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EVALUATION IN DYNAMIC PROCESS SPILLOVER EFFECT: ELEVEN MAJOR EXCHANGE RATE MARKETS

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ABSTRACT

This paper analyzes the dynamic process of the spillover effects among major eleven exchange rate markets. The period spanning from 2000 to 2014 includes several financial crises and Chinese monetary reforms. By the vector auto regression framework, the evidence presents strong spillover effects in terms of return and volatility among USD and several currencies, especially for HKD. High scores of the return and volatility indices are found spilling from ten currencies to HKD.

Keywords: Exchange rate, Spillover, Variance decomposition, Time-varying.

JEL Classification: C22, F31, G01.

Contribution/ Originality

The main contribution of this study is to investigate the dynamic process of the spillover effect among eleven major exchange rate markets that less discussed in previous studies. Moreover, we examine the spillover effect of the financial crisis.

1. INTRODUCTION

This paper mainly analyzes the dynamic spillover effect among eleven major exchange rate markets. Moreover, we consider the impact of the financial crisis on the interaction of the major exchange rate currencies around the world. Most of previous literature indicates that the financial crisis can impact the global financial market. For example, Caramazze *et al.* (2004) indicated that the financial linkages played a significant role in the spread of the Mexican, Asian, and Russian crises. Khan and Park (2009) analyzed the cross-country time-varying correlation coefficients of the stock prices for the Asian countries during the crisis and tranquil periods. Bjornland and Leitemo (2009) investigated the interdependence between U.S. monetary policy and her stock market. Furthermore, Diebold and Yilmaz (2009) provided the vector auto regression (VAR) model

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to measure return and volatility spillovers of the global equity markets in crisis. Yilmaz (2010) employed the VAR framework to investigate the return and volatility spillover among the East Asian equity markets. Most studies apply the VAR model to analyze the spillover effect of the return and volatility in the stock and exchange rates market. (Zhang *et al.*, 2008; McMillan and Speight, 2010; Singh *et al.*, 2010). Their finding showed significant spillover effects in terms of the return and volatility in both financial markets.

This study investigates the time-varying spillover relationship among the top eleven major exchange currencies. First, we employ the advantage framework of Diebold and Yilmaz (2009a) by which we can capture the time-varying spillovers during crisis and non-crisis periods, respectively. Second, we analyze both types of the spillover effects (i.e., return & volatility) among top eleven currencies. Third and finally, we apply the famous top eleven exchange rates by public exchange rate service in the study. Our evidence shows the high significant spillover effect in terms of return and volatility from USD to HKD. In addition, we find the interaction of the volatility spillover effect and several events in our sample period. High score of spillover of the return and volatility indices is found from other nine currencies to HKD. Our findings can offer policymakers and investors benefic suggestions or strategies.

The rest of the paper is as follows. Section 2 presents the estimation framework. Section 3 reveals the data and offers empirical analyses. Our conclusions are in Section 4.

2. METHODOLOGY

This paper employs the method of Diebold and Yilmaz (2009a) which offers a methodology of capture dynamic spillover easily through the vector autoregressie (VAR) framework with Cholesky factor orthogonalization in variance decomposition. The first step is to generate VAR framework for covariance stationary *p*th-order N-variable as:

$$\mathbf{y}_t = \sum_{i=1}^{p} \mathbf{\Phi}_i y_{t-i} + \boldsymbol{\varepsilon}_t \,, \tag{1}$$

where $y_t = (y_{1,t},...,y_{n,t})'$, $\mathbf{\Phi}_i$ is a k by k parameter matrix, and ε_t indicates vector error terms with zero mean and covariance matrix Σ. In this study, y_t is the vector of daily exchange rate index replaced by return and volatility, respectively. In one-step-ahead forecasting for the error vector $e_{t+1,t}$, it can be rewritten as

$$e_{t+1,t} = x_{t+1} - x_{t+1,t} = A_0 u_{t+1} = \begin{bmatrix} a_{0,11} & a_{0,12} \\ a_{0,21} & a_{0,22} \end{bmatrix} \begin{bmatrix} u_{1,t+1} \\ u_{2,t+1} \end{bmatrix}, \tag{2}$$

where $x_t = \{x_{1t}, x_{2t}\}$ is a vector of the one-step-ahead forecasting with $a_{0,11} + a_{0,12}$ and $a_{0,21} + a_{0,22}$, respectively. Matrix A_0 and vector u_{t+1} are denoted as the forms of moving average. The covariance matrix is denoted as $E(e_{t+1,t} e'_{t+1,t}) = A_0 A'_0$. Through the VAR framework, Diebold and Yilmaz (2009) develop the spillover index expressed as

$$S = \frac{a_{0,12}^2 + a_{0,21}^2}{trace(A_i A_i')} \times 100, \quad (3)$$

In particular, for the *p*th-order and *N*-variable VAR for *H*-step-ahead forecasts, Eq(3) can be rewritten as

$$S(H) = \frac{\sum_{h=0}^{H-1} \sum_{i,j=1, i \neq j}^{N} a_{h,ij}^2}{\sum_{h=0}^{H-1} trace(A_i A_i')} \times 100, \quad (4)$$

The sums of the off-diagonal elements of the matrix form standard variance decomposition via a VAR model. Through this measure, we can simply to examine the return and volatility spillovers among top eleven exchange currencies.

