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# Integration of ASEAN Capital Markets with Developed Countries: Spillover Analysis for the 2003-2019 Period

**Juniarti Puspita Wulandari[1], Moch. Doddy Ariefianto[2]**

*[1]School of Accounting, Bina Nusantara University, Jakarta, Indonesia;*
*[2] School of Accounting, Binus Graduate Program-Master Accounting, Bina Nusantara University, Jakarta, Indonesia.*

***Kata Kunci***
***Kata kunci:*** Integrasi Pasar; Krisis Keuangan, Volatilitas Spillover, DCC, MGARCH

***Abstrak***
Penelitian ini bertujuan untuk mengetahui spillover effect pada pasar saham ASEAN yang dipengaruhi oleh gejolak pusat pasar saham keuangan dunia yaitu Amerika Serikat, Jepang dan Inggris, serta untuk mengetahui pola pengaruh pusat keuangan terhadap negara-negara di ASEAN. Data yang digunakan dalam penelitian ini adalah data time series. Kemudian dilakukan analisis terhadap masing-masing indeks negara yang penulis peroleh dari periode 2003-2019, kemudian penulis gunakan untuk menemukan pasar negara berkembang yang dipengaruhi oleh negara maju. Penelitian ini menggunakan Dynamic Conditional Correlation-Generalized Autoregressive Heteroscedatic Model (DCC-GARCH) sehingga memungkinkan untuk meneliti transmisi volatilitas antara dua pasar saham yang berbeda secara bersamaan. Berdasarkan hasil penelitian, ditemukan adanya spillover effect dari negara-negara pusat keuangan ke negara-negara emerging market di ASEAN. Selain itu, ditemukan juga bahwa spillover effect antara pasar saham pusat keuangan dan pasar negara berkembang memiliki hasil yang bervariasi pada periode pengamatan. Krisis keuangan tahun 2008 yang bersumber dari krisis keuangan AS menyebabkan perubahan signifikan pada pasar saham ASEAN-5. Hal ini terlihat dari meningkatnya pengaruh atau spillover effect pasar saham Amerika yaitu SP500 dan FTSE100, dampak yang paling signifikan selama dan setelah krisis tahun 2008.

**Keywords**
**Keywords:** Market Integration; Financial Crisis, Volatility Spillover, DCC, MGARCH

**Abstract**
This study aims to determine the spillover effect on the ASEAN stock market, which is influenced by the turmoil of the world's financial stock market centres, namely the United States, Japan and the United Kingdom, and to determine the pattern of influence of financial centres on countries in ASEAN. The data used in this research is time series data. Then an analysis of each country index was carried out, which the author obtained from the 2003-2019 period, and then the author used it to find emerging markets that were influenced by developed countries. This study uses the Dynamic Conditional Correlation-Generalized Autoregressive Heteroscedatic Model (DCC-GARCH) so that it is possible to examine the transmission of volatility between two different stock markets together. Based on the research results, it was found that there was a spillover effect from financial centre countries to emerging market countries in ASEAN. Besides that, there is also a finding that the spillover effect between the stock market of financial centers and developing country markets has varying results in the observation period. The 2008 financial crisis, which stemmed from the US financial crisis, caused significant changes to the ASEAN-5 stock market. This can be seen from the increasing influence or spillover effect of the American stock market, namely the SP500 and FTSE100, the most significant impact during and after the 2008 crisis.

*Corresponding Author: Juniarti Puspita Wulandari, School of Accounting, Bina Nusantara University, Jakarta, Indonesia;
Email: juniarti.wulandari@binus.ac.id

## INTRODUCTION

The level of market movement is an important factor for assessing opportunities for diversification in the stock market. Previous studies have shown that trade markets are strongly influenced by the international trade routes of Frankel & Rose, (1998) monetary integration of Barry, (2015), and financial market integration of (Anghelache & Ciobanu, 2012). Cross-sectional effects among financial markets provide useful information for establishing asset price models in an international context, investigation of the dynamics of cross-market interactions both in terms of returns and transmission of volatility is of great interest to investors, fund managers and policymakers.

The interrelationship of financial systems between countries is inevitable in this era of globalization, although spillover volatility from developed markets to emerging markets or other developed markets is confirmed in many studies such as (Miyakoshi, 2003; Mohammadi & Tan, 2015). Panda & Nanda, (2018), found that the causes driving international financial integration and volatility transmission were due to the rapidly increasing globalization of world financial markets and the transfer of greater volatility between the stock markets of each country. Ratnawati & Anggraeni, (2022) suggest that the increasing integration and interdependence of international financial markets leads to spillovers that occur in the countries involved. Then with the interdependence between countries in the international economy, the relationship between yields and stock market volatility will also be stronger. This volatility overflow test is required by several parties, one of which is for investors and policymakers to have appropriate information in their decision making. Based on these thoughts, we conducted this study

Chris (2014) defines spillover as the tendency of volatility to change in one market or an asset following changes in volatility in another. It signals the rapid movement of information through a series of changes in short-term volatility in various markets. There are several types of volatility, namely exposure volatility with spillover volatility. Accordingly, volatility spillover focuses on the potential impact of volatility shock in one market on volatility in another in a short period of time. Meanwhile, exposure volatility or beta volatility can capture long-term relationships.

The global financial crisis that occurred in 2008 changed the long-term relationship between the Association of Southeast Asian Nations (ASEAN)-5 with other global stock markets. The lead-lag relationship and interdependence among the ASEAN-5, United States (US) and United Kingdom (UK) stock markets have changed. The mutual dependence on the stock market increased during the financial crisis, with the US stock market leading the declines during the financial crisis. However, after the financial crisis, the dependence on ASEAN-5 stock markets is stronger with US and UK stock markets than other Asian countries. Capital and global investment portfolios continue to flow to ASEAN (Pongsaparn & Unteroberdoerster, 2011). The 2008 global financial crisis was caused by the crash of the United States (US) stock market and shocked stock markets worldwide; this resulted in a decrease in global stock market returns (Reavis, 2012).

