The Contagion Effect: A Case Study of China and ASEAN Countries

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ABSTRACT

This study aims to fill a gap in the current literature by studying dynamic and interdependent relationship among real economic sectors and financial markets with the country and across countries, and determining which channels of contagion are the most significant in transmitting crises among countries. The question of this research is to investigate whether the recent crisis have the fundamental effects, the contagion effects or through China market in the case of 2nd round effects on ASEAN economy.

This study attempts to answer the questions by multivariate methods using Vector Autoregressive (VAR), then, solve for the contagion effect. I implement the technique to study the propagation of shock across U.S. Euro China ASEAN stock markets and trade markets by identify the episodes of market turbulence analyzing the residual obtained from a reduced form VAR. The result reveals the existence of the financial contagion effect between US and ASEAN countries. The trade contagion effects among China and ASEAN countries can not conclusive. Impulse response analyses of both VARs models indicate that US economy has the most significant and influencing impact on China economy and ASEAN economy.

Keywords: Contagion effect, financial contagion, trade contagion, VAR.

1. INTRODUCTION

The issue of contagion has been one of the most interested topics in international finance. Contagion is an expression of the phenomenon that the crises or shock are spread to other countries which is borrowed from epidemiology where it's defined as transmitting a disease by direct or indirect contact. Hence, Financial Contagion refers to the transmission of a disease, that is, the shocks of the financial market in one country are transmitted to financial markets in other countries.

There are several studies that tried to explain the reasons of these financial setbacks and the mechanisms of their spread across the globe. The negative effects were induced by the subprime crisis may wonder about the existence of a contagion phenomenon across different financial markets worldwide. It is necessary to define the notion of contagion which remains hard and complex to identify. Indeed, contagion may be defined as the spread of markets' turmoils from one country to other financial markets. Economics literature succeeded in identifying several possible mechanisms causing the spread of turmoils from one market to another.

This study aims to fill a gap in the current literature by determining which channels of contagion are the most significant in transmitting crises among countries. The

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fundamental question of this research is how financial crises are transmitted into ASEAN's markets and what the main transmission channel that plays an important role for Thai economy is. Another question is how crises transmits to ASEAN economy, is that through China market in the case of 2^{nd} round effect which the contagion effect affects China economy and then ASEAN economy. This study attempts to answer the questions by performing the empirical tests.

Objective of the study

1. Investigating whether the recent crisis have the fundamental effects, the contagion effects or the 2^{nd} round contagion effects on Thai economy and ASEAN economy.
2. Examining further how the fluctuation in China can transmits the fundamental effects or contagion effects to ASEAN economy.

2. REVIEW LITERATURE

The empirical evidence for contagion focused on co-movements in asset prices rather than on excessive co-movement in capital flows or disturbances in real markets. It can divide into three categories. The first method, cross-market correlation, examines correlations among markets to find the evidence of large co-movements in a variety of asset return. The evidence of contagion is a marked increase in correlations among different countries' markets. Baig and Goldfajn (1998) also use this method to test for evidence of contagion by applying the VAR approach to isolate the magnitude of shocks that transmit cross-market in the currency and stock market of Thailand, Malaysia, Indonesia, Korea, and Philippines. The impulse response analysis shows that shock from one market rapidly transmits to other markets and become a source of instability of financial markets in this region. Secondly, Conditional probability, this method attempts to estimate the probability that other countries will be affected by a crisis given that one country has already experienced it. Eichengreen, Rose and Wyplosz (1996) work on this method by using a probit model and panel of macroeconomic data of ERM countries. Their results show that the occurrence of crises elsewhere increases the probability of facing crisis in particular country. Studies of volatility spillover are interested in estimating stock prices movements' volatility across markets. According to Park and Song (1999) tested volatility spillovers on foreign exchange rates during the Asian crisis by applying GARCH model and indicated that the effect of the Indonesian and Thai crisis has been transferred to the Korean exchange market. By using weekly data for 1994-1998 Edwards (1998) found that while increases in financial and currency volatility in Mexico had been transmitted into higher volatility in Argentina, they had not affected the conditional variance of Chile's nominal interest rates.

