The effect of sub-prime crisis on select southeast Asian stock markets

Azahar, Nurshuhaida and Masih, Mansur

INCEIF, Malaysia, Business School, Universiti Kuala Lumpur, Kuala Lumpur, Malaysia

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Nurshuhaida Azahar[1] and Mansur Masih[2]

Abstract:The financial sub-prime crisis of USA in 2007-2008 was a contagion as it (within a short period of time) affected Europe within a short period of time. In Asia, particularly the East Asian countries were also affected financially. This is inevitable owing to the fact that these countries are financially connected to the USA. These Asian countries are vulnerable to credit, asset and investment bubble in the USA. As such, property and financial sectors as well as stock markets were greatly affected by the US crisis. This paper attempts to find out the effect of subprime crisis on 4 Southeast Asian countries' stock markets. Based on our Variance Decompositions (VDC) results, STI (Singapore) is identified as the most exogenous followed by KLCI (Kuala Lumpur). This is consistent with the findings that Singapore appeared to be a regional leader (Yang, Kolari and Min, 2002). JCI (Jakarta) is found to be endogenous and SET (Thailand) is the most endogenous. The small difference in the relative exogeneity between KLCI and STI implies that these two markets are highly integrated and that these markets tend to affect each other. Finally, for the investors, practitioners and decision makers, STI is the most leading index in the region and should subprime crisis affect STI, the effects are highly contagious.

Keywords: Sub-prime crisis, Southeast Asian stock markets, VECM, VDC

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[1] INCEIF, Lorong Universiti A, 59100 Kuala Lumpur, Malaysia.

2 **Corresponding author**, Senior Professor, UniKL Business School, 50300, Kuala Lumpur, Malaysia.

Email: mansurmasih@unikl.edu.my

1. OBJECTIVE AND MOTIVATION OF RESEARCH

The purpose of this research is to ascertain the extent of subprime (which occurred in the United States of America) impact on the regional stock market. It will also seek to find out which among the regional stock market has greater or lesser effect on the other markets through empirical studies. Finally, it asks the question; among the main indices in Malaysia, Thailand, Indonesia and Singapore, which is the most influential index.

Thus, the main research question of this paper is to determine the impact of subprime crisis to 4 regional stock markets. In order to arrive to such conclusion, this paper will also be able to ascertain whether these stock markets are co integrated. This study will also be able to determine which among the stock markets are the most influential and the least influential among themselves.

The variables that are used to represent equity markets are Kuala Lumpur Composite Index (KLCI), Jakarta Composite Index(JCI), Straits Times Index (Singapore) and Stock Exchange of Thailand (Thailand). The findings of this research would be helpful to investors to determine which particular index to refer to as a benchmark in estimating changes in investment returns.

2. LITERATURE REVIEW

There are numerous research works that have tested and found relations among stock markets globally and regionally.

Masih and Masih, (1999) found evidence that the stock market fluctuations in Southeast region are mostly influenced by the regional rather than the advanced or global markets. Cointegration studies that investigated long-run relationships focus on the extent to which nascent stock markets in Asian countries are internationally integrated and, in turn, have important implications to diversification potential in Asian stock markets (Chan, Gup, and Pan, 1992; Masih and Masih, 2001).

Jang and Sul (2002) studied whether the co-movements among a sample of Asian stock markets (i.e. Hong Kong Indonesia, Japan, Korea, Singapore, Taiwan and Thailand) changed as a consequence of the 1997 financial crisis. By using the Engle-Granger cointegration test, these authors found that cointegration characterized only a small number of countries. However, after the crisis the number of cointegrated stock markets increased dramatically. Unfortunately, their work does not explain why the financial crisis should have increased integration among these markets.

Ratanapakorn and Sharma (2002) investigated how short- and long-run relationships changed across five regional stock markets for the pre- and post 1997 Asian crisis. Results show that no long-run relationships characterized their relationship before the Asian crisis, whereas some evidence of integration was observed after the crisis. The main conclusion is that the Asian crisis increased integration among these markets. This supports the time varying integration suggested by Bekaert and Harvey (1995).

