Shock, Return and Volatility Spillovers among the us, Japan and European Monetary Union Stock Markets

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Abstract

This paper examines the return links and volatility spillovers between US, Japan and European stock markets over the turbulent period 2005-2012. We use a recent generalized VAR-GARCH model which allows for transmission in return and volatility. The results show that American stock market is mostly influenced by past shocks and volatilities. Besides, for all markets under investigation, the past own volatilities is stronger driver in determining future volatility. This implies that a market's fundamentals have more influence on volatility than shocks or news. Moreover, our results show the existence of shocks and volatility transmission between only US and EMU. For the Japanese market, only the past own conditional volatility and shocks are allowed to impact the future volatility.Our findings have important implications for the presence of diversification opportunities for portfolios investors.

***Index terms*—** var-garch models; stock markets; volatility spillovers.

1 Introduction

This issue is an important concern for policymakers, international investors, financial institutions, and governments for executing global hedging strategies and asset allocation decisions. Moreover, understanding the correlations and interactions among various financial markets as well as the behavior of return volatility between international financial markets is crucial for pricing domestic securities, portfolio diversification and risk management.

Early literature, such as Eun and Shim (1989), Hamao, Masulis and Ng (1990), King, Sentana and Wadhwani (1994) focused on the correlations among the financial markets of developed countries and show that developed financial markets are interconnected and that the volatility of the US stock market is transmitted to other developed markets. Bekaert and Harvey (1995) estimated the degree of integration between major emerging markets and world equity markets from 1969 until 1992. Bekaert and Harvey (1997) found that capital market liberalization often leads to a higher correlation between local and international markets. Focusing on the volatility spillover researches, Ng (2000) showed that markets that are geographically and economically close tend to influence one another. Indeed, he studied volatility spillovers from Japan and U.S. market to pacific-basin stock markets and found that there are significant volatility spillovers from the US and Japanese equity markets to the stock markets of the Pacific Basin. Sharma and Wongbangpo (2002) study the relationships among different Asian stock markets by applying cointegration tests. Miyakoshi (2003), Liu and Pan (1997) found that there are return and volatility transmission from U.S. and Japanese stock markets to four Asian stock markets namely Hong Kong, Singapore, Taiwan, and Thailand. Moreover, these markets are influenced more by the U.S. than by the Japan. Besides, Wang and Firth (2004) examined return and volatility transmissions across four emerging markets namely Hong Kong, Taiwan, Shanghai A and Shenzhen A and three developed markets which are New York, London and Tokyo. Their empirical results spillovers between US, Japan and European stock markets over the turbulent period 2005-2012. We use a recent generalized VAR-GARCH model which allows for transmission in return and volatility. The results show that American stock market is mostly influenced by past shocks and volatilities. Besides, for all markets under investigation, the past own volatilities is stronger driver in determining future volatility. This implies that a market's fundamentals have more influence on volatility than shocks or news. Moreover, our results show the existence of shocks and volatility transmission between only US and EMU. For the Japanese market, only the past own conditional volatility and shocks are allowed to impact the future volatility. ince the eighties, the process of economic globalization has accelerated and radically transformed national economies as well as patterns of trade in goods, services or capital. This trend of globalization has been driven by a deregulation movement that gives market place in the financing of economies. Financial markets have been at the heart of this liberalization and are considered interdependent because of their revolution reflecting the combination of different factors such as the accelerating of the capital movements and the emergence of new financial products. However, measuring instruments to monitor the evolution of this relationship over time are often frustrated. Indeed, both models to measure and monitor changes in volatility are different, both approaches to assess the evolution of this interdependence between the markets are relatively rare. Moreover, the outbreak of several financial crises (Asian Crisis in 1997, 1998 Russian crisis, subprime crisis and more recently the Greek crisis in late 2009) were able to increase the risk of contagion between financial markets and, more specifically, between stock markets. Indeed, being S inter dependent and with parallel evolutions, financial markets are transmitted as "bad events" and therefore accelerate the movement of contagion.

show that there exists a unidirectional contemporaneous return dependence of emerging Chinese markets on these developed markets, and bi-directional volatility spillover effects between the developed and the emerging markets.