During the financial crisis, financial institutions and instruments suddenly experienced large losses in asset value (Mersud & Naida, 2013). The US and European financial crises also affected the interdependence of global stock markets, including the ASEAN-5 countries. Many foreign investors withdrew from their investments in other countries, causing the financial crisis to spread to financial markets throughout the country (Naqvi, 2019). A *financial crisis* is defined as a condition used to determine differences in financial institutions or financial instruments that occur quickly and suddenly in large numbers and involve loss of asset value (Mersud & Naida, 2013). The global crisis of 2008 stemmed from the drop in home values in the US subprime mortgage market. House prices from the 1990s to 2006 have increased by 8% per year.

The high demand for housing causes more and more people to buy homes through various types of credit. The decline in house prices is affecting the increasing number of Americans who cannot pay mortgages. This causes bank liquidity difficulties. At the same time, banks are obligated to provide returns to their investors. This situation led to bank failures and precipitated the financial crisis in 2008. Financial markets became more integrated after the economic crisis in 2008-2009, which is described in the work of (Jiang et al., 2017; Kim et al., 2015; Živkov et al., 2019). The capital market has a very important role for some parties because, for companies or corporations, the capital market is an efficient source of long-term income for the company. For investors, it is a place to obtain additional profit value through investment in securities that have been estimated and calculated. Additionally, an integrated capital market is needed so Southeast Asian countries can increase their competitiveness in the global arena. The capital market is one of the parameters or a reflection of a country's economic development, so the development of the capital market must be considered.

We applied the DCC-GARCH model from Celık, (2012) to determine the presence of overflow during the observation period. This is because by using

DCC GARCH, we can detect possible changes in conditional correlations from time to time, allowing us to detect dynamic investor behaviour in responding to information and innovations. This study uses an empirical model, namely the bivariate GARCH model, so that it is possible to examine the transmission of volatility between two different stock markets together. Jebran & Iqbal, (2016) and Mensi et al., (2013) examined the transmission of stock return volatility, and these researchers provided evidence of spillover returns and volatility. Based on the explanation above, global markets are believed to be interrelated, so it is important to understand every volatility transmission from developed to developing country markets.

Therefore, this bivariate GARCH model is important to improve our understanding of the relationship between (co) volatility of the series we investigate. In particular, we analyze whether the cross-integration of ASEAN-5 markets into world markets increased after two major financial crises (the 2007-2008 global financial crisis and the 2010-2012 European debt crisis). In addition, we use the Diebold & Yilmaz, (2012) spillover index to measure the direction of spillover among various markets and assets. The spillover index from Diebold & Yilmaz, (2012) is based on the decomposition of the variance of the forecast error from a generalized vector autoregressive specification (VAR), where the decomposition of the variance of the forecast error does not differ from the ordering of the variables.

The main advantage of this method is that the spillover index measures the dynamic magnitude of return and spillover volatility over time, capturing the direction of spillover. For example, using a rolling-sample analysis, we can generate dynamic rates of return and spillover volatility in both crisis and non-crisis episodes, including trend and burst spillovers (Awartani et al., 2013; Awartani & Maghyereh, 2013). This index also assesses directionality in terms of the net contribution of one market to the information transmission mechanism of another market. Measurement of directional returns and volatility is important to understand spillover channels between ASEAN-5 and world stock markets and within the inter-regional markets of ASEAN-5 countries.

Next, we analyze net spillovers from each market and between each market pair to determine which markets were net receivers and transmitters of spillovers during the financial crisis. From the perspective of market interdependence, the findings on net profit and spillover volatility help us understand the direction of information transmission. They classify net senders and net recipients of information in ASEAN-5 countries. Identifying net receivers and emitters is useful to portfolio investors in predicting the risk of interdependence in their diversified portfolios, adjusting their asset portfolios in a timely manner, and improving their investment and hedging decisions.

We find a positive correlation between the ASEAN-5 and world stock indices, which were more prominent during the financial crisis. These findings support the contagion effect, following the notion of contagion as an increase in cross-country correlation after a shock to a country or a group of countries (Dungey & Gajurel, 2015, pp. 2007–2009; Forbes & Rigobon, 2002; Gagnon & Karolyi, 2006). In addition, we provide evidence that the connectivity from the world stock market to the ASEAN-5 stock market is lower than the reverse direction. Furthermore, the returns and spillover volatility shows an increasing pattern during periods of financial turbulence, confirming the intensity of spillovers during periods of turmoil. In addition, world markets were the only net emitters of spillover returns during the 2007-2009 global financial crisis, while world markets were net recipients and transmitters of spillover volatility during the 2007-2009 global financial crisis and the 2010-2012 European debt crisis. Most ASEAN-5 countries were net recipients of volatility returns and spillovers during the 2007-2009 global financial crisis and the 2010-2012 European debt crisis. Finally, in this study, we would like to point out the existence of heterogeneity among the ASEAN-5 stock markets in the level of spillover to world markets over time, especially in the 2003-2019 period, thereby increasing understanding of the economic channels connecting the ASEAN-5 equity markets.

## LITERATURE REVIEW

Chris, (2014) defines *spillover* as the tendency for volatility to change in one market or asset following changes in other markets. It signifies the rapid movement of information through a sequence of short-term volatility changes across several markets. Volatility exposure is different from volatility spillover (Gagnon & Karolyi, 2006). According to him, volatility spillovers focus on the potential impact of volatility surprises in one market on volatility in other markets in a short period. Meanwhile, volatility exposure or beta volatility can capture long-term relationships. Of course, in the spillover analysis, there is a transmission mechanism in the transfer of both positive and negative information. Information that moves from one market to another is information that has value (valuable information). Movement volatility can help understand the transmission of shocks (shock transmission) in the global financial system. An effect affects the volatility of financial markets and assets, namely volatility spillover.