Subramanian (2008) examines the long-term equilibrium relationship among the five major East Asian five major stocks i.e Shangai Stock Exchange, Tokyo Stock Exchange, Osaka Stock Exchange, Hong-Kong Stock Exchange and Korean Stock Exchange from January 4, 2000 to August 22, 2008. By employing co-integration and error-correction method the author finds that the price indices of the five markets are co-integrated. This implies that these indices are perfectly correlated in the long run and diversification among these five equity markets cannot benefit international portfolio investors. However, he agreed there could be excess returns in the short run.

Janor Ruhani Ali (2007) focuses studies on five major ASEAN economies namely; Malaysia, Singapore, Indonesia, Philippines and Thailand and using US, Japan and World market proxy for global market. The author finds out that some of the ASEAN markets are both regionally and globally integrated. This suggests that they are not completely segmented by national borders. However, based on her studies, the integration is not fully complete, thus suggesting some diversification benefits in these markets.

Daly (2003) studied the interdependence of the stock markets of Southeast Asian (Indonesia, Malaysia, Philippines, Singapore and Thailand) and the advanced stock markets of Australia, Germany and the United States (US). The author found mixed results on the effect of financial crisis. It was found that based on the bivariate cointegration test, there was one cointegrating vector over both the pre- and post-1997 crisis periods. In addition, the correlation analysis indicates that the majority of

stock markets in the study became more integrated after the October 1997 crash.

Lim L.K. (2009) found evidence consistent with past studies where the US market returns are found to have significant influence on the returns of all ASEAN-5 (Indonesia, Malaysia, the Philippines, Singapore and Thailand markets). Furthermore, subsequent to the 1997 financial crisis, ASEAN-5 markets were also affected by the terrorist suicide attacks upon the U.S. on September 11, 2001 which caused a sharp fall in global market indices. The author has also found out the Singapore market was more affected by the 9/11 attacks than the other ASEAN-5 markets.

Yang, Kolari and Min (2002) suggests that in general, both long-run cointegration relationships and short-run causal linkages among Asian markets strengthened during the financial crisis and that these markets have generally been more integrated after the crisis than before the crisis. The authors agreed with the previous findings of Bekaert and Harvey (1995) that the degree of integration among countries tends to change over time, especially around periods marked by financial crises. Secondly, the US exerted substantial influence on most Asian stock markets while Japan had little or no impact on most markets in the region except during the crisis period. The most interesting finding from their research is that Singapore, instead of Hong Kong appeared to be a regional leader.

3.0 RESEARCH METHODOLOGY, RESULTS AND INTERPRETATION

This study has adopted a time series technique, ranging from co integration, vector error correction model, and variance decomposition in order to test the long run relationship, causality and the relative degree of causality among the variables. This is a more preferable method over traditional regression for the very reason that these financial variables are non stationary. On the other hand, traditional regression assumes all variables are stationary and thus by removing the non stationary variables (in a differenced form), the theoretical part of the variables will be removed. This will defeat the objective of this paper to determine whether the variables are moving together in a long run. In other words, regression cannot test long term relationship among these stock markets.

Secondly, traditional regression cannot determine causality among variables. The endogeneity or exogeneity of variables is assumed and pre determined by the researchers on the basis of established theories. Cointegration time series model does not assume variable's endogeneity or exogeneity. This model essentially determines such causality based on data testing.

The data used in this research are the weekly closing of major stock indices of 4 South East Asian countries; Malaysia, Indonesia, Singapore and Thailand in the period of 1st Jan 2006 to 31st December 2010. Based on the author's observation, the subprime crisis was at its worst between July 2007- November 2008 (*Subprime Crisis Impact Time Line*, Wikepedia), when the US Federal Reserve pledges $800 billion more to

help revive the financial system. Weekly data is preferable since daily data might contain “too much noise” (Bailey and Stulz,1990) and monthly data could be highly seasonal in this case (Roca et al., 1999).