3.METHODOLOGY

Previous studies on contagion tended to focus on interactions and spillovers for a particular class of asset across countries, while other studies which examine interactions across asset markets tended to focus on these interactions in one state of the world, i.e. the non-crisis state. However, none of these studies have ever emphasized on contagion effects across regions. Therefore, this study employs multivariate methods using Vector Autoregressive (VAR) models to reveal the existence of contagion effects among China and ASEAN countries to test the hypothesis that "There exist contagion effects among

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China and ASEAN countries." Such an approach enables us to simultaneously estimate interdependence and contagion both within and across markets across economies.

This paper selects the set of variables which are the index of financial markets by using the trade between countries as an economic indicator. Monthly data of 12 endogenous variables and 2 exogenous variables are observed from January 1994 to December 2013 from *Datastream*. There are 4 variables of *stock market indices* which representing the financial sector of 4 regions (US, EU, China and ASEAN). There are 4 variables of *weighted-average of trade volume* which representing the real sector of 4 regions. There are 4 variables of the *coincident index* which representing the macroeconomic fundamentals of 4 region. There are 2 variables of the dummy variables for the Subprime crisis in 2007-2010 and for the Euro-debt crisis in 2010-2012. In order to answer the objectives of the study, this section present the implications of VAR models. There are Impulse Response Function (IRF) and Variance decomposition that are used to analyze the relationships among economic variable.

3.1. Impulse Response Function

An impulse response function (IRF) of a dynamic system is the results when imposing shocks into system. The IRF investigates the effects of shock to one endogenous variable onto the other variable in the system. In the case, the IRF describes the reaction of the system as a function of time.

The SVAR equation: $\mathbf{A_0X_t} = \mathbf{\Gamma_0} + \sum_{i=1}^{p} \mathbf{\Gamma_i X_{t-i}} + \mathbf{B\varepsilon_t}$

For simplicity, assuming $\mathbf{B} = \mathbf{I}$;

$$[\mathbf{A_0} - \mathbf{A}(\mathrm{L})]\mathbf{X_t} = \mathbf{\Gamma_0} + \mathbf{\varepsilon_t}$$

where $\mathbf{A}(\mathrm{L}) = \sum_{i=1}^{p} \mathbf{\Gamma_i} \mathrm{L}^i$, $\mathbf{L}$ is lag operator such that $\mathrm{L}^i\mathbf{X_t} = \mathbf{X_{t-i}}$, and assuming that $\mathbf{A_0} - \mathbf{A}(\mathrm{L})$ is invertible (non-singular matrix), then

$$\mathbf{X_t} = [\mathbf{A}_0 - \mathbf{A}(\mathrm{L})]^{-1}\mathbf{\Gamma_0} + [\mathbf{A}_0 - \mathbf{A}(\mathrm{L})]^{-1}\mathbf{\varepsilon_t}$$
$$\mathbf{X_t} = \boldsymbol{\mu} + \mathbf{D}(\mathrm{L})\mathbf{\varepsilon_t}$$

where$(\mathrm{L}) = [\mathbf{A_0} - \mathbf{A}(\mathrm{L})]^{-1} \in \mathrm{n} \times \mathrm{n}$, $\boldsymbol{\mu} = \mathbf{D}(\mathrm{L})\mathbf{\Gamma_0} \in \mathrm{n} \times 1$, $\mathbf{D}(0) = \mathbf{A}_0^{-1}$

$$\mathbf{X_t} = \boldsymbol{\mu} + \mathbf{D}(0)\mathbf{\varepsilon_t} + \mathbf{D}(1)\mathbf{\varepsilon_{t-1}} + \cdots + \mathbf{D}(\mathrm{s})\mathbf{\varepsilon_{t-s}}$$

