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Unraveling Market Links: Modelling Downside Market Risk Transmission Between the US and ASEAN-5 Stock Markets

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Abstract: Given the recent strides towards globalization in the past decades, international markets are ever becoming more integrated. With this in mind, the paper aims to investigate the underlying links that bind and affect different stock markets across different countries - namely, the risk transmission mechanisms rooted between the US and ASEAN-5 stock markets. Through the cross-quantilogram function and vector autoregression (VAR), we examined extreme downside market risk spillovers, measured through a market index's Value-at-Risk, between the chosen stock markets. The results verify the existence of risk interdependency between the US and ASEAN-5 stock markets, with the US market movements having the greatest predictive power towards the other markets. Despite this, we also observed smaller yet significant effects from the ASEAN-5 stock markets transmitted to the US, implying the presence of the feedback effect. Lastly, initial results show that despite the quick response of the ASEAN-5 markets to US shocks, it takes a prolonged period of time for the shocks to be completely absorbed.

Key Words: ASEAN; Risk Transmission; Value at Risk; VaR for VAR, Cross-Quantilogram

1. INTRODUCTION

1.1 Background of the Study

Following the recent cases of financial contagion, studies looking to monitor financial interdependence and risk have been gaining traction amongst policymakers, market participants, and even the academe. Sarwar & Khan (2016) explained that globalization decreases diversification benefits because of increasing relationships between these markets causing similarities in the direction of their movement. Moreover, there exists market interdependency in developed capital markets that negatively affect equity returns in emerging markets. Thus, it is important for investors to consider how and to what extent risk spills from one market to another. Among the emerging capital markets, the Association of Southeast Asian Nations (ASEAN) is popular amongst investors due to the increasing economic activity in the region. This is quantified by large inflows of foreign investment fuelling pro-growth policies (J.P. Morgan, n.d.). Furthermore, its abundance in natural resources, strategic geographic location and robust growth make its capital markets just as attractive to foreign investors as Western stocks. These reasons encourage further analysis and research regarding the financial risk transmission between the ASEAN-5's capital markets.

Due to the increase of international trade and investments, there is a growing link between economies indicative of a market interdependence, which leads to a spillover effect - an economic phenomenon wherein risk is transmitted from one country to another implying a relationship between one or more economic variables between countries. This was primarily seen in the risk spillover that occurred during the 2008 global financial crisis where a domestic crisis in the US transmitted itself to major emerging stock markets. These spillovers negatively affected the capital markets, causing the downfall of many financial institutions. Understanding the implications of the spillover effect is important, especially for investors and institutions, who look to diversify amongst international stock markets (Salvatore, 2010).

The studies behind the transmission of risk also differ between the structural development of the countries involved. Several studies show that a country's economic power is directly correlated to its impact on its surrounding markets. Such phenomenon is studied by Ding, Huang, and Pu (2014) in their paper which analyzed the volatility linkages between the US, German, Swiss, European, and Japanese equity markets with the countries' respective implied volatility indices. This paper showed that the implied volatility index of the US (VIX) had the greatest impact on other indices of other countries indicating that the risk from the US equity market is a source of uncertainty for the other countries employed in the study.

Today, United States is known for being one of the biggest investors in Asia with trade estimating to around 200 billion US dollars (Acuna, 2016). The increase in globalization builds stronger relationship ties between different economies worldwide forming market dependencies and economic integration. Consequently. this leaves different markets at risk of a spillover effect, especially from a larger market to a smaller one. External economic shocks have an impact to different macroeconomic variables in an economy which can affect financial and investment decisions due to uncertainty in the stock market. This will then lead to amplified volatilities. Because of this, significant changes in Value at Risk of a developing country should be expected when an economic shock in developed countries occur and vice versa. However, since developed countries have the resources and the finances to protect themselves from external economic shocks, it can be predicted that risk transmitted to the US economy should be less than the impact felt by developing countries when there is a shock in the US. Additionally, the US should have quicker absorption of these shocks and should be back at the steady state with faster than that of the chosen ASEAN countries.

