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Stock market integration:
After the Asian crisis 1997

Bachelor´s thesis

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Contents

1. INTRODUCTION

Past two decades has witnessed a series of financial and economic crises, affecting both developed and developing economies and many of them carrying regional or even global consequences. At the same time the capital flow has almost been worldwide free for the first time in the economic history causing the increasing interdependence among the world stock markets.

A considerable amount of academic work has been done on the stock market linkage across countries and markets. Many of them are based on Black Monday, 19th October, 1987, when stock markets around the world crashed after the collapse of the Dow Jones Index of the New York Stock Exchange. Various national stock markets had become so integrated that the developed markets, especially the US market, put a strong influence on other smaller national stock markets.

This paper focus on the time between the post- Asian crises and ongoing subprime crises and investigate the interrelationship between the five East Asian markets (Hong Kong, Korea, Singapore, Taiwan and Thailand) and three developed markets area (Europe, Japan, The Unites States of America). The interdependence between markets is based on three models: simple correlation analysis, Johansen co-integration test and Granger-causality test. The sample time-frame is 7.1.2000 - 30.7.2010 and while analyzing the interdependence of markets, three subsets are examined, post-Asian crisis/DotCom Bubble (2000-2003), growth period (2003-2007) and ongoing subprime crisis (2007-2010).

1.1 Background and motivation

First considerable academic research has been made from the U.S. point of view. Several articles (most notably Grubel (1968) and Levy and Sarnat (1970)) have used portfolio theory to demonstrate that international diversification can be a major gain from international economic relationships. Grubel (1968) finds that U.S. investors could have achieved better risk and return opportunities by investing part of their portfolio in foreign equity markets. Levy and Sarnat (1970) analyze international correlation in the 1951 – 1967 period, and show the diversification benefits from investing in both developed and developing equity markets. The greater the degree of comovement, the less opportunity there is for risk reduction through diversification. Grubel and Fadner (1971) pointed out that between 1965 and 1967 industry correlations within countries exceed industry correlations across countries. Goetzmann et al. (2002) examines the correlation structure of the major world equity markets over 150 years finding that correlations vary considerably through time. Lessard (1973) build up a multivariate analysis for four Latin American countries and showed that the results are substantially the same for different time periods.

There is also a group of papers that explores the interrelationship in emerging markets or the linkage between developed and emerging markets. Liu and Pan (1997) investigate the mean return and volatility spillover effects from the US and Japan to four south East Asian emerging markets. The empirical suggests that the US market plays a dominant role of influencing these markets. A similar conclusion is put forward by Liu et al. (1998), who find that the degree of national stock markets has increased substantially after the 1987 stock market crash.

The financial market shocks transmitted across geographical boundaries has received a lot of attention, especially when it comes to the Asian crises (e.g. Dungey 2002, Sander and Kleimeier, 2003, Park and Song, 2001) However, an ongoing subprime crisis added with the continuously increasing integration garners less attention than might be expected.

1.2 Purpose of this study

The purpose of the study is to define the theoretical determinants of portfolio theory and international diversification. The second contribution of this paper is to find out whether an investor could gain benefit of an international portfolio diversification. We are also going to analyze whether this possible benefit will be similar or not in different economic situation.

1.3 Structure of this study

The study consists of theoretical and empirical sections. Theoretical part relies on the next chapter. It focuses on Modern Portfolio Theory, unsystematic and systematic risk and international diversification. Chapter 3 is devoted to explain the used methodology in detail. Chapter 4 tells needed information for research data and some information about financial crises during the time period.

The empirical part of the study begins from chapter 5 where the data is described. This section uses correlation analysis, Johansen co-integration test and Granger-causality test to analyze interdependence between stock markets. The results are also described in the same chapter. Chapter 6 of the study concludes the findings and also presents ideas for further studies.

2. THEORY

2.1 Modern Portfolio Theory

The father of Modern portfolio theory Henry Markowitz (1952) drew special attention in his article to the common practice of portfolio diversification and showed exactly how an investor can reduce the standard deviation of portfolio returns by choosing stocks that do not move exactly together. Modern Portfolio Theory allows investors to estimate both the expected risks and returns, as measured statistically, for their investment portfolios. The expected rate of return on a portfolio is a weighted average of the expected rate of return on each component asset. Dr. Markowitz concluded that a diversified portfolio comprised of non-correlated asset classes can provide the highest returns with the least amount of volatility. (Markowitz 1952, Kane et al. 2005).

Modern portfolio theory assumes that investors try to avoid risk, meaning that given two portfolios that offer the same expected return, investors will prefer the one that is less risky. In other words, an investor will take on increased risk and choose the one with higher variance only if compensated by higher expected returns (figure 1). (Brealey et al. 2008). As more and more securities are added, the average variance on the portfolio declines until it approaches the average covariance, because of the individual risk of securities can be diversified away. So, to work out which portfolios are efficient and choose the best combination of portfolio, an investor must be able to state the expected return, standard deviation of each stock and the degree of correlation between securities. (Ross et al. 2005, 261)

