CHAPTER 3

On the Linkages between Exchange Rate, Stock Return, Bond Yield and Interest Rate in a Regime-Switching Model: Evidence from ASIAN Countries

This chapter is extracted from the original article named "On the linkages between Exchange rate movements, stock, bond and interest rate market in a regime-switching model: Evidence for ASIAN countries", which was published in "Special Issue on Applied Mathematics: Bayesian Econometrics" of the Thai Journal of Mathematics (2016), pp. 161-181 and this article can be found in Appendix A.

3.1 Introduction

With the development of international financial markets, the stock index, exchange rate, government bond yield and interest rate can grow more interacting via trade flow and capital flow. Volatility affecting one market may be transmitted rapidly to another by contagion effects. Estimating and understanding the dynamic linkages have important implications for asset allocation, portfolio diversification, currency risk hedging, the return predictability from stock and currency market. In this chapter, we investigate whether the spill-over effects exist and take place or not across exchange rate (against US dollar), interest rate, government bond and the stock markets. This study will cover six East and Southeast Asian countries because financial markets in Asia have become more attractive for foreign capital investment and these countries in particular have grown more export-dominant in recent decades. Hence, the goal of this paper is aimed at examining profoundly the various relationships between these four financial markets and providing the explanation for the different empirical results. To achieve our purpose, the Markov Switching Vector error correction model (MS-VECM), which was introduced in Krolzig, Marcellino, and Mizon (2002), is employed in this study. The model has an ability to examine the co-integrated structure of variables, and to capture the long-term correlation of the variables in the financial model and it can also explain the non-linearity embedded in the relationship of financial markets in each country. In order to estimate the parameters in the model, we select a Bayesian estimation technique because the computation in the conventional maximum likelihood method may be difficult in our case where we have a great number of unknown parameters in the model. Moreover, with the Bayesian prior for our estimated parameter, it is possible to decrease the estimation uncertainty and to gain accurately the inference.

3.2 Methodology

In this chapter, the Markov Switching Vector error correction model (MS-VECM) is employed to scrutinize profoundly the various relationships among four financial markets. In order to estimate the parameters in the model, we select a Bayesian estimation technique. Therefore, we choose a prior density for our parameters following the estimation by Doan in RATS software. From the priors times the likelihood functions, we can obtain the posterior densities. In this study, 10,000 iterations samples were produced utilizing the MCMC Gibbs sampling estimation procedure as presented in Chapter 2. The first 1,000 samples were abandoned and the surplus 9,000 samples were employed to depict the joint parameter density. Consequently, we can acquire the posterior means and standard deviations of these remaining samples.

3.3 Data

The data were collected from Thomson DataStream, Chiang Mai University, the selected variables consist of exchange rate, stock price, interest rate and bond yield from Thai, Malaysian, Singapore, Japanese, South Korean, and Chinese financial markets. The data are weekly, which are during the period from March 2009 to February 2016, covering totally 362 observations. In addition, we transformed these variables into logarithms before estimating in the model.

3.4 Empirical Results

3.4.1 The results of unit roots test

Before conducting the Markov-switching with co-integration analysis, it is important to decide the order of integration for all variables in order to make sure that they are non-stationary and not integrated at the zero order. In this study, we used the Bayes factor unit root test of Wang and Ghosh (2004) to tell the order of integration of our variables.

In this study, we specify the null hypothesis of unit root as $H_0 = P(\phi = 1 | \Delta y_t)$ and the alternative hypothesis as $H_a = P(0 < \phi < 1 | \Delta y_t)$. The null hypothesis can be determined as the marginal likelihood of AR(1) model $\Delta y_t = a + (\phi - 1)\Delta y_{t-1} + \varepsilon_t$ where $\phi = 1$ while $0 < \phi < 1$ for an alternative marginal likelihood of AR(1) model. In this test, Bayes factor is the posterior odd ratio $P(\phi = 1 | \Delta y_t) \ / \ P(0 < \phi < 1 | \Delta y_t)$ and the null hypothesis is rejected if Bayes factor is less than 1. The results of the Bayes factor are demonstrated in Table 3.1, which exhibited that the logarithm of all variables are I(1) and I(2).

