GLOBAL STOCK PRICE LINKAGES AROUND THE US FINANCIAL CRISIS: EVIDENCE FROM INDONESIA

Aldrin Herwany, Universitas Padjadjaran, Indonesia
Erie Febrian, Universitas Padjadjaran, Indonesia

ABSTRACT

Monetary authorities in Indonesia, as well as some academicians believe the absence of a long run relation between the Indonesian stock market and developed markets prevents this emerging market from being deeply affected by the US downturn. Nevertheless, this hypothesis may not apply to the domestic financial industry as these firms are involved in cross-country financial investments. This study examines the global linkage of Indonesian Financial Sector stock prices during the US downturn using co-integration tests and vector autoregression. This study examines linkages between the Indonesian Financial Industry with the same industry in the US, UK and four developed Asian markets, i.e., Tokyo, Hong Kong, Singapore, and Kuala Lumpur stock exchanges. We also conduct tests using pre-US-crisis data to show the linkage change magnitude. We find that financial sector stock prices in the Indonesian market are cointegrated with the six observed markets before and during the crisis. Nevertheless, Indonesian financial stock prices are relatively invulnerable to pressures coming from other observed markets Thus, fund managers can gain diversification benefit from a portfolio containing financial industry stocks of these markets either in the long or short run.

JEL: G01, G11, G15

KEYWORDS: Financial Sector, Financial Crisis, Market Co-integration

INTRODUCTION

Around the US financial crisis, global financial markets experienced tight liquidity, and international USD-based capital returned to the US, strengthening the USD against all world currencies. The reversing capital triggered a sharp decline in many stock markets, especially emerging markets like the Indonesia Stock Exchange (ISX). In October 2008, ISX index fell to 1,111.39 and suffered a significant market capitalization decrease by IDR 453 trillion. To avoid further contagious impact on domestic banking and financial industries, monetary authorities in Indonesia enacted some policies. For the banking industry, authorities raised the deposit insurance ceiling from IDR 100 million to IDR 2,000 million. The authorities also issued policies to govern the stock market, including a short-selling transaction ban, trading suspension, and lower-limit auto-rejection. The banking industry policy has been effective in maintaining public trust and preventing bank runs. However, that was not the case in the stock market. The ISX index declined by 31.4% month-to-month in October 2008. The daily transaction value dropped by 35%-50% during October 2008.

The US crisis also put significant pressure on Indonesian bonds. Despite showing conducive fundamentals like a low expected inflation rate and well controlled fiscal circumstances, SUN (Indonesian Government Bond) lost its financial attractiveness in all tenures. According to the monthly Bank Indonesia report, asymmetric buy-sell pressure on the bond made price in some series not well formed. The average SUN yield in all tenures was 17.14% (end of period), which was higher by 432 bps than that of previous month (September 2008). Thus, the high-low yield spread increase in 2008 was 12.23%.

In the second quarter of 2009, the ISX seemed to slightly recover. The Indonesian central bank reported that foreign investors recorded net buying of USD 501.63 million. About 37% of foreign cash inflow

(USD 3.18 billion) was invested in a stock portfolio. Meanwhile, yield spread between Indonesian government bonds and that of the US Treasury was the highest in Asia, which made the bond relatively attractive in the market. Foreign cash inflow allocated with the bond was USD 748.33 million.

These facts show the early recovery demonstrates the absence of a long run relation between the Indonesian stock market and developed markets. However, it is expected that such a relationship may be different in the financial sector. Financial investments are borderless transactions. Investors, portfolio managers, and policy makers expect to deal with cross-country financial investments, which lead to highly cointegrated financial markets worldwide. This paper identifies the linkage between the Indonesian Financial Industry with the same industry in US, UK markets and four developed Asian markets, i.e. Tokyo, Hongkong, Singapore, and Kuala Lumpur stock exchanges. The analysis uses time series data. Also, the study investigates the linkage among the observed markets.The rest of the paper is organized as follows. The next section provides a brief discussion of the relevant literature on cointegration studies and on linkage of markets. Section 3 provides a description of the data used and methodology adopted in this study. Section 4 discusses the results, while Section 5 concludes the paper and provides suggestions for future study**.**

LITERATURE REVIEW

Academicians, practitioners and decision makers seek a model that can prove linkages across financial markets, especially between developing and developed markets. The model provides them better perspectives on market movements. In doing so it allows them to appropriately manage their assets and the respective derivatives, as well as to diversify the associated portfolio risks. Cointegration analysis is the most popular method used by academicians and stock market researchers in developing such a linkage model. Cointegration analysis was introduced by Granger (1981), Engle & Granger (1987), and Granger & Hallman (1991). The analysis shows regular stochastic tendencies in financial time series data and is useful for long-run investment analysis. The analysis considers the integrated I(1) − I(0) type of cointegration in which linear permutations of two or more I(1) variables are I(0) (Christensen & Nielsen, 2003). In the bivariate case, if y_t and x_t are I(1) and hence nonstationary (unit root) processes, but there exists a process e_t which is I (0) and a fixed β such that : $y_t = \beta' x_t + e_t$, then x_t and y_t are defined as cointegrated. Thus, the nonstationary series shift together in the sense that a linear permutation of them is stationary and therefore a regular stochastic trend is shared.

