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Information transmission across currency futures markets: Evidence from frequency domain tests

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ABSTRACT

We investigate return and volatility spillovers across the currency futures markets utilizing recently developed frequency domain tests. Our analysis permits to differentiate between permanent and transitory linkages between the markets by examining high and low frequency dynamics. We identify significant informational dependencies between the euro, yen, Swiss franc and pound futures markets, which should be important for market participants and policy makers.

1. Introduction

Analyzing linkages between currency markets is important for several reasons. First, understanding exchange rate dependencies can be useful to determine the extent of policy coordination between international monetary authorities. For instance, Bonser-Neal and Tanner (1996) and Fratzscher (2005) argue that central bank exchange rate interventions have been coordinated internationally, which would be consistent with information spillovers across currency markets. Similarly, Hakkio and Rush (1989) and Baffes (1994) show that, when their underlying fundamentals are closely related, currencies move together and can in fact be considered same assets.

Also, evidence for significant linkages across exchange rates may be exploited to improve forecasts. In fact, MacDonald and Marsh (2004) suggest that the lack of success in forecasting exchange rates could be due to the fact that studies largely focus on individual currency dynamics, which results in omitting spillovers among exchange rates. These authors find that accounting for linkages between major currencies generate richer dynamics and help to obtain improved forecasting power. Several other studies, such as Kang (2008), Berkowitz and Giorgianni (2001) and Diebold, Gardeazabal, and Yilmaz (1994) examine cointegration between exchange rates, which also has implications for causality and market efficiency.[1]

Finally, an understanding of interdependencies could be useful for currency risk management activities of multinational corporations and international portfolio investors to determine whether exchange rates can be substituted to hedge against similar risks. Building on these points, our primary goal in this study is to investigate the structure of dynamic linkages between major exchange rates by providing evidence from currency futures markets. Specifically, we examine both return and volatility spillovers between the euro, yen, British pound and Swiss franc futures markets.

Our analysis covers the period between 1999 and 2009; hence, we are able to provide evidence on the influence of the single currency of the European Union in futures markets. This is likely important since there is evidence to suggest that the role of euro as an international reserve currency is increasing (Galati & Wooldridge, 2006 among others). Kuhl (2010) is a noteworthy recent addition in this aspect and focuses on cointegration and market efficiency between the euro and major exchange rates. Covering the period between 1999 and 2006, he finds in general little evidence to suggest that the exchange rate pairs are cointegrated since the introduction of the euro.[2]

Among the other articles in prior work, Asimakopoulos, Ayling, and Mahmood (2000) investigate return spillovers across currency futures markets and detect some support for nonlinear causality, although they argue that the causality disappears when the series are controlled for common ARCH effects. Elyasiani, Kocagil, and Mansur (2007) examine price linkages between currency futures contracts, within the context of a vector autoregression model (VAR), covering the period between 1985 and 2005. They conduct a variance decomposition analysis and identify significant dependencies. It is noteworthy that similar to our study, their data set includes the exchange rates

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[1] AuYong, Gan, and Treepongkaruna (2004) investigate cointegration between exchange rates in the Asian and emerging markets during the 1990s financial crises. They show that especially the 1997 Asian crisis generates significant spillover effects.

[2] They do find evidence for cointegration between the euro and British pound exchange rates in their sample, which is rejected in our study as we discuss further below.

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of the British pound, German mark (for pre-1999 period), Japanese yen and Swiss franc; however, they do not include the euro rate in their analysis.[3] Elyasiani et al. (2007) focus on the same issue in a cointegration framework and detect stable long run relations between the currency futures markets.

In terms of volatility spillovers, in recent work, Nikkinen, Salhstrom, and Vahamaa (2006) analyze the linkages between the markets using implied volatilities from currency option prices, focusing on European currencies, and detect significant influence from the euro to the pound and Swiss franc. Inagaki (2007) examines volatility spillover between euro and the British pound and show unidirectional causality from the euro to the pound. Kitamura (2009) finds that causality in volatility runs from the euro to both pound and Swiss franc markets. He also argues that comovements between the European currencies have increased following the introduction of the euro. Kearney and Muckley (2008) examine volatility spillover between four Asian currency rates by estimating several multivariate GARCH models. Their results seem to suggest that the Asian currencies can be successfully linked to Japanese yen, in addition to their traditional pegs with the US dollar.

Our main contribution to the extant work in this field stems from the fact that we examine return and volatility linkages between the currency markets using recently developed frequency domain causality tests due to Breitung and Candelon (2006). As explained in greater detail below, their approach permits to examine causality dynamics at different frequencies rather than relying on a single statistic as is the case with the conventional time domain analysis. Specifically, the time domain analysis, usually conducted within the context of a VAR model, implicitly assumes that a one-shot test statistic is sufficient to summarize the relation between variables at all frequencies, as no differentiation is allowed between shocks at high and low frequencies. This could lead the researcher to ignore the fact that financial variables might be related at different frequencies, undetected by conventional tests.

