VOLATILITY SPILLOVERS FROM THE JAPANESE STOCK MARKET TO EMERGING STOCK MARKETS

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ABSTRACT

The primary aim of this research is to investigate the transmission of volatility from the Japanese Stock Market to the Emerging Seven(E7) Stock Markets. In this study, the VAR-GARCH model has been utilized after collecting daily data from September 1, 2010, to March 15, 2021. The results indicate a substantial presence of volatility transmission from the Japanese stock market to the E7 markets. It becomes evident that the constant conditional correlations indicate a significant level of correlation between the stock markets of the majority of E7 countries and Japan. This finding implies that while analyzing the volatility between these markets, the consideration of the geographical proximity between them is also vital.

KEYWORDS: Volatility Spillover, E7 Stock Markets, Japan Stock Market, VAR-GARCH Model

1. INTRODUCTION

In the last couple of decades, the economy of Japan has observed three substantial financial shocks. Due to economic escalation and rapid money supply the stock market of Japan experienced an abnormal boost in 1991. However, in response to the said abnormality the Japan Central Bank tightened its toes, and consequently, the prices started to settle (Okina et al., 2001). The destruction of financial institutions in the 1990s is obvious to be observed in the spillover effect from the economy of Japan to the rest of the world especially to the native countries. Additionally, at the node of the crisis, firstly, the heat absorbed by the developed world such as the US and European markets. Consequently, the trail of shock also trickles down from the developed world to emerging economies like Japan, Turkey, or Russia (Bosworth and Flaaen, 2009). Furthermore, Japan has maintained its unique position in the region and the rest of the world. The contamination of the recent financial calamity harshly affected the worldwide and emerging markets as well. It is worth mentioning the fact that investors and portfolio managers should understand the significance of volatility spillover owing to its crucial function across the globe.

The aforementioned incidents have laid the foundation for a deeper understanding of volatility spillover between nations and financial markets as well. For instance, the transmission of volatility in capital markets may lead to better management of asset allocation, hedging and trading strategies. The incorporation of financial markets has been at the hub of a noteworthy amount of debates concerning international rule and it has progressively evolved into the main focus of policy talks on considerable economic collaboration. The intense collaboration may also generate several long-term initiatives such as capital formation and international trade enhancement. It is a universally proven fact that the intensive financial integration among the markets may diversify financial risk further helping generate stability in markets by improving the flow of information and resultantly enhancing domestic market investment sentiment (Sugimoto & Matsuki, 2019).

Even in the mid-21st century, the quantum of economic disparity is a bit wider among the countries by naming them developing and developed. The said disparity is also completely reflected in the capital markets of respective countries (Ehigiamusoe & Lean, 2018). One could easily understand the spillover effect from developing to developed countries. Normally, the aforesaid spillover comes from developed to emerging and ended in undeveloped countries.

The basic aim of this research article is to examine volatility spillover from the Japanese stock market to the E7 stock markets by using the most sophisticated methodology VAR-GARCH from the period of 2010-2021 (Ling & McAleer, 2003). The basic norm of the study is that the financial crisis in America has affected all the countries in the world with varying proportions. Therefore, Japan may be considered one of the strongest economies in Asia, henceforth, it may have a spillover effect on E7 stock markets as well (Price Waterhouse Coopers, 2015).

This study contributes in several ways to the literature. First, while the existing studies focus mostly on developed countries and a few emerging markets (Demiralay & Bayraci, 2015; Li & Giles, 2015), the present study focuses on the Japanese and Emerging Stock Exchanges. To the best of the author's knowledge, the Japanese stock

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exchange and stock exchanges of E7, have not been examined jointly in the literature. Second, the present study used a daily data set that covers ten years. Third, this study uses a sophisticated volatility spillover model VAR-GARCH. This study will be useful for portfolio managers, researchers, individual investors, and policymakers.
This research paper is organized as follows: After describing the motivation for the study in section 1, section 2 exhibits the literature review, section 3 shows the research methodology, section 4 explains the analysis of the problem, and section 5 consists of the conclusion.