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Spillover volatility was tested in many previous studies. Yi & Tan, (2009) includes spillover volatility from Japan (proxies for regional markets) and the United States (proxies for world markets) to six Pacific Basin equity markets such as Malaysia, Singapore, and Thailand. Miyakoshi, (2003) also examines the volatility spillover from Japan and the United States to seven Asian equity markets such as Singapore, Thailand, Indonesia and Malaysia. The research found that Japan and the United States transmit volatility to Asian markets. However, in contrast to the results found by Yi & Tan, (2009), Asian market volatility is more influenced by the Japanese market than by the United States, and there is a detrimental effect of volatility from Asian markets to Japanese markets.

Some of the research on capital market integration was conducted by Mulyadi et al., (2012), who examined the influence of the US capital market and the Japanese capital market on the Indonesian capital market using data from January 2004-December 2008. The results of this study were consistent with the results of research conducted by Ibrahim, (2006), who found that the US capital market and the Japanese capital market more influence the capital market in Indonesia. Forthemore Ibrahim also found that the relationship between the US capital market and the Indonesian capital market is one way in the sense that the US capital market influences the Indonesian capital market; this is also supported by Robiyanto, (2018), while the relationship between the Japanese capital market and Indonesia's capital are mutually influencing. According to Anghelache & Ciobanu, (2012), the US and Japanese stock markets strongly influence other countries' stock markets, which are the objects of their research. Six countries in the Asia Pacific region are Hong Kong, Korea, Malaysia, Singapore, Taiwan and Thailand.

Studies on the spillover effect have been conducted by Fedorova et al., (2014). Euro area economic news has been proven to influence CIVETS (Colombia, Indonesia, Vietnam, Egypt, Turkey, and South Africa) stock market volatility in several cases of stock returns. Evidence of the overall European impact of information on stock market volatility is found for Colombia, Vietnam, Egypt, and Turkey. Shabri Abd. Majid et al., (2008) empirically observed the dependence between ASEAN-5 countries, the US, and Japan. The data used is the JCI daily closing price for 1988-2006. The study found that in the long term relationship, Indonesia tends to be more independent from the US and Japan, Malaysia is more influenced by Japan than the United States, and the US market more influences Thailand, but in the long run, it also depends on Japan, we more impact the Philippines than Japan, and Singapore mutually influence with the US and Japan.

Research from Arief, (2021) found that the US market consistently influenced the stock markets of ASEAN-5 countries, Korea, Japan, Hong Kong and the UK in all periods. Interestingly, the US did not have interdependence with the UK before and during the crisis period but did have interdependence after the 2008 financial crisis. The US capital market is leading because of the transmission of information to other countries. After the 2008 financial crisis, the Indonesian stock market tended to move independently and was only influenced by the US stock market. Indonesia's lead-lag relationship was different before, during and after the financial crisis. Before the financial crisis, Indonesia was also influenced by the British. During the financial crisis, Indonesia was influenced by the US, UK and Japan. Similar to Indonesia, Thailand's stock market is also interdependent. Most of the lead-lag and interdependence relations between ASEAN-5 changed due to information transmitted globally during the financial crisis.

The US stock market has consistently led change globally before, during and after the financial crisis. However, after the crisis, the US and UK stock markets led the ASEAN-5 stock markets and have stronger interdependence compared to other Asian stock markets such as Japan. There has been no lead-lag relationship in the ASEAN capital market after the 2008 financial crisis. This is especially evident in Indonesia, which is not interdependent with other capital markets except the US stock market. This result is different from the results of Shabri Abd. Majid et al., (2008), Soesastro, (1998) and Yang, (2003), who found that after the 1998 crisis, the interdependence relationship between stock markets became stronger, even in Asian countries.

## Data

The data used in this study is data sourced from *the yahoo finance* website including historical data with weekly frequency and the observation period of January 1, 2003 to December 31, 2019 which contains data from the Finance Market Center including FTSE, N225, and SP500, and emerging markets consisting of JKSE, PSEI, SET, KLCI and STI, as shown in table 1 below:

Table 1. Data Sets

| Data | | Description |
|---|---|---|
| Finance Market Center | FTSE | Financial Times Stock Exchange 100 |
| | N225 | Nikkei 225 |
| | SP500 | Standard & Poors 500 |
| Emerging Market/ASEAN5 | JKSE | Jakarta Stock Exchanges |
| | PSEI | Philiphinnes Index |
| | SET | Stock Exchange of Thailand |
| | KLCI | Kuala Lumpur Composite Index |
| | STI | Strait Times Index |

Furthermore, the stock market data is calculated the return value by referring to $\frac{(X_t - X_{t-1})}{X_t}$ where X is the market value of the stock level at the time t level. In this study also divides the observation period differently starting from precrisis, during crisis, post crisis, where the timeline from during crisis is calculated from 1/1/2008-31/12/2009. Under 2008, the pre-crisis observation period was calculated and after 2009 counted as the post-crisis observation period.

## RESEARCH METHODS

This study used the US, Japan, and UK country indices as independent variables. where the three countries are financial centers located on different continents. As for bound variables, we chose several indices in ASEAN countries as research objects where the index selected is the market index of Indonesia, Malaysia, the Philippines, Thailand, and Singapore. The data used is secondary data obtained from the yahoo finance website including historical data with a weekly frequency and observation period from January 1, 2003 to December 31, 2019. The hypothesis used in this study is that there is a spillover effect of the financial center equity market on the ASEAN equity market, and there is a pattern of the same spillover effect between each ASEAN country.

