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An Empirical Study on Spillover Effects between CDS and FX at Korean Market

Janghee Lee

Abstract— **This paper has empirically investigated the shock and volatility spillover effects of counterparty risk on the deviations from CIP in the FX forward market of Korea. During the recent financial turmoil, there is significant shock and volatility transmission from the counterparty risk of European CDS market to the CIP deviations of FX market under investigation. In addition, the shock of counterparty risk for US corporations is more transmitted to the Korean FX market than that of the Korean Sovereign risk. FX Forward deviations tended to depend more on investment-grade European and US corporations rather than on Korean Sovereign ones, because the shock and volatility of the European and US CDS indexes were more transmitted to CIP deviations relative to those of Korean Sovereign. This finding is consistent with the view that the demand for dollar liquidity in the Korean FX market during the turmoil stemmed from mainly dollar Libor panel banks, such as European and US banks, rather than the financial institutions of emerging countries like Korea.**

Index Terms—**Volatility transmission; CIP condition; Multivariate GARCH;**

I. Introduction

The origins of the US dollar shortage as described in a number of recent BIS publications, largely stemmed from a sharp growth in US dollar assets of European banks that outpaced the growth in their dollar deposits (McGuire and Von Peter, 2008, 2009). European banks increasingly funded at very short maturities, raised roll-over risk (McAndews, Sarkar and Wang, 2008), and then they were heavily reliant on the FX derivative (swap and forward) market to obtain such dollar funding. Many financial institutions can borrow US dollar funding either directly in the Eurodollar cash market or in the local currency cash market and convert the proceeds into obligation in a US dollar through an FX swap.

On August 9, 2007 BNP Paribas announced the freeze of redemptions for three of its investment funds, cited an inability to value them. Then European financial institutions in particular demanded for dollar funding from global financial institutions. As many of these institutions were in great distress of funding dollars in the unsecured money market, they took advantage of the collateralized FX swap market as a channel for funding dollar. Therefore, the European financial institutions were perceived to be risky by the US financial institutions on the dollar lending side.

However, the dollar shortage of European financial institutions grew a global dollar shortage as Lehman Brothers failed September 15, 2008 and Federal Reserve Board (FRB) announced a bailout package for American Insurance Group (AIG). The US financial institutions also suffered from funding dollar in the money market and turned to the FX swap market. Since the turbulence in money markets spilled over to FX markets, global funding markets were actually collapsed. The increasing counterparty risk also heavily impacted on the US financial institutions due to the failure of Bear Sterns, and Lehman Brothers. Thus, higher counterparty risk was also perceived for US banks after Lehman failure.

The Korean FX markets were never immune to such kind of crisis. The won–dollar spot rates in the FX spot market increased by 400 won per dollar right after the Lehman Brothers' failure, and the turbulence in FX spot markets spilled over to FX derivative markets. As a result, FX spot and swap prices began to reflect the counterparty risk, indicating that the concern about the counterparty risk for non-US financial institutions was an important driver behind the deviations from a covered interest parity (CIP) in FX markets.

Apart from the previous studies, this study aims to investigate the effect of counterparty risk on CIP deviation in the Korean FX forward market. Our study initially examines a volatility spillover effect among the CIP deviations in the Korean won–dollar FX forward market. In doing it so, we use a multivariate GARCH model to simultaneously estimate the conditional variance of daily changes in the CDS indexes, thus avoiding the generated regressor problem associated with the two-step estimation process. Specifically, we employ a trivariate GARCH model to simultaneously estimate the mean and conditional variance using daily CDS indexes and deviations from CIP from the Bear Sterns turmoil in July 10, 2007 to September 30, 2009. We find significant volatility transmission among the markets under investigation. Our results are important for understanding the reasons of turbulence in FX market of Korea during the global financial crisis.