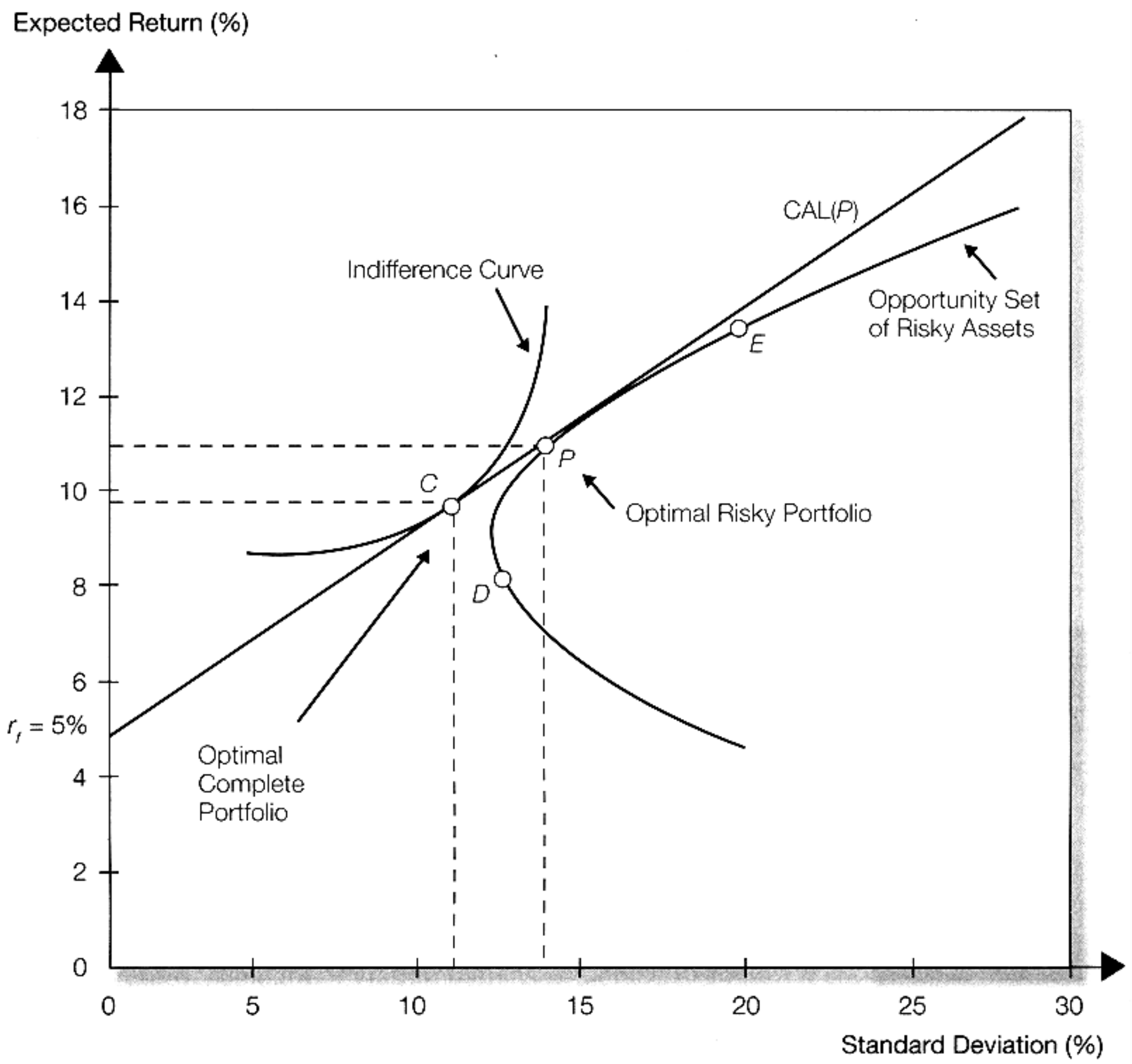

Figure 1 Determination of the optimal overall portfolio (Bodie et al. 2005)

In trying to make variance as small as possible it is not enough to invest in many randomly selected securities. It is necessary to avoid investing in securities with high covariances among themselves. It is generally more likely for firms within the same industry to do poorly at the same time than for firms in dissimilar industries, that is the reason why investors should diversify across industries because firms in different industries has lower covariances than firms within an industry.

Modern portfolio theory (MPT) is a theory of investment which attempts to create an efficient portfolio by maximizing portfolio expected return for a given amount of portfolio risk, or equivalently minimize risk for a given level of expected return, by carefully choosing the proportions of various assets. A diversified portfolio, of uncorrelated asset classes, can provide the highest returns with the least amount of volatility. The volatility of a diversified portfolio is less than the average of the volatilities of its component parts. (Boshnack, Elton et al. 2007)

2.1.1 Systematic risk and unsystematic risk

Markowitz had the insight that, while diversification would reduce risk, it would not generally eliminate it. The total risk of an asset can be divided into systematic risk, also called market risk, and unsystematic risk, which is also called unique risk. Systematic risk is non diversifiable risk that correlates with the market portfolio and is affected e.g. by inflation, exchange rates and interest rates. Unsystematic risk is independent of market fluctuations. It is affected by the companies' individual characteristics. As can be seen from figure 2, unsystematic risk can be eliminated by portfolio diversification, because the variances due to companies' individual characteristics offset each other. The standard deviation of the portfolio returns is reduced as the number of assets in the portfolio increases, if instrument are not perfectly positively correlated. This is the reason why investors should combine investments that are non-correlated with one another. The smaller the correlation between one another is the sharper it is going to reduce. Because the unsystematic risk can be eliminated, only the systematic risk should affect asset pricing. (Knüpfer & Puttonen 2004, 121-123; Brealey et al. 2006, 160-161; Fabozzi et al. 2002, 241-251.)

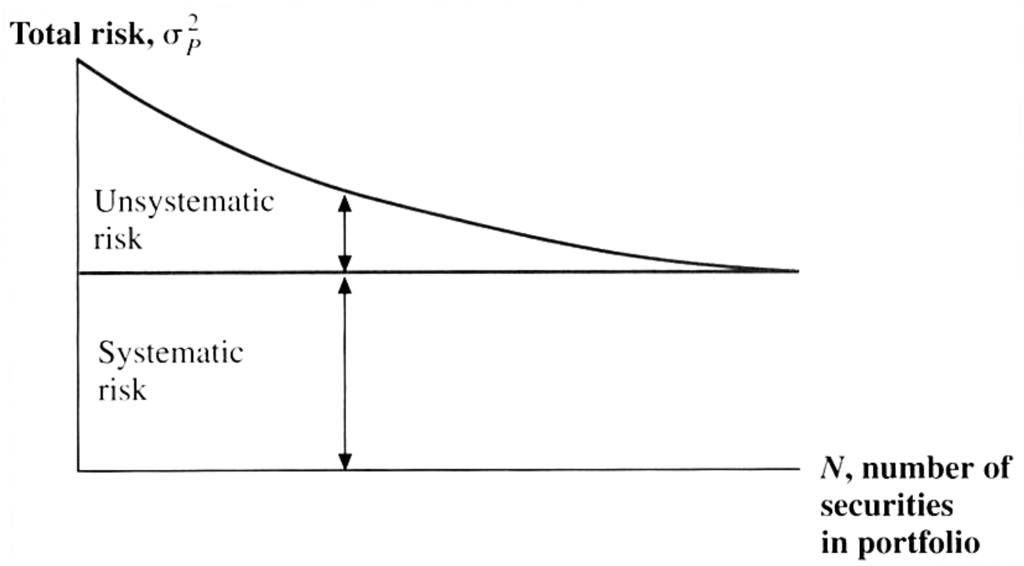

Figure 2 Diversification and the portfolio risk (Ross et al. 2005)

2.1.2 International diversification

International diversification means investing in securities that are traded in various countries. One of the major themes of modern portfolio theory concerns the merits of international diversification, but the benefits to international diversification have actually been well-known in the investment community for much longer. However, most investors hold nearly all of their wealth in domestic assets. (French et al. 1991)

Brooks et al. (2002) pointed out that the whole purpose of cross-country diversification is to reduce the exposure of a portfolio to country-specific shocks.

The return on a foreign investment is affected by the return on the assets within its own market and the change in the exchange rate between the security´s own currency and the currency of the purchaser´s home country. One way to remove exchange risk from international portfolio investment is to hedge foreign holdings. In many instances, exchange risk can be removed by buying a forward exchange contract.

International diversification is justified even if expected returns are less internationally than domestically. Solnik(1974) states that when securities of one country are doing worse than expected, another market is likely to be doing better, hence offsetting losses.