3.1 TESTING STATIONARITY OF VARIABLES

The first step employed by the author is to test the data collected in order to determine whether these data are non stationary. Non stationary data means the means, variances and co variances of these variables are changing. As such, the variables should be in their original level form and then only their differenced forms (stationary data) are created by taking the difference of their log forms. We adopted Augmented Dickey-Fuller (ADF) test for each variable. ADF is preferred over DF for it takes care of autocorrelation function. In this study, the results of such tests are summarized in the table below:

Table 1(a): Variables in Level Form

Variable	Test Statistics	Critical value	Implication
LKLCI	- 1.0597	- 3.4325	Variable is non stationary
LJCI	- 1.5008	- 3.4325	Variable is non stationary
LSTI	- 1.3561	- 3.4325	Variable is non stationary
LSET	- 1.0288	- 3.4325	Variable is non stationary

Table 1(b): Variables in Differenced Form

Variable	Test Statistics	Critical value	Implication
DKLCI	- 4.9272	- 2.8756	Variable is stationary
DJCI	- 4.1659	- 2.8756	Variable is stationary
DSTI	- 4.8113	- 2.8756	Variable is stationary
DSET	- 4.5267	- 2.8756	Variable is stationary

Based on the ADF test, the results showed that the variables in their level forms are non stationary and the differenced forms are stationary. Thus, we can proceed to co integration test.

3.2 DETERMINATION OF THE ORDER OF THE VAR MODEL

In order to test whether there is any co integration among these variables, we would first have to determine the best order of lags/vector auto regression (VAR). The results are summarized in the table below. While AIC focuses on predicting the best order of lags, it is less concerned on over parameter. It tends to choose higher order of lag. We shall accept the lag with the maximum value of AIC. SBC on the other hand, is more concerned on over parameter and tends to choose lower order of lag. We shall accept the order of lag with the minimum value of SBC.

The results are summarized as follows:

Table 2 (a): Best Order of VAR

	AIC	SCB
Optimal Order	4	6

Based on these results, AIC recommends 4 and SBC recommends 6 being the best order of lags. Given this conflict, we shall then refer to the adjusted LR test value and discover that 4 is the best order of lag selected by this model (based on the p-value of 42.7%, which is more than 10%). As such we accept the null hypothesis that the lag is in that order (4).

Nevertheless, in order to verify this order of lags, we shall check for serial correlation for each variable and the results are as in Appendix 2B-2F. As evident in the summarized results shown in the table below;

Table 2(b):

Variable	Chi sq p-value	Implication (at 10%)
DKLCI	0.0398	There is a serial correlation
DJCI	0.7627	There is no serial correlation
DSTI	0.7646	There is no serial correlation
DSET	0.1064	There is no serial correlation

From the above results, there is auto correlation in 1 out of 4 variables. Hence, if we adopt higher order, we may encounter the risk of over

parameterization. In our case, considering the trade-off lower and higher orders, we decided to choose the lower order of VAR 2.

3.3 TESTING CO INTEGRATION

Based on the results of step 1 and 2 in the above, we have determined that the variables are in the non stationary forms and the optimal order of VAR is 2. The variables are fit for the co integration test. Co integration tests aim to avoid "spurious regressions", and show valid *long term equilibrium* relationships (Granger 1986). The results are summarized as follows.

Table 3: Cointegration Test Results

Criteria	Number of cointegrating vectors
Maximum Eigenvalue	1
Trace	1

Based on the Maximal Eigenvalue and Trace value, we found out that there is 1 cointegration vector. There are established findings based on the literature reviews made by the author that stock markets are generally integrated. In other words, the performance of one market, to some degree may have an effect on other markets. As such, for the purpose of this study, we shall assume that there is one cointegrating vector.

Indeed, based on the results, these stock markets move together in a long run. In other words, these 4 indices are theoretically related. The economic

implication of financial market integration helps investors to make informed judgments in the allocation of their capital investment for the purpose of risk diversification. However, given the fact that these 4 indices are cointegrated; the investors' opportunity to make abnormal gains through diversification is limited. The reason being, eventually, these 4 indices would realign themselves into a long term relationship with one another.

3.4 LONG RUN STRUCTURAL MODELLING (LRSM)

The ultimate function of LRSM is to test the co efficient of variables against theoretical expectation. In order to do so, we normalize the variable of interest in an exact-identifying test, in this case, KLCI (A1=1). The result of exact-identifying is as in Appendix 4. Calculating the t-ratios (mean/standard deviation), the results are summarized below.

