THE RELATIONSHIPS OF FINANCIAL ASSETS IN FINANCIAL MARKETS DURING RECOVERY PERIOD AND FINANCIAL CRISIS: EVIDENCE FROM THAILAND

Atinuch Kusolpalalert
Master of Science in Financial Economics, Assumption University

Abstract

The aim of this paper is to examine the long run relationship between SET index, gold price, 1-year, 2-year, and 10-year Government Bond Yield (GB), and 1-month and 3-month T-bill rate in Thai's financial market for the period between March 2001-December 2010 using Johansen method and to study their short-run adjustment through the Vector Error Correction Model (VECM) in order to find the speed of adjustment towards long run equilibrium. Moreover, this paper also tests the impact on each variable resulting from the changes in other variables by using Impulse Response Function and Variance Decomposition Test. Results found that during economic recovery period, SET index has positive relationship with gold price, 2-year GB yield, and 3-month T-bill rate. Meanwhile, during economic crisis, SET index has a positive relationship with gold price, 1-year, 10-year GB yields, and 3-month T-bill rate. The Vector Error Correction model indicated that in the recovery period SET index rapidly adjust itself back to equilibrium after deviating from long run path, while during crisis period 1-year GB yield is the fastest in adjusting back to long run equilibrium. Moreover, the Impulse Response Function presented that SET index is significantly affected by the shock of itself which is consistent with the Variance Decomposition Test which indicates that the variation of SET index is mainly due to the change of itself during the recovery period; while during crisis, SET index has a positive response to the shock of itself. Variance Decomposition Test reported that 98.95% of variation of SET index can be explained by its own changes.

Keywords: Cointegration, Financial crisis, Gold, Stock market, Bond market

บทคัดย่อ

บทความนี้มีวัตถุประสงค์เพื่อศึกษาความสัมพันธ์เชิงดุลยภาพระยะยาว ระหว่างดัชนีหุ้นตลาดหลักทรัพย์ ราคาทอง อัตราผลตอบแทนพันธบัตรรัฐบาลอายุ 1 ปี 2 ปี และ 10 ปี และตั๋วเงินคลังอายุ1 เดือน และ 3 เดือน ในตลาดการเงินประเทศไทยตั้งแต่ มีนาคม 2544 - ธันวาคม 2553โดยประมาณค่าด้วยวิธี Johansen และศึกษาการปรับตัวในระยะสั้นด้วยการสร้างแบบจำลองการปรับตัวในระยะสั้น (Vector Error Correction Model: VECM) เพื่อหาความเร็วในการปรับตัวเข้าสู่ดุลยภาพระยะยาว นอกจากนี้ยังทำการทดสอบผลกระทบของตัวแปรแต่ละตัวต่อการเปลี่ยนแปลงอย่างฉับพลันของตัวแปรอื่นโดยใช้วิธีการวิเคราะห์ปฏิกิริยาตอบสนองต่อความแปรปรวน (Impulse Response Function) และการทดสอบการแยกส่วนของความแปรปรวน (Variance Decomposition Test) จากการศึกษาพบว่าในช่วงเศรษฐกิจฟื้นตัว ดัชนีหุ้นตลาดหลักทรัพย์มีความสัมพันธ์ในทิศทางเดียวกันกับราคาทอง อัตราผลตอบแทนพันธบัตรรัฐบาล 2 ปี และตั๋วเงินคลังอายุ 3 เดือน ขณะที่ในช่วงวิกฤตการณ์ทางการเงิน ดัชนีหุ้นมีความสัมพันธ์กับราคาทอง อัตราผลตอบแทนพันธบัตรรัฐบาลอายุ 1 ปีและ 10 ปี และตั๋วเงินคลังอายุ 3 เดือนในทิศทางเดียวกัน ผลการศึกษาการปรับตัวระยะสั้นของดัชนีหุ้นจากแบบจำลอง VECM พบว่าในช่วงเศรษฐกิจฟื้นตัว มีการปรับตัวสู่ดุลยภาพระยะยาวเร็วกว่าตัวแปรอื่น ในขณะที่ช่วงวิกฤตการณ์ทางการเงินอัตราผลตอบแทนพันธบัตรรัฐบาล 1 ปีมีการปรับตัวสู่ดุลยภาพระยะยาวเร็วกว่าตัวแปรอื่น นอกจากนั้นผลการวิเคราะห์ปฏิกิริยาตอบสนองต่อความแปรปรวนมีความสอดคล้องกับการวิเคราะห์