1.2 Scope and Objectives

Existing literature shows that financial contagion between the US and other developed markets are more prevalent and persistent compared to US and developing markets. This study aims to bridge the lack of literature on market interdependence between the developing and developed markets. Using various measures proposed by Shen (2017), White et al (2015), and Han (2016), this study aims to model the dynamic risk interdependency structure between the US and ASEAN-5 equity markets, specifically Malaysia, Indonesia, Philippines, Thailand, and Singapore. These countries were chosen for the study because of their status as the the top five performing countries based on the standards of the International Monetary Fund as of 2016. These countries were also chosen for its dominant participation in global trade based on the Global Enabling Trade Report of 2014 by the World Economic Forum (Jones, 2015).

Furthermore, the study would be focusing on the transmission of extreme market downside risk using the Value at Risk (VaR). Although market risk is commonly measured by volatility or the variation of

stock returns, a disadvantage of this measure of risk is that it treats gains and losses equally - despite investors having greater concern over losses. Moreover, volatility cannot sufficiently capture extreme market movements, which is important in analyzing periods of high price fluctuations. Thus, the use of VaR would be more effective in addressing the needs of investors that are more sensitive towards their losses over their gains.

2. METHODOLOGY

2.1 Data

The variables to be used consists of the daily closing stock market prices taken from the USA's S&P 500 Index, the Stock Exchange of Thailand (SET), the Singapore Straits Time Index (STI), the Indonesian Jakarta Stock Exchange Composite Index (JCI), the Philippines Stock Exchange Index (PSEI), and the Kuala Lumpur Stock Exchange (KLSE) of Malaysia from the Eikon Thomson Reuters database from the period of January of 2003 to December of 2018. The returns of these indices are then computed as:

$$r_{it} = ln(P_{it}/P_{i(t-1)}) * 100 \qquad \text{(Eq.1)}$$

where:
r_{it} = the indices (i) daily return (t)
P_{it} = the indices (i) closing prices (t)

2.2 Cross Quantilogram

Before characterising the downside risk market movements between the countries, we first confirm its existence through the use of Han's (2016) cross-quantilogram function - an extension of Linton and Whang's (2007) quantilogram. The quantilogram aims to measure and check the existence of directional probability for a given time series. This is accomplished through a test based on a correlogram of quantile hits, testing whether the past information set of a time series can predict whether it falls under the specified unconditional quantile or not. The cross-quantilogram provides an extension of this function, extending the process across two time series, measuring serial dependence and directional predictability from across conditional quantiles from one series to another. Directional dependence is also predicted by controlling information and using conditional quantiles. This function would be constructed by estimating the quantile hits and exceedance per quantile of the return series against the value at risk derived from the lowest 5% quantile of the respective distributions - after which, we construct the 95% confidence intervals using a stationary bootstrap procedure of 1,000 replicates. We apply this to test bidirectional causality between the US and the ASEAN-5 markets.

Results from this process confirm the existence of bidirectional tail-end causality between the US and ASEAN-5 indices, at the lowest 5% quantile. Consistent with findings of related literature, the US has a great impact on the ASEAN stock markets, exhibited by many significant lags over time. Albeit less apparent, numerous lags coming from ASEAN to the US are also seen, which indicate that the ASEAN-5 markets impact the US index as well. Findings suggest that there exists a greater effect of financial integration within these markets at the lowest 5% quantile. Thus, using Value at Risk - a measure of downside market risk, is not relevant but also appropriate to use to further characterise extreme downside market risk contagion between these markets.