We apply the GARCH test developed by Engle, (1979) which can be described as follows:

$$\sigma_t^2 = a_0 + a_1\varepsilon_{t-1}^a + \cdots + a_p\varepsilon_{t-P}^2 \quad (1)$$

With

$$\varepsilon_t = \sigma_t{}^{x}{}_{t,}x_{t\sim}i.i.d\ N(\mu,\sigma^2), a_0 > 0\ dan\ a_i \geq 0\ untuk\ i = 0 \quad (2)$$

In fact, it is often assumed to follow a standard normal distribution so that the ARCH (p) model can be characterized by _t=σ _t^2 x_t with _t^2 as the notation of the conditional variance in the above equation. In 1986 Bollerslev and Taylor developed the GARCH model in which the model allows the conditional variance to depend on the previous lag, so that the conditional variance equation in the simplest case is now.

$$r_t = \mu_t + a_t \quad (3)$$
$$a_t = h_t^{1/2} a_t z_t \quad (4)$$
$$h_t = a_0 + a_1 a_{t-1}^2 + \cdots + a_q a_{t-q}^2 + \beta_1 h_t + \cdots + \beta_p h_{t-p} \quad (5)$$

The t equation can be modeled as a time series, such as the ARIMA model, or simply as a constant. The volatility in (4) can be written as follows:

$$h_t = a_0 + \sum_{i-1}^{Q} a_i a_{t-i}^2 + \sum_{j=1}^{P} \beta_i h_{t-j} \quad (6)$$

In Equation (6), the conditional variance, h_t varies over time, depending on the return of the last square of. The DCC GARCH model was introduced by Engle and Sheppard. The idea in this model is that the covariance matrix can be composed into the conditional standard deviation and the correlation matrix In the DCC GARCH model, both and models are designed to be $\{a_{t-1}^2\}_i^q = 1 H_t D_t R_t . D_t R_t$ time-varying. The DCC GARCH model is generally defined as follows:

$$r_t = \mu_t + a_t \quad (7)$$
$$a_t = H_t^{1/2} a_t z_t \quad (8)$$
$$H_t = D_t R_t D_t D_t \quad (9)$$

Where : n x n, $D_t$ the diagonal matrix of the conditional standard deviation of at time: matrix nxn conditional correlation of at time t$a_t R_t$. In this study, the bivariate GARCH (1,1) model will be used to estimate the spillover effect in ASEAN member countries and also the spillover effect from developed countries (the US, Japan, and UK). The first step in the GARCH bivariate methodology is to determine the mean equation. Thus, the average equation for each return is as follows:

$$h_t = \alpha_0 + \alpha_1 U_{t-1}^2 \quad (10)$$

Where $U_t = \sqrt{h_t} v_t, v_t \sim (0,1)$. This formulation represents the ARCH (1) model, in which a single lagged $u^2$ enters the ARCH equation. A higher-order ARCH equation would include additional lags of $u^2$. To ensure a positive variance, $\alpha_0 > 0 \; and \; \alpha_1 > 0$. When $\alpha_0 > 0$, the squared errors are positively serially correlated even though the $u_t$ themselves are not. So there are 15 bivariate regressions to be carried out. The ARCH model has been extended to a generalized form which has proven to be much more appropriate in many contexts. In the simplest example, we may write

$$h_t = \alpha_0 + \alpha, U_{t-1}^2 + \; y_1 h_{t-1} \quad (11)$$

Which is known as the GARCH (1,1) model since it involves a single lag of both the ARCH term and the conditional variance term. We must impose the additional constraint that $y_1 > 0$ to ensure a positive variance. We use t-statistics to test consistency of dynamic correlation coefficients between capital market in the pre-crisis and crisis periods to judge the contagion effect. We define null and alternative hypotheses as:

$$H_0 = \mu_P^{pre-crisis} = \mu_P^{dur-crisis} = \mu_P^{post-crisis} = \mu_P^{full-crisis} \quad (12)$$

$$H_1 = \mu_p^{pre-crisis} \neq \mu_p^{dur-crisis} \neq \mu_p^{post-crisis} \neq \mu_p^{full\ crisis} \quad (13)$$

Where $\mu_P^{pre-crisis}, \mu_P^{dur-crisis}, \mu_P^{post-crisis}$ and $\mu_P^{full-crisis}$ are the conditional correlation coefficient means of population in the pre-crisis and crisis periods. If the sample sizes are $n^{crisis}$ and $n^{pre-crisis}$, the population variances $\sigma_{crisis}^2$ and $\sigma_{pre-crisis}^2$ are different and unknown. If the means of dynamic correlation coefficients estimated by DCC are $\tilde{P}_{ij}^{crisis}$ and $\tilde{P}_{ij}^{pre-crisis}$ and the variances are $s_{crisis}^2$ and $s_{pre-crisis}^2$, the t-statistic is calculated as:

$$t = \frac{\left(\bar{\rho}_{ij}^{pre-crisis} - \bar{\rho}_{ij}^{dur-crisis} - \bar{\rho}_{ij}^{post-crisis} - \bar{\rho}_{ij}^{full-crisis}\right) - \left(\mu_\rho^{pre-crisis} - \mu_\rho^{dur-crisis} - \mu_\rho^{post-crisis} - \mu_\rho^{full-crisis}\right)}{\sqrt{\frac{s_{pre-crisis}^2}{N^{pre-crisis}} + \frac{s_{dur-crisis}^2}{N^{dur-crisis}} + \frac{s_{post-crisis}^2}{N^{post-crisis}} + \frac{s_{full-crisis}^2}{N^{full-crisis}}}} \quad (14)$$

Where:

$$s_{crisis}^2 = \frac{1}{N^{crisis}-1} \sum_{t=1}^{N^{crisis}} \left(\rho_{ij}^{crisis} - \bar{\rho}_{ij}^{crisis}\right)^2 \quad (15)$$

$$s_{pre-crisis}^2 = \frac{1}{N^{pre-crisis}-1} \sum_{t=1}^{N^{pre-crisis}} \left(\rho_{ij}^{pre-crisis} - \bar{\rho}_{ij}^{pre-crisis}\right)^2 \quad (16)$$

## RESULTS AND DISCUSSION

### Descriptive Statistics

Table 2 shows descriptive statistics in which the results of the weekly market index before the crisis, during the crisis, after the crisis and in the period of the whole sample. The author divides this period into 4 (four) test periods, namely pre crisis period (2003-2007), during crisis period (2008-2009), post crisis period (2010-2019) and full period (2003-2019). During that periods we can see that the JKSE variable had the highest mean in the pre-crisis period of 0.0079, while for the standard deviation it was highest in the period during the crisis, which was 0.0477, the lowest skewness value occurred full sample data of -0.7654. For the 5th percentile both the pre-crisis period and during the crisis the highest value is owned by the KLCI variable as well as the 95th Percentile where the highest value is owned by the JKSE variable. ARCH-LM statistics show a significant ARCH effect during the pre-crisis period in Most of the observation variables except the US market index while for the period during the crisis there are 4 variables that show significance over the ARCH effect, the four variables are JKSE, KLCI, STI and SP500.