Matrix $\mathbf{D}(0)$ is the impact multipliers. We interpret the generic matrix within the moving average as following, $\mathbf{D}(\mathrm{s}) = \frac{\partial \mathbf{X_{t+s}}}{\partial \mathbf{\varepsilon_t}}$

Thus, the element of matrix $\mathbf{D}(\mathrm{s})$ represents the impulse response function (IRFs). The accumulated effects of unit impulses in one of structural innovations are the summation of coefficients of the impulse response functions. To be able to obtain structural innovations from reduced form estimation, Restriction should be imposed to matrix.

3.2. Variance Decomposition

$$\mathbf{X_t} = \boldsymbol{\mu} + \mathbf{D}(0)\mathbf{\varepsilon_t} + \mathbf{D}(1)\mathbf{\varepsilon_{t-1}} + \cdots + \mathbf{D}(\mathrm{s})\mathbf{\varepsilon_{t-s}}$$

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The *s* period forecast value of $\mathbf{X_{t+s}}$, at time t is the same as the *s* period forecast value of $\mathbf{X_t}$ at time *t-s*. $\mathbf{X_{t+s}} = \boldsymbol{\mu} + \mathbf{D}(0)\boldsymbol{\varepsilon}_t + \mathbf{D}(1)\boldsymbol{\varepsilon}_{t+1} + \cdots + \mathbf{D}(s)\boldsymbol{\varepsilon}_{t+s}$

Taking the conditional expectation of $\mathbf{X_{t+s}}$: $\mathbf{E_tX_{t+s}} = \boldsymbol{\mu}$
The *s* period forecast error, $\mathbf{X}_{t+s} - \mathbf{E_tX_{t+s}}$:

$$\mathbf{X}_{t+s} - \mathbf{E_tX_{t+s}} = \boldsymbol{\mu} + \mathbf{D(0)}\boldsymbol{\varepsilon}_t + \mathbf{D(1)}\boldsymbol{\varepsilon}_{t-1} + \cdots + \mathbf{D(s)}\boldsymbol{\varepsilon}_{t-s}$$

$$\mathbf{Var}(\mathbf{X_{t+s}} - \mathbf{E_tX_{t+s}}) = \mathbf{E}(\mathbf{X_{t+s}} - \mathbf{E_tX_{t+s}})(\mathbf{X_{t+s}} - \mathbf{E_tX_{t+s}})'$$

$$\begin{bmatrix} \boldsymbol{\sigma}^2_{11}(\mathbf{s}) & \boldsymbol{\sigma}^2_{12}(\mathbf{s}) & . & . & . & \boldsymbol{\sigma}^2_{1n}(\mathbf{s}) \\ \boldsymbol{\sigma}^2_{21}(\mathbf{s}) & \boldsymbol{\sigma}^2_{22}(\mathbf{s}) & . & . & . & \boldsymbol{\sigma}^2_{2n}(\mathbf{s}) \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ . & . & . & . & . & . \\ \boldsymbol{\sigma}^2_{n1}(\mathbf{s}) & \boldsymbol{\sigma}^2_{n2}(\mathbf{s}) & . & . & . & \boldsymbol{\sigma}^2_{nn}(\mathbf{s}) \end{bmatrix} = \mathbf{D(0)ID(0)}' + \mathbf{D(1)ID(1)}' + \cdots + \mathbf{D(s)ID(s)}'$$

$$\mathbf{D}(0)\mathbf{ID}(0)' = \begin{bmatrix} \phi_{11}(0) & \phi_{12}(0) & . & . & . & \phi_{1n}(0) \\ \phi_{21}(0) & \phi_{22}(0) & . & . & . & \phi_{2n}(0) \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ . & . & . & . & . & . \\ \phi_{n1}(0) & \phi_{n2}(0) & . & . & . & \phi_{nn}(0) \end{bmatrix}$$

$\phi_{11}(0)$ is the share of forecast error variance of the first endogenous variable $\sigma^2_{11}(s)$ attributed to the structural innovation in period *t*. Hence, the variance decomposition determines how much of the forecast error variance of each of the variable can be explained by exogenous shocks to the other variables.