2. LITERATURE REVIEW

The phenomenon of financial market integration, mostly driven by developed markets, has been extensively examined in the existing academic literature. A significant portion of this research focuses on the transmission of volatility across major stock markets in developed nations, as evidenced by (Uludag & Khurshid, 2019; Khurshid & Uludag, 2021). Hamao et al. (1990) conducted a study to quantify the transmission of volatility between the established stock markets of the United States, United Kingdom, and Japan. To achieve this, they utilized the GARCH-M model. The research findings indicate that there exists a transmission of volatility from the stock markets of the United States and the United Kingdom to the stock market of Japan. Theodossiou and Lee (1993) conducted a study utilizing the multivariate GARCH-M model, which revealed a noteworthy transmission of volatility between the United States and Japan. Bae and Karolyi (1994) conducted a study to examine the transmission of volatility spillover effects between the Japanese stock exchange and the US stock market. Their findings indicated that there is indeed a reciprocal transfer of volatility between these two stock exchanges. Booth, Martikainen & Tse (1997) checked volatility spillover in European stock markets and observed noteworthy spillover effects among these markets. Kanas (1998) employed the EGARCH model to investigate the presence of volatility spillovers within the stock markets of France, Germany, and the United Kingdom. He held the perspective that there exist noteworthy spillover effects of volatility inside stock markets.
In recent years, there has been a significant focus on emerging economies, mostly driven by the recognition of the substantial risks and potential for high returns associated with these markets. The scholarly discourse has acknowledged the interconnections between developed and emerging markets after the Asian crisis of 1997. Ng (2000) conducted a study in the Asia-Pacific region to analyze spillovers between the US, Japan and some Asian Pacific countries. The findings indicate a significant presence of spillovers between global and emerging markets, in contrast to regional equity markets. In contrast, Miyakoshi (2003) conducted a study examining the transmission of volatility across the stock markets of the United States, Japan, and seven Asian countries. The researcher utilized a bi-variate EGARCH model to analyze data spanning from 1998 to 2000. The findings of the study revealed a notable spillover effect of volatility from the US to other markets. The study also revealed that the regional stock market of Japan exerts a substantial influence on the Asian markets. In contrast, the study conducted by Sakthivel, Bodkhe and Kamaiah (2012) utilized bivariate GARCH methodology to analyze weekly stock market data from Japan, the United States, the United Kingdom, India, and Australia. The researchers concluded that there exist substantial bidirectional volatility spillovers inside the stock markets.
Worthington and Higgs (2004) examined volatility spillover in the Asian-Pacific equities markets. They focused on both developed and emerging Asian equity markets, and they employed an MV-GARCH model to assess the extent of volatility spillover. The study utilized data collected from the years 1988 to 2000. They documented noteworthy and statistically significant transmission of volatility from well-established Asian markets to emerging Asian equities markets. In a study conducted by Li (2007), an examination was undertaken to assess the interconnections and transmission of volatility within the stock markets of China, Hong Kong, and the United States. The findings of the research indicated the presence of minimal volatility spillovers between the concerned stock exchanges. Furthermore, a study conducted by Lee (2009) investigated the impact of volatility spillover in six Asian stock markets. The research findings demonstrated notable instances of volatility spillover effects occurring among the aforementioned stock markets. With the exception of India, the five geographically proximate countries (Hong Kong, Japan, Singapore, South Korea, and Taiwan) have stronger interconnections among themselves. Furthermore, Johansson and Ljungwall (2009) investigated the interconnections between the various stock markets within the Greater China region. The findings of the research indicate that there is a transmission of volatility among the concerned markets.
Syriopoulos, Makram and Boubaker (2015) examined the various sectors of BRICS countries and employed the VAR-GARCH model to analyze data from 2005 to 2013. The findings indicate a noteworthy transmission of volatility between the United States and BRICS countries, as well as a negative correlation observed between the United States and China. Abidin and Zhang (2011) examined Asian markets by employing the AR-GARCH model. In a recent study, Li and Giles (2015) examined six developing stock markets, as well as two developed stock markets (Japan and the United States). They utilized data from 1993 to 2012 and implemented the GARCH-BEKK model. The results indicate noteworthy volatility spillovers from the United States to several Asian nations. Moreover, the results indicate the presence of a two-way transmission of volatility during the Asian financial crisis.

Kocaarslan, Sari, Gormus, and Soytas (2017) aimed to examine the transmission of volatility between the stock markets of BRIC countries (Brazil, Russia, India, and China) and the United States. To achieve this, the researchers employed the DCC-EGARCH model, a widely used econometric tool for analyzing volatility spillovers. The findings indicate the presence of substantial spillover effects in volatility across connected stock markets.

Caloia, Cipollini, and Muzzioli (2018) utilized the Diebold and Yilmaz model to investigate the presence of volatility spillovers within five European stock markets. They observed noteworthy volatility spillovers throughout the aforementioned stock markets. Bissoondoyal, Brooks, Chi, and Do (2018) investigated the occurrence of volatility spillovers among the stock markets of Australia, China, and the United States during the global financial crisis. They collected data from 2007 to 2016 and discovered evidence of unidirectional volatility between the United States, China and Australia. Irshad, Khurshid, Badshah, and Bulut (2021) aimed to examine the transmission of volatility between the United States and seven emerging stock markets during the global financial crisis. To achieve this, the researchers employed the VAR-GARCH model. The authors highlighted the presence of substantial spillover effects of volatility originating from the United States onto other stock markets.