การแยกส่วนของความแปรปรวนซึ่งพบว่าความผันผวนของดัชนีหุ้นส่งผลกระทบกับตัวมันเองทั้งในช่วงเศรษฐกิจฟื้นตัวและช่วงวิกฤตการณ์ทางการเงินโดยพบว่าความผันผวนของดัชนีหุ้นส่งผลกระทบกับตัวมันเองถึงร้อยละ 98.95

INTRODUCTION

The Thai financial market primarily consists of stock market, bond market, money market and gold market. The Stock Exchange of Thailand (SET) was established since 1974 and until the end of 2011 there were 471 listed companies in the market (Stock Exchange of Thailand (SET), 2011). It is an essential market as a source of funds for corporate and an alternative investment for investors rather than savings in banks. Besides, the Thai bond market was small and underdeveloped prior to the 1997 Asian financial crisis. There were only government and state enterprise bonds in the market till 1998 when the government issued bonds for the first time to support the lack of liquidity in the financial markets as a result of the crisis in 1997. Consequently, the market size and trade volume increased significantly in the bond market. The structure of the Thai bond market is divided into two major components, which are government bonds, and corporate bonds whereby government bonds accounted for approximately 85% of total market outstanding in the Thai bond market (Chabchitrchaidol & Panyanukul, 2005).

In addition, Money market, represented by Treasury bills (T-bills), is a short-term debt instrument with maturity less than 1 year. Treasury bills in Thailand were first issued in 1945 with a total value of THB 50 million, and were ceased in 1990. In September 1999, the government has begun reissuing Treasury bills. In general, Treasury bills typically have 28 days, 91 days, and 182 days maturity periods.

Furthermore, Gold market is another essential market in recent years. In Thailand, gold has become more popular after the US subprime crisis which began in late 2007. The investors' behavior, particularly in Thailand, has changed in the last few years from people who buy gold for jewelry to those that buy for speculating, which shows a new perspective of financial market development in Thailand.

The aim of this study is to investigate the long run and short run relationships among financial assets in the Thai financial market. The period of testing is divided into two sub-periods, the first period is economic recovery period after Asian financial crisis in 1997 starting from March 2001 to June 2007, and the second period is financial crisis period affected by US subprime crisis starting from July 2007 to December 2010. Johansen cointegration approach is used to test the long run movement of asset variables and Vector error correction (VEC) model is applied to examine the speed of adjustment of variables in the short run. Besides, the impulse response function and Variance Decomposition are utilized to measure the interaction of each asset to the shock of other assets in the markets. This empirical study is beneficial to the individual investors, whereby the understanding of financial assets' relationships and their movement will support the investors' decision in selecting the combination of assets in their portfolios to enhance the effective management of their asset allocations.

REVIEW OF THEORIES AND EMPIRICAL STUDIES

1. Modern Portfolio Theory

Modern portfolio theory is a theory related to maximizing expected return and minimizing risk by choosing the proportions of various assets in the portfolio. This is the fundamental concept of Markowitz (1952, 1959) in his work on "Portfolio Selection". He argued that the investor should maximize the expected return and minimize risk level in their portfolio by selecting a combination of various assets to obtain the highest returns in the future. Moreover, Haugen (2001) has stated that the investor can make a decision to allocate assets in order to diversify risk and earn the expected return in portfolio. He divided asset allocation decisions into 2 types (i) strategic asset allocation decisions as regards the relative amount of assets classes for long term investments and (ii) tactical asset allocation focusing on the short term adjustments when the prices of assets are changed to help investors rebalance their portfolios.

2. Related Empirical Studies

There are several papers which have applied cointegration method to examine long run relationships for financial assets. For instance, the research by Aktar (2009), Yang, Kolari, and Min (2003), Wang and Huyghebaert (2008), Chen, Gerlach, and Cheng (2009) and Azman-Saini, Azali, Habibullah, and Matthew (2002), Janak and Sarat (2008), Psillaki and Margaritis (2008) examined the cointegration of stock markets both internationally and domestically. The results of those papers found that the stock markets are integrated across countries, but major stock markets in the world such as US and Japan's stock market tend to influence performances of emerging markets in Asia. Moreover, the Asian stock markets are more integrated after the financial crisis in 1997.