All series depict positive kurtosis both during the pre-crisis period, and during the crisis. For skewness, all variables are negative except the STI variable at the time of the crisis period. When the skewness is negative it means indicating that in proportion, the country's market index has more weight in the *left tail.* after the crisis and the full period of observation, during that period we can see that the highest mean in the period after the crisis was owned by the US market index while the full period was

owned by the Indonesian market index. For standard deviations both during the period after the crisis and the full period the highest value is found in the variable N225. All observation variables of both developing and developed countries in the period after the crisis and the full observation period showed the effect of ARCH. All series describe positive kurtosis both during the period after the crisis, and the full period of observation. For skewness, all variables are negative except the STI variable in the aftermath of the crisis.

Table 2. Summary Statistics of (Pre Crisis, During Crisis,Post Crisis, Full Sample) Weekly Return

| | JKSE | PSEI | SET | KLCI | STI | FTSE | N225 | SP500 |
|---|---|---|---|---|---|---|---|---|
| ***Pre Crisis*** | | | | | | | | |
| Mean | 0,0079 | 0,0050 | 0,0035 | 0,0034 | 0,0038 | 0,0019 | 0,0024 | 0,0017 |
| SD | 0,0293 | 0,0284 | 0,0273 | 0,0180 | 0,0211 | 0,0171 | 0,0242 | 0,0167 |
| Skewness | -0,4083 | -0,1410 | -0,2321 | -0,4481 | -0,1745 | -0,2710 | -0,4093 | -0,1490 |
| Kurtosis | 5,9009 | 4,9565 | 3,2585 | 7,8764 | 4,3829 | 4,4655 | 3,4647 | 4,4089 |
| P5 | -0,0420 | -0,0410 | -0,0420 | -0,0210 | -0,0320 | -0,0255 | -0,0365 | -0,0285 |
| P95 | 0,0505 | 0,0460 | 0,0475 | 0,0285 | 0,0350 | 0,0265 | 0,04 | 0,0285 |
| ARCH-LM | 23.998*** | 17.813*** | 8.839** | 5.485** | 8.192*** | 24.532*** | 2.191* | 0,812 |
| Obs | 261 | 261 | 261 | 261 | 261 | 261 | 261 | 261 |
| ***During Crisis*** | | | | | | | | |
| Mean | 0,0004 | -0,0004 | -0,0001 | -0,0010 | -0,0007 | -0,0006 | -0,0021 | -0,0013 |
| SD | 0,0477 | 0,0414 | 0,0421 | 0,0254 | 0,0443 | 0,0419 | 0,0459 | 0,0418 |
| Skewness | -0,8619 | -0,6883 | -1,5662 | -0,5114 | 0,0315 | -0,8099 | -1,2545 | -0,3976 |
| Kurtosis | 5,8212 | 6,4802 | 11,2106 | 3,4770 | 5,8696 | 9,1539 | 9,4422 | 6,1645 |
| P5 | -0,081 | -0,069 | -0,063 | -0,045 | -0,056 | -0,068 | -0,066 | -0,068 |
| P95 | 0,075 | 0,060 | 0,059 | 0,034 | 0,053 | 0,057 | 0,055 | 0,062 |
| ARCH-LM | 8.05* | 0,007 | 0,007 | 6.841** | 7.882* | 0,315 | 1,758 | 6.909*** |
| Obs | 104 | 104 | 104 | 104 | 104 | 104 | 104 | 104 |
| ***Post Crisis*** | | | | | | | | |
| Mean | 0,0019 | 0,0020 | 0,0017 | 0,0005 | 0,0004 | 0,0008 | 0,0019 | 0,0023 |
| SD | 0,0214 | 0,0209 | 0,0199 | 0,0128 | 0,0176 | 0,0195 | 0,0263 | 0,0193 |
| Skewness | -0,5101 | -0,2639 | -0,3154 | -0,1152 | 0,0827 | -0,3892 | -0,4107 | -0,4985 |
| Kurtosis | 6,2558 | 4,2811 | 4,5239 | 4,6820 | 4,8179 | 5,2988 | 4,2442 | 4,8697 |
| P5 | -0,035 | -0,032 | -0,033 | -0,021 | -0,030 | -0,029 | -0,042 | -0,034 |
| P95 | 0,035 | 0,033 | 0,032 | 0,020 | 0,027 | 0,031 | 0,041 | 0,031 |
| ARCH-LM | 12.286*** | 8.134*** | 24.317*** | 25.135*** | 21.074*** | 12.324*** | 11.329*** | 20.787*** |
| Obs | 522 | 522 | 522 | 522 | 522 | 522 | 522 | 522 |
| ***Full Sample*** | | | | | | | | |
| Mean | 0,0035 | 0,0026 | 0,0020 | 0,0012 | 0,0013 | 0,0010 | 0,0016 | 0,0017 |
| SD | 0,0282 | 0,0264 | 0,0256 | 0,0164 | 0,0233 | 0,0227 | 0,0287 | 0,0225 |
| Skewness | -0,7654 | -0,4676 | -1,0015 | -0,4396 | -0,0560 | -0,8442 | -0,9287 | -0,6272 |
| Kurtosis | 8,9650 | 7,6447 | 11,8045 | 6,7798 | 10,6006 | 14,6286 | 9,6654 | 10,6147 |
| P5 | -0,041 | -0,039 | -0,040 | -0,024 | -0,037 | -0,031 | -0,047 | -0,038 |
| P95 | 0,045 | 0,041 | 0,041 | 0,027 | 0,036 | 0,032 | 0,043 | 0,032 |
| ARCH-LM | 77.883*** | 13.424*** | 66.375*** | 19.808*** | 110.078*** | 175.298*** | 59.007*** | 134.733*** |
| Obs | 887 | 887 | 887 | 887 | 887 | 887 | 887 | 887 |

Note: ***, **, * indicates the significance level at 0.01, 0.05, and 0.1 respectively.