Using the BEKK parameterization of the multivariate GARCH model, Ewing and Malik (2005) studied the volatility transmission mechanism between large and small capitalization stocks. Lee (2009) used bivariate GARCH model and examined the volatility spillover effects among six Asian countries. His findings suggest that there are statistically significant volatility spillover effects across the stock markets of these six countries.

Boubaker, A., and Jaghoubi, S., (2011) employ the student-t-copula to model the dependence structure of among a sample of eight emerging and eight developed markets. Their results show that this new approach proves more appropriate to describe the non-linear and complex dynamics of the financial market returns than traditional modeling which imply a normality hypothesis. In addition, they confirm the contagious nature of the Subprime crisis between emerging and developed markets.

More recently, Wang, C.H and al (2015) investigate the relationship between short-term international capital inflows and asset markets in China using a structural vector auto-regressive (SVAR) model. Their empirical results demonstrate that the relationship between short-term international capital inflows and asset prices is self-fufilling and mutually reinforcing.

In European market context, many authors studied the effect of the introduction of the EURO on linkage between European markets each other and between European and U.S. stock markets. Most of the studies found that linkages between European markets increased after the introduction of the EURO. However, there is no definite evidence for linkage between European and U.S. markets.

Cheung and Westermann (2001) concluded that there is no volatility spillover between U.S and European market before and after the introduction of the EURO. However, Veiga and McAleer (2003) found that there is volatility spillover from UK to the U.S. and Japan and from the U.S. to UK. Using dynamic correlation framework, Savva, Osborn, and Gill (2004)examined the spillover among three developed markets namely U.S., German and UK and French markets. They found that only UK and German markets are affected by the U.S. market. Also, they concluded that the correlation between European markets has increased after the introduction of the EURO. Syriopoulos (2007) examined both the short-run and long-run linkages between emerging and developed European stock markets and found that emerging markets are well co-integrated with their developed counterparts.

Using copula model, **??**artram, Stephen, and Wang (2007) investigated the impact of the introduction of the EURO on dependence of equity markets in Europe and found that market dependence within the EURO area increased as a likely result of increased European integration only for some countries, such as France, Germany, Italy, Netherlands and Spain.

Boubaker, A., and Jaghoubi, S., (2012) examine the extent of the current financial Greek crisis and the contagion effects it concludes toward the euro zone by conducting an empirical investigation of the dependence structure between seventeen European stock markets during the period 2007-2011. They found that the dependence between European stock returns is modeled by the copula Student which retains the correlation dependence and also has symmetric nonzero tail dependence. Moreover they conclude that there is existence of the financial contagion effect between Greek and these European countries: Italy, Portugal, Belgium and Slovenia, when the Greek financial crisis.

Boubaker, A., and Jaghoubi, S., (2014) examine the dynamic correlation and volatility transmission between the European Monetary Union and the FX returns and explore the dependence structure between daily stock returns, after the occurrence of the current financial Greek crisis. They used the VAR (1)-GARCH (1,1) model which allows for transmission in returns and volatility and two measures of dependence: correlations and copula to test the degree of the dependence between financial returns using functions. Their empirical results for the first objective suggest that past own volatilities matter more than past shocks (news) and there are moderate cross market volatility transmission and shocks between the markets. Moreover, the result on the second objective implies that, considering all the financial returns together, the Student-t copula seems the best fitting model, followed by the Normal copula, both for the two sub-period. The dependence structure is symmetric and has non-zero tail dependence.

Recent literature on Middle East and North Africa (MENA) market volatility uses univariate GARCH models to examine volatility behavior at the market index level. In this context, we notice the work of Hammoudeh and Li (2008) who examined sudden changes in volatility for five GCC stock. Their empirical results indicate that most of these stock markets are more sensitive to major global events than to local and regional factors. This paper extends from existing literature by using the recently multivariate technique that examines shock and volatility spillover among the US, Japan and the Euro zone stock markets. The technique is the vector autoregressive moving average GARCH (VAR-GARCH) model developed by Ling and McAleer (2003) 1 The remainder of this paper proceeds as follows. Section 2 describes the data used in this study and presents some statistics on stock returns. Section 3 discusses the methodology for the estimation of models considered in this paper. Empirical findings for each . This method allows for spillover effects in both returns and conditional volatilities to examine both own conditional volatility for each market and conditional cross market volatility transmission among US, Japan and European Monetary Union (EMU), over the Greek crisis period. It also provides meaningful estimates of the unknown parameters with less computational complication than several other multivariate specifications, such as the full-factor multivariate GARCH model (Hammoudeh and al., 2009). Besides, the specific aspect of this model is that allows us to observe the impact of Monetary European stock market events or news in Japan and U.S. equity index returns.