Besides, the papers by Jeon, Ji, and Zhang (2012), Falkowska and Lewicki (n.d.), Laopodis (2008), and Mills and Mills (1991) studied the international linkages of the government bond yields across countries by using cointegration analysis. These studies found that there is no cointegration between bond markets and international bond markets, which implied that there is no existence of a long run relationship in the bond markets across countries. This is because bond yields are determined by the policy of each country.

Some empirical studies examined the relationship between stocks and bonds for instance, Ahmed (2009), Johansson (2010), and Lim, Ong, and Ho (2012) studied the relationship between stock and bond markets. The authors found that stocks and bonds have a negative correlation to each other. In addition, Hartmann, Straetmans, and de Vries (2004) analysed the comovement between stocks and bonds by focusing on the flight to quality case (meaning a crash in stock markets accompanied by a boom in government bond markets) by using a novel approach. The authors found that when stock markets crash, the investors will move their investment to bonds but this does not happen during market stability.

Moreover, there are few papers which studied the relationships between stocks, bonds and Treasury bills such as Antell (2004) who studied the volatility linkages in the Finnish stock, bond, and money markets. The author found that the volatility of bonds and money market does not influence stock market, but the money market volatility has a negative effect on both stocks and bonds markets. Recent research from Farrell (2011) analyses the return and risk data for major assets such as stocks, bonds, and T-bills over an 80 years period. The author found that stocks provided the highest risk as well as returns, whilst bonds generated a lower returns and lower variance than stocks. For the T-bills, it was found that there was little variance compared to bonds and they provided the lowest returns among different financial assets.

Furthermore, there are empirical studies on gold market and its relation to other asset markets such as stock indices, bonds and commodities indices. Researchers such as Dempster (2008), Herbst (1983), Lawrence (2003), Smith (2001, 2002), Wozniak (2008), Baur and Lucey (2009), and Do and Sriboonchitta (2010) applied Granger causality test and Johansen cointegration technique. Those authors concluded that the prices of gold move independently from stock markets, but gold prices and bonds move in the same direction. Besides, Ranson and Campbell (2005), and Gulati and Mody (1982) studied the role of gold as a safe haven, and as a leading indicator for inflation and interest rates. The results show that gold serves as a diversifier asset for investors during the financial market uncertainty as well as a good predictor of nominal long and short term interest rates.

Since the previous empirical studies have examined the relationships of various types of assets, this study uses similar methodology of Baur and Lucey (2009) as a guideline to identify the long run and short run relationship between the different types of financial assets by focusing on the domestic market in Thailand. The research framework and methodology are presented in the next section.

RESEARCH FRAMEWORK AND METHODOLOGY

1. The Conceptual Framework

The Johansen cointegration method is applied to examine the long run relationship among SET index, gold price, 1-year, 2-year, and 10-year government bond (GB) yields, and 1-month, 3-month Treasury bill (T-bills) rates using daily data for the economic recovery period, starting from March 2001 to June 2007 and the financial crisis period, starting from July 2007 to December 2010. Vector Error Correction Model (VECM) is used to test the speed of adjustment of asset variables in the short run dynamic. Apart from examining cointegration relationship, it is useful to identify the interaction of each variable to other variables by applying Impulse Response Functions to examine the response of assets. Variance decomposition is applied to test how one asset is influenced by the shocks of other assets in the model.

The variables in this paper consist of (i) SET index, denoted by (SET), (ii) Gold price, denoted by (Gold) is the selling price which is quoted in Thai Baht, (iii) 1-year, 2-year, and 10-year government bond (GB) yields, denoted by (GB1Y), (GB2Y), and (GB10Y), respectively, (iv) 1-month and 3-month Treasury bill rates representing the short-term interest rates in money market, denoted by (TBILL1M) and (TBILL3M). All variables are daily data and collected from March 2001 to December 2010. The raw data was obtained from Bloomberg for SET index and gold prices. Government bond yields and Treasury bill rates were gathered from the website of Thai Bond Market Association (www.Thaibma.or.th). All variables are converted into the natural logarithm form for cointegration analysis.