Table 3.1 Bayes factor unit root test

Variable	Bayes factor	Integrated order
SET	0.9969	I(2)
THB	0.7862	I(2)
THI	0.9978	I(2)
THBY	0.9979	I(2)
KLSE	0.9997	I(1)
MYR	0.1926	I(1)
MYI	0.9993	I(1)
MYBY	0.9972	I(1)
STI	0.9979	I(1)
SGD	0.9999	I(1)
SGI	0.9976	I(2)
SGY	0.9945	I(2)
Nikkei	0.9993	I(1)
JPY	0.9934	I(2)

Table 3.1 (Continued)

Variable	Bayes factor	Integrated order
JPI	0.9999	I(2)
JPBY	0.9990	I(1)
KOSPI	0.9978	I(1)
KWR	0.2799	I(2)
KI	0.9986	I(1)
KBY	0.9583	I(1)
SSE	0.5438	I(1)
CHY	0.9343	I(2)
CHI	0.9996	I(1)
CHBY	0.9994	I(1)

3.4.2 Lag length selection

In this part, we are going to identify the lag length for the MS-VECM model in order to choose the shortest lags which produce serially uncorrelated residuals. In order to find the best number of lag lengths, we are going to use the vector error correction lag length criteria. When it comes to the VECM lag length criteria based on BIC, the results are showed in Table 3.2, which make clear that the BIC values for lag=1 are the lowest. As a result, this study selects the proper lag length p=1 to estimate our model.

Table 3.2 VECM Lag length criteria

Country	Lag	BIC
Thailand	1	4.668841*
	2	4.868588
	3	5.09762
	4	5.342994
Malaysia	1	-1.674580*
	2	-1.44877
	3	-1.23569

Table 3.2 (Continued)

Country	Lag	BIC
	4	-1.00201
Singapore	1	1.165207*
	2	1.315242
	3	1.459583
	4	1.576193
Japan	1	14.02791*
	2	14.08883
	3	14.21729
	4	14.35055
Korea	1	12.88807*
	2	13.1272
	3	13.33543
	4	13.50933
China	1	1.954617*
	2	2.147083
	3	2.334305
	4	2.51713

3.4.3 Test for number of co-integration

In order to investigate the rank of the number of co-integration vectors, Bayesian information criteria (BIC) is conducted and the results are displayed in Table 3.3. This study selects the rank of the long-term correlation employing BIC, which was gained from VECM with a conjugate prior. This study defined 0.10, 0.10, and 0.50 as a tightness parameter, a decay parameter, and a parameter for the lags of the variables, respectively. Based on the results of co-integration selection shown in Table 3.3, the models of Thailand, Malaysia, Japan, and Korea present the lowest value of BIC at one co-integrating vector, while Singapore and China have two and zero number of co-integration, respectively. Therefore, the study chose r = 1 for Thailand, Malaysia, Japan, and Korea, r=2 for Singapore, and r=0 for China (MS-VAR).

Table 3.3 Co-integration rank selection

BIC	r=0	r=1	r=2	r=3
Thailand	-20.3081	-20.3634	-20.3571	-20.3337
Malaysia	-23.5417	-23.5848	-23.5785	-23.5663
Singapore	-12.9893	-13.0257	-13.3597	-12.8657
Japan	-11.6093	-11.6653	-11.6005	-11.5077
Korea	-20.5098	-20.5454	-20.5446	-20.5218
China	-23.9792	-23.9220	-23.8084	-23.6927

3.4.4 Model estimation result

In this section, the estimated results of six financial markets in six countries are presented in Tables 3.4-3.9. The results contain the estimated parameters in the model and the transition matrix.

Table 3.4 Estimated MS(2)-VECM(1): Thailand

	SET	**THB**	**THI**	**THBY**
Regime-dependent intercepts				
Regime 1	-9.751(2.530) [a]	-0.084(2.191)	21.962(17.788)	5.077 (2.884)
Regime 2	-11.696(2.554) [a]	3.602(1.675) [a]	-11.494(10.692)	-0.462(2.348)
Regime-dependent Autoregressive parameters at lag 1				
Regime 1				
SET	0.022(0.464)	-260(0.239)	1.467(0.969)	0.661(0.676)
THB	-1.632(2.164)	0.218(0.592)	1.778(2.743)	0.561(1.904)
THI	-0.460(0.753)	-0.161(0.137)	1.275(0.775)	0.530(0.559)
THBY	-0.389(0.281)	-0.202(0.143)	0.865(0.747)	0.847(0.365) [a]
ECT(1)	-0.187(0.027) [a]	-0.039(0.024)	0.234(0.196)	0.043(0.033)
Regime 2				
SET	-0.428(0.726)	0.087(0.212)	-0.049(0.892)	-0.063(0.380)
THB	-1.763(2.946)	0.583(0.675)	-0.256(3.387)	-0.147(1.258)
THI	0.751(0.812)	-0.236(0.151)	0.990(0.742)	-0.092(0.337)
THBY	-0.272(0.448)	-0.068(0.119)	-0.081(0.545)	0.365(0.301)
ECT(1)	-0.208(0.028) [a]	0.002(0.019)	-0.136(0.118)	-0.020(0.027)

