries, some scholar instead real interest rate and real exchange rate with nominal interest rate and the nominal exchange rate on the study of relationship between interest rate and exchange rate, so as to avoid the effect of inflation rate on interest rate and exchange rate. The following is a summary of the theoretical models and empirical researches in this area.

The Theoretical Models of the Relationship between Real Exchange Rate and Real Interest Rate

The Model of Dornbusch and Frankel

Frankel (1979) [1] on the basis of the most notably Dornbush (1976) [2]sticky price theory, assumed long-term purchasing power parity holds, proposed the relationship model between real exchange rate and real interest rate difference. The model marks the beginning of the research on the relationship between real exchange rate and real interest rate.

\[ e - p + p^* = -\lambda [(i - \pi) - (i^* - \pi^*)] \] (1)

where, \(e\) for the natural logarithm of the spot exchange rate, \(p\) and \(p^*\) for the natural logarithm of the domestic and foreign price levels. Therefore, on the left side of the formula said real exchange rate. \(\lambda\) for an adjustment coefficient that greater than zero, \(i\) and \(i^*\) for domestic and foreign interest rates, \(\pi\) and \(\pi^*\) for domestic and foreign inflation, then \((i-\pi)\) and \((i^*-\pi^*)\) for domestic and foreign real interest rate.

The Model of Edison and Pauls

Edison and Pauls (1993) [3] introduced of a variable of risk subsidy based on the uncovered interest parity. The risk subsidy variable is assumed to be white noise, in order to express the dynamic of model, a variable relate to cumulative current account is introduced into the model. Finally, we get a model of relationship between real exchange rate and real interest rate.

\[ q_t = E(r_{tT}) - E(r^*_{tT}) + k + \bar{q}(ccbal_t) - \rho_i \] (2)
where $q_t$ for the natural logarithm of the real exchange rate, $E(r_{r,t})$ for expectations value of real domestic interest rate, $E(r_{r,t}^*)$ for expectations value of the foreign real interest rate, $k$ for constant, $ccbal_t$ for cumulative current account variable, $\bar{q}(ccbal_t)$ for the function of the cumulative current account variable, $\rho_t$ for risk subsidy variables. The model reveals that the real exchange rate is affected by actual interest rate difference between the two countries, the cumulative current account and the risk subsidy.

**The Model of Krugman and Obstfeld**

Krugman and Obstfeld (1997) [4] on the basis of uncovered interest parity, introduced the relative purchasing power parity, and obtained a real interest rate model that reflects the relationship of real interest rate and real interest rate.

\[
    r^e - r^{*e} = (q^e - q)/q
\]

where, $r^e$ for expected domestic real interest rates, which is equal to domestic nominal interest rate minus domestic expected rate of inflation. $r^{*e}$ for expected foreign real interest rates, it is equal to foreign nominal interest rate minus expected foreign inflation rate. $q^e$ for expected real exchange rate, it is equal to expected nominal exchange rate multiplied by the ratio of abroad and domestic price level. $q$ for spot real exchange rate, it is equal to spot nominal exchange rate multiplied by the ratio of abroad and domestic price level. The model reveals the relative purchasing power parity and interest rate parity conditions are established on the premise, expects the two countries the size of the real interest rate differential and the expected rate of change of the real exchange rate is consistent, when expected domestic real interest rates higher than foreign real interest rate, people will expect that a real depreciation of the country's currency relative to foreign currencies in the future.

**The Simplified Model of M-F-D**

The simplified model of M-F-D that included in the sticky price monetary theory is about the relationship between real interest rate and real exchange rate, the model is important to study the relationship between the real exchange rate and real interest rates. Following is a brief introduction of the derivation of the model.

Meese and Rogoff (1988) [5] proposed a simplified model about the relationship between the real exchange rate and real interest rate based on the Dornbusch [6] and Frankel’s model (D-F model) [7] and Hooper and Morton’s model (H-M model). [8] D-F model and H-M model assumption that expect price adjustment of commodity market is relatively slow from the impact of currency. Therefore, small expected monetary shocks can cause real exchange rate deviates temporarily from its long-run equilibrium value. The following is their derivation of the model.

The simplified model of the relationship between real interest rate and real exchange rate is mainly based on the following three equations (4), (5), (7). Firstly, according to the D-F model and the H-M model, it is assumed that the temporary deviation of real exchange rate from the elastic price equilibrium value decrease with a constant damping ratio in the absence of further shock.