The reminder of the paper is organized as follows. Section 2 gives an overview the basic structure of an FX swap and forward and its relationship to CIP condition; it also decomposes CIP deviations into counterparty risks. Section 3 explains the methodology for the trivariate GRARCH model. Section 4 describes the descriptive statistics, and provides results of the empirical analysis. Section 6 provides some concluding remarks.

Janghee Lee, Business Administration, Konkuk University, Chungju, South Korea

II. Procedure for Paper Submission CIP deviation and Counterparty Risk

A FX swap is a short–term contract in which one party borrows a currency from, and lends another currency simultaneously to the same party. The FX swap is exposed to the counterparty risk more than the interest swap due to beginning and ending exchange rates of notional amounts. When financial institutions demand dollar funding via a FX swap, they exchange a local currency for dollars at a current FX spot rate, while contracting to exchange in reverse direction at maturity at a FX forward rate. If we call total funding costs, the FX swap-implied rates through the FX swap, the equality of US dollars Libor rates and FX swap-implied rates define a condition of covered interest parity (CIP). If CIP condition holds, a parity forward rate always equals the market (actual) forward rate in the FX forward market.

The CIP condition depends on minimal transaction costs as well as on the lack of political risk, credit (counterparty) risk, liquidity risk, and measurement errors. To the extent the counterparty risk was concentrated on the (one) end of the FX swap market, a deviation from CIP could have emerged. For example, if Korean financial institutions on dollar borrowing the side of FX market were perceived to be risky by both the US and European financial institutions, then risk premia could have been added to the dollar funding rates. Therefore, the FX swap-implied rate is over dollars Libor, and parity (theoretical) forward rate is higher than the market (actual) forward rate in the FX forward market, and the deviations from CIP i.e., occurred because of the counterparty risk and dollar domination in Korea.

Both the difference between market forward rates and parity (theoretical) forward rates and the spread between the FX swap-implied dollar rate and dollar cash Libor are termed as CIP deviations from the FX forward market and the FX swap market, respectively. Therefore negative swap point gaps and positive interest gaps were generally found during the turmoil in the Korean FX market.

In Korea, the three-month and 1-year FX market forward rate funded by the Korean won moved together rather closely with a parity forward rate prior to the Bear Stearns' turmoil. However, from the turmoil in the mid-August 2007, three month(one-year) deviations from CIP in the FX Forward market began to increase considerably, reaching more than 15.39(27.66)won in November 2007. The large and persistent deviations from CIP increased substantially by 40.83(81.19) won in December 2008.

Some studies discuss the dislocation in the FX swap market. These empirical studies focus on three issues: (i) the term structure of CIP deviations (Bekaert et al., 2007; Drakos, 2003), (ii) arbitrage and leveraged carry trade using CIP deviations (Blenman, 2000; Akram, Rime, and Sarno, 2008; Darvas, Z. 2009; Fong, Valente, and Fung, 2009) and (iii) the behavior of and reasons for CIP deviations in the FX forward market for various currencies (Poitras, 1988; Popper, 1993; Takezawa, 1995; Jeng, 1999; Batten and Szilagyi, 2007).

A couple of studies investigated the factors leading to CIP deviations in the Korean FX forward market. Shin and Jang (2006) explained that CIP deviations are brought about by the anticipated domination of the US dollar and the herding effect in the exchange market. Ryo and Park (2008) argued that CIP deviations were amplified by the unprecedented impact on the global financial market. Chang (2008) documented that the swap point (swap rate) has a cointegration relationship with short-term interest differentials between the won and the dollar; therefore, CIP deviations become disappear. On the other hand, he argued that both the foreign investment in the stock market and the government intervention in the FX market cause CIP deviations to persist over longer time periods.