Granger & Hallman (1991) prove that investment decisions merely-based on short-term asset returns are inadequate, as the long-term relationship of asset prices is not considered. They also show that hedging strategies, developed based on correlation, require frequent rebalancing of portfolios, whereas those developed strictly based on cointegration do not require rebalancing. Lucas (1997) and Alexander (1999), using applications of cointegration analysis to portfolio asset allocation and trading strategies, show that Index tracking and portfolio optimization based on cointegration rather than correlation alone may result in higher asset returns. Meanwhile, Duan and Pliska (1998), by developing a theory of option valuation with cointegrated asset prices, reveal that cointegration methods can have a considerable impact on spread option price volatilities. Cointegration approach complements correlation analysis, as correlation analysis is appropriate for short-term investment decisions, while cointegration based strategies are necessary for long-term investment.

In the context of crisis, In et al (2002), using Vector Autoregression (VAR) Models, find that markets become more closely linked during financial crisis. Observing various economic indicators before and during the crisis, they prove that all observed markets, except for the Malaysian market, experience significant impact. They also reveal that investor decisions are influenced by geographical distance, which may limit diversification options. In et al (2001) finds more specific results, in which news in one country stimulates reaction in other country. Using data from the 1997-1998 crisis and a volatility model,

they demonstrate that local news in one country may be responded to by investors or decision makers in the adjacent markets only in days. Their study reveals that two-way volatility transmission occurs in the relationship between markets of Korea-Hongkong, Korea-Thailand and Hongkong-Thailand.

Conducting similar study in Latin America, Dianmantis (2009), however, showed that despite the existence of cointegration, there are only limited long-run advantages from cross-country portfolio diversification as stock prices adjust very slowly to the common trends. This suggestion partly corrects the recommendation from a study in Latin America done by Christofi and Pericli (1999). Christofi and Pericli (1999) suggest the potential of portfolio diversification using regional market stocks.Masih and Masih (1999) investigate contagion effects of a crisis by comparing data of OECD and emerging markets. They find significant cointegration between markets in the OECD region and emerging markets, both in the short and long run. In their study, markets in the US and UK are the leading factors to the relationship significance, which stimulates contagion effects among the observed markets.

DATA AND METHODOLOGY OF THE STUDY

This study employs data from the financial sector of several world stock markets, i.e. in the US, UK, Japan, Hongkong, Singapore, and Malaysia, in addition to data from ISX. The financial sector data includes stock price data of listed banks, insurance companies, multifinance companies, mutual fund, and other financial institutions. The data includes daily stock prices from 2 January 2007 to 30 December 2010. The data has been adjusted for stock split, mergers & acquisition and other financial information. The observation is conducted in two periods of observation, i.e., pre crisis period (2 January 2007 - 14 September 2008) and crisis period (15 September 2008 - 30 December 2010). The period cut off is decided based on study done by Tsai and Chan (2010).

The number of total stocks from the seven markets in the observed periods is initially 3,290. Stock markets of Hongkong, Japan, Indonesia, Malaysia, Singapore, UK and US contribute 325, 335, 95, 127, 96, 982 and 1330 stocks, respectively. Due to missing data, the number of stocks is then reduced to 2,524 or 76.72% of the previous sample. This study examines the long-term equilibrium relationship as well as the short-term dynamics between ISX and the six stock markets using the Johansen and Juselius (1990) model. If the indices share a common stochastic trend, then they are considered cointegrated (Christensen & Nielsen, 2003). The presence of cointegration relation forms the basis of the Vector Error Correction (VEC) specification. Below is vector auto-regressive (VAR) model of order *p:*

$$X_t = \mu \sum_{i=1}^{p} A X_{t-1} + \varepsilon_t \qquad (1)$$

where, X_t is a column vector of variables, here, the log price indices, μ, is a vector of constants, and ε_t is a vector of innovations, random errors usually assumed to be contemporaneously correlated but not autocorrelated, and *p* is the number of lags of variables in the system. If the variables in the vector X, are integrated of order, say one, 1(1), and are also cointegrated, that cointegration restriction has to be included in the VAR identified by equation (1). The Granger Representation Theorem (Engle and Granger, 1987) states that variables, individually determined by permanent shocks, are cointegrated, if and only if there is a vector error correction representation of the time series data. With this restriction imposed, a VAR model is referred to as VEC. Variables in the model enter the equation in their first derivatives, and the error correction terms are added to the model. The VEC representation of equation (2), following Johansen and Juselius (JJ) is:

$$\Delta X_t = \mu + \sum_{i=1}^{p} \Gamma \Delta X_{t-1} + \alpha \beta' X_{t-1} + \varepsilon_t \qquad (2)$$

where, Γ are (m x m) coefficient matrices (i = 1,2, ..., k), α, β are (m x r) matrices, so that $0 < r < m$, r is the number of linear combinations of the elements in X_t that are affected only by transitory shocks. Matrix β is the cointegrating matrix of r cointegrating vectors, β_1 β_2,...., β_i. The β vectors represent estimates of the long-run cointegrating relationship between the variables in the system. The error correction terms, $B' X_{t-1}$, are the mean reverting weighted sums of cointegrating vectors. The matrix a is the matrix of error correction coefficients that measure the speed at which the variables adjust to their equilibrium values. It is obvious that the model in equation 3 is the standard VAR in the first differencing of X_t, augmented by the error correction terms, a $B' X_t$. The JJ method provides maximum likelihood estimates of a and B'.

EMPIRICAL RESULTS AND FINDINGS

As indicated in Table 1, in the long period (Full Period) observation, stock prices in Hongkong, Indonesia, Malaysia and Singapore result in positive returns. Financial stocks in Indonesia provide the highest average rate of return, i.e., 0.00066, while those in Japan record the lowest average rate of return at - 0.0006. The highest standard deviation is also recorded by Indonesian financial stocks, i.e., 0.038, while the lowest is formed by stocks in the UK market. This Table shows that stock price data of all observed financial markets is normally distributed, since the Jarque Bera test results indicate the probability of each market data is lower than the significance level of 5%.

Table 1: Returns in Natural Logs (Full Period)

	HK	INA	JP	MY	SG	UK	US
Mean	0.0001	0.0007	-0.0006	0.0005	0.0001	-0.0001	-0.0001
Median	0.0011	0.0000	0.000	0.0009	0.0006	0.0006	0.000
Maximum	0.0701	0.2877	0.0841	0.0492	0.0677	0.0513	0.1417
Minimum	-0.0981	-0.1719	-0.125	-0.098	-0.111	-0.058	-0.123
Std. Dev.	0.0174	0.0384	0.0184	0.010351	0.0145	0.0097	0.0186
Skewness	-0.4603	0.797	-0.525	-16.251	-0.428	-0.561	0.684
Kurtosis	6.595	8.127	8.753	18.582	8.898	8.066	15.5
Jarque-Bera	566.9***	1186.7***	1407.9***	10429***	1462***	1108.1***	6509.1***
Probability	0.000	0.001	0.002	0.003	0.004	0.005	0.006
Sum	0.0687	0.6485	-0.617	0.456374	0.115054	-0.081	-0.064
Sum Sq. Dev.	0.2981	1.457	0.333	0.1057	0.2087	0.0925	0.3409
Observations	988	988	988	988	988	988	988

*This table shows return of financial stocks in the observed markets using stock-price data from 2 January 2007 to 30 December 2010 (Full Period). All prices are in natural log at the first differencing. ***, **, and * indicate significance at the 1, 5, and 10 percent levels respectively.*

Table 2 shows that none of the observed financial stock price data was normally distributed, since the Jarque Bera test results indicate that the respective probability is higher than the significance level of 5%. Table 2 also shows that mean returns in all markets were negative; indicating that weakening performance of financial sector stocks had started since 2007. Financial stocks in the US show the highest mean return, i.e., -0.0001, while those in Indonesia show the lowest, i.e., -0.0017.

Table 3 shows the highest correlation coefficient was 0.27, i.e., between Hongkong and Singapore, implying that diversification involving both markets before the crisis would provide little benefit. The correlation coefficient of Hongkong-US is the lowest at -0.00165, reflecting potential diversification involving the two markets.

Table 4 shows that during-crisis data (from 16 September 2008 to 30 December 2010) consists of total 570 observations. Results of the Jarque Bera test on each market show that none of the market data is normally distributed. In this observation period, financial sector stocks in Indonesian markets record the highest standard deviation, i.e., 0.038, implying that fluctuation rates of stock prices in the financial sector during the crisis is the highest among the observed markets. The Malaysian financial sector market data shows the least risky stocks during the crisis, indicated by the lowest standard deviation, 0.008.

