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Are volatility spillovers between currency and equity market driven by economic states? Evidence from the US economy

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HIGHLIGHTS

- Volatility spillovers between equity and currency markets are time-varying.
- Volatility spillovers are high when preceding periods of economic turbulence.
- In quiet states, volatility spillover effects are virtually non-existent.
- The volatility spillover indices may guide policy actions.

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ABSTRACT

This study examines the volatility spillovers between the foreign exchange rate markets of three of the USA's major trading partners and the US stock market, utilizing the forecast-error variance decomposition framework of a VAR model proposed by Diebold and Yilmaz (2009). The empirical results, based on a data set covering the period 1986–2014 suggest that the level of total volatility spillover effects is high only when they precede periods of economic turbulence. If the economy is quiet, volatility spillover effects are virtually non-existent.

1. Introduction

The recent developments in the USA and European economies, such as the US federal budget deficit hitting an outstandingly high level in the last decade or the sovereign debt crisis, especially in Southern Europe, have highlighted the significance of measuring and monitoring the spillover effects across markets. A policy maker would like to know how spillover effects will behave during economic downturns and whether they can be employed to predict the future evolution of specific market indicators. A tool capable of describing the behavior of spillover effects in different economic states could guide policy actions intended to monitor, control, or forecast contagion effects across markets that could lead to financial instability.

Spillover effects in financial markets have been investigated extensively in the economic literature. Most studies concentrate on analyzing return or volatility spillovers across countries but for identical assets. Claeys and Vasicek (2012) studied the sovereign bond yield spillover effects in EU countries, whereas Christiansen (2007) and Skintzi and Refenes (2006) explored cross country bond-market volatility spillovers. Moreover, Antonakakis (2012) and Bubak et al. (2011) investigated volatility spillover effects in currency markets, while Diebold and Yilmaz (2009) did the same in global equity markets. They proposed volatility spillover indices based on the forecast-error variance decomposition framework of a VAR model.

The current research focuses on spillover effects across different asset classes. Ehrmann et al. (2011) investigates the intensity of the transmission mechanisms among different asset markets within a country, and across countries while Diebold and Yilmaz (2012) explore volatility spillovers among four key US asset classes: stocks, bonds, foreign exchange, and commodities.

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This paper investigates the dynamic behavior of volatility spillover effects between major foreign exchange markets and the US equity market in the presence of economic turbulence. Employing the forecast-error variance decomposition framework of a VAR model proposed by Diebold and Yilmaz (2009), volatility spillover indices reveal the interdependencies between the US stock market and the foreign exchange rate markets of three of the USA's large trade partners (i.e., Europe, Japan, and Canada) that have a floating exchange rate against the US dollar. Cyclical movements in volatility spillovers are accounted for by estimating the models by using a 60-month rolling time window.

This study contributes to the existing literature by extending the work of Ehrmann et al. (2011) and Diebold and Yilmaz (2012) in the following ways. First, volatility spillover indices for the foreign exchange rate markets of three major trade partners of the US and the US stock market are constructed. In doing so, the sample period is expanded from 1991 to 2014 to investigate whether spillover effects have increased after the financial crisis, as Diebold and Yilmaz (2012) suggest they would. This study diverges from Diebold and Yilmaz (who estimated daily variance using daily high and low prices in line with Parkinson (1980)) in employing a consistent realized volatility approach to estimate the monthly realized volatilities of the corresponding markets. Furthermore, the volatility indices are estimated for each of the three foreign exchange rate markets and the US stock market separately. Hence, it is possible to decompose individual and general spillover effects.

The results indicate that volatility spillover effects between the major foreign exchange rate markets and the US stock market are high before economically troubled periods but virtually non-existent when the economy is quiet. Specifically, all volatility spillover indices jumped several months before the collapse of Lehman Brothers in September 2008. In contrast, the policy chaos in Japan of 1993 was only anticipated by the volatility spillover model accounting for the US/YEN exchange rate market and the US stock market. Surprisingly, in the 2009–2013 ex post financial crisis period, all constructed volatility spillover indices show that spillover effects are virtually non-existent, contradicting Diebold and Yilmaz (2012). The results strongly indicate that in times of economic turbulence, the uncertainties in the foreign exchange rate and US stock markets are driven by the same factor, whereas in quieter economic times, the volatility processes in these markets follow their own paths. Spillovers typically reach a high level several months before the economic event takes place.

The paper is organized as follows. Section 2 describes the data. Section 3 provides the empirical framework and the results. The last section concludes.

2. Data

Canada, Japan, and the European Union are among the five largest trade partners for the US economy that have floating exchange rate regimes. I downloaded daily data on the US/CAN, US/EUR and US/YEN spot exchange rates from Datastream. The data on the US/CAN and US/YEN exchange rates run February 1986–February 2014, whereas the data for the US/EUR runs January 2000–February 2014. I employed the CRSP index as proxy for the US equity market and downloaded daily data for the value-weighted excess returns of the CRSP index from Kenneth French's website covering the period February 1986–February 2014.