4. EMIPIRICAL RESULTS

This chapter consists of 3 major parts. The first part explains the process of finding the optimal lag length. The second and the third part reveal the results from VAR (Vector Auto Regressive), respectively. I divided the variables into three groups which are the group of financial market variable, the group of real market variable and the group of aggregate macroeconomic condition variable then analyzed each group by using VAR model. The results consist of the estimated Granger Causality, Impulse Response Functions (IRFs) and Forecast Error Variance Decomposition (FEVD).

4.1. Optimal Lag Length

For the Unite Root test, the results of testing each series using the Augmented Dickey Fuller (ADF) test. The results from ADF test at level reveal that all variables are stationary or non-unit root series. These endogenous financial variables are stationary when integrated offirst order, I(1), whereas trade variables and macroeconomic condi tion variables are stationary or I(0).

The appropriate lag length is determined by Information Criterion (IC) which Akaike Information Criterion (AIC) and Schwarz Bayesian Information Criterion (SBIC) are considered. For the AIC and SBIC approaches, the optimal lag length is the number of lags that yield the minimum estimated values of AIC and SBIC. Both are measurements of goodness of fit for the trade-off between the loss of degrees of freedom and the inclusion of the additional lag in the model.

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For the financial model, the optimal lag length for AIC is 1 lags, while the optimal lag length for SBIC is 0 lags (AIC = -12.3928, SBIC = -12.2949). AIC gives more superior results so the model with 1 lags is preferred. The stability test for VAR model is analyzed. The result show that all the eigenvalues of the financial market variables lay inside the unit circle. Therefore, the estimated VAR system satisfies stability condition.

For the real model, the optimal lag length for AIC is 3 lags, while the optimal lag length for SBIC is 2 lags (AIC = 13.4559, SBIC = 13.9908). The result from SBIC is consistent with the information that is SBIC always selects more economical model than AIC. Thus, SBIC with 2 lags is preferred. The stability test shows the eigenvalues of the real market lay inside the unit circle. Therefore, the estimated VAR system satisfies stability condition.

4.2. Financial market

4.2.1. Impulse Response Function

The impulse response function of China financial market to a shock on the US, EU and ASEAN financial market innovation has large fluctuations. A structural innovation leads to increase in China stock and occurs in 3-months continually. Cumulative orthogonalized impulse response function from US, Euro and China financial market to ASEAN financial market is stability within 4-5 months.

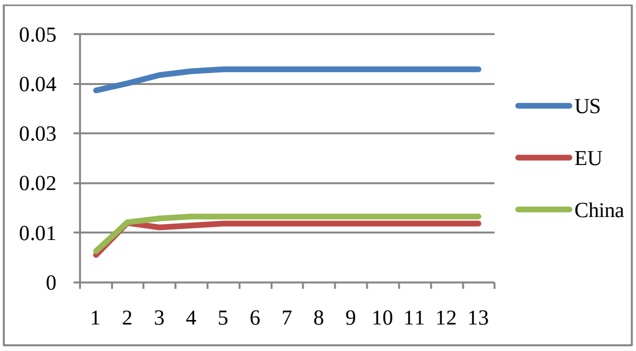

Figure 1: Cumulative Orthogonalized Impulse Response Function: From US, EU and China financial market to ASEAN financial market.

4.2.2. Variance Decomposition

The results from the forecast error variance decomposition (FEVD) of China financial market due to structural innovations use Choleski decomposition with the ordering US, EU, China and ASEAN financial market. On ASEAN financial market, the forecast error variance decomposition (FEVD) figure shows that the most effective to ASEAN is itself and the US real market is the second one.

