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An investigation of the causal relations between exchange rates and interest rate differentials using wavelets

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ABSTRACT

This paper uses wavelet analysis to investigate causality between the spot exchange rate and the nominal interest rate differential for seven country pairs, which includes Sweden. Impulse response functions are also utilized to examine the signs of how one of these variables affects the other over time. One key empirical finding from the causality tests is that there is strengthening evidence of the nominal interest rate differential Granger causing the exchange rate as the wavelet time scale increases. When considering impulse responses on how the interest rate differential affects the exchange rate, there appears to be some evidence of more negative relationships at the shorter time scales (i.e. an increase in the Swedish interest rate compared to that of another country is associated with a lower Swedish krona price of the other country's currency) and more positive relationships at the longer time scales.

1. Introduction

The relationship between the exchange rate and the interest rate has been investigated in various theoretical models of international economics, with such models frequently including other fundamental-variable determinants of the exchange rate such as relative money supplies and domestic and foreign outputs (Bilson, 1978; Dornbusch, 1976; Engel and West (2005); Frenkel, 1976, 1979; among others). The theoretical relationship between the spot exchange rate (defined in this paper as the domestic-currency price of foreign currency) and the interest rate differential (the domestic interest rate minus the foreign interest rate) is often considered to be negative in the short run when product prices are sticky and positive in the long-run when they are not. The short-run negative relationship arises from the intuition that, all else equal, an increase in the home-country interest rate relative to the foreign one will induce financial capital flows to the home country, which creates pressure for the home country's currency to appreciate. The long-run positive relationship can be explained by the intuition that the home-country interest rate increasing relative to the foreign one frequently reflects an increase in the conditions for higher inflation in the home country relative to the foreign one, which also creates pressure for the home country's currency to depreciate. A positive relationship may also be associated with a depreciation of the home-country currency leading to an increase in the home country's trade balance and a decrease in the foreign trade balance, which induces the domestic interest rate to rise and the foreign interest rate to fall.

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The contemporaneous relationship at different time scales between the spot exchange rate and interest rate differential was studied by using wavelets and simple regression in a paper by Hacker, Karlsson, and Månsson (2012). However, by just investigating the contemporaneous relationship between these variables using simple regression, that paper had its results subjected to several problems such as autocorrelation and explanatory-variable endogeneity. By using dynamic models instead and by using Granger causality one can diminish these problems (again using wavelet-decomposed data). Also, by considering Granger causality in either direction between the variables of interest, one can gain further insights on how they are related.

In investigating the relationship between exchange rates and interest rate differentials, wavelet analysis is used in this paper. Wavelet analysis has become increasingly popular for analyzing economic time series due to its advantages that one can decompose a time series into different time scales so the relationship between variables can be analyzed at the short run, intermediate run and up to the long run. This has been done by for example Ramsey and Lampart (1998) to investigate the permanent income hypotheses and in Almasri and Shukur (2003) to examine the causality in a Granger sense between government spending and revenue. In this paper we explore the Granger-causal relationships between the spot exchange rate and the cross-country difference in the rate of interest, with wavelet decomposition utilized to consider these relationships at various time scales. Impulse responses associated with the utilized time scales are also investigated to consider the sign of the effect of one variable on the other over time.

In the wavelet decomposition of this paper, a multiresolutionary analysis (MRA) for a maximal overlap discrete wavelet transform (MODWT) is used to filter the data. Subsequently, to test for Granger causality a method developed by Månsson and Shukur (2009) is used. According to that method the causality testing is performed by applying an LM test with White's heteroscedasticity consistent covariance matrix (HCCME). This method is chosen since a characteristic of the investigated variables is that the variance of each studied time series is non-constant and follows an autoregressive conditional heteroscedasticity (ARCH) process or generalized autoregressive conditional heteroscedasticity (GARCH) process. Finally to consider the sign of the relationship between the variables associated with the causal effect we use impulse response functions.

The data used to test for Granger causality are monthly spot exchange rates for seven currencies (U.S. dollar, Japanese yen, euro, pound sterling, Norwegian krone, the Korean Won and Swiss franc) against the Swedish krona along with the three-month treasury bill interest rates for the associated countries. By performing this investigation for several pairs of countries we can consider the robustness of the empirical relationships between the variables of interest. The choice to focus on Sweden versus other countries is based on taking advantage of Sweden's small-country situation, a characteristic utilized in many open macroeconomic models to reduce some feedback.

The paper is organized as follows. In the next section the economic theory and previous research in the area is studied. In Section 3 the theoretical foundations of wavelet filtering is explained, then in Section 4 the data is described along with some example wavelet decomposition. In Section 5 a description is provided for the methodology used when testing for Granger causality and for generating impulse responses. Then in Section 6 the results from the Granger causality tests and impulse responses are described and in Section 7 the conclusions drawn are summarized.

2. Economic theory and previous research

The introduction briefly covered the intuition behind the short-run and long-run relationships between the exchange rate and the interest rate differential. In this section we briefly review various open macroeconomic models dealing with these relationships. More detailed descriptions of these models are given in Hacker et al. (2012).[1]

A negative relationship between the exchange rate and the interest rate can be justified by portfolio reallocations as a result of changes in the interest rate. As a country's interest rate increases, that country's interest-bearing assets become more attractive, all else equal. That induces investors to own more of those assets, resulting in an appreciation of that country's currency since that is the currency in which those assets are denominated. This is a typical result of portfolio balance models (Branson, 1983; Branson & Halttunen, 1979; Branson, Halttunen, & Masson, 1977).

We can see this mechanism at work also in the Mundell–Fleming (M–F) model (as in Fleming, 1962; Mundell, 1963, and countless textbooks) with capital inflows positively associated with the difference between home and foreign interest rates, so a domestic interest rate rise results in greater demand for domestic assets and a domestic-currency appreciation given sufficiently high capital mobility. This mechanism is also present in the equilibrating of expected asset returns as found in the uncovered interest rate parity condition.[2] This condition indicates a negative relationship between the domestic interest rate and the spot exchange rate, holding the foreign interest rate and the expected future exchange rate as constant. In the Dornbusch overshooting model, originally formulated by Dornbusch (1976), the uncovered interest rate parity condition provides a basis for the interest rate and the exchange rate being negatively related as a result of monetary shocks, both during a time period when the aggregate price level is held constant and during the period in which the aggregate price level is moving slowly toward its new long-run equilibrium.

[1] In our discussion we will often discuss how the domestic interest rate moves and assert without explanation that the interest rate differential moves in the same direction. The reason is that in these cases we can say that the foreign interest rate is either constant (due to a small country assumption) or that the foreign interest rate is moving in the opposite direction due to a symmetrically opposite logic.

[2] The uncovered interest rate parity condition is still an issue of active empirical research (see, for example, Chinn & Meredith, 2004; Cook, 2009; Craighead, Davis, & Miller, 2010).