3. Econometric methods

Let us denote the daily return of time series i at day k as $R_{i,k}$. Then, based on the individual daily squared returns, we can calculate the monthly realized volatilities and realized variance-processes for all time-series $i = \left\{CRSP, \frac{US}{CAN}, \frac{US}{YEN}, \frac{US}{EUR}\right\}$ as,

$$REVOL_{i,t} = M\sqrt{\frac{1}{M}\sum_{k=1}^{M} R_{i,k}^2}, \quad \text{and}$$

$$REVAR_{i,t} = M\sum_{k=1}^{M} R_{i,k}^2,$$

where M denotes the number of trading days in month t. Then, I estimated the following models (M1)–(M3)

$$\boldsymbol{Y}_{1,t} = \boldsymbol{c}_1 + \boldsymbol{A}_1\boldsymbol{Y}_{1,t-1} + \cdots \boldsymbol{A}_p\boldsymbol{Y}_{1,t-p} + \boldsymbol{E}_{1,t} \tag{M1}$$

$$\boldsymbol{Y}_{2,t} = \boldsymbol{c}_2 + \boldsymbol{B}_1\boldsymbol{Y}_{2,t-1} + \cdots \boldsymbol{B}_p\boldsymbol{Y}_{2,t-p} + \boldsymbol{E}_{2,t}, \quad \text{and} \tag{M2}$$

$$\boldsymbol{Y}_{3,t} = \boldsymbol{c}_3 + \boldsymbol{G}_1\boldsymbol{Y}_{3,t-1} + \cdots \boldsymbol{G}_p\boldsymbol{Y}_{3,t-p} + \boldsymbol{E}_{3,t}, \tag{M3}$$

where,

$$\boldsymbol{Y}_{1,t} = \left(REVAR_{CRSP,t}, REVAR_{\frac{US}{CAN},t}\right)',$$

$$\boldsymbol{Y}_{2,t} = \left(REVAR_{CRSP,t}, REVAR_{\frac{US}{YEN},t}\right)',$$

$$\boldsymbol{Y}_{3,t} = \left(REVAR_{CRSP,t}, REVAR_{\frac{US}{EUR},t}\right)', \quad \text{and}$$

$\boldsymbol{A}_1, \ldots, \boldsymbol{A}_p, \boldsymbol{B}_1, \ldots, \boldsymbol{B}_p$, and $\boldsymbol{G}_1, \ldots, \boldsymbol{G}_p$ denote 2×2 parameter matrices and the error terms $\boldsymbol{E}_{1t}$, $\boldsymbol{E}_{2t}$, and $\boldsymbol{E}_{3t}$ are assumed to be distributed as multivariate normal with $\boldsymbol{E}_{i,t} \sim MVN(\mathbf{0}, \boldsymbol{\Sigma}_i)$, where $\boldsymbol{\Sigma}_i$ is the corresponding covariance matrix. Moreover, $\boldsymbol{c}_1$, $\boldsymbol{c}_2$, and $\boldsymbol{c}_3$ are 2×1 vectors containing the constant terms. The optimal lag-order p is determined by employing the AIC criterion that suggests $p = 13$, $p = 4$ and $p = 4$ for (M1), (M2), and (M3) respectively. To construct the volatility spillover indices, I estimated the moving average representation and the variance decompositions, as detailed in Diebold and Yilmaz (2009, pp. 158–160). The models are updated at the beginning of each month and accounted for 60 months of data.

Fig. 1 shows the realized volatilities of the CRSP index and the US/CAN exchange rate covering February 1986–February 2014. Fig. 1 illustrates that the realized equity market's (e.g., CRSP index) volatility is considerably higher than the realized exchange rate (e.g., US/CAN) volatility confirming Diebold and Yilmaz (2012). The patterns are the same for all other foreign exchange markets (unreported results). Fig. 1 shows two spikes in the realized volatility process of the CRSP. The first spike occurred due to the stock market crash of October 1987 (realized volatility was at 110%). The second spike occurred in October 2008 where the estimated realized volatility in the wake of the collapse of Lehman brothers was at 116%.

To investigate the cyclical movements of volatility spillover effects between the US equity market and the major foreign exchange markets, I followed Diebold and Yilmaz (2009) and employed a rolling sample model. I used a rolling time window of $K = 60$ months and a forecast-error variance decomposition using a horizon of $h = 1$ month.[1] Because the sample for the models (M1) and (M2) starts in February 1986, the corresponding estimated volatility spillover indices are constructed from February 1991 to February 2014. Fig. 2 presents the dynamic volatility spillover index for (M1). From Fig. 2, the evolution of the volatility spillover process shows cyclical patterns. The volatility spillovers

[1] In a robustness check I also used a forecast error variance decomposition with a horizon of $h = 2$ months. The results are very similar and available upon request. In an additional robustness check I compared the spillover indices using a rolling sample of 60 months with employing a rolling sample of 50 months. The results are also very similar and available upon request.