3. DATA AND EMPIRICAL RESULTS

3.1. Data

The source of daily exchange rate data is from Pacific Exchange Rate Service databased per special drawing right (SDR); the data covers the period from 2000 to 2014 (3,747 observations).[1] In analyzing the dynamic time-vary spillover effects, we use a list of the top eleven major exchange rates including United States(USD), Canada(CAN), Euro(EUR), Japan(JPY), Germany(GBP), Switzerland(CHF), Australia(AUD), Hong Kong(HKD), New Zealand(NZD), South Korea(KRW), and Mexico(MXN). Note that we take first difference to all series to keep them stationary.

3.2. Empirical Results

The estimations of the static spillover effects of return and volatility are shown in Tables 1 and 2, respectively. The both spillovers of return and volatility are approximate to 45%. In both of the return and volatility spillover indices, USD contributes the greatest spillover effects to the other countries, especially for HKD and EUR, respectively. Thus, USD always plays a significant role for the global exchange rates markets. Meanwhile, NHK is the currency easiest suffering spillovers from other exchange markets (referring to the column "contribution from others", in Tables 1-2).

Table-1. Return spillover

	From											**Contribution**
To	USD	CAD	EUR	JPY	GBP	CHF	AUD	HKD	NZD	KRW	MXN	**from others**
USD	97.3	0.1	0.4	0.1	0.1	0.5	0.2	0.1	0.4	0.6	0.2	3
CAD	0.2	97.6	0.1	0	0	0.2	0.2	0	0.1	0.9	0.6	2
EUR	65.2	1.1	31.4	0.2	0	0.6	0.3	0.1	0.2	0.7	0.2	69
JPY	0.2	9.2	51.2	38.2	0.1	0.1	0.2	0.1	0	0.3	0.3	62
GBP	11.5	3.4	2.5	49.2	32.3	0.1	0.3	0.2	0.2	0.2	0.1	68
												Continue

[1] Pacific Exchange Rate Service: http://fx.sauder.ubc.ca/.

CHF	37.6	0.3	5.1	2.5	0.1	53.7	0.4	0.1	0.1	0.2	0	46
AUD	6.2	22.6	1.5	3.1	0.7	0.6	64.1	0.1	0	0.7	0.4	36
HKD	96.1	0.1	0.4	0.1	0.1	0.5	0.3	1.2	0.4	0.6	0.3	99
NZD	5.5	15.5	1.3	3.1	0.6	0.6	34.2	0.1	37.6	0.8	0.5	62
KRW	6.1	5.9	0.2	1.1	0.2	0.6	4.8	0.2	0.1	78.3	2.6	22
MXN	5.5	11.9	1	3.9	0.2	0.8	6	0.4	0.3	1.5	68.6	31
Contribution to others	234	70	64	63	2	5	47	1	2	7	5	500
Contribution including own	331	168	95	101	34	58	111	3	39	85	74	Spillover index=45.40%

Note: the spillover index is calculated from contribution to others divide contribution including own.

Table-2. Volatility spillover

	From												**Contribution**
To	USD	CAD	EUR	JPY	GBP	CHF	AUD	HKD	NZD	KRW	MXN		**from others**
USD	98.4	0.1	0.3	0.1	0	0.4	0.1	0.1	0.2	0.1	0.2		2
CAD	0.3	98.7	0.1	0	0.1	0.2	0.1	0	0.1	0.1	0.5		1
EUR	66.4	1.1	31.4	0.1	0	0.5	0.2	0.1	0.1	0.1	0		69
JPY	0.2	9.1	50.8	39.4	0.1	0.1	0.1	0	0	0.1	0.1		61
GBP	11.9	3.2	2.4	47.5	34.6	0	0	0	0.2	0.1	0		65
CHF	38.5	0.2	5.2	2.6	0.1	52.9	0.4	0.1	0	0	0		47
AUD	6.2	23.3	1.3	2.9	0.7	0.8	64.1	0.1	0	0.4	0.2		36
HKD	97.3	0.1	0.3	0.1	0	0.4	0.1	1.2	0.2	0.1	0.2		99
NZD	5.5	15.9	1.2	3	0.6	0.6	34.3	0.1	38.2	0.3	0.1		62
KRW	6	5.9	0.1	1	0.2	0.6	4.5	0.1	0.1	79.1	2.5		21
MXN	5.8	12.4	0.9	3.8	0.1	0.9	5.7	0.3	0.2	1.2	68.6		31
Contribution to others	238	71	63	61	2	5	46	1	1	2	4		493
Contribution including own	336	170	94	100	37	58	110	2	39	82	72		Spillover index=44.80%

Note: the spillover index is calculated from contribution to others divide contribution including own.