2.1.3 Contagion theory

National economies have recently become more closely linked, not only because of growing international trade and investment flows, but also due to terms of international financial transactions. In finance, the term contagion is relatively new meaning financial turmoil that quickly spread across markets in the economy. It is based on Black Monday 1987, when stock markets around the world crashed in a very short time. After that, several crises around the world has affected to other market areas also. A currency crisis in Thailand 1997 quickly spread throughout East Asia and then on to Russia and Brazil. Even developed markets in North America and Europe were affected. In the month following the 1998 devaluation of the Russian ruble, the Brazilian stock market fell by over 50 percent. Ongoing subprime crises started from US and has affected worldwidely for a long time.

Literature of different theories why contagion can occur can be divided into two groups: fundamental causes and investors´ behavior. Fundamental causes includes common shocks, trade linkages and certain financial linkages. For example, a crisis in one country can have direct financing effects on other countries, such as through reductions in trade credit, foreign direct investment, and other capital flows.

Some of the leading explanations for investors´ behavior, especially after the Russian default in 1998, were based on changes in psychology, attitude and behavior. Losses in one country may induce investors to sell securities in order to fear of losing all of the funds invested. (Claessens et al. 2004)

3. METHODOLOGY

3.1 Correlation

Correlation coefficient scales the covariance to a value between -1.0 and +1.0 and it is a measure of how closely two series move together. If two stock returns moved in perfectly same way, the correlation coefficient between the returns would be 1.0 and it is perfectly positively correlated. If their returns were completely unrelated, the correlation would be zero. The correlation coefficient will be negative if the returns on two stocks are likely to move inversely and when returns are moving in perfect but inverse lockstep, the correlation coefficient will be -1.0. If the returns are not correlated, diversification could eliminate risk. (Levy et al. 1970, Brealey et al. 2009, 327)

However, in the real world most firms have a common dependence on the overall economy and no matter how many securities you hold, you cannot eliminate all risk and correlations between two stocks returns is typically positive. Unsystematic risk can be diversified, but the risk that you cannot avoid is generally known as market risk. It can be reduced marginally by diversifying international securities. Generally for a reasonably well-diversified portfolio, only market risk matters. As long as correlation coefficient is <1.0, an investor has deserved benefits from diversification.

The sample correlation coefficient can be written:

$$\rho_{XY} = \frac{Cov(X,Y)}{\sigma_x \sigma_y} \tag{1}$$

Where

$$-1 \leq \rho_{xy} \leq 1 \tag{2}$$

$$Cov(X,Y) = \frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y}) \tag{3}$$

$$\sigma_x \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(x_i - \overline{x}\right)^2} \quad (4)$$

Correlation analysis has been widely used to measure the degree of financial contagion, because of its simplicity.

Traditionally, correlation has been modeled as a constant and unconditional variable. Over the years, practitioners have come to realize that correlation actually varies through time and several researchers have provided empirical evidence to support this view.

Longin and Solnik (1995) studied the correlation of monthly excess returns for seven major countries over the period 1960-90 and found out that the international covariance and correlation matrices are unstable over time. Grubel (1968) pointed out that diversification in different countries would have permitted investors to attain higher rates of return or lower variance of their portfolios.

Goetzmann et al. (2002) doubted diversification and asked whether it works when it is most needed, because the periods of poor market performance were associated with high correlations, rather than low correlations. Correlation coefficients across markets are likely to increase during a highly volatile period. This is the most relevant outcome concerning this research. Meaning that if a crisis hits country A with increasing volatility in its stock market, it will be transmitted to country B with a rise in volatility and, in turn, the correlation of stock returns in both country A and country B. (Chiang et al. 2007)

3.2 Unit Root tests

Many of the variables studied in finance are non-stationary time series. The econometric consequences of non-stationary can be quite severe, leading to least squares estimators, test statistics and predictors that are unreliable. The use of non-stationary data can also lead to spurious regressions. In other words one may obtain seemingly significant relationships from unrelated variables. The stationary of a time series can be tested directly with a unit root test. There are several models for testing the stationary of the time series. (Hill et al. 2001) (Brooks 2008)

3.2.1 The Dickey-Fuller tests

Dickey-Fuller (1976, 1979) has done the early and pioneering work on testing for a unit root in time series. The sample DF formula can be written:

$$y_t = (p-1)y_{t-1} + \mu_t \tag{5}$$

if we changed (p-1) into y, the formula will be

$$\Delta y_t = \phi y_{t-1} + \mu_t \tag{6}$$

The basic objective of the test is to examine the null hypothesis that time series has a unit root, ϕ=1 in against the one sided alternative ϕ<1. Thus the hypotheses of interest are H_0: series contains a unit root versus H_1: series is stationary. The null hypothesis of a unit root is rejected in favour of the stationary alternative in each case if the test statistic is more negative than the critical value. (Brooks 2001)

Critical values for Dickey-Fuller test can be seen in table 1. Comparing these results with the standard normal critical values in the last row, it can be seen that the DF critical values are much bigger in absolute terms.

Table 1. Critical values for (A)DF-tests

Table shows critical values for Augmented Diceky-Fuller test (Hill et. al 2001)

Significance level	**10 %**	**5 %**	**1 %**
CV for constant but no trend	-2,57	-2,86	-3,43
CV for constant and trend	-3,12	-3,41	-3,96
Standard critical value	-2,33	-1,65	-1,28

The Dickey-Fuller and the augmented Dickey-Fuller test are also known as t-tests and can be conducted allowing for an intercept, or an intercept and deterministic trend, or neither, in the test regression. (Brooks, 2008, 326-329)

To control for the possibility that the error term in one of the equations, for example is autocorrelated, additional terms are included. The modified model is augmented Dickey-Fuller test and can be written

$$\Delta y_t = \varphi y_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta y_{t-1} + u_t \qquad (7)$$

3.3 Cointegration

It is commonly known that using non-stationary time series variables in regression models can lead to spurious regression and it may also obtain seemingly significant relationships from unrelated variables. That is the reason why non-stationary time series variables should not be used in regression models. (Hill et al. 2001, 346)

However, there is an exception to this rule. Engle and Granger (1987) pointed out that a linear combination of two or more non-stationary series may be stationary. If we take a look at the linear combination $e_t = y_t - \beta_1 - \beta_2 x_t$. In most cases, if y_t and x_t are non-stationary $\mathrm{I}(1)$ variables, then we would expect that their difference or any linear combination of them to be $\mathrm{I}(1)$ as well. However, there are some important cases when $e_t = y_t - \beta_1 - \beta_2 x_t$ is a stationary $\mathrm{I}(0)$ and the implication would be that the series are drifting together at roughly the same rate. If such a stationary linear combination exists, the non-stationary time series y_t and x_t are said to be cointegrated. The stationary linear combination is called the cointegrating equation and may be interpreted as a long-run equilibrium relationship among the variables. (Hill et al. 2001, 346)