2. Methodology

For the workflows of testing Johansen cointegration, all variables have to undergo the Unit root test. The Augmented Dickey-Fuller (ADF) unit root test is applied to each individual variable. The test of the unit root hypothesis was introduced by Dickey and Fuller (1979, 1981) and the following hypotheses are tested:-

$H_0: \beta = 0$ (variable contains a unit root), and

$H_1: \beta = 0$ (variable is stationary)

The null hypothesis (H0) is rejected if t-statistics is smaller (negative) than the critical value, it means that the series are stationary (Griffiths, Hill & Lim, 2007).

Secondly, the important step is to select an appropriate lag length to be included in the model. This research uses Akaike Information Criteria (AIC) to compute the optimal lag length where the smaller value of AIC is selected (Harris, 1995).

After obtaining the order of integration using ADF test and the optimal lag length to be included in the model, the Johansen cointegration analysis is used to investigate the long run relationship of variables in the model. The important aspect of conducting Johansen cointegration test is to determine the number of cointegrating vector (r) or rank. There are two statistical tests to determine the rank (r) which are trace test and maximum eigenvalue.

The functional forms of test are given as;

$$\lambda_{trace}(r) = -T\sum_{i=r+1}^{g}\ln\left(1-\hat{\lambda}_i\right) \text{ and}$$

$$\lambda_{max}(r, r+1) = -T\ln\left(1-\hat{\lambda}_{r+1}\right)$$

where r is the number of co-integrating vectors and $\hat{\lambda}_i$ is the estimated value for the ith ordered eigenvalue (characteristic roots) from the Π matrix. T is the number of observation.

The hypothesis of λ_{trace} are;

$H_0: r = 0 \quad H_1: 0 < r < g$

The hypothesis of X_{max} are;

$H_0: r = 0 \quad H_1: 0 < r + 1$

For the hypothesis of trace statistic, if the null hypothesis ($r = 0$) cannot be rejected, then it implied that there is no cointegrating vectors. Consequently, the test for long run relationships is completed because if there is no long run relationship, then there is no short run relationship as well. However, if the null hypothesis ($r = 0$) is rejected, then it implies that there is cointegrating vector, and there is existence of long run relationship among variables (Brooks, 2002).

Johansen cointegration test is based on vector error correction model (VECM). This is because

VECM is a useful technique for testing for cointegration in a whole system of equations in one step and without requiring a specific variable to be normalized (Maysami & Koh, 2000). The functional form of VECM is presented as follows:

$$\begin{bmatrix} \Delta GOLD_t \\ \Delta SET_t \\ \Delta GB10Y_t \\ \Delta GB2Y_t \\ \Delta GB1Y_t \\ \Delta TBILL3M_t \\ \Delta TBILL1M_t \end{bmatrix} = \sum_{i=1}^{k-1} \Gamma_i \begin{bmatrix} \Delta GOLD_{t-i} \\ \Delta SET_{t-i} \\ \Delta GB10Y_{t-i} \\ \Delta GB2Y_{t-i} \\ \Delta GB1Y_{t-i} \\ \Delta TBILL3M_{t-i} \\ \Delta TBILL1M_{t-i} \end{bmatrix} + \Pi \begin{bmatrix} \Delta GOLD_{t-k} \\ \Delta SET_{t-k} \\ \Delta GB10Y_{t-k} \\ \Delta GB2Y_{t-k} \\ \Delta GB1Y_{t-k} \\ \Delta TBILL3M_{t-k} \\ \Delta TBILL1M_{t-k} \end{bmatrix} + \begin{bmatrix} \mu_1 \\ \mu_2 \\ \mu_3 \\ \mu_4 \\ \mu_5 \\ \mu_6 \\ \mu_7 \end{bmatrix}$$

This model contains seven variables of the first difference, and k-1 lags of the first differenced dependent variables μ_t is the white noise residual vector with E (μ_{it}) = 0, E (μ_{1t}, μ_{2t}) = 0 where i = 1, 2, ..., k-1 and $\Gamma_i = \left(\sum_{j=1}^{i} \beta_j\right) - I_g$ where represents short-term adjustments among variables across seven equations at the *i*th lag.

$\Pi = \left(\sum_{j=1}^{k} \beta_i\right) - I_g$ the Π matrix contains the coefficients of long run equilibrium of seven variables in the data vector. It can be defined as $\Pi = \alpha\beta'$, where α is the speed of adjustment to disequilibrium, β is a matrix of long run coefficients.