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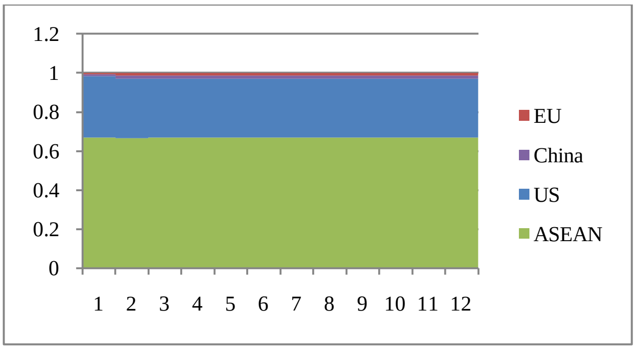

Figure 2: Forecast Error Variance Decomposition on ASEN financial market.

4.3. Real market and Macroeconomic condition

4.3.1. Impulse Response Function

The result is the same as VAR model with the impulse response function of ASEAN real market to a shock on the China real market, China and ASEAN macroeconomic condition innovation. A structural innovation leads a fluctuation in China real market and it occurs in 8-10 months continually, as show in figure 3.

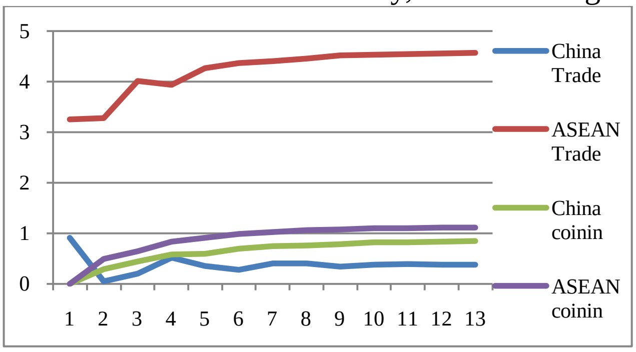

Figure 3: Cumulative Orthogonalized Impulse Response Function: From China real market, China ASEAN macroeconomics condition to ASEAN real market.

4.3.2. Variance Decomposition

Then, this figure shows the results from the forecast error variance decomposition (FEVD) of China, ASEAN real market due to structural innovations by Choleski decomposition. From the figure 4.27, the forecast error variance decomposition on ASEAN real market, the most effective to ASEAN is itself and the China real market is the second one.

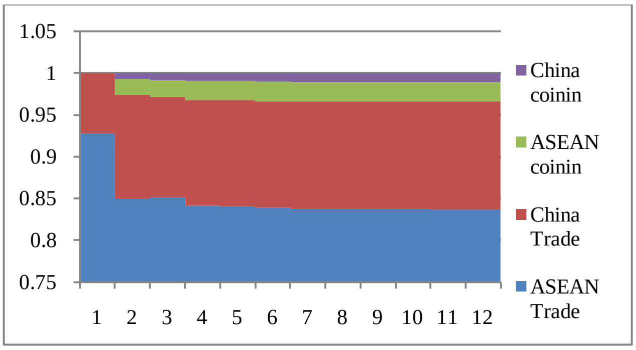

Figure 4.25: Forecast error Variance Decomposition on ASEAN real market.

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5. CONCLUSION

The results show that contagion effect from US and Eurozone can transmit through ASEAN by direct and indirect contact. The impact from US and Eurozone to financial market is quiet small compared to reality that we can observe. The reason is that pure contagion effect is not included into the model and the effect that we observed is only from fundamental-based contagion. But in real economy, there are the effects from US and EU pass to ASEAN directly and indirectly via China economy in significantly. And macroeconomic model explains in distinguishing the fundamental-based contagion and pure contagion from the overall contagion effect. It presents that two contagion effects exist.