Table 4(a): Exactly-Identifying Test

Variable	Coefficient	Standard Error	T-ratio	Implication
LKLCI	- 1.00	None		Normalization
LJCI	- 0.0430	0.2732	- 0.16	Variable is insignificant
LSTI	0.1850	0.3673	0.50	Variable is insignificant
LSET	- 0.7543	0.4434	1.70	Variable is significant
Trend	0.5260	0.6528	0.81	Variable is insignificant

Based on the above results, it is a surprise to note that none of the other markets is significant. We then decided to verify the significance of the variables by subjecting them to over-identifying restrictions and the results are summarized below. When we made over-identifying restrictions all at once, (that is to test the null hypothesis that JCI, STI SET and Trend are insignificant), the null hypothesis is rejected. Instead, when we drop SET from the over-identifying restrictions, the null hypothesis (JCI, STI and Trend are insignificant) cannot be rejected. For details, refer to Appendix 4B.

Based on the result of over-identifying, it confirmed the earlier findings that JCI, STI and Trend are insignificant. However, SET was found to be significant despite our earlier result showed that its t-ratio was less than 2. Applying our intuition, we are more inclined to believe that SET is significant. We based our intuitive findings on the contagious effect theory. Malaysia and Thailand are located near to each other and are within the Southeast Asia region. In addition, Malaysia shares some partnerships with Thailand in the political, economic and business sectors. Thus, in our opinion, any crisis that occurred in Malaysia could bring about a contagious effect in Thailand.

The equation derived from these tests is as follows;

1 *LKLCI – 0*LJCI + 0*LSTI -0.6292 *LSET + 0*Trend

3.4 VECTOR ERROR CORRECTION MODEL (VECM)

The cointegration test merely determines whether the variables are theoretically related in a long run. It does not however establish the causality

among the variables (that is which index is the leading variable and which is the laggard variable). This information is useful to investors particularly to forecast the expected return of their investment. An exogenous variable would have a significant bearing on the other indices. As such, investors would be able to predict their return based on the performance of this leading index.

Based on VECM, we are able to ascertain which among these variables are exogenous and endogenous. VECM examines the error correction term (ECT) (e) for each variable. If such ECT is significant (the t-ratios is more than 2 or the p-value is less than 10%), it means that the ECT has a significant effect on the variable. As such, we can conclude that such variable is endogenous (follower) and vice versa. From our observations, KLCI and STI are identified as exogenous variables while JCI and SET are endogenous variables. Our findings are summarized as follows;

Table 5: VECM Results

Variable	ECM(-1) t-ratio p-value	Implication
LKLCI	0.934	Variable is exogenous
LJCI	0.070	Variable is endogenous
LSTI	0.703	Variable is exogenous
LSET	0.000	Variable is endogenous

Thus, the indices of interest of investors are; KLCI and STI. These indices, (if affected by any crisis) would transmit the effects of those crises to

other indices. The results are consistent with the previous findings that some Asian stock indices are substantially influenced by the USA (Lim L.K, 2009; Yang, Kolari and Min, 2002). Upon receipt of such shocks, these exogenous indices shall transmit the effects of those shocks to other indices. Since these 4 regional indices are cointegrated, contagious effects of any shocks are hard to avoid. The fact that there are more than 1 exogenous variable in our study, the possibility of one index (being subjected to the US subprime crisis) would inevitably affect the others.

VECM is also able to tell us how long for a variable will take to get back to long term equilibrium if that particular variable is shocked. For an example, the co efficient of JCI is 0.10. This implies that should any shock is applied to JCI, it would take (1/0.10) 10 weeks to return to the state of equilibrium with other indices.

3.5 VARIANCE DECOMPOSITION (VDC)

With reference to VECM results, KLCI and STI are identified as the exogenous variables while JCI and SET are identified as the endogenous variables. VEC could not ascertain which is among the exogenous variables are the most exogenous and least endogenous among the endogenous variables. VDC however, is able to tell us about the relative degree of exogeneity or endogeneity of variables by forecasting the error variance of

each variable into proportions (attributable to shocks to each variable in the equation including its own).

We applied the Generalized VDC instead of Orthogonalized VDC. It is due to the fact that Orthogonalized VDC has two limitations. Firstly, Orthogonalized assumes that when a particular variable is shocked, all other variables are 'switched off'. Secondly, it does not produce a unique solution for the generated numbers are depending on the ordering of variables. For an example, since KLCI is placed higher in the variables' ordering than STI, then there might be a possibility that KLCI could be more exogenous than STI as the first variable would be given higher percentage than the latter. This could lead to a biased result.