Table 2: Descriptive Statistic of Return (Pre-Crisis)

	HK	INA	JP	MY	SG	UK	US
Mean	-0.0002	-0.0017	-0.0014	-0.0001	-0.0006	-0.0008	-0.0001
Median	0.0014	0.000	-0.0007	0.0001	0	-0.0006	-0.0003
Maximum	0.0696	0.2877	0.0611	0.0487	0.055	0.027	0.0397
Minimum	-0.0981	-0.1484	-0.067	-0.0699	-0.0538	-0.0335	-0.0422
Std. Dev.	0.0178	0.0391	0.018	0.0129	0.0138	0.0082	0.0105
Skewness	-0.4456	1.378	-0.1495	-0.9046	-0.211	-0.073	0.1754
Kurtosis	5.857	12.06	4.061	8.785	4.387	3.92	4.597
Jarque-Bera	155.6***	1557.2***	21.12***	638.3***	36.52***	15.13***	46.43***
Probability	0.00	0.00	0.00	0.00	0.00	0.0005	0.00
Sum	-0.0817	-0.7097	-0.5968	-0.0491	-0.2662	-0.3137	-0.0441
Sum Sq. Dev.	0.1324	0.6374	0.1351	0.0696	0.0789	0.0279	0.0454
Observations	417	417	417	417	417	417	417

*This table shows return of financial stocks in the observed markets using stock-price data from 2 January 2007 to 14 September 2008 (Pre Crisis Period). All prices are in natural log at the first differencing. ***, **, and * indicate significance at the 1, 5, and 10 percent levels respectively.*

Table 3: Correlation Matrix of Log Return (Pre-Crisis)

	HK	INA	JP	MY	SG	UK	US
HK	1.00	0.1145	0.1593	0.0542	0.2731	0.0713	-0.0017
INA	0.1145	1.00	0.0664	-0.069	-0.013	-0.0665	-0.0309
JP	0.1593	0.0664	1.00	0.1194	-0.011	-0.094	0.0029
MY	0.0542	-0.0691	0.1194	1.00	0.2432	0.0608	0.0093
SG	0.2731	-0.013	-0.011	0.2432	1.00	0.175	0.215
UK	0.0713	-0.0665	-0.094	0.0608	0.175	1.00	0.0779
US	-0.0017	-0.031	0.0029	0.0093	0.215	0.0779	1.00

This table presents correlation coefficients between markets based on stock-price data from 2 January 2007 to 14 September 2008 (Pre Crisis Period). All prices are in natural log at the first differencing.

Table 4: Descriptive Statistic of Log Return (During Crisis)

	HK	INA	JP	MY	SG	UK	US
Mean	0.0003	0.0024	0.000	0.0009	0.0006	0.0005	0.000
Median	0.0009	0.000	0.0004	0.0012	0.0007	0.001	-0.0005
Maximum	0.0701	0.1417	0.0841	0.0492	0.0677	0.0513	0.1417
Minimum	-0.0977	-0.1719	-0.1247	-0.0979	-0.1109	-0.0582	-0.1229
Std. Dev.	0.0171	0.0379	0.0187	0.0079	0.015	0.0105	0.0228
Skewness	-0.467	0.3441	-0.7786	-314.6	-0.5762	-0.752	0.6293
Kurtosis	7.205	5.0891	11.82	48.196	11.29	8.898	11.753
Jarque-Bera	440.7	114.9	1905.7	49453.4	1665.4	879.8	1857.3
Probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sum	0.1448	1.34	-0.0246	0.5189	0.3503	0.2644	-0.0233
Sum Sq. Dev.	0.1657	0.8157	0.1978	0.0357	0.1285	0.0632	0.2954
Observations	570	570	570	570	570	570	570

This table shows return of financial stocks in the observed markets based on stock-price data from 15 September 2008 to 30 December 2010 (During-Crisis Period). All prices are in natural log at the first differencing.

Table 4 also shows that financial sector returns during the crisis vary across the observed markets. Financial sector markets of Hongkong, Indonesia, Malaysia, Singapore and UK showed positive returns, while those of Japan and US recorded negative returns. The highest mean return is recorded by financial sector stocks in the Indonesian market, i.e., 0.0023, while the lowest is recorded by financial sector stocks in Japan. Table 5 shows that the highest correlation coefficient was 0.3, between Malaysia and UK, implying that diversification involving both markets during the crisis provides a non-significant benefit. The correlation coefficient between Indonesia-US is the lowest, at 0.007, indicating that diversification using financial sector stocks in the two markets may provide effective result.