## Spillover of Finance Center's Effect on Emerging Market

Tables 3 and 4 below will explain the analysis of the average spillover effect and volatility between stock market prices in developed countries (FTSE, N225 and SP500) and several developing countries in ASEAN (JKSE, PSEI, SET, KLCI and STI) in different time periods. In particular, the authors used the DCC-GARCH model to test the effects of stock market overflow from developed countries to emerging market countries. The results also show a Lambda value which means the shock effect exerted by the variable itself in the past.

Table 3. DCC-GARCH Coefficient and DCC Test Pre, During Crisis

| | Corellation FTSE | Corellation N225 | Corellation SP500 | Lambda 1 | Lambda 2 | DCC-Test |
|---|---|---|---|---|---|---|
| ***Pre Crisis*** | | | | | | |
| JKSE | 0.342*** | 0.450*** | 0.367*** | 0.002 | 0.963*** | 46. 769*** |
| PSEI | 0.421*** | 0.493*** | 0.402*** | 0.019 | 0.161 | 1 |
| SET | 0.446 *** | 0.446*** | 0.375*** | 0.004 | 0.952 *** | 33. 749*** |
| KLCI | 0.450*** | 0.421 | 0.373 | 0.004 | 0.961*** | 46. 769*** |
| STI | 0.597 *** | 0.649*** | 0.562 *** | 0.007 | 0.947*** | 27. 334*** |
| ***During Crisis*** | | | | | | |
| JKSE | 1.018** | 0.935*** | 1.128** | 0.0183 | 0.955*** | 56. 693*** |
| PSEI | 0.551*** | 0.680*** | 0.524*** | 0.0290 | 0.592 | 3.71 |
| SET | 0.644*** | 0.600*** | 0.570*** | 0.0166 | 0.0706 | 0.13 |
| KLCI | 1.004*** | 0.754*** | 1.095*** | 0.0228* | 0.942*** | 16. 480*** |
| STI | 3.090 | 0.397 | 3.587 | 0.0282 | 0.964*** | 27. 334*** |

Note: ***, **, * indicates the significance level at 0.01, 0.05, and 0.1 respectively.

The results of table 3 show that, before the crisis, the FTSE had a spillover effect on all emerging market stock markets. In addition, before the crisis, only the KLCI stock market was not affected by the N225 and SP500, however, the N225 stock market gave the strongest spillover effect compared to the FTSE and SP500. During the crisis, it was found that there was a significant change, where all financial center stock markets did not have a spillover effect on the STI stock market. At the time of the crisis the strongest influence was exerted by the US stock market, namely the SP500, of course this was not surprising because, the global financial crisis in 2008 originated in the US, where the crisis stemmed from bad loans experienced by companies or financial institutions that invested in the property sector.

Table 4. DCC-GARCH Coefficient and DCC Test Post Crisis and Full Sample

| | Corellation FTSE | Corellation N225 | Corellation SP500 | Lambda 1 | Lambda 2 | DCC-Test |
|---|---|---|---|---|---|---|
| ***Post Crisis*** | | | | | | |
| JKSE | 0.0843 | 0.152 | 0.134 | 0.00399 | 0.987*** | 15. 000*** |
| PSEI | 0.298 | 0.363 | 0.203 | 0.00422 | 0.989*** | 11. 000*** |
| SET | 0.428*** | 0.554*** | 0.512*** | 0.00453 | 0.986*** | 13. 000*** |
| KLCI | 0.330** | 0.418*** | 0.356*** | 0.00364 | 0.987*** | 15. 000*** |
| STI | 0.604*** | 0.613*** | 0.579*** | 0.0401** | 0.474* | 12.3*** |
| ***Full Period*** | | | | | | |
| JKSE | 0.359*** | 0.288** | 0.317*** | 0.00771*** | 0.986*** | 94. 308*** |
| PSEI | 0.411*** | 0.428*** | 0.372*** | 0.0287** | 0.0127 | 5.8* |
| SET | 0.465*** | 0.420*** | 0.462*** | 0.0119*** | 0.977*** | 78. 276*** |
| KLCI | 0.409 | 0.628 | 0.615 | 0.00605 | 0.992*** | 21. 000*** |
| STI | 0.591*** | 0.638*** | 0.548*** | 0.0148*** | 0.952*** | 88. 221*** |

Note: ***, **, * indicates the significance level at 0.01, 0.05, and 0.1 respectively.

Table 4 explains the conditions during the post-crisis period, where in the period after the crisis, changes occurred in JKSE and PSEI, where all finance center stock markets no longer have a spillover effect on the two stock markets (JKSE and PSEI), this indicates that slowly the stock markets of developing countries, especially JKSE and PSEI, are not too dependent on the stock markets of developed countries. In addition, the biggest spillover effect is no longer contributed by the SP500 stock market, this is due to the factors of the steady improvement of the financial sector in the US after the crisis. The most dominant stock market at the time after the crisis was held by N225, this is because the cooperation built in the economic field by ASEAN-5 countries is more leaning or greater with Japan (N225) so that it will have an impact on the stock market.