Recently, Baba and Packer (2009a) argued that dollar shortages of financial institutions were largely responsible for the dislocation in the FX swap market prior to September 2008. The reasons for CIP deviations are explained in two ways. First, if the non-US financial institutions on the dollar borrowing the side of FX swap market were perceived as risky by the US financial institutions on the dollar lending side, then risk premium could be added to FX swap prices. Second, if market liquidity is not sufficient, the liquidity risk may play a role in CIP deviations as well. Both the liquidity risk and the counterparty risk are most likely interwined in a complex manner particularly in times of stress, and it is thus quite difficult to distinguish quantitatively between two premiums.

To test the reasons for CIP deviations discussed above we basically decompose the formula of FX Forward deviations from CIP as proposed by the studies of Baba and Packer (2009a, 2009b), using an interest rate swap (IRS) rate. The IRS is an swap agreement, where one party commits to pay a fixed percentage of notional against a receipt that is indexed to a floating rate, typically Libor. But the credit risk of IRS is negligible due to no initial and end exchange of principal.

$$\frac{F}{S}\left(1+r_t^f\right)-\left(1+\ r_t^d\right)\approx[(\ln F-\ln S)-(\text{USD IRS}-\text{KRW IRS})]+(\text{CD3m}-\text{KRW IRS})-(\text{Libor 3m}-\text{US IRS})] \quad (1)$$

$$\approx \text{Counterparty Risk} + \text{Liquidity Risk}$$

where, we can separate the term involving the FX forward discount rate from that involving short-term interest rates. The counterparty risk is directly related to the first term on the right –hand side of Eq. (1). If Korean financial institutions facing US dollars shortages are perceived to be risky by US financial institutions, a risk premium may be added to the forward discount rate. If counterparty risk of European and US financial institutions impacted on Korean FX market, we expect the coefficients to be significant on CIP deviations. The spreads between Libor CD and IRS in the second term in the right–hand side of Eq. (1) captures liquidity risk of Korean financial institutions and US financial institutions. But , we don't consider Liquidity risk hypothesis in our study

III. Methodology

There are two lines of research by examining the shock and volatility transmission mechanism across different markets. The first approach is to investigate the transmission of shocks and the co-movements between different international financial markets (Kasa, 992). This type of research to explain volatility spillover effects, referring to financial contagion, defined as a shock to one country's asset market that causes changes in asset prices in another country's financial market.

The second approach is to explore the time path of volatility transmission mechanism across different markets (Engle, Ito, and Lin, 1990; Hamao, Masulis, and Ng, 1990; Engle and Susmel, 1993). It is well known that market volatility in one foreign exchange market is transmitted to other foreign exchange markets like a "meteor shower" (Engle, Ito, and Lin, 1990). The increasing integration of major financial markets has generated strong needs in understanding the volatility spillover effects from one market to another. These volatility spillovers are usually attributed to cross-market hedging.

Researchers have mostly used the autoregressive conditional heteroscedasticity (ARCH) to model time variant conditional variances. The ARCH model originally developed by Engle (1982), and later generalized by Bollerslev (1986), is one of the most popular methods used for modeling volatility of high-frequency financial time series data. In recent years research has focused more on the persistence and transmission of volatility from one market to other markets. Consequently, multivariate generalized autoregressive conditional heteroscedasticity (MGARCH) models have been commonly used to estimate the volatility spillover effects among different markets. Kearney and Patton (2000) used a multivariate GARCH model to study significant volatility transmission among different exchange rates in the European Monetary System. Fornari, et al., (2002) used the trivariate GARCH model to analyze the impact of political and economic 'news' on conditional volatility of several Italian financial variables. They found a significant regime shift and seasonal daily pattern in the unconditional variance of the variables under study.