Decomposing the information content of the causality analysis in this manner allows testing for permanent and transitory dependencies separately, as conducted in the present paper. Specifically, we calculate test statistics at near-zero frequency to identify long term transmission of information between the currency futures markets, which could be interpreted as permanent shocks. As Haug, McKinnon, and Michelis (2000) suggest, long term linkages in exchange rate markets are likely due to convergence of macroeconomic variables. On the other hand, we also calculate the test statistics at higher frequencies of the spectra to determine whether there are short term linkages, which could be interpreted as transitory shocks. These are likely due to processing of private information across the markets. We also provide conventional causality tests in the time-domain for a comparison of our findings.

As mentioned above, we also investigate volatility spillovers in addition to price linkages. Since volatility is latent, it has to be estimated. We use conditional volatility series estimated from a GARCH model as prior research indicates that this specification closely approximates the underlying volatility process. Moreover, we examine the period between 2007 and 2009 separately in an extension of the empirical analysis to investigate whether the dynamics differ during the recently experienced global financial crisis.

In empirical analysis, we show that there is no evidence of cointegration between the currency futures markets, contrary to the argument raised by MacDonald and Marsh (2004), among others. In terms of causality tests, it can be argued that the Swiss franc contract is the most influential in return spillovers. There is causality running from the Swiss franc market to all of the other currency contracts. However, it is worth mentioning that the euro also impacts the Swiss franc at low frequencies in a feedback relation.

In volatility spillover tests, we detect several highly significant dependencies, supporting transmission of shocks across the currency futures markets. Relative to return spillover tests, we show that the influence of the British pound market is higher as there is permanent and transitory causality running from this market to the other in our sample. However, we also show that during the recent global financial crisis, innovations in the euro futures markets were the most important for the evolution of the rest of the currency futures contracts, pointing to the growing importance of the single currency.

We organize the rest of the paper as follows: In the next section, we discuss the statistical method of analysis. We present the data in Section 3 and the empirical findings of the study in Section 4. We offer the concluding remarks of the study in the final section of the article.

2. Statistical method

As mentioned above, Granger causality tests are widely used to detect information transmission across financial markets. Specifically, a variable is said to cause another if information contained in the first variable is useful to improve the forecast of the second variable, as originally introduced by Granger (1969). These tests are conventionally conducted as Wald tests in vector autoregression (VAR) models, and hence, they produce a single, one-shot statistic regarding predictability. In other words, the conventional analysis implicitly ignores the possibility that causal dynamics could show variation across different frequencies.

This point has been recognized in the literature, see Geweke (1982); however, the test statistics to conduct the frequency domain analysis have proven difficult to estimate due to nonlinearities. The contribution of Breitung and Candelon (2006) is that they offer a different approach to calculate the causality tests. In particular, by building on earlier work by Geweke (1982), these authors show that the frequency domain causality tests be calculated by imposing linear restrictions on the autoregressive parameters in a VAR model, permitting to test for informational linkages at any frequency. Furthermore, they also find that their method has good size properties in Monte Carlo experiments.[4] Below is a brief discussion the testing methodology and we refer to the original paper for further details.

As mentioned above, the Breitung–Candelon analysis is based on earlier work by Geweke (1982), who considers the two-dimensional vector containing Y_t and X_t with a finite-order VAR representative of order p,

$$\Theta(L)\begin{pmatrix} Y_t \\ X_t \end{pmatrix} = \begin{pmatrix} \Theta_{11}(L) & \Theta_{12}(L) \\ \Theta_{12}(L) & \Theta_{22}(L) \end{pmatrix}\begin{pmatrix} Y_t \\ X_t \end{pmatrix} = \varepsilon_t \tag{1}$$

where $\Theta(L) = 1 - \Theta_1 L - \ldots - \Theta_p L_p$ is a 2×2 lag polynomial and $\Theta_1, \ldots, \Theta_p$ are 2×2 autoregressive parameter matrices, with $L^k X_t = X_{t-k}$ and $L^k Y_t = Y_{t-k}$. The error vector ε_t is white noise with zero mean, and $E(\varepsilon_t \varepsilon_t^{'}) = \Sigma$, where Σ is positive definite. The MA representative of the system is

$$\begin{pmatrix} Y_t \\ X_t \end{pmatrix} = \psi(L)\eta_t = \begin{pmatrix} \psi_{11}(L) & \psi_{12}(L) \\ \psi_{21}(L) & \psi_{22}(L) \end{pmatrix}\begin{pmatrix} \eta_{1t} \\ \eta_{2t} \end{pmatrix}, \tag{2}$$

with $\Psi(L) = \Theta(L)^{-1} G^{-1}$ and G is the lower triangular matrix of the Cholesky decomposition $G'G = \Sigma^{-1}$, such that $E(\eta_t \eta'_t) = I$ and $\eta_t = G\varepsilon_t$.

[3] They do point out in their paper that the influence of the euro should be highly significant in regards to exchange rate interdependencies.

[4] In empirical applications, Ciner (2011) uses this approach to test for short- and long-term causality between commodity prices and inflation, while Ciner (2010) investigates Eurocurrency interest rate linkages.