**Spillover Pattern Effect of Different Periods**

Tables 5 to 7 show the results of the t-test on different timelines, table 5 describes the per--iod before the crisis and crisis period, in addition to that also from the results of tables 5 to 7 it can also indicate that this study rejects or accepts the null hypothesis, which in the findings of this study found that there is an effect of transmission from the financial

center stock market to the emerging market ASEAN-5.

Table 5. DCC coefficient and spillover effect test Pre-Crisis, During-Crisis

| | Mean | | Varian | | t-*stat H0* = μPre-Crisis = μDur-Crisis |
|---|---|---|---|---|---|
| | Pre-Crisis | Hard-Crisis | Pre-Crisis | Hard-Crisis | |
| JKSE | 0,008 | 0,000 | 0,001 | 0,002 | 1,836** |
| PSEI | 0,005 | 0,000 | 0,001 | 0,002 | 1,422* |
| SET | 0,004 | 0,000 | 0,001 | 0,002 | 0,991 |
| KLCI | 0,003 | -0,001 | 0,000 | 0,001 | 1,868** |
| STI | 0,004 | -0,001 | 0,000 | 0,002 | 1,307* |
| FTSE | 0,002 | -0,001 | 0,000 | 0,002 | 0,834 |
| N225 | 0,002 | -0,002 | 0,001 | 0,002 | 1,214 |
| SP500 | 0,002 | -0,001 | 0,000 | 0,002 | 1,027 |

Note: ***, **, * indicates the significance level at 0.01, 0.05, and 0.1 respectively.

Table 5 explains that where the situation before and after the crisis, for emerging market countries, it was found that there was no pattern of spillover of the same effect devolved by finance center countries (JKSE, PSEI, SET, KLCI, STI, FTSE, N225 and SP500), the stock market that has the same pattern between before and during the crisis is only found on the stock exchange of Thailand stock market, the dependence of the emerging market stock on the finance center in the period before and during the current crisis because the emerging market stock still relies on investors, most of whom come from finance center countries, this also reflects that in the period when the stock markets were not too strong and became the main choice of investors. As the crisis stemmed from the financial center specifically the American stock market slowly began to release its dependence, this was evidenced by the mean value of all stock markets that were declining at the time of the financial crisis. Table 6 For periods describes the period during which a crisis occurred and the period after the crisis occurred.

Table 6. DCC coefficient and spillover effect test Dur-Crisis, Post-Crisis

| | Mean | | Varian | | t-*stat H0* = μDur-Crisis=μPost- Crisis |
|---|---|---|---|---|---|
| | Hard-Crisis | Post-Crisis | Hard-Crisis | Post-Crisis | |
| JKSE | 0,000 | 0,002 | 0,002 | 0,000 | -0,526 |
| PSEI | 0,000 | 0,002 | 0,002 | 0,000 | -0,886 |
| SET | 0,000 | 0,002 | 0,002 | 0,000 | -0,686 |
| KLCI | -0,001 | 0,001 | 0,001 | 0,000 | -0,936 |
| STI | -0,001 | 0,000 | 0,002 | 0,000 | -0,398 |
| FTSE | -0,001 | 0,001 | 0,002 | 0,000 | -0,558 |
| N225 | -0,002 | 0,002 | 0,002 | 0,001 | -1,218 |
| SP500 | -0,001 | 0,002 | 0,002 | 0,000 | -1,372* |

Note: ***, **, * indicates the significance level at 0.01, 0.05, and 0.1 respectively.

The test results as shown in the table above show that, in the crisis period and after the crisis, shows that there is a spillover effect from the finance center with the same pattern on the emerging market stock market, on conditions during a crisis of confidence or dependence on the finance center stock market does decrease, but at a time when global economic conditions begin to stabilize after the dependency crisis of all markets emerging market stocks against the finance center stock market are rising again, and are moving towards a positive correlation direction referring to their mean value. This is because during the post-crisis economic relations (import-exports) have increased, so that macroeconomically it will cause a positive correlation, meaning that any changes (increases) in the finance center market will also cause delinquency to the emerging market stock.

As we can see at the conditions of the period before and after the onset of the crisis, overall as shown by table 7, it is found that there is no spillover pattern of the same effect (there is a difference in pattern) devolved by the finance center countries, the stock market which has the same pattern between before and during the crisis is only found on the stock exchange of Thailand stock market.

Table 7. DCC coefficient and spillover effect test Pre-Crisis, Post-Crisis

| | Mean | | Varian | | t-*stat H0* = μPre-Crisis=μPost- Crisis |
|---|---|---|---|---|---|
| | Pre-Crisis | Hard-Crisis | Pre-Crisis | Hard-Crisis | |
| JKSE | 0,008 | 0,002 | 0,001 | 0,000 | 3,256*** |
| PSEI | 0,005 | 0,002 | 0,001 | 0,000 | 1,650** |
| SET | 0,004 | 0,002 | 0,001 | 0,000 | 1,085 |
| KLCI | 0,003 | 0,001 | 0,000 | 0,000 | 2,543*** |
| STI | 0,004 | 0,000 | 0,000 | 0,000 | 2,423*** |
| FTSE | 0,002 | 0,001 | 0,000 | 0,000 | 0,775 |
| N225 | 0,002 | 0,002 | 0,001 | 0,001 | 0,266 |
| SP500 | 0,002 | 0,002 | 0,000 | 0,000 | -0,332 |

Note: ***, **, * indicates the significance level at 0.01, 0.05, and 0.1 respectively.

**Spillover Pattern Effect of Different Indicators**

Table 8 shows the results of the t test or different tests on the same timeline or time period but with two different variables which in this result will explain the tendency of the ASEAN-5 stock market influenced by the Finance center stock market, and to see the dominance between the finance center stock markets against ASEAN-5.