If $q$ for the natural logarithm of the real exchange rate, then, $q = e + p^*_t - p_t$, where $e$ for the natural logarithm of the nominal exchange rate of direct quotation, $p$ for the natural logarithm of the level of the domestic commodity prices, $p^*$ for the natural logarithm of the foreign commodity price level with foreign currency, $t$ is the corresponding time subscript. Then the first hypothetical equation is as follows.

\[
    E_t(q_{t+k} - \bar{q}_{t+k}) = \theta^k(q_t - \bar{q}_t), 0 < \theta < 1
\]

where, $E_t$ for expectation operator at time $t$, $\bar{q}_t$ for the equilibrium level of real exchange rate at time $t$ under the elasticity price condition, $\theta$ for the adjustment parameter of speed.
In general, $E_\{\bar{q}_{t+k}\}$ is not equal to $\bar{q}_t$, unless there is no real impact or all the real shocks follow a random walk process. Similarly, according to the D-F model and the H-M model, we can get the second hypothetical equations as follows.

$$E_\{\bar{q}_{t+k}\} = \bar{q}_t$$  \hspace{1cm} (5)

Put (5) into (4) get

$$q_t = \alpha(E_\{q_{t+k}\} - q_t) + \bar{q}_t$$  \hspace{1cm} (6)

where, $\alpha = 1/(\theta^k - 1) < -1$

The third important hypothetical equation is the non-covered interest parity.

$$E_\{e_{t+k}\} - e_t = k_r - k_r^*$$  \hspace{1cm} (7)

where, $k_r$ for the nominal interest rate at time $t$ with length of $k$.

Equation (7) shows that

$$E_\{q_{t+k}\} = k R_t - k R_t^*$$  \hspace{1cm} (8)

where, $k R_t$ for real interest rate at time $t$ with length of $k$, $k R_t = k R_t - (E_t P_{t+k} - P_t)$, $(E_t P_{t+k} - P_t)$ for the expected inflation rate at time $t$ with length of $k$.

Put (8) into (6) get

$$q_t = \alpha(k R_t - k R_t^*) + \bar{q}_t$$  \hspace{1cm} (9)

where, $\alpha < 0$. $\bar{q}_t$ is a constant in the sticky price monetary theory. Equation (9) is the simplified model of the relationship between real interest rate and real exchange rate in the sticky price monetary theory.

The simplified model reveals the reverse change relationship between actual exchange rate of the domestic currency and actual interest rate spread of the domestic currency and the foreign currency. Because the exchange rate in the model is the direct quotation method, therefore, the actual exchange rate appreciation (depreciation) of the domestic currency value positive change with the actual interest rate spread of the domestic currency and the foreign currency.

**Empirical Research on the Relationship between Real Exchange Rate and Real Interest Rate**

**The Relationship between Real Exchange Rate and Real Interest Rates Do Not Exist**

Meeze and Rogoff (1988) [9] using the data of the United States, the United Kingdom, Germany and Japan during 1973-1988 years, as well as the methods of traditional regression analysis and co-integration test to analyze the relationship between real exchange rate and the real interest rate. The empirical results have not found that the stable relationship between the real exchange rate and the real interest rate of the Dollar, the Pound, the German Mark and the Yen.

Edison and Pauls (1993) [10] using co-integration test and Error Correction Model, and introduced the cumulative current account balance variable may affect the real exchange rate in the long run into the model. Data of exchange rate and interest rate of G10's during 1974-1990 years were used to study the relationship. Empirical results show that the data of real exchange rate and real interest rate are non-stationary, and there is no co-integration relationship between them.

**The Relationship between Real Exchange Rate and Real Interest Rates Do Exist**

Frankel (1979) [11] absorbed assumes of sticky prices theory of Dornbusch, improved the flexible price monetary model, and brought the real interest differential model. The data of exchange rate and interest rate of the United States and Germany during 1974-1978 years were tested, empirical result support the relationship of the real exchange rate and real interest differentials included in the model.
Campbell and Clarida (1987)[12] using data from 1979 to 1986 in the United States, Canada, Britain, Germany and Japan, and the method of state space analysis to analyze the relationship of the real exchange rate and real interest rate. The results show that the change of the real exchange rate of the dollar is mainly affected by the long-term equilibrium exchange rate which is not expected, and the expected real interest rate difference is only a small part of the impact.

Baxter (1994)[13] using the method of band spectrum, studied the relationship between real exchange rate and real interest rate. The study found there is no relationship on the high frequency data, while has a strong connection on the low-frequency data that attention trend and the business cycle. Therefore, the author thinks the reason that the previous research failure to find relationship between real exchange rate and real interest rate spread, main reason is that the studies are concerned with is the real exchange rate short-term fluctuations rather than the long term behavior.

Mark and Moh (2009)[14] using nonlinear dynamic models, as well as data in Japan, Canada, Germany, the United Kingdom and the United States during the 1975-2002 years. Empirical results show that the relationship between real interest rate and real exchange rate is stronger in a relatively short period than that in a relatively long period.

Conclusions
According to the theoretical models of the relationship between the real exchange rate and the real interest rate, the real exchange rate has a close relationship with the real interest rate. However, empirical research result on the relationship between real exchange rate and real interest rate is different, some studies found evidence to support this relationship, and some studies are not found evidence to support this relationship. However, most of the studies have proved that the real exchange rate is related to the real interest rate.

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References