	p_{1t}	p_{2t}	**Duration**	**Observations**
Regime 1	0.982	0.020	55.55	186
Regime 2	0.018	0.980	50	175

() is standard deviation, a is significant

The estimated parameters of MS(2)-VECM(1) model, in the case of Thailand are shown in Table 3.4. Apparently, the estimated intercept parameters seem to have a statistically significant economic interpretation. The values of the intercept term in regime 2 are mostly lower than those in regime 1 and thus we can interpret regime 2 as low growth economic state and regime 1 as high growth economic state. The four error correction terms (ECT(1)) are shown in both regimes. The first important feature of these estimates is that there exists a weakly exogenous variable. Consider regime 1, in all four equations, there is only SET that will adjust significantly if the index deviates from the long-run price equilibrium. For all other equations, no significant adjustments are observed in case of a short-run deviation from their equilibrium, which suggests that these variables are weakly exogenous. Thus, we can say that SET index has the long-term relationship and short-term adjustment dynamics, thus, the deviation of SET index from long-term equilibrium is corrected gradually through a series of partial short-term adjustments. Similar to regime 1, there is only SET that has a statistically significant long-term relationship and short-term adjustment dynamics. However, the results show that SET index adjusted more rapidly in the high growth markets since the speed of adjustment to long-term equilibrium of ECT(1) in regime 1 is larger than regime 2. The results furthermore show that THBY is significantly affected by its own lag in regime 1.

Consider the matrix of transition probability parameters, which are also reported in Table 3.4. The result shows that the probabilities of switching between regime 1 and regime 2 are less than 2%, while those of remaining in their own regime are more than 98%, meaning that the two regimes are persistent. Moreover, the expected number of months that the economy stays in high growth and low growth are 55.55 and 50 weeks, respectively. This means that the Thai economy stays in high growth state slightly longer than in low growth one.

Table 3.5 Estimated MS(2)-VECM(1): Malaysia

	KLSE	MYR	MYI	MYBY
Regime-dependent intercepts				
Regime 1	4.895(0.233) [a]	0.417(0.083) [a]	0.518(0.134) [a]	-1.336(0.117) [a]
Regime 2	2.225(0.117) [a]	0.153(0.203)	-4.715(0.203) [a]	1.811(0.090) [a]

Table 3.5 (Continued)

	KLSE	MYR	MYI	MYBY
Regime-dependent Autoregressive parameters at lag 1				
Regime 1				
KLSE	0.455(0.453)	0.260(0.158)	-0.108(0.255)	0.006(0.224)
MYR	0.469(0.638)	0.758(0.228) [a]	0.543(0.363)	0.104(0.317)
MYI	-0.441(0.634)	-0.423(0.233)	0.272(0.356)	-0.222(0.331)
MYBY	-0.074(0.304)	-0.030(0.108)	-0.295(0.173)	0.229(0.153)
ECT(1)	0.068(0.006) [a]	0.002(0.002)	0.015(0.004) [a]	0.072(0.003) [a]
Regime 2				
KLSE	-0.073(0.316)	0.589(0.543)	0.724(0.545)	-0.151(0.238)
MYR	-0.610(0.403)	0.782(0.692)	0.722(0.689)	0.128(0.299)
MYI	-0.935(0.270) [a]	-0.898(0.458)	-0.452(0.472)	-0.030(0.203)
MYBY	-0.883(0.213)	-0.174(0.362)	-0.942(0.371) [a]	0.374(0.158) [a]
ECT(1)	0.140(0.003) [a]	0.031(0.006)	0.157(0.006) [a]	-0.011(0.002) [a]
	p_{1t}	p_{2t}	**Duration**	**Observations**
Regime 1	0.987	0.021	76.923	135
Regime 2	0.013	0.979	47.619	226