2.3 Value at Risk

Despite the straightforward definition of the VaR, there exists many ways to compute for a portfolio's Value at Risk, thus identifying the most appropriate method is most crucial to accurately model market interdependencies. The methods in estimating such varies from the Historical Simulation method, to the Monte Carlo method, but the decision of which to use ultimately lies on the characteristics of the return distribution. A quick test on the return series reveals an ARCH effect within the distributions. This finding brings about the need of a filtering process in order to eliminate volatility clustering amongst the residuals. Without this procedure, conducting the following steps of the methodology on the unfiltered values would make the distributions prone to outliers, and therefore cannot be equally comparable to one another. Thus, an AR-GARCH (1,1) model is utilized in order to filter said residuals into a fully functional conditional distribution, fitted to the conditions of the upcoming steps in the methodology.

2.4 VAR for VaR

It has been previously confirmed by the cross-quantilogram function that bidirectional causality persists between the US and ASEAN-5 stock markets. This provides motivation to investigate the said relationship using the VAR for VaR model proposed by Halbert White, Tae-Hwan Kim, and Simone Manganelli (2013), which was utilized in order to investigate how extreme economic phenomena in one country can affect other financial institutions in another country, as well as to analyze VaR spillovers caused by system-wide shocks

specific to financial institutions. This paper utilizes White et.al's specialized iteration of the VAR for VaR model called the Multivariate Multi Quantile Conditional Autoregressive Value at Risk (MVMQ-CAViaR) model in order to simultaneously derive for each market's filtered VaRs, and to eventually see how these individually correlate to one another (2013).

The filtering process would be done by specifying the parameters of the original model's standard deviations in order to satisfy the restrictions in the AR-GARCH (1,1) process. Results from this procedure would then be used to manipulate the original model into the formal MVMQ-CAViaR model, which is specified by:

$$q_{1t} = c_1(\theta) + a_{11}(\theta)\left|Y_{1t-1}\right| + a_{12}(\theta)\left|Y_{2t-1}\right| + b_{11}(\theta)q_{1t-1} + b_{12}(\theta)q_{2t-1}$$
$$q_{2t} = c_2(\theta) + a_{21}(\theta)\left|Y_{1t-1}\right| + a_{22}(\theta)\left|Y_{2t-1}\right| + b_{21}(\theta)q_{1t-1} + b_{22}(\theta)q_{2t-1} \quad \text{(Eq. 2)}$$

where:
q_{1t}, q_{2t} = VaR series of the US and individual ASEAN-5 stock markets
Y_{1t}, Y_{2t} = return series of the US and individual ASEAN-5 stock markets
θ = confidence level

2.4.1 Pseudo Impulse Response Functions

The previous MVMQ-CAViaR process would then be used to construct the Pseudo Impulse Response Functions (PIRFs) which would allow us to characterize the tail dependency of one stock market to another, as well as to visualize how a one standard deviation shock to a country's VaR affects other markets. The PIRFs used in this paper differs from the regular impulse response functions because it assumes that the intervention variable only affects the current period, which offers an analysis focused towards the markets' response per quantile, making the process more practical than just generally estimating risk spillovers.

3. RESULTS AND DISCUSSION

After running the bivariate VAR for VaR model, Table 1 shows the coefficient results corresponding to the two equations of the MVMQ-CAViaR model that were used. The first line displays the responses of the US market to the ASEAN country. Inversely, the second line shows the responses of the ASEAN country towards shocks in the US economy. The coefficients a_{12} and a_{21} manifest the effects of the return series of one country to another while the values of b_{12} and b_{21} are indicative of the conditional quantiles of the Value at Risk.

Table 1. Estimates and standard errors for PH, VAR for VaR

Philippines				
c_1	a_{11}	a_{12}	b_{11}	b_{12}
-0.0722 (0.0392)	**-0.231* (0.0356)**	**-0.0041 (0.0222)**	**0.8954* (0.0183)**	**-0.037 (0.0264)**
c_2	a_{21}	a_{22}	b_{21}	b_{22}
-0.1965* (0.0664)	**-0.3237* (0.075)**	**-0.1934* (0.0458)**	**-0.1208* (0.0269)**	**0.7851* (0.0561)**