The interests of this study are twofold. First, the market correlation and their co-movement are the basis of any international diversification strategy (King, Sentana and Wadhawani, 1994). Second, the international diversification is based on low correlations between asset markets which are geographically apart. However, in the current context of increasing globalization and the global integration of stock markets, the existence of shocks and volatility transmissions reinforces the interdependence between stock markets and thus reduced earning of the international diversification.

The main purpose of this paper is to explore the joint evolution of conditional returns, volatility and correlation between the United States of America, the Japan and the European markets in the last turbulent years. To highlight the dynamic relationship between markets, we undertake an empirical study similar to that of the Hammoudeh and al., 2009. Thus, we estimate a developed multivariate econometric technique, Vector Autoregressive-Generalized Autoregressive Conditional Heteroskedasticity model (VAR-GARCH model).

Our empirical results suggest that past own volatilities matter more than past shocks (news) and there are moderate cross-market volatility transmission and shocks between American and European Monetary markets with the exception of the Japan. However, both the US and the euro zone market indices commove together during all the period. In addition, it is apparent that the financial Greek crisis in the period 2009-2010 was accompanied by decreases both in the US and the European monetary union. These decreases are dramatic for the Japan.

The descriptive statistics for daily returns shown in Table 1 suggest that all the data series are negatively skewed implying that these distributions are skewed to the left and have long left tails. Furthermore, the Kurtosis value of all returns is large than three times the value of Normal distribution. This means that all these financial returns have peaks relative to the normal distribution. Hence, these financial returns show the properties of asymmetry, leptokurtosis, and tail dependence; indicating that the normality assumption has been severely challenged. The Jarque-Bera statistics are highly significant for all return series and just confirm that an assumption of normality is unrealistic. The returns are in national currencies. The sample contains weekly market returns from January 4, 2005 to July 9, 2012

Correlations are the most familiar measures of dependence in finance. Although most studies have focused on measuring the dependence between financial markets have used the Pearson correlation, this coefficient is only reliable when the random variables are jointly Gaussian. Therefore, we consider two other measures of dependence: the Kendall's tau and the Spearman's Rho, which are measures of concordance and generalize the linear correlation.

Tables 2(a,b,c) bellow report the linear correlations, the Kendall's tau and the Spearman's rho rank correlations, between the stock market returns, over the period. We observe that all the correlations are positive indicating that the increase (decrease) of the one stock market is associated with the increase (decrease) of the other market. The Kendal's Taus for our stock market returns are all positive showing that the probability of concordance is significantly higher than the probability of discordance. The Spearman's Rhos are also positive. From these results, we can conclude that there are strong linear and rank correlations. The higher correlation is between the American and the European Monetary Union markets. However, the lowest

2 Empirical Model

Our objective is to apply recent techniques in modeling volatility in the general indices of the US, Japan and Euro zone stock markets to upgrade the use of the univariate GARCH approach to a multivariate system. We choose the VAR-GARCH model, developed by Ling and McAleer (2003) which allows for spillover effects in both returns and conditional volatilities to examine both own conditional volatility for each market and conditional cross market volatility transmission among these financial markets.

The conditional mean equation of the VAR (1)-GARCH (1,1) system is giving by:? ?? ?? = ?? + ??? ????? + ?? ?? ?? ?? = ?? ?? ??/?? ?? ??

3 Where

-?? ?? = (?? ?? ?????? , ?? ?? ???? , ?? ?? ??????????) ; ?? ?? ?????? , ?? ?? ???? , ?? ?? ?????????? are the returns on the EMU, US and Japan market indices at time t, respectively.