Table 5: Correlation Matrix of Log Return (During-Crisis)

	HK	INA	JP	MY	SG	UK	US
HK	1.00	-0.0177	0.0685	0.1649	0.1167	0.2192	0.0695
INA	-0.0177	1.00	-0.0452	0.0796	0.0476	-0.0428	0.007
JP	0.0685	-0.0452	1.00	0.2127	0.093	0.2228	0.136
MY	0.1649	0.0796	0.2127	1.00	0.1827	0.3067	0.1424
SG	0.1167	0.0476	0.093	0.1827	1.00	0.2456	0.171
UK	0.2192	-0.0428	0.2228	0.3067	0.2456	1.00	0.1371
US	0.0695	0.007	0.136	0.1424	0.171	0.1371	1.00

This table presents correlation coefficients between markets based on stock-price data from 15 September 2008 to 30 December 2010 (During-Crisis Period). All prices are in natural log at the first differencing.

The initial phase in the estimation process is to decide the order of integration of the individual market prices in natural log levels. The log of prices in each market, denoted as HK, INA, JP, MY, SG, UK and US, are then tested for unit roots using the augmented Dickey-Fuller (ADF) (1979) test. The result is indicated by Schwarz Bayesian Information Criterion (SBIC). The p-values used for the tests are the MacKinnon (1996) one-sided *p*-values. The test results in Table 6 indicate that the null hypothesis that price in log levels contains a unit root, can not be rejected for each of the seven price series. Then, unit root tests are performed on each price series in first log differencing. The null hypothesis of a unit root can be rejected for each of the time series. No further tests are performed, since each of the series is found to be stationary in the first log differencing. The finding that each price series is non-stationary implies that each of the observed markets is weakly efficient.

After completing the ADF Unit Root Test, we conduct cointegration estimation with the following equation:

$$lHK_t = \alpha_0 + \alpha_1 lINA_t + \alpha_2 lJP_t + lMYI + lSG + lUK + LUS + \varepsilon_t \quad (3)$$

All the observed financial sectors were found to be cointegrated in the three different observation periods, at the significance level of 5%. This indicates that an investor might not form an efficient portfolio if he/she included the observed financial sector stocks in his/her portfolio, as the intended diversification may not be achieved.
The JJ estimation procedure that uses the maximum likelihood method was then employed. The cointegration tests assumed there was no deterministic trends in the series and used lag intervals 1 to 1 as suggested by the SBIC for appropriate lag lengths. However, it would not have made any difference if we had chosen the AIC (Akaike Information Criterion) because both the AIC and SBIC suggested the same lag length as well as the assumptions for the test. The assumptions of the test were that the price series in log levels had no deterministic trends and the cointegrating equation had an intercept, but no intercept in the VAR. The trace test, which tests the null hypothesis of *r* cointegrating relations against *k* cointegrating relations, where *k* is the number of endogenous variables, for *r* = 0,1, ……*k.* If there are *k* cointegrating relations, it implies that there is no cointegration between each pair of the seven series. The maximum eigenvalue test, which examines the null hypothesis of *r* cointegrating relations against the alternative of *r* + 1 cointegrating relations, results in one cointegrating equation at the 5% percent level of significance. The critical values used from Osterwald-lenum (1992) are slightly different from those reported in JJ (1990).

We tested for market indices cointegration between the pairs, and found that all the pairs were cointegrated. The test results are not presented, as our focus was the relationship among the seven financial sector markets. The finding that the market indices were cointegrated meant that there was one linear combination of the seven price series that forced these markets to have a long-term equilibrium relationship even though the markets might wander away from each other in the short-run. It also implies that returns on the markets were correlated in the long-term. The message for long-term international investors is that it would not matter, in terms of portfolio returns, whether investors in the observed markets held a fully diversified portfolio of stocks contained in all of the seven financial sector markets or held portfolios consisting of all stocks of only one financial sector market.

Table 6: Results of Augmented Dickey Fuller (ADF) Unit Root Test

Daily Closing Price Indices	Period	Lag	Test Statistic	SIC Values
HK	Pre-Crisis	1	-19.331	-5.189
INA	Pre-Crisis	1	-18.184	-3.627
JP	Pre-Crisis	1	-17.935	-5.186
MY	Pre-Crisis	1	-16.392	-5.878
SG	Pre-Crisis	1	-17.797	-5.724
UK	Pre-Crisis	1	-21.284	-6.745
US	Pre-Crisis	1	-18.572	-6.265
HK	During Crisis	1	-22.365	-5.319
INA	During Crisis	1	-23.046	-3.678
JP	During Crisis	1	-9.355	-5.151
MY	During Crisis	1	-9.153	-6.874
SG	During Crisis	1	-12.604	-5.596
UK	During Crisis	1	-21.312	-6.268
US	During Crisis	1	-24.782	-4.705

This table displays the results of Augmented Dickey Fuller (ADF) Unit Root Test of Financial Sector Stock Price in the seven markets, both before and during the crisis.