Finally, to determine how one variable responds over time to a shock of other variables or its own shock, Impulse Response Function (IRF) approach is used to examine how the shock of one asset can effect to other assets in different markets. Variance Decomposition is useful to determine how much of the forecast error variance for any variables in a system can be explained by innovations (or shocks) to each explanatory variable in the system over a time horizon (Brooks, 2002). This analysis will identify how each asset contributes to the shock of other assets and the volatility transmission across markets.

RESULTS

1. Unit Root Test

As cointegration requires that the variables are stationary in the same level or integrated of the same order, the use of Augmented Dickey Fuller (ADF) with no intercept and no trend is applied. The null hypotheses of unit root in both periods of March 2001-June 2007 and July 2007-December 2010 cannot be rejected for each individual variable at 95% confidence level, and it suggested that all variables are non-stationary. Then each variable is tested at the first difference and the results show that the null hypotheses of unit root test in the first difference can be rejected at 95% confidence level, and it indicates that all variables are stationary. Hence, all variables are integrated at level one or I(1) which means that they are stationary after the first difference.

2. Lag Length Selection Criteria

The results presented in table 1 are the optimal lag length, which is selected based on the lowest values of Akaike Information Criterion (AIC). Thus, AIC determined 6 lags (-44.99688) for the first period (Mar. 2001 - Jun.2007) and 3 lags (-40.65263) for the second period (Jul.2007 - Dec.2010).

Table 1: Lag Order Selection

Lag	AIC (Mar.01-Jun.07)	AIC (Jul.07-Dec.10)
0	-11.83583	-10.46646
1	-44.56368	-40.19277
2	-44.85608	-40.62459
3	**-44.83932**	**-40.65263***
4	-44.83831	
5	-44.82924	
6	**-44.99688***	

3. Johansen Cointegration Test

Table 2 and 3 present the trace statistics which indicate that the period from Mar. 01 to Jun. 07, the null hypothesis of 3 cointegrating equations cannot be rejected at 5% significance level, while in the period from Jul. 07 to Dec. 10, the null hypothesis of 4 cointegrating equations cannot be rejected at 5% significance level. This implies that there is existence of long run relationships among asset variables in both periods.

Table 2 and 3 presents the results of the λ_{trace}

Table 2: Johansen Cointegration Test Summary for Mar. 01-Jun. 07

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.043425	187.9281	111.7805	0.0000
At most 1 *	0.032096	114.8962	83.93712	0.0001
At most 2 *	0.019363	61.23176	60.06141	0.0397
At most 3	0.009814	29.06705	40.17493	0.4047
At most 4	0.004388	12.84306	24.27596	0.6349

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level
*denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 3: Johansen Cointegration Test Summary for Jul. 07-Dec. 10

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.068040	178.6088	111.7805	0.0000
At most 1 *	0.036993	114.4851	83.93712	0.0001
At most 2 *	0.035823	80.18318	60.06141	0.0004
At most 3 *	0.029699	46.98637	40.17493	0.0089
At most 4	0.010821	19.55128	24.27596	0.1759

Trace test indicates 4 cointegrating eqn(s) at the 0.05 level
*denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

and λ_{Max} tests. Based on the above results, it concludes that there are 3 cointegrating relationships at 5% significance level for the period from Mar. 01 to Jun. 07 and there are 4 cointegrating relationships at 5% significance level for the period from Jul. 07 to Dec. 10. For normalizing with respect to SET index, the cointegrating coefficients of long run relationship of SET to other assets during recovery are given below;

$$\beta = (1.00, -3.707384, 253.0218, -122.0847, 25.88216, 188.5573, -328.0658)$$

and this gives the cointegraing relation as;

$$LSET_t = 3.707384LGOLD_t - 253.0218LGB1Y_t + 122.0847LGB2Y_t - 25.88216LGB10Y_t - 188.5573TBILL1M_t + 328.0658TBILL3M_t$$

During economic recovery period, it shows that the SET index has a positive correlation with gold price, 2-year GB yield and 3-month T-bill rate, while SET index has an inverse correlation with 1-year, 10-year GB yields and 1-month T-bill rate.