Table 8. Spillover Effect Finance Center Pattern On Asean 5

| | Mean | Varian | t-*stat H0* = μ Asean5=μ FTSE | t-*stat H0* = μ Asean5=μ N225 | t-*stat H0* = μ Asean5=μ SP500 |
|---|---|---|---|---|---|
| ***Pre Crisis*** | | | | | |
| JKSE | 0,008 | 0,001 | 3,286*** | 3,051*** | 3,424*** |
| PSEI | 0,005 | 0,001 | 1,806* | 1,523 | 1,926* |
| SET | 0,004 | 0,001 | 0,916 | 0,631 | 1,012 |
| KLCI | 0,003 | 0,000 | 1,076 | 0,67 | 1,235 |
| STI | 0,004 | 0,000 | 1,631 | 1,114 | 1,732* |
| ***During Crisis*** | | | | | |
| JKSE | 0,000 | 0,002 | 0,230 | 0,603 | 0,394 |
| PSEI | 0,000 | 0,002 | 0,060 | 0,435 | 0,243 |
| SET | 0,000 | 0,002 | 0,130 | 0,538 | 0,312 |
| KLCI | -0,001 | 0,001 | -0,110 | 0,275 | 0,090 |
| STI | -0,001 | 0,002 | -0,010 | 0,468 | 0,212 |
| ***Post Crisis*** | | | | | |
| JKSE | 0,002 | 0,000 | 1,023 | -0,012 | -0,328 |
| PSEI | 0,002 | 0,000 | 1,205 | 0,110 | -0,191 |
| SET | 0,002 | 0,000 | 0,888 | -0,181 | -0,572 |
| KLCI | 0,001 | 0,000 | -0,379 | -1,265 | -2,002** |
| STI | 0,000 | 0,000 | -0,651 | -1,701* | -2,446*** |

Note: ***, **, * indicates the significance level at 0.01, 0.05, and 0.1 respectively.

Based on the results of the test, it can be seen that in the period before the crisis, there was no pattern of spillover effects shown between FTSE, N225, and SP500 against the JKSE stock market, and FTSE, as well as SP500 against PSEI, for the JKSE stock market it can be seen that the most influential stock market is SP500, as well as the PSEI stock market. As for STI, there are only differences in spillover patterns against SP500, while for the SET stock market, KLCI found the same pattern of spillover effect transmitted by the finance center stock market. As for the period of time during the crisis, all financial center stock markets provide contagion with the same pattern to the emerging market stock market, this looks very reasonable because where the crisis originated from the global financial crisis so that the emerging market stock was also affected together.

Based on the results in table 8, it was found that there were several significant relationships from the t-stat, which was obtained above 1.960 as in the pre-crisis JKSE, it affected FTSE, N225 and SP500 at a significance of 0.05. PSEI only affects FTSE and SP500 at a significance of 0.1. Meanwhile, STI only affects SP500 at a significance of 0.1. During the crisis, there was also influence from JKSE, PSEI, SET, KLCI and STI on FTSE, N225 and SP500 but not significant. After the crisis, it was found that the overall effect was negative. However, only a few significant ones, such as KLCI and STI, had a negative and significant effect

on SP500 at a significance of 0.05. The rest had a positive and negative effect but not significantly from JKSE, PSEI, SET, and KLCI on FTSE and N225.

## CONCLUSION

This study aims to test the existence of spillover effects between market indices of developed countries in several different regions from developing countries using the DCC-GARCH model which has several advantages over other models. The authors tested the contagion effect of the US sub-prime crisis on 5 emerging market indices with 3 developed market indices. The main finding of this analysis is that the authors found evidence of transmission from developed countries to developing countries during the observation period, this is in line with the results of research also found evidence of financial transmission from the US market to several other developing countries. From the results of the discussion above, researchers found several important results, namely that the spillover effect between the financial center stock market and the emerging market has varying results in the observation period. In the observation period referring to the results of the DCC test before the 2008 crisis, the strongest influence was given by the N225 stock market to the ASEAN-5 stock market, especially to the STI stock market with a correlation figure of 0.649 while at the time of the crisis the SP500 had the strongest influence, especially on the JKSE stock market with a correlation figure of 1,128 and the dcc test result of 56,693. At the time of the 2008 financial crisis, which originated from the American financial crisis, led to significant changes in the ASEAN 5 stock market, it was seen that the increasing influence or increase in the overflow effect exerted by the American stock market, namely SP500 and FTSE, the biggest impact at the time of the 2008 crisis was felt by the JKSE and KLCI stock markets.

For the results of testing with different periods, namely during the pre-crisis with the time of the crisis, it was found that there were differences in the pattern of transmission (Spillover) of the finance center to the emerging market stock, the same pattern was only found in the SET stock market, besides that also in the period before and during the crisis the finance center had a diminishing influence. For the period during and after the crisis, the spillover finance center effect on emerging markets has a repeating effect with the same pattern as providing an increasingly strong influence. Meanwhile, for the period before and after the crisis, it was seen that there were only differences in transmission pattern only in the KLCI and STI stock. Tests with different indicators found results, before the crisis found differences in transmission patterns from FTSE, N255 and SP500 to the JKSE stock market, and FTSE and SP500 to PSEI. As for the period during and after the crisis, on average, spillovers with the same pattern are found.

The findings of this study can be used by various parties, including the following: For international investors and portfolio managers because the high spillover effect during the observation period implies that the benefits of international diversification of these infectious countries are reduced, in the event of a crisis investors, especially investors investing in the ASEAN-5 region, should be aware of the movement of the crisis stemming mainly from finance center this is because the ASEAN-5 stock market is still very dependent on the movement of the finance center stock market. Policymakers in the event of a crisis must take protective policies to protect the ASEAN-5 stock market from capital outflows, meaning that policy makers must provide a sense of security to investors so as not to withdraw investments caused by the crisis, especially from the finance center. For academics, this research is expected to be a reference material if doing the research related to the stock market, and look at the volatility of stock market prices, suggestions for future research, if any to do research on the same theme, then exposure volatility as a more relevant option, because it is able to see the effect of volatility or volatility on the stock market over a long period of time, The suggested analysis model is to use the Bekk, Contaigon model which is still the same as the ARCH – GARCH clump..

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