3.3.1 The Johansen Method

The purpose of the cointegration test is to determine whether a group of non-stationary series are cointegrated or not and its focuses on the short- and long-term relationship between the variables. The Engle and Granger (1987) method is based on assessing whether single-equation estimates of the equilibrium errors appear to be stationary. The second approach, due to Johansen is a procedure for testing cointegration of several $\mathrm{I}(1)$ time series and is based on VAR approach. (Greene 2008, 761)

To carry out the Johansen test, the VAR with k lags is formulated:

$$\gamma_t = \beta_1 \gamma_{t-1} + \beta_2 \gamma_{t-2} + ... + \beta_k \gamma_{t-k} + \mu_t \qquad (8)$$

In order to use Johansen test, the VAR above needs to be turned into a vector error connection model (VECM) of the form

$$\Delta\gamma_t = \Pi\gamma_{t-k} + \Gamma_1 \Delta y_{t-1} + \Gamma_2 \Delta y_{t-2} + ... + \Gamma_{k-1} \Delta y_{t-(k-1)} + \mu_t \qquad (9)$$

where

$$\Pi = (\sum_{i=1}^{k} \beta_i) - \mathrm{I}_g \quad \text{and} \quad \Gamma_i = (\sum_{j=1}^{i} \beta_j) - \mathrm{I}_g \qquad (10)$$

Johansen proposes two types of test statistics for cointegration, either with trace or with eigenvalue, and the inferences might be a little bit different. The trace test is a joint test, where the null hypothesis is the number of cointegration vectors is less than or equal to *r .* (Brooks 2002, 351) This test is formulated as

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{g} \ln(1 - \hat{\lambda}_i) \qquad (11)$$

The maximum eigenvalue test , on the other hand, tests the null hypothesis that the number of cointegrating vectors is *r* against an alternative of *r* + 1. The name comes from the fact that the test statistic involved is a maximum generalized eigenvalue. (Brooks 2002, 351) This can be written as

$$\lambda_{maz}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1}) \quad (12)$$

Critical values for the two tests statistics are given by Johansen and Juselius (1990) and Osterwald-Lenum (1992). The distribution of the test statistics is non-standard, and the values depend on the value of *g – r.* The null hypothesis will be rejected if the test statistic is greater than the critical value. (Brooks 2002)

3.4 Granger Causality test

The Granger causality test is used to help to determine whether time series X can help in forecasting time series Y. More specifically Granger (1969) approaches the question of whether X causes Y by seeing how much of the current Y can be explained by past values of Y and then to see whether adding lagged values of X can improve the explanation. In general, X is said to Granger-cause Y, if X provides statistically robust information in predicting the future values of Y. (Glezakou et al. 2009)

A standard bivariated dynamic structural model on which the Granger test is based can be expressed as:

$$Y_t = \sum_{i=1}^{m} \alpha_i Y_{t-1} + \sum_{i=1}^{m} \beta_i X_{t-1} + \mu_t \quad (13)$$

$$X_t = \sum_{i=1}^{m} \gamma_i Y_{t-1} + \sum_{i=1}^{m} \delta_i X_{t-1} + e_t \quad (14)$$

H_0: X does not cause Y

(Or H_0: β1 =β2 = …. = βm = 0; from the model above)

If the estimated coefficients γ_i, of the variables Y_{t-1} prove to be statistically significant and the coefficients β_i of the variables X_{t-1} are not, then Y Granger-causes X. Vice versa, if coefficients γ_i, are insignificant and coefficients β_i are significant, X Granger-causes Y. Finally, in case of both coefficients γ_i and β_i are significant, X and Y Granger-cause each other. (Glezakou et al. 2009) (Thornton et al. 1985)

The null hypothesis that X does not Granger-cause Y in the first regression and that Y does not Granger-cause X in the second regression is rejected, if at least one of the β_i or of the δ_i proves to be statistically significant. It is noticeable that Granger causality test is applied only to stationary time series.
The lag length *m* was identified for every pair using the Schwarz criterion (SC), which is given by the following equation:

$$SC = -2(l/T) + k\log(T)/T \tag{15}$$

where the *l* is the value of the log of the likelihood function with the *k* parameters of the statistical model estimated using *T* observations. (EViews 6 User's Guide II 2009, 647)

4. DATA

4.1 Research data

This article aims to study the interdependence among 8 international stock markets in different market conditions. The stock markets under examination are those of Europe, USA and Japan from developed countries and Hong Kong, Malaysia, Philippines, Singapore and Thailand from South East Asian emerging markets.

The reasoning behind the selection of these specific markets is that the stock market of the USA is the most influential market worldwide, while Japan is the dominant market in Asia. Europe is also undoubtedly the leading economies in the world and South East Asian markets is an interesting emerging market area still with huge growth potential. Stock indices which are in use can be seen from table 2.

Table 2. Stock Indices for each market area

Stock Indices and symbols for Europe, Hong Kong, Japan, Malaysia, Philippines, Singapore, Thailand and USA can be seen from table.

Country/market area	Stock Index	Symbol
Europe	FTSE 100 EURO	FTSE 100
Hong Kong	Hang Seng	HSI
Japan	Topix	TPX
Malaysia	FTSE BURSA	FTSE
Philippines	Philippines SE Composite	PSEI
Singapore	Straits Timers Index	STI
Thailand	Bangkok S.E.T.	S.E.T.
USA	S&P 500 Composite	SPX

The sample includes the logarithmic weekly closing prices of the above indices from Friday to Friday from 7th of January 2000 to 30th of July 2010. For the entire period 552 observations were analyzed. Time series are total return indices, which measure the total return on the underlying constituents, combining both capital performance and reinvested income. All the stock-price indices are in US $ currency and all the data were obtained from Datastream.

Furthermore, as our aim is to determine whether the interdependence is affected by the market conditions, the sample is divided into three sub-periods. The first sub-period extends from 7th of January to 28th of February 2003 with 165 observations includes the Dot Com Mania and post-Asian crisis. The second period from 1st of March to 29th of December 2006 with 200 observations was growing season and pretty much all the markets boomed. Finally, the last sub-period, extending from 30th of December 2006 to 20th of July 2010, includes the current subprime crisis with 187 observations.

4.2 FINANCIAL CRISES

4.2.1 Asian Crises

During the 1980s the gradual liberalization of financial markets in Asia, including Korea, Taiwan and other emerging markets, has helped to gain considerable investment interests in the East Asian equity markets. In the beginning of 1990 Asian economy was still expanding very rapidly and international investors expressed great interest in the Asian emerging markets because of the huge growth potential of this region and a strong track record in recent years. (Cheung et al. 2007, Choi-mak 1992)

However, financial crisis gripped much of the Asia beginning in July 1997. The crisis had significant macro-level effects, including sharp reductions in values of currencies, stock markets and other asset prices in several Asian countries.