-?? ?? = (?? ?? ?????? , ?? ?? ???? , ?? ?? ??????????); ?? ?? ?????? , ?? ?? ???? and ?? ?? ?????????? are the residual of the mean equations for the EMU, US and Japan markets returns, respectively.

-?? ?? = (?? ?? ?????? , ?? ?? ???? , ?? ?? ??????????), refers to the innovation and is an i.i.d distributed random vectors.

? ?? ? ?? ?????? = ?? ?????? + ?? ?????? (?? ???1 ??????) 2 + ?? ?????? ? ???1 ?????? +?? ???? (?? ???1 ????) 2 +?? ???? ? ???1 ???? +?? ?????????? (?? ???1 ??????????) 2 +?? ?????????? ? ???1 ?????????? ? ?? ???? = ?? ???? + ?? ???? (?? ???1 ????) 2 + ?? ???? ? ???1 ???? +?? ?????? (?? ???1 ??????) 2 +?? ?????? ? ???1 ?????? +?? ?????????? (?? ???1 ??????????) 2 +?? ?????????? ? ???1 ?????????? ? ?? ?????????? = ?? ?????????? + ?? ?????????? (?? ???1 ??????????) 2 + ?? ?????????? ? ???1 ?????????? +?? ???? (?? ???1 ????) 2 +?? ???? ? ???1 ???? +?? ?????? (?? ???1 ??????) 2 +?? ?????? ? ???1

4 ??????

From these equations above, we can see how volatility is transmitted over time across the EMU, the US and the Japanese markets. Thus, the past shock and volatility of one market are allowed to impact the future volatility not only of itself but also of all other markets in the system.

5 Empirical Results

Our objective is to examine both own conditional volatility and shocks and conditional crossmarket volatility transmission and shocks between the Euro zone, the American and the Japanese stock returns. We experiment on GARCH terms up to p=1 and q=1. The optimal lag order for the VAR model is selected using the AIC and SIC information criteria. The estimation of the VAR (1)-GARCH (1,1) for the two subperiod, is presented in table 3. We will discuss the empirical results of VAR(1)-GARCH(1,1) models in terms of own volatility and shock dependence, cross market volatility and shock spillover for the Euro zone, the US and the Japanese stock markets during the period 2005-2012.

For the EMU, the sensitivity to past own conditional volatility and past own shocks or news are significant. We find the same result for cross-market volatility transmission; showing that future volatility can be target by the past own conditional volatility in the long run. However, the sensitivity to own volatility is much better than the sensitivity to own shocks implying that the fundamental in the euro zone matter more than news. We find the same result for the conditional crossmarket volatility transmission showing that future volatility in the euro zone can be predicted, in the long run, by conditional American and Japanese volatilities.

However, for the Japanese stock market, only the past own conditional volatility is significant at the level of 1% but has a negative coefficient. We find the same result for the past own shock or news, displaying that, in Japan, both cross market volatility transmission and shocks are not allowed to impact the future volatility.

Considering now the American stock market, both own conditional volatility and conditional crossmarket volatility transmission and shocks are important in predicting future volatility. This implies that the American market is very sensitive to the Economic Monetary Union and Japan.

V.

6 Conclusion

In this paper, we investigate the dynamics relationship between European Monetary Union, Japan and American stock market, over the period 2005-2012. We use a VAR-GARCH model which allows for spillover effects in both returns and conditional volatilities. Our empirical results show that there are moderate cross-