Financial market participants are interested in how the shocks and volatility of CDS indexes are transmitted across markets over time. This paper examined the volatility and shock transmission mechanism between FX forward and CDS markets, i.e., Korean sovereign CDS, European iTraxx and US CDX markets. To study the effects of the shocks and volatility of CDS spreads on the dislocation in the FX forward market for the global crash period, we estimated the following mean equation for daily changes in the CIP deviations and CDS indexes given as:

$$Ri,t = \mu i + \alpha Ri,t{-}1 + \varepsilon it \qquad (2)$$

where $R_{i,t}$ is the change in index i between time t−1 and t, μi is a long-term drift coefficient,
and εit is the error term for the change in index i at time t. Eq. (2) was then tested using the test described in Engle (1982) for the existence of ARCH. All estimated series exhibited evidence of ARCH effects. Since we are interested in the possibility of volatility transmission among different markets, as well as persistence of volatility within each market, we employ a variant of the multivariate GARCH model.

In our trivariate case of the traditional BEKK parameterization, we have a total number of 78 estimated elements for our variance equation. In order to ensure a positive semi-definite covariance matrix, all elements must stay positive during estimation. A more practicable alternative is the BEKK model given by Engle and Kroner (1995). This model is designed in such a way that the estimated covariance matrix will be positive semi-definite, which is a requirement needed to guarantee non-negative estimated variances.

The BEKK parameterization is given as:

$$H_{t+1} = C'C + A'\varepsilon_t\varepsilon_t A + B'H_tB \qquad (3)$$

The individual elements for C, A, and B matrices in Eq. (3) are given as follows:

$$A = \begin{vmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{vmatrix} \quad B = \begin{vmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{vmatrix}$$

$$C = \begin{vmatrix} c_{11} & 0 & 0 \\ c_{21} & c_{22} & 0 \\ c_{31} & c_{32} & c_{33} \end{vmatrix} \qquad (4)$$

where C is a 3×3 lower triangular matrix with six parameters. A is a 3×3 square matrix of parameters and shows how conditional variances are correlated with past squared errors. The elements of matrix A measure the effects of shocks or 'news' on conditional variances. B is also a 3×3 square matrix of parameters and shows how past conditional variances affect current levels of conditional variances. The total number of estimated elements for the variance equations for our trivariate case is 24.

The conditional variance for each equation, ignoring the constant terms, can be expanded for the trivariate GARCH(1,1) as:

$$h_{11,t+1} = a^2_{11}\varepsilon^2_{1,t} + 2a_{11}a_{12}\varepsilon_{1,t}\varepsilon_{2,t} + 2a_{11}a_{31}\varepsilon_{1,t}\varepsilon_{3,t} + a^2_{21}\varepsilon^2_{2,t} + 2a_{21}a_{31}\varepsilon_{2,t}\varepsilon_{3,t}$$
$$+a^2_{31}\varepsilon^2_{3,t} + b^2_{11}h_{11,t} + 2b_{11}b_{12}h_{12,t} + 2b_{11}b_{31}h_{13,t} + b^2_{21}h_{22,t} + 2b_{21}b_{31}h_{23,t} + b^2_{31}h_{33,t}$$

(5)

$$h_{22,t+1} = a^2_{12}\varepsilon^2_{1,t} + 2a_{12}a_{22}\varepsilon_{1,t}\varepsilon_{2,t} + 2a_{12}a_{32}\varepsilon_{1,t}\varepsilon_{3,t} + a^2_{22}\varepsilon^2_{2,t} + 2a_{22}a_{32}\varepsilon_{2,t}\varepsilon_{3,t}$$
$$+a^2_{32}\varepsilon^2_{3,t} + b^2_{12}h_{11,t} + 2b_{12}b_{22}h_{12,t} + 2b_{12}b_{32}h_{13,t} + b^2_{22}h_{22,t} + 2b_{22}b_{32}h_{23,t} + b^2_{32}h_{33}$$

(6)

$$h_{33,t+1} = a^2_{13}\varepsilon^2_{1,t} + 2a_{13}a_{23}\varepsilon_{1,t}\varepsilon_{2,t} + 2a_{13}a_{33}\varepsilon_{1,t}\varepsilon_{3,t} + a^2_{23}\varepsilon^2_{2,t} + 2a_{23}a_{33}\varepsilon_{2,t}\varepsilon_{3,t}$$
$$+a^2_{33}\varepsilon^2_{3,t} + b^2_{13}h_{11,t} + 2b_{13}b_{23}h_{12,t} + 2b_{13}b_{33}h_{13,t} + b^2_{23}h_{22,t} + 2b_{23}b_{33}h_{23,t} + b^2_{33}h_{33,t}$$