The final phase was the estimation of the three-variable VEC model. In terms of this study analysis, the estimated vector error-correction model of price indices has the following form:

$$\Delta lKHK_t = \alpha_0 + \sum \beta_{1i} \Delta lINA_t + \sum \beta_{2i} \Delta lJP_t + \sum \beta_{3i} \Delta lMY + \sum \beta_{4i} \Delta lSG + \sum \beta_{5i} \Delta lUK + \sum \beta_{6i} \Delta lUS + \lambda_1 Z_{t-1} + \varepsilon_t \qquad (4)$$

where Δl are the first log differencing of the seven markets lagged *p* periods, Z_{t-1} are the equilibrium errors or the residuals of the cointegrating equations, lagged one period, and λ_i are the coefficients of the error-correction term. The lag lengths for the series in the system were determined according to the SIC. The suggested lag lengths were one to one. No restrictions are imposed in identifying the cointegrating vectors. The coefficients of the error correction terms were denoted by λ. The results can be seen in Table 7, 8, and 9. On the bottom of the tables, the log likelihood values, the AIC and SBIC are reported. Three types of inference, concerning the dynamics of the seven markets, can be drawn from the reported results of the VEC model in Table 7, 8, and 9. The first concerns whether the left hand side variable in each equation in the system is endogenous or weakly exogenous. The second type of inference is about the speed, degree, and direction of adjustment of the variables in the system to restore equilibrium following a shock to the system. The third type of inference is associated with the direction of short-run causal linkages between the markets.

Table 7 (pre-crisis period) shows that all error correction term coefficients are significant at 1% level, meaning that financial sector in all of the observed markets experienced strong shock. The strongest pressure came from Singapore market, indicated by its error correction term coefficient of -0.106 and R square of 23.83% (significant at significance level of 1%). The weakest pressure came from the Indonesian market with error correction term coefficient of -0.04 and R-square of 4%. Overall, financial sectors in all observed markets were shock triggers, not shock receivers.

When Hongkong was set as the basis, financial stock prices in Malaysia and Singapore markets received short-term pressure, indicated by their coefficients of 0.156 and 0.178 (significant at significance level of 5%), respectively. Overall, more markets received pressure when Malaysia, Singapore and UK markets were set as the basis, as indicated by more significant coefficients in the respective columns on Table 7. On the other hand, if Indonesian market was set as the basis, none of

other observed markets received pressure. In Table 8 (During Crisis period) it can be seen that more markets received pressure during the crisis, as indicated by more significant coefficients.

Table 7: Estimated Vector Error Correction Model Results (Pre-Crisis)

Variables	Δ*lHK*	Δ*lINA*	Δ*lJP*	Δ*lMY*	Δ*lSG*	Δ*lUK*	Δ*lUS*
ECM (λ)	-0.0867***	-0.0400***	-0.0637***	-0.0662***	-0.1060***	-0.0605***	0.0806***
ΔlHK (-1)	0.0259	-0.1003	0.1304**	0.0495	0.0022	0.0140	0.0499*
ΔlINA (-1)	0.0237	0.1202**	0.0046	0.0193	0.0103	-0.0159	0.0090
ΔlJP (-1)	0.0256	0.1264	0.1580***	0.0928	0.0584*	0.0173	0.0666**
ΔlMY (-1)	0.1556**	-0.1009	0.0588	0.2367***	0.3553***	0.0840***	0.0503
ΔlSG (-1)	0.1784**	-0.1613	-0.0613	-0.1154**	0.0407	0.1313***	-0.0502
ΔlUK (-1)	0.0190	0.0637	0.0243	0.1375*	0.1754**	-0.0903*	0.0874
ΔlUS (-1)	0.0504	-0.0317	-0.0526	0.1066*	0.2744***	-0.0601*	0.1361***
R-Squared	0.0899	0.0413	0.0533	0.1372	0.2383	0.1689	0.1110
F-Statictic	5.0274***	2.1917**	2.8630***	8.0904***	15.915***	10.3396***	6.351***
	Log likelihood : 43.840,78						
	SIC : -42,37702						

*This table shows estimated VEC results beased on stock-price data from 2 January 2007 to 14 September 2008 (Pre Crisis Period). ***, **, and * indicate significance at the 1, 5, and 10 percent levels respectively.*

When Hongkong was set as the basis, Indonesian, Japan, Malaysia, and Singapore markets received pressure. Singapore market seemed to be the most important shock trigger during the crisis, with R-Square of 28.6, as all markets, except for Indonesian and Malaysian markets, receive pressure if Singapore is set as the basis. It is worth noting that during the crisis, UK market does not provide shock to any other observed markets. From Table 8 we can infer that financial sector stock prices in the Indonesian market caused changes to those in Hongkong during the crisis (significant at significance level of 1%). Financial sector stock prices in Japan, Malaysia, Singapore and UK had a two-way causality relationship with those in Hongkong.

