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Granger causality from exchange rates to fundamentals: What does the bootstrap test show us?

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ABSTRACT

We use a residual-based bootstrap method to re-examine the finding of the Granger causality relation from exchange rates to fundamentals in Engel and West (2005), in which the relation is taken as evidence for their explanation for the present-value model for exchange rates. Our test results are against the previous findings. The Monte Carlo experiment results suggest that the previous evidence for the causality relation from exchange rates to fundamentals is very likely caused by the size distortion. Hence, the existing Granger causality evidence is not strong enough to validate the new explanation for the present-value model.

1. Introduction

Since Meese and Rogoff (1983a,b), a great number of researchers have proposed looking for the empirical evidence for the relationship between exchange rates and fundamentals implied by the theoretical models. However, the evidence for the relationship in the relevant literature is rarely significant (e.g. Cheung, Chinn, & Pascual, 2005; Kilian, 1999; Molodtsova & Papell, 2009; Rogoff & Stavrakeva, 2008). The weak relationship between the exchange rate and the macroeconomic aggregate such as money supplies and outputs and the difficulty of linking the exchange rate to the rest of the economy are included as part of the "exchange-rate disconnect puzzle" (Obstfeld & Rogoff, 2000).

In a recent paper, Engel and West (2005) propose a solution to the puzzle. They show that, in the present-value model, when at least one fundamental follows a unit root process and the discount factor is close to one, the exchange rate will be close to a random walk. This finding implies that the weak connection between exchange rates and fundamentals found in the empirical studies is an implication of the present-value model for exchange rates rather than evidence against the macroeconomic models. To provide direct validation, Engel and West (2005) evaluate the Granger causality relationship between exchange rates and observable fundamentals implied by a present-value model. They uncover some statistically significant Granger causality relationships from exchange rates to fundamentals based on the asymptotic distribution. Since the finding is consistent with the implication of the present-value model for exchange rates, Engel and West (2005) argue that their finding may change the terms of the exchange rate debates. Nevertheless, due to the data availability Engel and West's test results from asymptotic study could suffer from the small-sample problem.

In response to the asymptotic Granger causality test in Engel and West's (2005) paper, the goal of this article is to re-assess the existing evidence of the present-value model for exchange rates with a more reliable test method. Owing to advanced computer technology, the bootstrap technique can now be quickly implemented. Moreover, the bootstrap method is generally believed to

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have less size distortions providing more precise test inferences than the asymptotic method in many applications if the available sample size is small (see Hacker & Hatemi-J, 2006). In addition, it has been employed in many studies investigating the relationship between exchange rates and fundamentals (e.g. Kilian, 1999; Mark, 1995; Mark & Sul, 2001) and the causality relationship between the budget deficit and the current account deficit (e.g. Hatemi-J & Shukur, 2002; Xie & Chen, 2014).

In this study, we employ the residual-based bootstrap method to re-assess the existing evidence of the Granger causality relationship from exchange rates to fundamentals. We use Engel and West's (2005) data and provide a comparison of the test results from the bootstrap distribution and the asymptotic distribution. The asymptotic test results indicate that as the sample size applied in the test gets smaller, more evidence shows that exchange rates could Granger cause economic fundamentals in the asymptotic test. However, the bootstrap test shows the opposite results. In particular, when the smallest sample is applied, eleven out of thirty null hypotheses that exchange rates do not Granger cause fundamentals are rejected at the 5% significance level in the asymptotic tests, but only five out of thirty null hypotheses are rejected in the bootstrap tests.

In order to examine whether the bootstrap test performs better than the asymptotic test in this application, we implement the Monte Carlo experiment to compute the size and power of the asymptotic and bootstrap test methods, respectively. We find that the size of the asymptotic Granger causality test is overall larger than that of the bootstrap Granger causality test. The large size of the asymptotic test shows that the size distortion affects the asymptotic test, and it means that the asymptotic Granger causality test tends to spuriously reject the null hypothesis in this application. In addition, the power of the bootstrap test is generally larger than that of the asymptotic test, which implies that the results based on the bootstrap test are more convincing.

The remainder of this paper proceeds as follows. The next section gives a review of the present-value model for exchange rates and briefly introduces Engel and West's (2005) explanation for exchange rates in the present-value model. Section 3 illustrates the Granger causality test model and the bootstrap algorithms. Section 4 presents the empirical findings. Section 5 displays the size and power of the bootstrap test and the asymptotic test. Section 6 is the conclusion.

2. Exchange rate under the present-value model

2.1. The monetary-income model for exchange rates

An exchange rate can be viewed as an asset price in the present-value model. To construct the present-value model for the exchange rate, we denote the log of the nominal exchange rate measured at time t by s_t and denote the observable macroeconomic fundamentals of the nominal exchange rate measured at time t by f_t. In the conventional money income model, the money market relationship is given by

$$m_t = p_t + \phi y_t - \lambda i_t$$

$$m_t^* = p_t^* + \phi y_t^* - \lambda i_t^*$$

The variable m_t is the log of the money supply, p_t is the log of the price level, y_t is the log of income, and i_t is the level of interest rate. The asterisk represents variables in the foreign country. The parameter $0 < \phi < 1$ is the income elasticity of money demand and $\lambda > 0$ is the interest rate semi-elasticity of money demand. The parameters of the foreign money demand are identical to the parameters of the home country.

Assuming the purchasing power parity (PPP) holds, the nominal exchange rate is expressed as:

$$s_t = p_t - p_t^*$$

The financial market equilibrium is given by the uncovered interest rate parity (UIRP):

$$i_t - i_t^* = \mathrm{E}_t s_{t+1} - s_t$$

Here, $\mathrm{E}_t s_{t+1}$ is the rational expectation of the exchange rate at time $t + 1$. Combining and rearranging the above equations, the present-value formula for the exchange rate takes the form:

$$s_t = \gamma f_t + \psi \mathrm{E}_t s_{t+1} = \gamma \sum_{j=1}^{k} \psi^j E_t f_{t+j} + \psi^{k+1} E_t s_{t+k+1} \tag{1}$$

where

$$f_t \equiv (m_t - m_t^*) - \phi(y_t - y_t^*)$$

$$\gamma \equiv 1/(1+\lambda)$$