For the crisis period, after normalizing with respect to SET index, the cointegrating coefficients of long run relationship of SET to other assets are given below;

$$\beta = (1.00, -0.683334, -11.27484, 7.717752, -0.646741, 8.115458, -4.039348)$$

and this gives the cointegraing relation as;

$$LSET_t = 0.683334LGOLD_t + 11.27484LGB1Y_t - 7.717752LGB2Y_t + 0.646741LGB10Y_t - 8.115458TBILL1M_t + 4.039348TBILL3M_t$$

For the financial crisis period, the coefficients of gold price, 1-year, 10-year GB yields and 3-month T-bill rate have a positive relation to SET index but the 2-year GB yield and 1-month T-bill rate show a negative relation to SET index. The next steps will analyze the short-term relationships among financial asset variables.

4. Vector Error Correction Estimation (VECM)

Table 4 presents the results of the VEC estimation during recovery period and crisis period. It shows the coefficient of lagged variables in the error terms which measure the speed of adjustment of variable after deviating from long run equilibrium. During recovery period, the coefficient of SET index implies that the speed of adjustment in the short run deviation from the long run path is faster than

Table 4: Results of Vector Error Correction Estimation

Error Correction:	SET	GOLD	GB1Y	GB2Y	GB10Y	TBILL1M	TBILL3M
1st period	-0.000142	-0.0000503	-0.0000321	0.0000656	-0.0000475	-0.000068	0.0000734
	[-3.784]***	[-1.92954]*	[-1.08856]	[1.78457]*	[-1.54962]	[-1.71386]*	[2.22644]**
2nd period	0.000268	-0.000096	0.006598	0.001117	0.001351	-0.002152	0.001261
	[0.15795]	[-0.07112]	[5.37437]***	[0.78149]	[0.86997]	[-1.70291]*	[1.09159]

Note: Figures in ( ) indicate Standard errors & [ ] indicate t-statistics

[*] indicates significant at 90% confidence level, [**] indicates significant at 95% confidence level, [***] significant at 99% confidence level.

other assets by moving downward to the long run equilibrium by approximately 0.000142 percent. In the crisis, the speed of adjustment of 1-year GB yields in the short run increased as compared with the earlier period because its coefficient value 0.006598 percent adjusted itself when it moved away from long run path by rising upward to long run equilibrium.

5. Impulse Response Function (IRF) Analyses

During the recovery period, IRF results show the response of assets in the market to the shocks of stock market considering 5 days market variations. It found that all financial assets have a negative response to the stock market shock immediately but only 10-year GB yield has a positive response 2 days later. It indicated that stock market has a low response to the shock of other assets in the markets, while gold price has a negative response to the shock of stock market and bond market. Moreover, 2-year and 10-year GB yields have an inverse response to the shock of 3-month T-bill rate. Furthermore, during financial crisis, the results show that government bond yields and Treasury bill rates have a positive response to the stock market shock while gold price has a negative response and only little impact from the stock market shock. Meanwhile, SET index and gold price have a negative response to the shocks of bond market and T-bills, but Gold price has a positive response to the shock of 3-month T-bill rate. Bond market has an inverse response to the change in 10-year GB yield and 3-month T-bill rate. In addition, T-bills rates have an inverse response to the change of 10-year GB yield.

6. Variance Decomposition Analyses

The variance decomposition results found that during the recovery period the changes in SET index and gold price can be fully explained by their own shocks where variations are mainly due to their own changes 99%. For government bond yields, variations are attributed mainly from the shock in the bond market as well as stock market. For, 1-month and 3-month T-bill rates variations attributed from 1-year GB yield of 25.77% and 35.97%, respectively. These results imply that the variations of stock market and gold price have limited impact from the changes of other assets in the markets during recovery period.

On the other hand, during the financial crisis the variation of SET index is completely explained by its own shock in the first day and then decreases to 98.95% after 5 days where variation is attributed to the 10-year GB yield. Similarly, gold's variation is mainly explained by itself on the first day and 5 days after the shock impact from itself and 1-year GB yield decreased to 97.68%. For bond market, variation in 1-year and 2-year GB yields are attributed to the variation of 10-year GB yields. Furthermore, the variations of T-bill rates are attributed by themselves and 1-year GB yield. Thus, results in both periods show that variations of stock market and gold price are mainly explained by its own shock.