In a recent study conducted by Ahmed Zhao and Habiba (2022), an examination was conducted to assess the presence of volatility spillovers within the stock markets of China, Japan, Pakistan, Hong Kong, South Korea, and Malaysia. The study utilized daily data from 2010 to 2018. The findings from the bivariate EGARCH model indicate the presence of notable volatility spillovers among the stock markets, except for China.

Furthermore, the study undertaken by Bossman, Junior, and Tiwari (2022) examined the transmission of volatility between Islamic and Conventional stock markets in the context of the COVID-19 pandemic. They also concluded that there are notable spillover effects of volatility between Islamic and Conventional stock exchanges. In their work, Khurshid and Uludag (2017) investigated the Balkan stock markets. They utilized data from 2000 to 2016 and employed the VAR-GARCH model for their analysis. The findings indicate the presence of notable spillover effects originating from the oil market toward the stock markets in the Balkan region. Uludag and Khurshid (2019) examined the transmission of volatility from the Chinese stock exchange to both global and emerging stock markets. It has been discovered that there exists a notable impact of volatility spillovers originating from the Chinese stock market on the majority of stock markets in both E7 and G7 nations. Moreover, Khurshid and Uludag (2021) collected data from 1995 to 2019 and findings revealed the presence of notable volatility spillover effects between the oil market and emerging economies.

The existing body of literature has extensively examined the phenomenon of volatility spillover effects across various periods and using diverse methodologies. The majority of these studies have consistently found a relationship between volatility spillovers and stock markets. However, a subset of studies has put forth the argument that there exists a negative relationship between volatility spillover effects and stock markets. These investigations have explored different geographical regions and economic blocks.

3. DATA AND METHODOLOGY

As it has been mentioned in the introduction part, this study wraps up the volatility spillovers between the Japanese stock market and the emerging seven stock exchanges. The emerging seven stock markets include Brazil, China, Mexico, India, Indonesia, Russia and Turkey. By considering the aim of the study, the daily data of benchmark indices of these markets have been downloaded from Thomson Reuters Data Stream starting from 1st September 2010 to 15th March 2021. The list of benchmark indices is given in Table 1.

Table 1: List of Benchmark Indices

Country	Market Index
Japan	Nikkei 225
Brazil	BOVESPA
China	Shanghai Composite
Mexico	IPC BOLSA
India	S & P BSE 100
Indonesia	JSX Composite
Russia	RTS
Turkey	BIST 100

The returns were calculated by applying the following equation:

$$r_t = \{\ln(p_t) - \ln(p_{t-1})\}/ \ln(p_{t-1}) * 100 \qquad (1)$$

Where,

r_t = returns

$\ln(p_t)$ = current price

$\ln(p_{t-1})$ = previous price

A number of techniques are used in the existing literature regarding the volatility spillover effects including ARCH-GARCH, MGARCH, EGARCH, etc. Moreover, Fama (1965) and Mandelbrot (1963) have also introduced volatility clustering techniques by focusing on the time-varying approach. Similarly, Engle (1982) showed the ARCH technique and Bollerslev (1986) suggested the GARCH model to tackle volatility clustering. Ling and McAleer (2003) introduced the VAR-GARCH model by using the CCC-GARCH model of Bollerslev (1990) to examine the spillovers. In this study, we have used the VAR-GARCH model of Ling and McAleer (2003) to examine the volatility spillovers between E7 and the Japanese stock exchange. This model eliminates the complexities in the estimates and also have been run by (Hammoudeh et al., 2009; Arouri et al., 2011; Mensi et al., 2014).

4. EMPIRICAL RESULTS AND DISCUSSION

Table 2 shows the results of descriptive statistics of all the countries. The returns are on average positive all over. The data point out that generally, the stock returns of emerging seven countries are higher than those of Japan. According to the results of Table 1, Japan has lesser volatility but poorer returns than other emerging countries.

The null hypothesis of normality is not supported by the results of the Jarque-Bera test for either the emerging stock market or the Japanese stock return series. The findings of the L-B test summit to the continuation of autocorrelation in the return series. The Russian market is the most volatile of the E7 stock markets.

4.1. RESULTS OF UNIT ROOT TESTS

The study used both the Augmented Dickey–Fuller (ADF) and the Phillips–Perron (PP) tests to determine the normality on time series however, it is established that all the series are normal at 1% (stationary).