() is standard deviation, a is significant

Table 3.5 presents the estimated results of Malaysia financial market. Regimes 1 and 2 are also interpreted as high and low growth economic states, respectively. Consider regime 1, we found that MYR has a positive significant effect from its own lag. In addition, the error correction term (ECT(1)) of KLSE, MYI, and MYBY show a significant adjustment in the short-run deviation. However, the values of the ECT(1) of these equations are all positive, which means that they diverge from the long-term equilibrium. For regime 2, we can see that the coefficients of KLSE and MYI equations demonstrate that the lagged MYI and MYBY seem to significantly influence KLSE and MYI, respectively. Consider the ECT(1) of this regime, the similar result is obtained except for the ECT(1) of MYBY equation. The error correction term of MYBY is statistically significant negative and lies between 0 and -1, which means that only Malaysian bond yield is co-integrated with Kuala Lumpur Stock Exchange, Malaysia ringgit and interest rate, respectively.

Consider the matrix of transition probability parameters, which are also reported in Table 3.5. The result tells us that regime 1 and regime 2 are persistent since the probabilities of switching between these two regimes are around 1.3-2.1% while remaining in their own regime has approximately 98% probability. While the high growth regime has a duration of approximately 76.923 weeks, the low growth regime has a duration of 47.619 weeks. This means that the Malaysian economy stays mostly in high growth state rather than in low growth situation.

Table 3.6 Estimated MS(2)-VECM(1): Singapore

	STI	**SGD**	**SGI**	**SGBY**
Regime-dependent intercepts				
Regime 1	0.984(0.263) [a]	-1.386(0.851)	-40.196(12.158) [a]	-9.906(2.241) [a]
Regime 2	0.267(0.212)	3.116(0.822) [a]	16.740(11.406)	-1.006(1.642)
Regime-dependent Autoregressive parameters at lag 1				
Regime 1				
STI	0.228(0.129)	0.066(0.185)	0.700(3.789)	-1.601(0.868)
SGD	-0.066(0.239)	0.447(0.366)	-0.627(7.407)	-1.192(1.645)
SGI	0.002(0.003)	0.005(0.005)	0.106(0.104)	-0.003(0.023)
SGBY	-0.024(0.038)	-0.002(0.058)	-0.073(1.193)	0.313(0.262)
ECT(1)	0.002(0.002)	-0.003(0.002)	-0.027(0.048)	-0.001(0.011)
ECT(2)	0.087(0.003) [a]	0.016(0.010)	0.419(0.124) [a]	0.124(0.025) [a]
Regime 2				
STI	-0.047(0.094)	-0.046(0.135)	-1.873(2.736)	-0.547(0.341)
SGD	-0.325(0.260)	0.767(0.435)	7.029(8.752)	0.226(0.842)
SGI	0.004(0.003)	0.002(0.005)	0.042(0.093)	0.019(0.010) [a]
SGBY	-0.044(0.040)	0.032(0.066)	1.512(1.365)	0.464(0.127) [a]
ECT(1)	0.001(0.001)	-0.002(0.002)	0.040(0.042)	-0.009(0.004) [a]
ECT(2)	0.095(0.002) [a]	-0.036(0.009) [a]	-0.183(0.113)	0.013(0.020)

	p_{1t}	p_{2t}	**Duration**	**Observations**
Regime 1	0.968	0.023	43.478	215
Regime 2	0.032	0.977	31.250	146

() is standard deviation, a is significant

Table 3.6 shows the estimated results of Singapore financial market. The values of the intercept term in regime 1 are mostly lower than regime 2 thus we can interpret regime 1 as low growth economy and regime 2 as high growth economy. Consider regime 1, for all equations, there are no significant adjustment to be observed in case of a short-run deviation from their equilibrium thus suggesting that these variables are weakly exogenous. In addition, the error correction term (ECT(2)) of STI, SGI, and SGBY show a significant adjustment in the short-run deviation; however, the values of the ECT(2) of these equations are positive, which means they diverge from the long run equilibrium. For regime 2, we can see that the coefficients of SGBY equation demonstrate that SGI seems to significantly influence SGBY. Consider the ECT(1) of this regime, the error correction term of SGBY is statistically significant negative and lies between 0 and -1, meaning only Singapore bond yield is co-integrated with Singapore Straits Times Index, Singapore dollar and interest rate. Consider the ECT(2) of regime 2, the error correction term of SGD is negative at statistically significant level and lies between 0 and -1, meaning only Singapore dollar is co-integrated with Singapore Straits Times Index, Singapore bond yield and interest rate. The results, furthermore, show that SGBY is significantly affected by its own lag in regime 2.