CONCLUSION AND RECOMMENDATIONS

During the recovery period, SET index, gold price, 2-year GB yield, and 3-month T-bill rate move in the same direction in the long run. In the short run, SET index seems to adjust itself fastest after shifting away from long run path, while 1-year and 10-year GB yields move independently of the SET index. For the crisis period, SET index, gold price, 1-year and 10-year GB yields have moved together in the long run, whereas 3-month T-bill rate show, a insignificant and negative relationship to stock market. It implies that 3-month T-bill will not impact stock market volatility. While the testing of speed of adjustment in the short run, it is found that 1-year GB yield has rapidly adjusted itself after deviating from long run path. Thus, the investor may select shares, gold, and Government bonds, which have maturity longer than 1 year, in order to diversify risks in their portfolios and consider 1-year, 10-year GB as a hedger during the recovery period. Besides, the shares, gold, 1-year and 10-year GB, and 3-month T-bill should be considered for investment in the long run.

However, the results of impulse response indicates that gold responds negatively to the shock of stock market. Hence, it can be either a hedger or diversifier against stock market when the market is unstable. Moreover, the variation of stock market is mainly due to its own shock according to variance decomposition results.

Additionally, for allocating assets in a portfolio, investors should consider the economic factors and political situations in domestic and outside countries to make decision in managing their portfolio apart from the asset correlations.

For further research on Thai financial markets, researchers should focus on the relationships of financial assets between Thailand and other Asian countries. The study on the cointegration relationships of various types of assets in the international markets will be beneficial to the investors which will help to enhance the efficiency in their portfolio management, asset allocation and risk diversification across markets.

References

Ahmed, J. A. (2009). The equilibrium relations between stock index and bond index: Evidence from Bursa Malaysia. *International Research Journal of Finance and Economics*, 30, 7-17.

Aktar, I. (2009). Is there any Comovement Between Stock Markets of Turkey, Russia and Hungary? *Journal of Finance and Economics*, 26, 192-200.

Antell, J. (2004). *Volatility Linkages in the Finnish Stock, Bond, Money markets*. Swedish School of Economics and Business Administration. Switzerland: EMFA 2004. Retrieved October 15, 2011, from http://papers.ssrn.com

Azman-Saini, W., Azali, M., Habibullah, M. S., & Matthews, K. G. (2002). Financial integration and the ASEAN-5 equity markets. *Applied Economics*, 34(18), 2283-2288.

Baur, D. G., & Lucey, B. M. (2009). Is gold a hedge or a safe haven? An analysis of stock, bonds and gold. *The Financial Review*, 45(2), 217-229.

Brooks, C. (2002). *Introductory Econometrics for Finance* (2nd ed.). Cambridge: Cambridge University Press.

Chabchitrchaidol, A., & Panyanukul, S. (2005). *Key Determinants of Liquidity in the Thai Bond Market*. Bank of Thailand. Bangkok: Bank of Thailand.

Chen, W. S., Gerlach, H. R., & Cheng, Y. P. (2009). The Impact of Structural Breaks on the Integration of the Asean-5 Stock Markets. *Social Science Research Network (SSRN)*, 3-24. Retrieved from http://ssrn.com/abstract=1410605

Dempster, N. (2008). What does a *US recession imply for the gold price?* London: World Gold Council.

Dickey, D. A., & Fuller, W. A. (1979). Distributions of the estimators for Autoregressive Time Series with a Unit Root. *Journal of the American Statistical Association*, 75, 427-431.

Dickey, D. A., & Fuller, W. A. (1981). Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root. *Econometrica*, 49, 1057-1072.

Do, G. Q., & Sriboonchitta, S. (2010). *Cointegration and Causality among International Gold and ASEAN Emerging Stock Markets*. Retrieved December 5, 2012, from SSRN: http://ssrn.com/abstract=1533919

Falkowska, A., & Lewicki, P. (n.d.). *Analysis of European, American and Japanese bond* *yields: Stationarity, cointegration, Granger causality*. Retrieved April 7, 2012, from http://homepage.univie.ac.at/robert.kunst/tser11_proj_falkowka.pdf

Farrell, L. J. (2011). Asset allocation under extreme uncertainty. *Journal of Portfolio Management*, 37(2), 72-82.