Table 2. Estimates and standard errors for ID, VAR for VaR

Indonesia				
c_1	a_{11}	a_{12}	b_{11}	b_{12}
-0.0436 (0.0245)	**-0.2375* (0.0466)**	**-0.0589 (0.0367)**	**0.8912* (0.0274)**	**-0.0427 (0.0241)**
c_2	a_{21}	a_{22}	b_{21}	b_{22}
-0.0932* (0.0314)	**-0.3226* (0.085)**	**-0.1956* (0.0644)**	**-0.1228* (0.0451)**	**0.8505* (0.0391)**

Table 3. Estimates and standard errors for MY, VAR for VaR

Malaysia				
c_1	a_{11}	a_{12}	b_{11}	b_{12}
-0.0259 (0.023)	**-0.2126* (0.0371)**	**-0.0683 (0.0616)**	**0.8993* (0.0242)**	**-0.0403 (0.0571)**
c_2	a_{21}	a_{22}	b_{21}	b_{22}
-0.0613* (0.0228)	**-0.14* (0.0359)**	**-0.2214* (0.0525)**	**-0.0324 (0.0269)**	**0.7949* (0.0639)**

Table 4. Estimates and standard errors for SG, VAR for VaR

Singapore				
c_1	a_{11}	a_{12}	b_{11}	b_{12}
-0.0801 (0.0694)	**-0.0513 (0.0871)**	**-0.1332 (0.0709)**	**0.5477* (0.1986)**	**-0.4589* (0.2218)**
c_2	a_{21}	a_{22}	b_{21}	b_{22}
-0.2187 (0.1219)	**-0.4435* (0.0502)**	**-0.0776 (0.0838)**	**-0.4039* (0.1286)**	**0.1808 (0.1965)**

Table 5. Estimates and standard errors for TH, VAR for VaR

Thailand				
c_1	a_{11}	a_{12}	b_{11}	b_{12}
-0.2081 (0.1357)	**-0.1158 (0.0621)**	**-0.0264 (0.0536)**	**0.6707* (0.1091)**	**0.3663 (0.1826)**
c_2	a_{21}	a_{22}	b_{21}	b_{22}
-0.2362 (0.1255)	**-0.3165* (0.091)**	**-0.1451* (0.0431)**	**0.0617 (0.1146)**	**0.6203* (0.1892)**

According to the results displayed at Tables 1 to 5, there exists at least one significant non-zero variable for the conditional quantiles of the Philippines, Indonesia, Singapore and Thailand, indicating tail interdependencies and the presence of risk spillovers between these ASEAN economies and the US. Out of all the ASEAN nations, only Singapore and Thailand have significant effects towards the US. However, Malaysia produced insignificant b_{12} and b_{21} showing no linkage between US and Malaysia in terms of their Value at Risk. Thus, the VAR for VaR model will be reduced to its normal form which is the CAVIAR model indicating that there is no tail interdependence with their conditional quantiles. At the same time, b_{21} of Thailand is insignificant; thus, Thailand financial market responds insignificantly to shocks in the US market. These are two counter-intuitive results, given that there are both diplomatic and economic ties between Thailand, Malaysia and the US. The shift in trade relationships from western to ASEAN countries brought about by the ASEAN integration initiative might explain the reason for the decreasing US spillover effects. For example, during Thaksin Shinawatra's previous term as the prime minister of Thailand, and Najib Rasak of Malaysia (2015), they both focused on building an Asia for Asians. Thus, focusing more on building relationships with China, Japan, India and EU with the aspiration of building an Asia for Asians (Chambers, 2004).

On the other hand, all a_{21} coefficients appeared significant while all a_{21} does not. This means that the US returns series of the VAR for VaR model have an effect on ASEAN countries, but the return series of the ASEAN countries does not. The results follow a priori expectations wherein ASEAN countries tend to follow US trends. It also follows the theoretical assumption that developed nations tend to have stronger impacts to developing economies.

Out of all the ASEAN countries being observed in this study, the Philippines and Indonesia are the two economies that showed significant coefficients for all variables under study. This implies that the VaR of the two countries heavily depend on both the international and domestic market information.