Table 2: Descriptive Statistics for Japan and Emerging Countries

Country	Japan	Brazil	China	India	Indonesia	Mexico	Russia	Turkey
Mean	0.0001	0.0009	0.0005	0.0007	0.0008	0.0009	0.0011	0.0018
Std. Dev.	0.017	0.025	0.020	0.019	0.019	0.017	0.033	0.030
Min	-0.119	-0.170	-0.196	-0.112	-0.155	-0.150	-0.326	-0.019
Max	0.125	0.520	0.138	0.174	0.206	0.136	0.343	0.331
Skewness	-0.119	2.267	-0.138	0.370	0.401	0.309	0.727	0.796
Kurtosis	4.856	53.350	6.477	8.089	13.785	9.250	17.201	11.933
J-B	3660.22 (0.000)	44379.43 (0.000)	6507.34 (0.000)	10214.93 (0.000)	29514.55 (0.000)	13305.64 (0.000)	46129.49 (0.000)	22438.24 (0.000)
ARCH-LM	379.784 (0.000)	44.095 (0.000)	190.397 (0.000)	166.401 (0.000)	162.338 (0.000)	194.720 (0.000)	148.088 (0.000)	107.801 (0.000)
LB-Q (12)	9.193 (0.000)	33.262 (0.000)	27.385 (0.000)	32.969 (0.000)	90.022 (0.000)	40.395 (0.000)	46.190 (0.000)	28.092 (0.000)
LB-Q (24)	16.221 (0.000)	56.412 (0.000)	38.455 (0.000)	43.771 (0.000)	109.297 (0.000)	60.607 (0.000)	72.925 (0.000)	65.902 (0.000)
# of Obs	3715	3715	3715	3715	3715	3715	3715	3715

Note: P-values are shown in parentheses. The empirical statistics of the Jarque-Bera test for normalcy based on skewness and excess kurtosis are denoted by JB. The empirical statistics of the statistical test for conditional heteroskedasticity of order 6 are referred to as ARCH. The empirical statistics of the Ljung-Box tests for autocorrelations are denoted by LB.

4.2. RESULTS OF VAR (1)–GARCH (1) MODEL FOR JAPAN AND EMERGING COUNTRIES

The empirical results are shown in Table 3 which provides in general the summary. Most of the estimates except for China are resolute to be statistically significant when using the mean equation. The results demonstrate an insignificant coefficient Chinese stock market which indicates the returns of the Japanese stock market and the Chinese stock market have no relationship. Contrarily, the results demonstrate that Russian and Indonesian stock markets negatively influence the returns of Japanese stocks.

Table 3: Results of Unit Root Test for Japan and E7 Countries

	With Trends		Without Trends	
Country	ADF	PP Test	ADF	PP Test
Japan	-63.231***	-63.362***	-61.532***	-62.865***
Brazil	-62.536***	-61.142***	-60.345***	-60.475***
China	-63.130***	-62.212***	-60.134***	-60.231***
India	-55.537***	-55.754***	-57.346***	-55.542***
Indonesia	-56.234***	-56.363***	-56.463***	-56.435***
Mexico	-55.373***	-56.463***	-56.453***	-56.573***
Russia	-57.352***	-54.256***	-55.353***	-57.364***
Turkey	-59.211***	-61.423***	-59.351***	-61.243***

*Note: The symbols ***, **, and * indicate that the coefficients are significant at 1%. 5% and 10% are the equivalent levels.*