However, the large amounts of financing provided by the IMF, readjustment of their financial institutions and the enhancement of their endeavor, most of the East Asian countries have started to improve their economic conditions since early 1999, when the average GDP of the region climbed back to 4-6 percent annual growth, although this is still lower than the average of 7-9 percent the region experienced in the pre-crisis years of 1991-1996. (Muchhala 2007)

Even though these East Asian equity markets suffered a major setback during this Asian financial crisis, these markets have come back quite strongly and still represent good investment opportunities or diversification possibilities for international investors. (Cheung et al. 2007)

4.2.2 DotCom Crises/IT bubble

Ofek and Richardson (2003) explored the rise and fall of internet stock prices and pointed out that in the two-year period from early 1998 through March 2000, the

Internet sector earned over 1000 percent returns on its public equity. On March 10, 2000 the technology heavy NASDAQ Composite index peaked at 5,048.62 more than double its value just a year before. However, by the end of 2000 these returns had completely disappeared.

However, in some markets DotCom crises did not affect at all. Some emerging markets were excluded because any technology stocks were not included in indices.

4.2.3 Subprime Crises

The ongoing subprime crisis started basically in August 2007, though it has had some background in the beginning of 2000, and caused strong fluctuations on stock markets. The fluctuations continued also in the beginning of the year 2008. The bad news from the U.S has made investors nervous and they have withdrawn their alternatives. The current economic crisis is so strong and persistent that it can be only compared to Great Depression of 1929. (Gklezakou et al. 2009)

The subprime crisis has affected financial business globally and several banks and financial companies have got into trouble because of the crisis. Because of the stock price fluctuations the crisis has also had an impact on ordinary small-scale investors.

5. EMPIRICAL RESULTS

5.1 Descriptive statistics

Descriptive statistics of the indices´ return for the whole period and the three sub-periods for each eight markets are presented in the table 3. Mean, standard deviation, minimum, maximum, skewness, kurtosis and p-value are reported. All statistics are logarithmic weekly data.

As can be seen from the table 3, USA and Japan weekly returns for the whole time period have been negative. All other markets have positive annual returns although it has been really small for European market. Thailand (9.93 %), Malaysia (8.57 %) and Singapore (6.80 %) have enjoyed the biggest average return.

Table 3. Descriptive statistics

Descriptive statistics for each market area are presented in table. Mean, standard deviation, minimum, maximum, skewness, kurtosis and p-value are presented for each time period. All values are logarithmic prices.

Market/Period	Mean	Std.Dev.(%)	Min.	Max.	Skewness	Kurtosis	p-value
Europe	1,335	3,583	-0,2748	0,1285	-1,1455	10,96	< 0.001
IT/Post-Asian crises	-19,17	3,414	-0,1011	0,1285	0,0475	4,201	< 0.05
Growing period	27,51	2,056	-0,0536	0,0534	-0,2639	3,198	< 0.10
Subprime crises	-6,879	4,752	-0,2748	0,1277	-1,2876	9,132	< 0.001
Hong Kong	6,219	3,421	-0,1765	0,1190	-0,2390	5,173	< 0.001
IT/Post-Asian crises	-14,18	3,652	-0,1059	0,1081	0,2054	3,590	< 0.05
Growing period	25,13	2,090	-0,0514	0,0492	-0,2956	2,675	< 0.10
Subprime crises	4,410	4,248	-0,1765	0,119	-0,3090	4,594	< 0.001
Japan	-2,882	2,907	-0,1605	0,1126	-0,2344	4,786	< 0.001
IT/Post-Asian crises	-24,06	3,173	-0,0723	0,1126	0,3972	3,598	< 0.05
Growing period	20,10	2,613	-0,0905	0,0696	-0,2234	3,541	< 0.10
Subprime crises	-8,487	2,927	-0,1605	0,0734	-0,8030	7,093	< 0.001
Malaysia	8,566	2,827	-0,1243	0,4622	7,7155	130,9	< 0.001
IT/Post-Asian crises	-7,267	2,982	-0,1243	0,1220	-0,0628	5,828	< 0.001
Growing period	12,70	1,569	-0,060	0,0580	0,1552	5,365	< 0.001
Subprime crises	18,63	3,623	-0,0828	0,4622	10,901	139,7	< 0.001
Philippines	5,674	3,603	-0,2052	0,1633	-0,2893	6,445	< 0.001
IT/Post-Asian crises	-30,86	3,554	-0,0938	0,1633	1,0462	6,840	< 0.001
Growing period	32,98	2,819	-0,0854	0,0864	-0,2328	3,649	< 0.05
Subprime crises	8,804	4,267	-0,2052	0,1229	-0,8901	6,423	< 0.001
Singapore	6,802	3,286	-0,1867	0,1707	-0,5185	8,030	< 0.001
IT/Post-Asian crises	-20,34	3,220	-0,1330	0,1042	-0,2741	4,712	< 0.001
Growing period	29,59	2,104	-0,0652	0,0758	-0,2294	4,505	< 0.001
Subprime crises	7,138	4,205	-0,1867	0,1707	-0,4881	7,097	< 0.001
Thailand	9,93	3,699	-0,2701	0,1192	-1,055	8,816	< 0.001
IT/Post-Asian crises	-10,72	3,993	-0,1521	0,0927	-0,5331	4,514	< 0.001
Growing period	24,56	3,019	-0,1008	0,0858	-0,4232	3,460	< 0.05
Subprime crises	14,64	4,044	-0,2701	0,1119	-1,6683	13,39	< 0.001
USA	-0,734	2,784	-0,2002	0,1141	-0,8372	9,665	< 0.001
IT/Post-Asian crises	-15,69	3,015	-0,1229	0,0753	-0,4654	4,856	< 0.001
Growing period	15,84	1,529	-0,0384	0,0725	0,1940	4,732	< 0.001
Subprime crises	-4,724	3,511	-0,2002	0,1141	-0,8298	8,683	< 0.001

The first period is characterized by relatively large negative returns for all the eight markets, while during the growing period all the markets boomed. The average return during the first sub-period is -17.78 %, while the markets have grown 23.55 % annually during the second period. Ongoing subprime crisis has affected to developed countries more than South East Asian emerging markets. All three developed countries have negative average annual return, while South East Asian countries have continued growing also in the last sub-period.

Standard deviation has been higher during the crises than in growing period. Overall it has been pretty similar for all market areas starting from 2.78 % (USA) to 3.7 % (Thailand).

Kurtosis is a measure of whether the data are peaked or flat relative to a normal distribution and tells how fat the tails of the distribution are. Skewness characterizes the degree of asymmetry of a distribution around its mean. Positive skewness indicates a distribution with an asymmetric tail extending towards more positive values. Negative skewness indicates a distribution with an asymmetric tail extending towards more negative values. A normal distribution is defined to have a coefficient of kurtosis of 3 and it is not skewed. (Brooks 2001, 161)

Kurtosis is over the 3 for all the 8 markets including extremely high coefficient for Malaysia (130). It has 5.8 and 5.4 coefficients from the first two sub-periods but in the third period it has increased sharply to 140.