(7)

Eqs. (5), (6), and (7) show how shocks and volatility are transmitted across markets and over time. Since we consider two regional CDS index series except for the Korean sovereign CDS index, we study the transmission mechanism by estimating two trivariate GARCH models where each model contains different regional CDS index series. We maximized the following likelihood function assuming that errors are normally distributed:

$$L(\theta) = -T\ln(2\pi) - \frac{1}{2}\sum_{t=1}^{T}(\ln|Ht| + \varepsilon'_t H_t^{-1}\varepsilon_t)$$

where θ is the estimated parameter vector and T is the number of observations. Numerical maximization techniques were utilized in order to maximize this non-linear log likelihood function. Initial conditions were obtained by performing several initial iterations using the simplex algorithm as recommended by Engle and Kroner (1995). The BFGS algorithm was then used to obtain the final estimate of the variance-covariance matrix with corresponding standard errors.

IV. DATA AND DESCRIPTIVE STATISTICS

We used changes in daily quotes of CDS indices with a maturity of 5years from July 10, 2007 to September 30, 2009 obtained from Bloomberg and changes in the three- month and one-year deviations from the CIP of NDF market in Seoul. We used a Korean sovereign CDS spread, iTraxx European and CDX(IG) index series in our analysis. Changes in series were used as all series in level form possessed a unit root.

Table 1. Descriptive statistics
CIP 3M Deviation CIP 1Y

	CIP 3M Deviation	CIP 1Y Deviation	Korea CDS	iTraxx Europe	CDX (IG)
Mean	-0.007	-0.029	0.129	0.086	0.088
Median	-0.001	-0.006	-0.016	0.000	0.000
Maximum	14.64	24.23	111.4	24.42	43.33
Minimum	-9.638	-24.98	-185.3	-26.02	-31.07
Std. Dev.	1.486	3.497	13.70	4.796	5.612
Skewness	0.972	0.274	-2.498	-0.306	0.242
Kurtosis	26.28	19.20	64.16	7.579	14.40
Jarque-Ber a	3880.42***	7833.24***	16261.23***	636.010***	112210.9***
Q(20)	128.44 (0.00)	74.484 (0.00)	157.44 (0.00)	34.947 (0.02)	75.610 (0.00)

Notes*:* The sample contains daily change in indices from July 10, 2007 to September 30, 2009. The total number of usable observations is 581. Q(20) is the Ljung-Box statistic for serial correlation. The values in parenthesis are p-values. *** indicates the rejection at the 1% level.

Table 1 gives descriptive statistics for the changes in daily quotes of CDS indices and in the deviations from CIP. All series were found to be leptokurtic (i.e., fat tails) and therefore the mean equation in all cases were tested for the existence of autoregressive conditional heteroscedasticity using the test given by Engle (1982). The mean equation for all series exhibited evidence of ARCH effects and therefore the estimation of GARCH model is appropriate. We found significant autocorrelation as detected by the Ljung-Box statistic in all cases. The Korean sovereign CDS spread shows the largest standard deviation which is consistent with the general impression that the Korean CDS is more volatile relative to other CDS indices

V.EMPIRICAL RESULTS

As discussed earlier, we have two regional CDS and Korean sovereign CDS indexes focusing on CIP deviations under investigation; thus, we precede with the estimation of two trivariate GARCH models each containing CIP deviation, CDS index, and sovereign CDS. The estimation results of the trivariate GARCH model with BEKK parameterization for each variance equation are reported in Table 2 and Table 3. In Table 2, the symbol h_{11},t expresses the conditional variance (volatility) for the deviations from CIP at time t and h_{12},t shows the conditional covariance between the deviations from CIP and iItraxx CDS index in our model. The error term "ε" in each model represents the effect of 'news' (i.e., unexpected shocks) in each model on different sectors. For instance, ε_{21},t ε_{22},t , and ε_{23},t represent the deviations from the mean due to some unanticipated event in a particular market. The cross values of error terms like ε_1,t, ε_2,t represent the news in the CIP deviation and iTraxx in time period t.