Policy Implications

1. For ASEAN, the real market is the most important one. It easy to have more effect on real economy than financial market.
2. China is the country that has more influence on ASEAN real economy.
3. There are the effects that transmitted through China to ASEAN. By the way, there is the impact that transmitted directly to ASEAN.

Limitations and Suggestions

This study aims to apply the model in analyzing contagion effect in financial and real market. The paper has emphasized on contagion effects across regions which is China and ASEAN economy. In the analyzed, we can see that China's financial market is not related to other countries. Thus, in the financial market, it should be considered on other countries which Japan or Hong Kong to see more impact.

APPENDIX

Table 4.10: Cumulative Orthogonalized Impulse Response Function:From US, Euro and China financial market to ASEAN financial market

step	US	EU	China
0	0.038703	0.005225	0.006703
1	0.040321	0.011883	0.013024
2	0.039971	0.011347	0.013455
3	0.040231	0.011545	0.013608
4	0.040225	0.011563	0.013649
5	0.04023	0.011564	0.013654
6	0.040231	0.011566	0.013656
7	0.040231	0.011566	0.013656
8	0.040231	0.011566	0.013656
9	0.040231	0.011566	0.013657
10	0.040231	0.011566	0.013657
11	0.040231	0.011566	0.013657
12	0.040231	0.011566	0.013657

Source: Author's calculation

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Table 4.12: Forecast Error Variance Decomposition on ASEAN financial market

step	ASEAN	US	China	EU
0	0	0	0	0
1	0.669219	0.315565	0.009464	0.005752
2	0.666012	0.302441	0.01711	0.014436
3	0.66648	0.301934	0.017118	0.014468
4	0.66648	0.301924	0.017121	0.014475
5	0.666481	0.301923	0.017121	0.014475
6	0.666481	0.301923	0.017121	0.014475
7	0.666481	0.301923	0.017121	0.014475
8	0.666481	0.301923	0.017121	0.014475
9	0.666481	0.301923	0.017121	0.014475
10	0.666481	0.301923	0.017121	0.014475
11	0.666481	0.301923	0.017121	0.014475
12	0.666481	0.301923	0.017121	0.014475

Source: Author's calculation

Figure 4.16: Cumulative Orthogonalized Impulse Response Function (SVAR): From China real market, China aggregate macroeconomics condition and ASEAN aggregate macroeconomics condition to ASEAN real market.

step	China Trade	ASEAN Trade	China coinin	ASEAN coinin
0	0.906458	3.25783	0	0
1	0.048777	3.28507	0.288842	0.488038
2	0.203805	4.01421	0.446659	0.643787
3	0.51777	3.9386	0.579177	0.837284
4	0.352614	4.2661	0.588489	0.908245
5	0.270432	4.36468	0.699249	0.982642
6	0.407338	4.40384	0.74509	1.02756
7	0.397177	4.4565	0.760605	1.05782
8	0.341019	4.52047	0.788998	1.07718
9	0.375661	4.53015	0.815583	1.09414
10	0.393275	4.54391	0.821827	1.10447
11	0.371104	4.56643	0.82993	1.11131
12	0.374088	4.57458	0.84041	1.11702

Source: Author's calculation

Figure 4.16: Forecast Error Variance Decomposition (SVAR) on ASEAN real market.

step	ASEAN Trade	China Trade	ASEAN coinin	China coinin
1	0.928145	0.071855	0	0
2	0.849606	0.124651	0.019065	0.006678
3	0.850962	0.12073	0.020037	0.008271
4	0.841168	0.126715	0.02262	0.009496
5	0.840406	0.12743	0.02276	0.009404

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6	0.838985	0.127608	0.023114	0.010293
7	0.837577	0.12877	0.023222	0.010431
8	0.837532	0.128739	0.023283	0.010446
9	0.837312	0.128892	0.023297	0.010499
10	0.837177	0.128959	0.023314	0.01055
11	0.837151	0.128976	0.023321	0.010552
12	0.83712	0.129002	0.023322	0.010556

Source: Author's calculation

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