Malaysia is also the only market with positive value for the skewness. Data that are skewed right meaning that the right tail is long relative to the left tail. All other markets have negative values for the skewness and are therefore skewed left.

Negative values for the skewness indicate data that are skewed left and positive values for the skewness indicate data that are skewed right. By skewed left means also that the left tail is long relative to the right tail. Similarly, skewed right means that the right tail is long relative to the left tail.

At this point Malaysia can be seen as an outlier. One possible reason for this kind of measurement errors is structural change in FTSE Bursa Malaysian stock index. On May 2009, the index, was expanded to include three new sector themed indices and on July 2009 the KLCI (Kuala Lumpur Composite Index) was transitioned to the FTSE Bursa to be the primary market benchmark for Malaysia. The improvements provide the market with a robust benchmark index that is more investable, tradable and transparently managed.

5.2 Analysis of correlation coefficients

The matrices of correlation coefficients of the eight indices for the entire period, as well as three different sub-periods are shown below.

Table 4. Correlation Coefficients overall

Overall correlation coefficient can be seen from table. Time period starts from 7th of January and ends to 30th of July 2010. All values are logarithmic prices.

	Europe	Hong Kong	Japan	Malaysia	Philippines	Singapore	Thailand	USA
Europe	1							
Hong Kong	0,6625	1						
Japan	0,4589	0,5039	1					
Malaysia	0,2029	0,2187	0,1522	1				
Philippines	0,4011	0,4419	0,3583	0,1880	1			
Singapore	0,6689	0,7598	0,5277	0,2661	0,4992	1		
Thailand	0,4430	0,4642	0,4184	0,2689	0,4602	0,5225	1	
USA	0,8004	0,5693	0,3992	0,1943	0,3555	0.5728	0,3344	1
Average:	0,4326							

As can be seen from table 4, the average correlation coefficient for the time period is relatively small (0.427). The smallest correlation for whole time period is between Japan and Malaysia (0.152) and the biggest between USA and Europe (0.800). These two markets are the leading markets in the world and the strong correlation is obvious. Hong Kong and Singapore are also correlated quite strongly with others. Both have only Malaysia with under average correlation coefficient. A possible explanation might be the strong regional effect in South East Asian markets. Philippines and Malaysia has all correlation coefficients under average both with one exception.

Table 5. Correlation Coefficients post-Asian crisis/DotCom bubble

Table presents correlation coefficients among markets in post-Asian crisis/DotCom bubble period. It covers the period from 7th of January 2000 to 28th of February 2003. All values are logarithmic prices.

	Europe	Hong Kong	Japan	Malaysia	Philippines	Singapore	Thailand	USA
Europe	1							
Hong Kong	0,5944	1						
Japan	0,2657	0,3595	1					
Malaysia	0,1729	0,2546	0,1049	1				
Philippines	0,0724	0,1637	0,0376	0,1182	1			
Singapore	0,4939	0,5992	0,3252	0,3203	0,2058	1		
Thailand	0,2537	0,3797	0,2363	0,3703	0,4217	0,5093	1	
USA	0,7331	0,4702	0,2352	0,1965	0,0912	0,4135	0,1767	1
Average:	0,3063							

DotCom bubble seemed to affect most in the USA and European markets while Philippines and Malaysia demonstrates low correlation with the other markets in the first sub-period. A possible explanation could be the amount and different of technology and internet companies between developed and emerging markets. DotCom bubble affected much strongly to the high-technology countries than into emerging markets. The average correlation coefficient for the sub-period is low (0,306) giving some benefit for investors to diversify internationally.

Table 6. Correlation Coefficients growing period

Correlation coefficients for the growing period among the markets are shown in table. Time period is between 1.3.2003-29.12.2006. All values are logarithmic prices.

	Europe	Hong Kong	Japan	Malaysia	Philippines	Singapore	Thailand	USA
Europe	1							
Hong Kong	0,4718	1						
Japan	0,4986	0,4423	1					
Malaysia	0,2478	0,4263	0,3710	1				
Philippines	0,3824	0,3063	0,3677	0,3237	1			
Singapore	0,5903	0,6755	0,5649	0,4639	0,4624	1		
Thailand	0,3866	0,4166	0,4169	0,4513	0,3576	0,4752	1	
USA	0,7753	0,4229	0,4301	0,1711	0,2778	0,4752	0,2492	1
Average:	0,4250							

In the table 6 is presented the correlation coefficients from 1st of March 2003 to 29th of December 2006. All the markets were growing sharply during this sub-period. For example Europe enjoyed third highest return (27,51%) after Philippines (32,98%) and Singapore (29,59%). The average correlation coefficient (0,4250) have also risen significantly from the first sub-period (0,3063). Increasing integration might be one reason for higher average. It is noticeable that Philippines have all coefficients under average except one with Singapore.

Table7. Correlation Coefficients Subprime crisis period

Correlation coefficients during ongoing subprime crisis are presented in table. The last sub-period covers the time between 30.12.2006-30.7.2010. All values are logarithmic prices.

	Europe	Hong Kong	Japan	Malaysia	Philippines	Singapore	Thailand	USA
Europe	1							
Hong Kong	0,7418	1						
Japan	0,5992	0,6680	1					
Malaysia	0,2040	0,1420	0,1013	1				
Philippines	0,5751	0,6578	0,5909	0,1808	1			
Singapore	0,7664	0,8726	0,6750	0,1819	0,6666	1		
Thailand	0,5959	0,5569	0,5876	0,1398	0,5399	0,5657	1	
USA	0,8439	0,6614	0,5361	0,1921	0,5405	0,6838	0,4872	1
Average:	0,5198							

During the economic recession, the links between the markets are impressively tightened and correlation coefficients have continued to rise sharply as it can be seen from table 7. Hence, the average correlation coefficient has also boomed from 0.425 to 0.520. For example the value of the correlation coefficient between USA and Europe has changed from 0.775 to 0.844, while the smallest interdependence is observed between Japan and Malaysia reaching just 0.101. It is noticeable to see how Malaysia demonstrates low correlation compared to the previous sub-period. The Malaysian stock indices exhibit seven lowest correlation coefficients from eight in the last sub-period, which can be explained by the integration of some indices into the FTSE BURSA in 2009. Generally Japan seemed to connect more closely to other stock markets than in previous sub-periods. A possible explanation is that as the crisis is global, it strongly affects almost all the economies worldwide.

Table 8. The average correlation coefficients

The average correlation coefficients for each market area in different time periods are shown in table. It covers total average for each time period as well as averages for each market individually.