Table 3: Estimates of VAR (1)-GARCH (1) model for Japan and Emerging7

	Brazil		China		India		Indonesia		Mexico		Russia		Turkey	
Mean Eq	Japan	Brazil	Japan	China	Japan	India	Japan	Indo	Japan	Mexico	Japan	Russia	Japan	Turkey
Japan (1)	-0.062***	0.172***	-0.009	-0.017	-0.037*	0.071***	-0.007	0.018*	-0.047***	0.242***	-0.065***	0.054***	-0.025	0.026***
	(0.000)	(0.000)	(0.521)	(0.212)	(0.032)	(0.000)	(0.341)	(0.043)	(0.000)	(0.000)	(0.000)	(0.000)	(0.272)	(0.00)
E7(1)	0.018(0.192	-0.022	0.009	0.003	-0.002	0.085***	-0.021***	0.121***	-0.013	0.052***	-0.041***	0.034***	0.021	-0.0002
	)	(0.000)	(0.400)	(0.453)	(0.532)	(0.000)	(0.000)	(0.000)	(0.434)	(0.003)	(0.000)	(0.000)	(0.373)	(0.322)
Variance Equation														
C (10) [4]	0.025***	0.133***	0.212***	0.074***	0.048***	0.023***	0.323***	0.112**	0.027***	0.024***	0.125***	0.322***	0.056***	0.024***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.019)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$(\varepsilon_{t-1}^{J})^2$	0.039***(0.	0.031***	0.212***	0.003***	0.034***	0.034***	0.162***	-0.003***	0.034***	0.023***	0.221***	0.003***	0.058***	0.004**
	00)	(0.00)	(0.00)	(0.003)	(0.00)	(0.002)	(0.000)	(0.004)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.042)
$(\varepsilon_{t-1}^{E7})^2$	0.042***	0.044***	-0.003***	0.050***	-0.004	0.045***	-0.019***	0.123***(	0.004	0.045***	-0.036***	0.221***(	0.051*	0.013***(
	(0.003)	(0.000)	(0.003)	(0.00)	(0.102)	(0.000)	(0.000)	0.000)	(0.218)	(0.000)	(0.000)	0.000)	(0.056)	0.000)
h_{t-1}^{J}	0.373***	-0.043***	0.432***	-0.030***	0.233***	-0.007	0.124***(	0.017***	0.438***	-0.035**	0.341***	0.004***	0.525***(	0.002
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.232)	0.000)	(0.000)	(0.000)	(0.015)	(0.000)	(0.000)	0.000)	(0.338)
h_{t-1}^{E7}	-0.025**	0.632***	0.003	0.343***	0.006	0.435***	0.032***	0.260***(	-0.005	0.525***	0.224***	0.421***(	-0.036	0.544***(
	(0.021)	(0.000)	(0.354)	(0.000)	(0.358)	(0.000)	(0.000)	0.000)	(0.330)	(0.000)	(0.000)	0.000)	(0.324)	0.000)
CCC Japan and E7	0.221*** (0.000)		0.322*** (0.000)		0.325*** (0.00)		0.428*** (0.000)		0.325*** (0.000)		0.313*** (0.000)		0.223*** (0.000)	
Log Like	14276.57		18468.81		22324.23		22328.08		22410.27		13432.08		16146.03	
AIC	9.445		10.131		10.522		11.251		11.613		9.364		9.415	
H-Q	9.332		10.239		10.228		11.131		11.653		9.270		9.336	

*Note: From September 1,2010 to March 15, 2021, the bivariate VAR(1)-GARCH(1, 1) model is estimated for each emerging countries. In brackets, the p values are given. The AIC and H-Q information criteria are used to determine the best lag order for the VAR model. The symbols ***, **, and * indicate that the coefficients are significant at 1%. 5% and 10%, respectively.*

However, as per Karim (2010), a negative relationship between the Japanese stock market and the Indonesian stock market exists by following that most of the emerging stock markets do not influence the Japanese markets. Focusing on the variance equation, most of the coefficients of emerging markets are significant. The findings demonstrate that the financial shocks from the Japanese stock market have a significant effect on most of the emerging markets as well. Similarly, the shocks from the emerging seven stock markets also influence the return of the Japanese stock market extensively. However, the results show that stocks from the stock markets of India and Mexico do not influence the Japanese market.

The results also explain that the Japanese stock exchange has large volatility spillovers to the majority of the emerging stock exchanges. It is worth mentioning the fact that both India and Turkey have small volatility considerations. This conclusion entails that the Japanese stock market has no major volatility spillovers to the Indian and Turkish stock markets. The correlations among the said stock markets are positive and high which exhibit that emerging markets are well connected with the Japanese stock market.

5. CONCLUSION

The study seeks to investigate the volatility spillover from the Japanese stock market and the stock markets of E7 economies from 2010 to 2021 by estimating the VAR–GARCH model. The Japanese stock market seems to have a higher influence on the emerging countries. The Japanese stock market has a substantial impact on the return dynamics of stock markets in the E7. The study concludes that the Japanese stock market is integrated with the stock markets of Asia among the emerging markets. It is imperative to keep in mind that stock exchanges existing within the same geographical locations have higher volatility. The findings provide credence to the notion that the closeness of geographical locations, the absence of time zones and the close cultural familiarity may all contribute to the ease with which information and investment opportunities are disseminated. The study concludes that to some extent Japan has an influence on emerging markets particularly that rests in the region. From an investor's perspective, the said findings provide a solid foundation for diversification of portfolio and making it an efficient choosing. The findings are essential for portfolio managers and policymakers to construct an optimal portfolio and accurately estimate the volatility of stock return returns in light of the difficulties that have been described above.

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