Table 8: VEC Estimated Results (During Crisis)

Variables	Δ*lHK*	Δ*lINA*	Δ*lJP*	Δ*lMY*	Δ*lSG*	Δ*lUK*	Δ*lUS*
ECM	-0.0493***	-0.0479***	-0.0795***	-0.04***	-0.0947***	-0.024	-0.0598***
Δ*lHK* (-1)	0.0816*	-0.0355	0.1021**	0.0884***	0.1374***	0.142	0.0854
Δ*lINA*(-1)	0.0391**	0.0667	-0.0144	0.0115	0.0162	-0.0099	-0.0336
Δ*lJP* (-1)	0.066*	0.1898**	0.0194	0.0448**	0.1768***	0.0216	0.1101**
Δ*lMY* (-1)	0.1722*	0.2925	0.2223**	0.0972**	0.0528	0.15**	0.0634
Δ*lSG* (-1)	0.0918*	0.0666	0.1378***	0.0361	0.0746**	-0.0316	-0.088
Δ*lUK* (-1)	0.0785	0.0588	0.386***	0.0464	0.119**	0.0393	0.4356***
Δ*lUS* (-1)	-0.0283	-0.0491	0.0287	-0.0016	0.0546**	0.0192	-0.0474
R-Squared	0.0543	0.0326	0.1583	0.1222	0.286	0.0916	0.0988
F-Statictic	4.0195***	2.3561**	14.358***	9.747***	28.0452***	7.0606***	7.6781***
	Log likelihood : 43.840,78						
	SIC : -42,37702						

*This table shows estimated VEC results beased on stock-price data from 15 September 2008 to 30 December 2010 (During-Crisis Period). ***, **, and * indicate significance at the 1, 5, and 10 percent levels respectively.*

Table 9 displays the results of VEC Granger Causality test using Chi-Square with significance level of 10%, 5%, and 1%. The most right column indicates the causality between the observed markets. The results are reported for the time periods before the crises and during the crisis.

CONCLUSION

This study was aimed at investigating the existence of the global linkage of Indonesian Financial Sector stock prices as well as linkage among prominent markets during the US crisis. The study also employed pre-US-crisis data to show degree of the linkage change. The observed markets included US, UK, Japan, Hongkong, Singapore, and Malaysia markets, in addition to Indonesian market. The data was financial

sector stock prices from 2 January 2007 to 14 September 2008 for pre-crisis period and from 15 September 2008 to 30 December 2010 for during-crisis period.

Table 9: VEC Granger Causality

Dependent Variable	Δ*lHK*	Δ*lINA*	Δ*lJP*	Δ*lMY*	Δ*lSG*	Δ*lUK*	Δ*lUS*	Causality
Pre-Crisis								
Δ***lHK***	-	0.867	0.307	0.277	0.000	0.028	0.001	HK->JP HK->MY HK->US HK->SG
Δ***lINA***	0.808	-	0.291	0.798	0.255	0.245	0.996	INA->MY
Δ***lJP***	0.000	0.028	-	0.046	0.000	0.584	0.082	JP->MY JP->SG JP->UK JP-.US
Δ***lMY***	0.000	0.854	0.101	-	0.000	0.097	0.995	MY->HK MY->SG MY->UK
Δ***lSG***	0.000	0.567	0.000	0.673	-	0.000	0.931	SG->UK SG->HK
Δ***lUK***	0.011	0.998	0.253	0.307	0.000	-	0.561	UK->SG UK->HK
Δ***lUS***	0.406	0.452	0.573	0.551	0.515	0.178	-	US->SG US->UK
During Crisis								
Δ***lHK***	-	0.000	0.000	0.004	0.225	0.000	0.348	HK->JP HK->MY HK->SG UK->HK HK->UK HK->US
Δ***lINA***	0.000	-	0.000	0.000	0.087	0.431	0.448	INA->HK INA->JP INA->MY INA->UK MY->INA
Δ***lJP***	0.002	0.002	-	0.000	0.000	0.936	0.016	JP->HK JP->INA JP->MY JP->SG JP->UK JP->US
Δ***lMY***	0.000	0.108	0.000	-	0.002	0.257	0.159	MY->HK MY->JP MY->UK MY-SG MY->US
Δ***lSG***	0.021	0.075	0.000	0.259	-	0.000	0.120	SG->HK SG->JP SG->MY SG->UK
Δ***lUK***	0.213	0.091	0.000	0.280	0.000	-	0.000	UK->SG UK->MY UK->JP
Δ***lUS***	0.349	0.185	0.879	0.314	0.003	0.055	-	US->SG US->UK UK->US

This table displays the results of VEC Granger Causality test using Chi-Square with significance level of 10%, 5%, and 1%. The most right column indicates the causality between the observed markets.