	Overall	**IT/post-Asian crises**	**Growing period**	**Subprime crises**
	7.1.2000-30.7.2010	7.1.2000-28.2.2003	7.3.2003-29.12.2006	5.1.2007 - 30.7.2010
Europe	0,5197	0,3694	0,4790	0,6180
Hong Kong	0,5172	0,4030	0,4517	0,6144
Japan	0,4026	0,2235	0,4417	0,5369
Malaysia	0,2130	0,2197	0,3507	0,1631
Philippines	0,3863	0,1587	0,3540	0,5359
Singapore	0,5453	0,4096	0,5296	0,6303
Thailand	0,4159	0,3354	0,3934	0,4962
USA	0,4608	0,3309	0,4003	0,5636
Average:	0,4326	0,3063	0,4250	0,5198

As the correlation coefficients of the three sub-periods reveal, there is an upward trend towards the interdependence of the stock markets. Table 8 presents the average correlation coefficients for each market area in different time periods. The observed sharp increase in the correlations of the last sub-period among the stock markets under study might be attributed to the constantly increasing integration of the global economy, with the exception of the Malaysian market, which has not continued upward trend. One possible reason for this might be again some structural changes in FTSE BURSA happened in 2009.

However, generally the interdependence between examined markets rises significantly and their links became more strengthened during the current economic crisis. Integration alone cannot justify the large rise in the correlation coefficients documented during the ongoing deep economic crises. This finding may be due to the worldwide integration and the severity of the crisis together.

5.3 Testing for a unit root in the level

In order to test stationary of the data the augmented Dickey-Fuller test (ADF) is applied. The Augmented Dickey-Fuller test was executed using the EVIEWS program. The null hypothesis is that the series has a unit root and thus when the probability is less than 0.05, the time series is considered to be stationary. In this case, an automatic lag length selection is chosen by using a Schwarz Information Criterion and a maximum lag length of 18.

5.3.1 The Augmented Dickey-Fuller test in the level

The ADF statistic values and the associated one-sided p-values are shown in table 9 as well as the critical values at the 1 %, 5 % and 10 % levels are reported. Tests are made by using EVIEWS.

Table 9. The ADF-test results in level¨

Results of the Augmented Dickey-Fuller test in the level. Test statistics, p-value and test critical values for different significance levels are presented in the table

Market		t-Statistics	p-value
Europe		-1,25589	0,6513
Hong Kong		-0,77085	0,8259
Japan		-1,79193	0,3846
Malaysia		1,19869	0,9982
Philippines		0,06251	0,9626
Singapore		-0,01429	0,9559
Thailand		-0,20335	0,9353
USA		-1,88459	0,3396
Test critical values:	1 % level	-3,464101	
	5 % level	-2,876277	
	10 % level	-2,574704	

The ADF-test results are shown in table 9. Clearly, the test statistics are not more negative than the critical values, so the null hypothesis of a unit root cannot be rejected for all eight markets. All markets includes at least one unit root and therefore are non-stationary time series. Non-stationary time series can be analyzed with cointegration analysis.

5.4 Johansen Cointegration method

Johansen's method of estimating cointegrating vectors is a good starting point for tests of long run relationships. Series are known to be non-stationary and the null hypothesis of the Johansen test is that the stock indices of the eight markets are not co-integrated (r=0) against the alternative of one or more co-integrating vectors (r>0). The test statistic results are indicated at the level of 5 %. Table 10 and table 11 exhibit the results from the Johansen co-integration test for any long-term relationship between the eight stock markets. Cointegration test is made by using two (trace and maximum eigenvalue) test statistics, which may yield conflicting results. The (nonstandard) critical values are taken from MacKinnon-Haug-Michelis (1999).

Table 10 Johansen co-integration test overall

Johansen co-integration test results for the whole time period are presented in table. It covers eigenvalue, trace statistics, max-eigen statistics, 5 per cent critical values and hypothesized no. of CE(s).

Eigenvalue	Trace Statistic	5 per cent Critical value	Max-Eigen Statistic	5 per cent Critical value	Hypothesized No. Of CE(s)
Overall					
0,11	165,72	159,53	60,64	52,36	None
0,07	105,10	125,62	39,67	46,23	At most 1
0,04	65,43	95,76	22,99	40,08	At most 2
0,03	42,44	68,82	15,60	33,88	At most 3
0,03	26,84	47,86	14,13	27,58	At most 4
0,02	12,71	29,78	8,64	21,13	At most 5
0,01	4,06	15,50	3,10	14,27	At most 6
0,00	0,97	3,84	0,97	3,84	At most 7

In table 10 can be seen the Johansen co-integration test for the overal time period. These results indicate that there can be found opportunities for portfolio diversification. Only one significant co-integration relationship can be found in both test statistics, if we base our judgement on a 5 percent significance level.

Table 11 Johansen co-integration test in three sub-periods

Table covers Johansen co-integration test results for different subperiods covering eigenvalue, trace statistics, max-eigen statistics, 5 per cent critical values and hypothesized no. of CE(s).

Eigenvalue	Trace Statistic	5 per cent Critical value	Max-Eigen Statistic	5 per cent Critical value	Hypothesized No. Of CE(s)
7.1.2000-28.2.2003					
0,30	214,41	159,53	58,08	52,36	None
0,26	156,33	125,62	47,88	46,23	At most 1
0,21	108,45	95,75	37,64	40,08	At most 2
0,13	70,81	69,82	25,58	33,88	At most 3
0,12	45,23	47,86	21,21	27,58	At most 4
0,08	24,02	29,80	12,70	21,13	At most 5
0,07	11,32	15,50	11,26	14,27	At most 6
0,00	0,06	3,84	0,06	3,84	At most 7
1.3.2003-29.12.2006					
0,22	167,84	159,53	48,24	52,36	None
0,14	119,60	125,62	28,80	46,23	At most 1
0,13	90,80	95,75	26,85	40,08	At most 2
0,11	63,95	69,82	22,10	33,88	At most 3
0,09	41,84	47,86	18,13	27,58	At most 4
0,05	23,71	29,80	10,43	21,13	At most 5
0,04	13,28	15,50	8,41	14,27	At most 6
0,03	4,88	3,84	4,88	3,84	At most 7
30.12.2006-30.7.2010					
0,24	163,31	159,53	50,28	52,36	None
0,17	113,03	125,62	34,48	46,23	At most 1
0,16	78,55	95,75	32,76	40,08	At most 2
0,10	45,80	69,82	19,40	33,88	At most 3
0,08	26,40	47,86	14,72	27,58	At most 4
0,03	11,68	29,8	5,67	21,13	At most 5
0,03	6,02	15,5	4,62	14,27	At most 6
0,00	1,40	3,84	1,40	3,84	At most 7

The results in first sample period are especially strong, where it shows four statistically significant co-integration relationship in Trace test and two in Max-Eigen value test. No other relationship in Max-Eigen test can be found in the second and third sample period. Hence, the null hypothesis cannot be rejected for these sample periods. Though, the results show one statistically significant co-integration relationship in trace test.

The test confirms that a long-run relationship does not exist much between these stock markets. Thus they do not behave like a single, integrated regional market. A short-run relationship is going to be presence later in the Granger-causality test.

5.5 Testing for a unit root in the first difference

The Augmented Dickey-Fuller test in the first difference is made same way than the previous with one exception. Test is made by using the EVIEWS program in the first difference.