Analyzing the data with the results from the PIRFs, it is prevalent in all graphs how the US takes longer to absorb shocks from ASEAN nation than the other way around. And amongst all of these graphs, Singapore and Thailand exhibited relatively quicker shock absorption; further supported by the significant b_{12} coefficient found in tables above. A possible explanation for this difference is the strong economic standing of Singapore and Thailand's growing influence worldwide. In addition, the difference in the opening times of the two stock markets. ASEAN markets open earlier than the US market, therefore, having the ability to absorb it quicker than the US.

4. CONCLUSIONS

Given the different findings above, it is proven that there exists tail interdependency between the US, Indonesia, Thailand, Philippines and Singapore but not in Malaysia, as a result of having varying degrees in trading and interaction between the US and the ASEAN countries. The difference in degrees of impact can be seen in the different significance of the coefficients. Additionally, return series of ASEAN nations follows US trends, but does not follow under conditional quantiles. Upon further analysis of the IRFs, it has been observed how the US absorbs shocks slower than the ASEAN countries, as well, but with developed nations having stronger impact than developing countries. These findings support the previous literature about spillover effects but give a preview of the shifts in market dependencies. For example, Malaysia is exhibiting contrary expectations that might indicate a shift in market relationships between US and ASEAN nations.

Overall, the study of risk transmission is important to address risk spillover brought by globalization. Local government can have insights on how to reduce these negative impact through policies and regulation that avoids a contagion effect.

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6. REFERENCES

Acuna, R. (2016). ASEAN connectivity through trade and investment. Retrieved from https://asean.usmission.gov/wp-content/uploads/sites/77/2016/04/ACTI-OVERVIEW-Dec-2015_FINAL.pdf

Chambers, P. (2004). U.S.-Thai relations after 9/11: A new era in cooperation?. Retrieved from http://www.jstor.org/stable/25798704

Ding, L., Huang, Y. & Pu, X. (2014). Volatility Linkage across Global Equity Markets. Global Finance Journal. doi: 10.1016/j.gfj.2014.06.002

Han, H., Linton, O., Oka, T., & Whang, Y. J. (2016). The cross-quantilogram: measuring quantile dependence and testing directional predictability between time series. *Journal of Econometrics*, *193*(1), 251-270

Jones, M. (2015). Which ASEAN country is the top trader?. Retrieved from https://www.weforum.org/agenda/2015/04/which-asean-country-is-the-top-trader/

J.P.Morgan. (n.d.). ASEAN's bright future: Growth opportunities for corporates in the ASEAN region. Retrieved from https://www.jpmorgan.com/country/US/EN/cib/investment-banking/trade-asean-future

Linton, O., & Whang, Y. J. (2007). The quantilogram: With an application to evaluating directional predictability. *Journal of Econometrics*, *141*(1), 250-282.

Macaraig, A. (n.d.). ASEAN leaders launch single market community. Retrieved from https://www.rappler.com/world/regions/asia-pacific/113657-asean-declaration-community-2015

Sarwar, G., & Khan, W. (2016). The Effect of US Stock Market Uncertainty on Emerging Market Returns. Emerging Markets Finance and Trade, 53(8), 1796-1811. doi:10.1080/1540496x.2016.1180592

Shen, Y. (2017). International risk transmission of stock market movements. *Economic Modelling*, *69*, 220-236.

Salvatore, D. (2010). The Global Financial Crisis: Predictions, Causes, Effects, Policies, Reforms and Prospects. The Journal of Economic Asymmetries, 7(2), 1–20. doi:10.1016/j.jeca.2010.02.002

White, H., Kim, T. H., & Manganelli, S. (2015). VAR for VaR: Measuring tail dependence using multivariate regression quantiles. *Journal of Econometrics*, *187*(1), 169-188.'

7. APPENDIX

Fig. 1. Pseudo Impulse Response Functions