Therefore, considering the shortcomings of Orthogonalized VDC, we shall then adopt Generalized VDC. The forecast horizon is fixed at 30 weeks. The results are summarized below.

Table 6: VDC Results

Shocks	LKLCI	LJCI	LSTI	LSET
LKLCI	98.88 (42.02%)	46.78 (19.88%)	56.19 (23.88%)	33.46 (14.22%)
LJCI	75.83 (29.71%)	85.76 (33.61%)	64.17 (25.14%)	29.44 (11.54%)
LSTI	50.04 (22.14%)	43.82 (19.38%)	99.26 (43.92%)	32.89 (15.88%)
LSET	89.50 (35.86%)	49.55 (19.85%)	60.94 (24.42%)	49.60 (19.87%)

According to these results, the ranking of indices by degree of exogeneity is as per table below;

No.	Index
1.	STI
2.	KLCI
3.	JCI
4.	SET

Based on the above results, STI is identified as the most exogenous followed by KLCI. This is consistent with the earlier findings that Singapore appeared to be a regional leader (Yang, Kolari and Min, 2002). JCI is the least

endogenous and SET is the most endogenous. The small difference in the relative exogeneity implies that KLCI and STI are highly integrated and that these markets tend to affect each other. Finally, for the investors, STI is the most influential index in the region and should subprime crisis affect STI, the effects are highly contagious.

3.6 IMPULSE RESPONSE FUNCTIONS (IRF)

IRF produces the same information as the VDCs except that the information is represented in graphical forms. Refer to Appendix 7 for details.

3.7 PERSISTENCE PROFILE (PP)

PP illustrates a situation where the entire cointegrating vector is shocked and indicates the time it would take for the whole system to get back to the state of equilibrium. It traces about the effect of a system-wide shock on the cointegrating vector unlike IRFs that traces the effect of a variable-specific shock on the long run relations. The chart in Appendix 8 indicates that it would take approximately 25 weeks for the cointegrating vector to return to the state of equilibrium following the system-wide shock. For details, refer to Appendix 8.

4 CONCLUSION

In conclusion, based on the above quantitative analysis, it was found that these 4 indices are cointegrated. It supports the theory that Asian indices tend to integrate after 1997 financial crisis. More even so, it appeared in our analysis these 4 indices are cointegrated during the US subprime crisis between 2007-2006.

Among these variables, STI has been identified as the most exogenous index in the region followed by KLCI. This also supports the earlier findings that STI is the regional leader. Relying on the findings that Singapore was more affected by the terrorist suicide attacks upon the U.S. on September 11, 2001 (Lim L.K, 2009), it is assumed that the subprime crisis would also have greater impact on Singapore than other Asean countries. It has also been reported that Singapore was the first East Asian country to fall into a recession from the current global economic crisis after July 2008. This clearly reflects the greater vulnerability of the Singapore economy to global economic shocks. (East Asia Forum, January 5th, 2009). The reason being; while Singapore's exposure to subprime loans is limited, US and Europe are the Singapore's key importers (accounting for nearly 33 per cent of the total non-oil exports over the last few years).

Thus, any crisis in those countries would have significant effect on Singapore. This would eventually hurt the Singapore's stock market. True enough, based on our raw data observations, STI was greatly affected by the US subprime crisis. It appeared that on 1-12-2006 (1st observation) the point recorded was 2766.07. However, the index point has substantially decreased to 1600.28 on 24-10-2008

(102nd observation). Since Singapore is the most influential regional index, any shock applied to STI would inevitable affect the whole region (including other 3 indices). This is based on the contagious effect theory. In fact, our data observations support the conclusion that the US subprime crisis (2007-2008) has significantly affected all 4 regional indices based on substantial decrease of index points during the crisis.

5 LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

Our observations are not supported by the direct changes in the US stock market but merely relying on the time line of the subprime impact. US Stock market could be represented by NYSE. It would be very helpful for future research to examine whether there is cointegration among these regional indices and US stock markets before, during and after the subprime crisis. If it does, to what extent the subprime crisis had affected these indices by using NYSE as the proxy and not merely based on the subprime time line.

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