Second, we furthermore use the 200-week rolling window and 10-stephorizonforecast error variance to measure the time-varying spillover effects of both return and volatility indices shown in Figures 1 and 2, respectively. In Figure 1, there are several crises involving in the return and volatility time-varying spillover indices. These events include the dot-com bubble burst (from 2000 to 2001), 9/11 terrible attack (2001), Iraq war (2003), Chinese monetary reforms (2005), global financial crisis (from 2007 to 2008), Euro debt crisis (from 2010 to 2011), and Greece debt (2010). The range of the spillover return index is between 52 and 75. The episode and crises almost suddenly influence the financial exchange market and impact the investment decision impressively. Figure 2 shows the volatility time-varying spillover effect, in which it has similar shocks with the return time-varying spillover effect caused by those events or crises.

Figure-1. Time-varying return spillover index

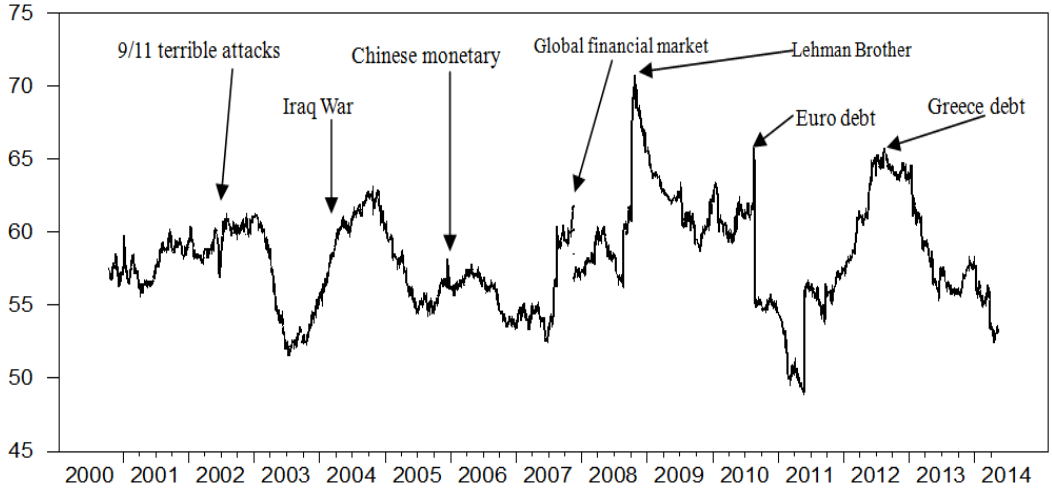

Figure-2. Time-varying volatility spillover index

Nevertheless, we investigate the eleven currencies market, in which we are concerned about how USD impacts the other currency. We use the 200-weeks rolling window and 10-step horizon forecast error variance for the volatility spillover including two spillover indices - containing USD and excluding USD (ten currencies). The evidence is shown in Figure 3. The straight line and dot-line indicate the spillover of containing USD and excluding USD, respectively. The inclusion of the USD currency has significant impact on other currencies in volatility spillover between 53% and 72% (straight line). Finally, through comparing both lines, we find that USD explains around 15% of the larger spillover index containing USD. In other words, the ten currencies (excluding USD), especially for HKD and EUR, have always concerned the USD movement.

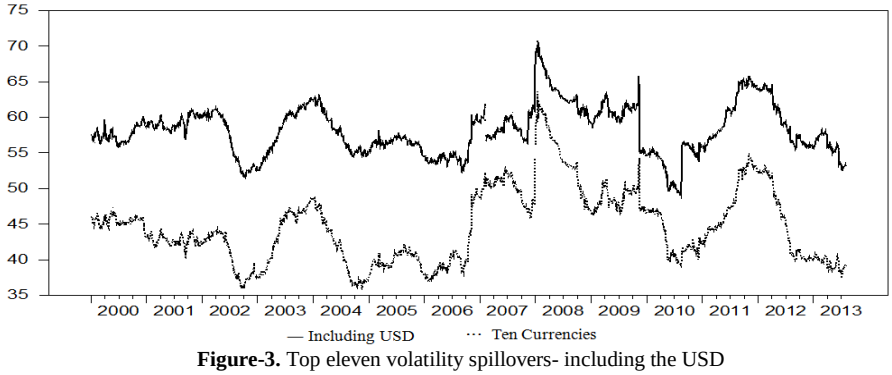

Figure-3. Top eleven volatility spillovers- including the USD

4. CONCLUSIONS

This study investigates the time-varying spillover, with respect to return and volatility of exchange rates, among the top eleven major currencies of the world. The daily exchange rate data span from 2000 to 2014 covering the global financial crisis and several economic events. We primarily employ the method of Diebold and Yilmaz (2009a) to easily illustrate the time-varying spillovers over crisis and non-crisis periods. Secondarily, we analyze two types of spillovers including return and volatility spillover effects. In addition, we apply the famous top eleven exchange rates by public exchange rate service databased in the first home-pages. Our evidence first shows the highest spillover effect (in either return or volatility) from USD to HKD. Second, we find that HKD is easiest suffering spillover from other currencies. Moreover, the empirical results also find the impact of several events or crises on our spillover analysis. Finally, our findings offer some suggestions to policymakers or investors. For example, the firms trading with HKD need to pay more attention to the variation of other currencies if they tend to hedge foreign exchange risk.

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