Griffiths, E. W., Hill, R. C., & Lim, C. G. (2007). *Using Eviews for Principles of Econometrics* (3rd ed.). John Wiley & Sons, Inc.

Gulati, I. S., & Mody, A. (1982). International gold price movements, 1972-1982. *Economic and Political Weekly*, 17, 46, 1861-1870

Harris, R. (1995). *Using cointegration analysis in econometric modelling*. New Jersey: Prentice Hall International Inc.

Hartmann, P., Straetmans, S., & de Vries, C. G. (2004). Asset market linkages in Crisis periods. *Review of Economics & Statistics*, 86(1), 313-326.

Haugen, R. A. (2001). *Modern Investment Theory* (5th ed.). New Jersey: Prentice Hall International Inc.

Herbst, F. A. (1983). Gold versus U.S. common stocks: some evidence on inflation hedge performance and cyclical behavior. *Financial analysts journal*, 66-74.

Janak, R., & Sarat, D. (2008). *Integration of India's stock market with global and major reginal markets*. Retrieved November 20, 2012, from BIS Paper No. 42: http://www.bis.org/publ/bppdf/bispap42h.pdf

Jeon, B. N., Ji, P., & Zhang, H. (2012). *International linkages of Japanese bond markets: an empirical analysis*. Australia: MPRA. Retrieved from http://mpra.ub.uni-muenchen.de/36929/

Johansson, C. A. (2010, April). Stock and Bond Relationships in Asia. (*CERC Working Paper* No. 14), China Economic Research Center, Stockholm School of Economics. Retrieved from http://www.hhs.se/cerc

Laopodis, T. N. (2008). Government Bond Market Integration within European Union. *International Research Journal of Finance and Economics* (19), 56-76.

Lawrence, C. (2003). *Why is gold different from other assets? An Empirical Investigation*. London: World Gold Council.

Lim, S. Y., Ong, S. L., & Ho, C. M. (2012). Co-Movement Between Malaysian Stock Index and Bond Index: Empirical Evidence from Rank Tests for Cointegration. *Journal of Applied Finance*, 18(1), 5-18.

Markowitz, M. H. (1952). Portfolio Selection. *The Journal of Finance*, 7(1), 77-91.

Markowitz, M. H. (1959). *Portfolio Selection: Efficient Diversification of Investments*. New York: Wiley.

Maysami, R. C., & Koh, T. S. (2000). A vector error correction model of the Singapore stock market. *International Review of Economics and Finance*, 9, 79-96.

Mills, T. C., & Mills, A. G. (1991). The International Transmission of Bond Market Movements. *Bulletin of Economic Research*, 43(3), 273-282.

Psillaki, M., & Margaritis, D. (2008). Long run interdependence and dynamic linkages in international stock markets: Evidence from France Germany and the U.S. *Journal of Money, Investment and Banking*, 4, 59-73.

Ranson, D., & Campbell, R. (2005). *Gold as a leading indicator of inflation. London: World Gold Council*. Retrieved January 10, 2011, from World Gold Council: http://www.gold.org/value

Smith, G. (February 2002). *London gold prices* and stock price indices in Europe and Japan. London: World Gold Council.

Smith, G. (November 2001). *The price of gold and stock price indices for the United States*. London: World Gold Council.

Stock Exchange of Thailand. (2011). *Annual Report 2011: Stock Exchange of Thailand*. Thailand. Retrieved from http://www.set.or.th/en/about/annual/files/AW%20SET_ar11_en_lowres_update.pdf

Wang, L., & Huyghebaert, N. (2008). *The Co-Movement of Stock Markets in East Asia. Did the 1997-1998 Asian Financial Crisis Really Strengthen Stock Market Integration?* United Kingdom: The Chinese Economic Association. Retrieved from http://www.ceauk.org.uk

Wozniak, R. (2008). *Is gold a volatile asset? London: World Gold Council*. Retrieved from

http://www.gold.org/
Yang, J., Kolari, J., & Min, I. (2003). Stock market integration and financial crisis: the case of Asia. *Applied Financial Economics*, 13, 477-486.

About the Author:

Atinuch Kusolpalalert obtained her Masters of Science in Financial Economics from Martin de Tours School of Management and Economics. Her email address is atinuch k @ yahoo.ocm