The results show that financial sector stock prices in Indonesian market were cointegrated with other observed markets before and during the crisis. All other observed pairs were proven to be cointegrated in both before and during the crisis periods. However, Indonesian financial stock prices were relatively immune from pressures emerging in other observed markets, while Hongkong was proven to have the most two-way causality relationships with other observed markets during the crisis. Thus, financial industry fund managers may want to diversify their portfolio using financial sector stocks in the Indonesian market either in long run or short run, in moderate or downturn circumstances. For further development, future study can be carried out using more specific financial sector data, e.g., banking,

insurance, mutual funds, etc, to reveal more particular characters of market linkage. This is necessary since the development of such sub financial sectors varies accross economies.

REFERENCES

Alexander, C, (1999) "Optimal Hedging using Cointegration," *Philosophical Transactions of the Royal Society A* 357, 2039-2058.

Christensen, Ben J., Morten Ø. Nielsen (2003) "Asymptotic Normality of Narrow-Band Least Squares in the Stationary Fractional Cointegration Model and Volatility Forecasting," University of Aarhus

Christofi, A., and Pericli, A (1999) "Correlation in price changes and volatility of major Latin American stock markets." *Journal of Multinational Financial Management*, 9, 79-93.

Dickey, D.A. and Fuller, W.A (1979) "Distribution of the Estimators for Autoregressive Time Series with a Unit Root," *Journal of the American Statistical Association*, 74, p. 427–431

Duan, J.C., and Pliska, S (1998) "Option Valuation with Cointegrated Prices, " *Working Paper,* Department of Finance, Hong Kong University of Science and Technology.

Engle, R., and Granger, C. J. W (1987) "Cointegration and Error-Correction: Representation, Estimation, and Testing," *Econometrica,* (March), pp. 251-276.

Granger, C. W. J (1981) "Some properties of time series data and their use in econometric model specification," *Journal of Econometrics* 16, 121—130.

Granger, C. W. J. & Hallman, J. J (1991) "Long Memory Series with Attractors," *Oxford Bulletin of Economics and Statistics*, 53, 11-26.

In, Francis. Kim, S. and Yoon, J. H.and Viney, C (2001) "Dynamic interdependence and volatility transmission of Asian stock markets Evidence from the Asian crisis." *International Review of Financial Analysis*, 10, 87-96

In, Francis. Kim, S. and Yoon, J. H (2002) "International stock market linkages: Evidence from the Asian financial crisis," *Journal of Emerging Market Finance*, 1, 1

Johansen, S. & Juselius, K (1990) "Maximum Likelihood Estimation and Inference on Cointegration with Application to the Demand for Money," *Oxford Bulletin of Economics*

Liu, X, Burridge, P. and Sinclair, P (2002) "Relationship between economic growth, foreign direct investment and trade: evidence from China," *Applied Economics,* 34, 1433-1440

Liu, X. and Romilly, P (1997) "An empirical investigation of the causal relationship between openness and economic growth in China," *Applied economics,* 29, 1679- 86.

Lucas, A (1997) "Strategic and Tactical Asset Allocation and the Effect of Long-run Equilibrium Relations, Research Memorandum," 1997-42, *Vrije Universiteit,* Amsterdam.

MacKinnon, J (1996) Numerical Distribution Functions for Unit Root and Cointegration Tests, *Journal of Applied Econometrics*, 11, 601-618.

Masih Abul M.M. and Masih Rumi. (1999) "Are Asian stock market fluctuations due mainly to intra-regional contagion effects? Evidence based on Asian emerging stock markets," *Pacific-Basin Finance Journal* 7, 251-282

Osterwald-Lenum, M (1992) "A Note with Quantiles of Asymptotic Distribution of the Maximum Likelihood Cointegration Rank Test Statistics," *Oxford Bulletin of Economics and Statistics,* 54, 461-72.

Tsai Feng-Jen and Chang-Chuan Chan (2011) "The Impact of the 2008 Financial Crisis on Psychological Work Stress among Financial Workers and Lawyers," *Int. Arch Occup Environ Health*, 84, 445-452

THE AUTHORS

Aldrin Herwany is the head deputy, Center for Management and Business Studies at the Faculty of Economics & Business, Universitas Padjadjaran, Bandung, Indonesia. Email: aldrin.herwany.fe@unpad.ac.id; and herwany@yahoo.com; Office fax# +62 22 4239954.

Erie Febrian is an assistant Professor at the Faculty of Economics & Business, Universitas Padjadjaran, Bandung, Indonesia. Email: erie_febrian.fe@unpad.ac.id; erie_febrian@yahoo.com; Office fax # +62 22 2509055.