Table 12 ADF-test results in first difference

Results of the Augmented Dickey-Fuller test in the first difference. Test statistics, p-value and test critical values for different significance levels are presented in the table

Market		t-Statistics	p-value
Europe		-23,30706	<0.001
Hong Kong		-23,97252	<0.001
Japan		-24,74828	<0.001
Malaysia		-22,44874	<0.001
Philippines		-22,74578	<0.001
Singapore		-22,77558	<0.001
Thailand		-13,88351	<0.001
USA		-24,96000	<0.001
Test critical values:	1 % level	-3,464101	
	5 % level	-2,876277	
	10 % level	-2,574704	

As can be seen from the table 12 and as one would expect, the test statistics are much more negative for all eight indices than the critical values and they are also statistically significant. So, based on the large negative values the null hypothesis of a unit root in the first differences is convincingly rejected and the alternative that it is stationary is accepted.

5.6 Granger causality analysis

Pair-wise Granger causality tests are performed between all eight pairs of stock indices. This is because correlation does not necessarily imply causation in any meaningful sense of that word. In order to perform Granger causality tests, the proper lag length=5 is set according to the Schwarz criterion. Granger causality tests results for three sub-periods and overall time period are summarized in table 13. Confident level for the test is 95 %, while also 90 % significance level can be seen in the brackets.

Table 13. Results of the Granger causality test

Table covers the results from Granger causality analysis among the eight markets.

Market	Overall 7.1.2000-30.7.2010		IT/post-Asian crises 7.1.2000-28.2.2003		Growing period 7.3.2003-29.12.2006		Subprime crises 5.1.2007 - 30.7.2010	
	Affects	*Affected from*	*Affects*	*Affected from*	*Affects*	*Affected from*	*Affects*	*Affected from*
Europe	HK JPN SGP THA	HK (PHI) (SGP)	HK JPN SGP	HK SGP (USA)	MAL		JPN PHI SGP (HK)	
Hong Kong	EUR PHI THA USA	EUR (THA) USA	EUR	EUR SGP USA	MAL	MAL (PHI) (THA)	PHI	(EUR) PHI USA
Japan		EUR USA (PHI)		EUR USA			PHI	EUR PHI USA
Malaysia					HK	EUR HK SGP (USA)		
Philippines	(EUR) (JPN)	HK SGP THA USA		SGP USA THA	(HK)		HK JPN SGP (USA)	EUR HK JPN SGP USA
Singapore	THA PHI USA (EUR)	EUR USA	EUR PHI HK	EUR USA	MAL		PHI (USA)	EUR PHI (THA) USA
Thailand	PHI (HK)	EUR HK SGP USA	PHI		(HK)		(SGP)	USA
USA	HK JPN PHI SGP THA	HK SGP	HK JPN PHI SGP (EUR)		(MAL)		HK JPN PHI SGP THA	(PHI) (SGP)

The results verify once more that USA and Europe are undoubtedly the leading stock markets. The results are very similar compared to the previous correlation analysis. Singapore, Europe, Hong Kong and USA had the highest average correlation coefficient and same markets are affecting widely to other markets in Granger Causality tests. Especially the USA has a really dominant role towards other markets in Granger Causality tests. Vice versa Malaysia had the lowest correlation and is affecting to just Hong Kong during 2003-2007. Otherwise this growing period exhibit weak interrelationship and the markets are not affecting each other except with few markets affecting to Hong Kong.

During the current economic crisis, the causality among the stock markets is significantly differentiated. The interdependence among the price indices of 8 markets has become more tightened. Only Malaysia is not affected by any market. A possible explanation for this might be again internal changes in FTSE BURSA in 2009. Europe, USA and Hong Kong seem to have dominant influence, while the other markets are inconclusive.

6. CONCLUSIONS

The paper presents an empirical study on the interdependence between three developed countries/markets and five countries from South East Asian emerging markets in three different sample period. The objectives of this study were to find out if there are any benefits for an investor by diversifying internationally. Research is also focusing on the question whether the relationship between markets during tranquil periods are different from those during periods of crisis. The sample includes the weekly prices from 7 January 2000 to 30 July 2010. While analyzing the interdependence of markets, three subsets are examined, Post-Asian crisis/DotCom Bubble (7.1.2000-28.2.2003), growing period (1.3.2000-29.12.2006) and subprime crisis (30.12.2007-30.7.2010).Two well-known theories in the finance literature, the Capital Asset Pricing Model (CAPM) and the Modern Portfolio Theory (MPT), suggest that individual and institutional investors should hold a well-diversified portfolio to reduce risk, international portfolio diversification can be used as a means of reducing risk.

First we derived the simple correlation analysis. The average correlation coefficient for the entire time period was relatively small (0,4274). This Result indicates that an investor would still gain some benefits for an international diversification. However, from first to third sample period the average correlation coefficient has boomed from 0,3063 to 0,5198. Hence, the difference between third and first sample period is 0,2135. A possible explanation for the increasing correlation is integration and ongoing economic crises.

Goetzmann et al. (2002) pointed out that correlation coefficients across markets are likely to increase during the unstable economic conditions. As a result, during a crisis when stock market volatility increases, estimates of cross-market will be biased upward.

Results of interdependence should not only be based on correlation analysis because of some statistical limitations. Another technique to estimate co-integration was applied, The Johansen co-integration test. We analyzed long-run stock market price convergence among the eight markets. The Johansen test was employed after the non-stationary of time series was tested. The Augmented Dickey-Fuller (ADF) test was used to test the market data for non-stationary. The results suggested that these markets share one co-integrating vector in the whole time period and a bit more in the first sample period (IT/Post-Asian crises).

As a final step of this research, the presence of a short-run relationship was tested by using Granger-Causality test. Before that a unit root test was made in the first difference with the Augmented Dickey-Fuller test (ADF). The results are very similar compared to correlation analysis. Europe and USA seems to affect most to other examined markets. Hong Kong shows also quite significant role, which can be explained by a regional meaning. Also in this test the causality among markets has become more tightened during subprime crisis.

The test result of this research paper indicates that cross-market linkages have become more tightened during ongoing subprime crisis, this is interpreted as evidence of contagion. Generally, the magnitude and persistence of shocks that transmit to the other market are significantly larger in negative news compared to positive ones.

However, economic decrease alone cannot justify that various national stock markets had become so integrated that some markets exerted a strong influence on some other markets. Continuously increasing economic integration will also tend to increase interdependence and correlation in different markets. In the future the pace of interdependence may continue to speed up market integration. Due to the growing interdependence among the international markets, the benefits of international portfolio diversification may be overstated.

For further studies, longer time-span of the data could be studied. It would be also interesting to expand research to other market areas, especially in the South American and African emerging markets would be interesting area to explore. It would be also interesting to know if firms within the same industry to do poorly at the same time than firms from dissimilar industries. Similarly, should an investor diversify across industries to gain maximum benefit for diversification?

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