Table 2. Trivariate GARCH model for CIP deviation, Korean CDS, and iTtraxx

Independent variable	CIP 3M	CIP 1Year
$\varepsilon^2_{1,t}$	0.387 (0.065)***	0.393 (0.086)***
$\varepsilon_{1,t}\varepsilon_{2,t}$	-0.038 (0.097)	0.083 (0.066)
$\varepsilon_{1,t}\varepsilon_{3,t}$	0.012 (0.026)	-0.001(0.000)***
$\varepsilon^2_{2,t}$	0.721 (0.070)***	0.712 (0.082)***
$\varepsilon_{2,t}\varepsilon_{3,t}$	0.206 (0.027)***	0.189 (0.024)***
$\varepsilon^2_{3,t}$	0.360 (0.040)***	0.320 (0.040)***
$h_{11,t}$	0.577 (0.045)***	0.685 (0.043)***
$h_{12,t}$	0.129 (0.078)*	0.617 (0.133)***

$h_{13,t}$	0.764 (0.167)***	-1.018 (0.000)***
$h_{22,t}$	0.615 (0.022)***	0.615 (0.024)***
$h_{23,t}$	0.759 (0.013)***	0.771 (0.012)***
$h_{33,t}$	0.751 (0.019)***	0.761 (0.021)***
Log(L)	-3682.9061	-4118.0527
$Q_1^2(20)$	1.682	44.425
$Q_2^2(20)$	14.987	11.655
$Q_3^2(20)$	14.149	7.444

Notes: h_{11} denotes the conditional variance for the deviations from CIP. h_{22} is the conditional variance for the Korean CDS index series, and h_{33} is the conditional variance for the Europe iTraxx index series. The corresponding standard errors are given in parenthesis below each estimated coefficient. Our estimated results are based on the BEKK parameterization. *, ** and *** indicate the rejection at the 10%, 5% and 1% levels, respectively.

The estimated results from the model that includes the deviations from CIP, Korean sovereign CDS spread, and iTraxx index are reported in Table 2. Note that the deviations from CIP in FX derivatives markets are significantly indirectly affected by news generated from the Europe iTraxx index (see the significant ε_1,t, ε_3,t coefficient term). However, CIP deviations of Korean FX market are not indirectly affected by news from its own CDS index. CIP deviation in FX market is directly affected by volatility generated by its own market (see significant coefficient for h_{11},t) and indirectly more affected by volatility from the iTraxx than Korea sovereign CDS (see significant coefficient for h_{13},t). Overall, there is significant volatility transmission between the deviations of FX market and the counterparty risk of European CDS markets under investigation.

Likewise, the results for the model that includes the CIP deviations, the Korean sovereign CDS spread, and the CDX index are reported in Table 3. The symbol h_{12},t shows the conditional covariance between the CIP deviations and CDX(IG) index in our model. The cross values of error terms like ε_1,t ε_2,t represent the "news" in the CIP deviation and CDX in time period t. CIP deviations are directly affected by news from its own market and indirectly more affected by news from the CDX(IG) index than sovereign CDS.

The volatility in the FX derivative market is directly affected by its own volatility and indirectly affected by volatility in the Korean CDS spread and CDX index. Although similar to the first model, we find more shock transmission among markets but all markets are affected more by their own news and volatility. When we consider the significance and size of coefficients, FX forward deviations tend to depend more on investment-grade European and US corporations than on the Korean Sovereign. This supports the relative counterparty risk hypothesis.