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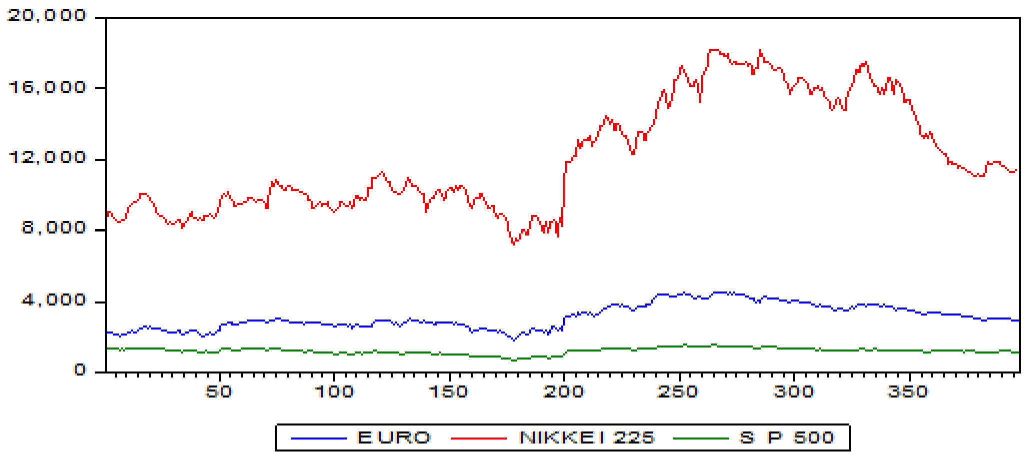
Volume XV Issue X Version I Year ( ) C market volatility transmissions and shocks between American and European Monetary markets due may be to the inter-connection with these financial markets. Indeed, for the euro zone, we find that the sensitivity to past own conditional volatility and past own shocks or news and cross-market volatility transmission are positive and significant indicating the existence of long run and short run persistence. The American market shows also cross-market volatility transmission and shocks dependence and

Figure 1:



1

Figure 2: (CFig 1 :

II. Data and Descriptive Statistics The data used in this study cover the three weekly stock market indices, namely S&P 500 (United States of America), NIKKEI 225 (Japan) and the Euro Stoxx 50 2
2

[Note: 1 See Chan, Lim,& McAleer, 2005 for an early application of the model.model]

Figure 3:

1

	EURO STOXX 50	NIKKEI 225	S&P 500
Mean	-0.029199	-0.029659	0.014541
Median	0.103064	0.080502	0.043832
Maximum	5.002127	4.972519	4.931805
Minimum	-10.91427	-12.11004	-8.722261
Std. Dev.	1.463870	1.398568	1.215377
Skewness	-1.295690	-1.850975	-0.910500
Kurtosis	11.56496	17.36755	10.94124
Jarque-Bera	1321.218	3632.163	1095.258
Probability	0.000000	0.000000	0.000000
Observations	398	398	398

Figure 4: Table 1 :

Stock markets	EURO STOXX 50	NIKKEI 225	S&P 500

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Figure 5:

2

(a) : Pearson correlations
Table 2 (b) : Spearman rank correlations
Table 2 (c) : Kendall's Tau rank correlation

Figure 6: Table 2

3

Variables		EMU	US	Japan
Mean equation				
	c	0.116968 (0.0170)	0.146933 (0.0015)	0.173781 (0.0106)
AR(1)		-0.182215*** (0.0038)	-0.166096*** (0.0014)	0.032489 (0.5491)
Variance equation				
	c	-0.258747 (0.0937)	-0.405163 (0.0044)	1.101118 (0.0000)
?? ?????? ??	(?? ? ??)	0.204352** (0.0187)	-0.133764*** (0.0011)	-0.110622 (0.2075)
?? ???? ?? (?? ? ??)		0.049152 (0.5497)	-0.046632 (0.3812)	-0.109637 (0.2976)
?? ?????????? ??	(?? ? ??)	-0.051923 (0.4400)	0.117125*** (0.0021)	0.091325*** (0.0000)
?? ?????? (t-1)		0.358387** (0.0455)	0.743436*** (0.0000)	0.413702 (0.1424)
?? ???? (t-1)		0.623554** (0.0231)	-0.378193** (0.0537)	0.483706 (0.2233)
?? ?????????? (t-1)		0.209215** (0.0809)	0.442608*** (0.0032)	-0.620153*** (0.0002)
Log-likelihood		-622.9006	-543.9374	-634.1763
AIC		3.199497	2.799683	3.256589
H-Q		3.235416	2.835603	3.292508
Notes: ?? ??				

*[Note: 2 (?? ? 1) represents the past unconditional shocks of the ?? ??? market in the short run, or news.? ?? (t-1) denotes the past conditional volatility dependency. J= EMU, FX. *, **, ***indicate statistical significance level at the 10%, 5% and 1%.]*

Figure 7: Table 3 :

past own conditional volatility sensitivity. In contrast, the Japan market shows crossmarket volatility and shocks independence. [1] [2] [3]

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