Together with the results discussed above, this finding is consistent with the view that the demand for dollar liquidity in the Korean FX market during the turmoil stemmed from mainly dollar Libor panel banks, such as European and US banks, rather than the financial institutions of emerging countries like Korea. It seems that liquidity conditions in the Libor funding markets were more important to FX spot and derivative markets during the turmoil than before the turmoil. This phenomenon is corresponding to the relative counterparty risk. Particularly, we find there are significant transmission and spillover effects of shock and volatility from the European CDS markets to the deviations of Korea FX market under investigation.

Table 3. Trivariate GARCH model for CIP deviation , Korean CDS, and CDX(IG)

Independent variable	CIP 3M	CIP 1 Year
$\varepsilon^2_{1,t}$	0.418 (0.065)***	0.275 (0.016)***
$\varepsilon_{1,t}\varepsilon_{2,t}$	-0.036 (0.029)	-0.039 (0.023)*
$\varepsilon_{1,t}\varepsilon_{3,t}$	0.011 (0.005)**	0.012 (0.006)**
$\varepsilon^2_{2,t}$	0.760 (0.081)***	0.376 (0.014)***
$\varepsilon_{2,t}\varepsilon_{3,t}$	0.374 (0.104)***	0.333 (0.013)***
$\varepsilon^2_{3,t}$	0.344 (0.040)***	0.300 (0.020)***
$h_{11,t}$	0.560 (0.043)***	0.764 (0.005)***
$h_{12,t}$	0.798 (0.065)***	0.869 (0.000)***
$h_{13,t}$	0.971 (0.003)***	0.935 (0.004)***
$h_{22,t}$	0.605 (0.025)***	0.725 (0.004)***
$h_{23,t}$	-0.195 (0.149)	0.501 (0.007)***
$h_{33,t}$	0.794 (0.017)***	0.802 (0.010)***
Log(L)	-3883.4050	-4293.0074
$Q_1^2(20)$	1.516	10.298
$Q_2^2(20)$	13.082	17.000
$Q_3^2(20)$	4.497	2.096

Notes: h_{11} denotes the conditional variance for the deviations from CIP in Korean FX market of Korea, h_{22} is the conditional variance for the Korean CDS index series, and h_{33} is the conditional variance for the US CDX(IG) index series. The corresponding standard errors are given in parenthesis below each estimated coefficient. Our estimated results are based on the BEKK parameterization. *, ** and *** indicate the rejection at the 10%, 5% and 1% levels, respectively.

VI. CONCLUSION

This paper has empirically investigated dislocations in the Korean FX Forward market using three regional counterparty risk measures. The estimation results of trivariate GARCH model are as follows. First we found the volatility spillover effect of counterparty risk on the deviations from CIP in the FX forward market, the coefficients are significantly positive. This suggests that the CDS index is more likely to properly capture the influence of the counterparty risks of Korean Sovereign, European and US Investment-grade Corporations (including financial institutions) on CIP deviations in the FX market.

However, the results indicate that during the turmoil, the deviations from CIP in the Korean FX derivatives market is more significantly affected by the shocks and volatility from the counterparty risk of European corporations than from the Korean CDS index. There is significant shock and volatility transmission from the counterparty risk of European CDS market to the deviations of FX market under investigation. In addition, the shocks of counterparty risk of US corporations are more transmitted to the Korean FX market than that of Korean Sovereign risk. The FX forward deviations tended to depend more on investment-grade European and US corporations than on the Korean Sovereign risk, because the shocks and volatility of the European and US counterparts was more transmitted to CIP deviations relative to those of Korean Sovereign.

To sum up, the demand for dollar liquidity in the Korean FX market during the turmoil stemmed from mainly dollar Libor panel banks, such as European and US banks, rather than the financial institutions of emerging countries like Korea.

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