Consider the matrix of transition probability parameters, which are also reported in Table 3.6. The result tells us that regime 1 and regime 2 are persistent since the probabilities of switching between these two regimes are around 2.3-3.2% while remaining in their own regime is approximately 97%, meaning that the two regimes are persistent. While the high growth regime has a duration of approximately 31.25 weeks, the low growth regime has a duration of 43.478 weeks. This means that Singapore economy stays in low growth economy longer than in high growth economy.

Table 3.7 Estimated MS(2)-VECM(1): Japan

	Nikkei	**JPY**	**JPI**	**JPBY**
Regime-dependent intercepts				
Regime 1	9.217(0.015) [a]	4.334(0.013) [a]	-2.300(0.001) [a]	0.027(0.041)
Regime 2	9.623(0.047) [a]	4.605(0.026) [a]	-2.300(0.001) [a]	0.149(0.081)
Regime-dependent Autoregressive parameters at lag 1				
Regime 1				
Nikkei	0.367(0.221)	0.396(0.195) [a]	0.001(0.001)	0.285(0.616)
JPY	0.036(0.415)	-0.490(0.367)	-0.001(0.001)	-1.240(1.170)
JPI	0.001(0.001)	0.001(0.001)	0.001(0.001)	0.001(0.001)
JPBY	0.086(0.148)	0.101(0.131)	0.001(0.001)	0.911(0.412) [a]
ECT(1)	0.019(0.005) [a]	-0.037(0.004) [a]	-0.001(0.001)	-0.025(0.014)

Table 3.7 (Continued)

	Nikkei	JPY	JPI	JPBY
Regime 2				
Nikkei	0.282(0.679)	0.161(0.379)	0.001(0.001)	-0.624(1.256)
JPY	-1.289(1.469)	-0.584(0.820)	-0.001(0.001)	6.260(2.755) [a]
JPI	0.001(0.001)	0.001(0.001)	0.001(0.001)	0.001(0.001)
JPBY	0.076(0.114)	0.048(0.063)	0.001(0.001)	-0.355(0.209)
ECT(1)	-0.020(0.019)	-0.032(0.010) [a]	-0.001(0.001)	0.371(0.032) [a]

	p_{1t}	p_{2t}	**Duration**	**Observations**
Regime 1	0.985	0.011	66.667	167
Regime 2	0.015	0.989	90.909	194

() is standard deviation, a is significant

Table 3.7 shows the estimated result of Japan. The values of the intercept term in regime 1 are mostly lower than regime 2 thus we can interpret regime 1 as low growth economy and regime 2 as high growth economy. Consider regime 1, we can see that the coefficients of JPY equations demonstrate that Nikkei seems to significantly influence the lagged values of JPY. In addition, the error correction term (ECT(1)) of JPY is statistically significant negative and lies between 0 and -1, meaning only Japanese Yen is co-integrated with Nikkei index, Japan bond yield and interest rate. Consider the error correction term (ECT(1)) of Nikkei, a significant adjustment takes place when there is a short-run deviation; however, the value of the ECT(1) of Nikkei is positive, which means the divergence from the long run equilibrium. For regime 2, we can see that the coefficients of JPBY equation demonstrate that JPY seems to significantly influence the lagged JPBY. Similar to regime 1, there is only JPY that has a statistically significant long run relationship and short-run adjustment dynamics. However, the results show that JPY adjusts more rapidly in the low growth market since the speed of adjustment to long-run equilibrium of ECT(1) in regime 1 is faster than in regime 2. Consider the error correction term (ECT(1)) of JPBY, there is a significant adjustment in the short-run deviation; however, the value of the ECT(1) of JPBY is positive, which means it diverged from the long run equilibrium. The results furthermore show that JPBY is significantly affected by its own lag in regime 1.

Consider the matrix of transition probability parameters, the result shows that regime 1 and regime 2 are persistent since the probabilities of switching between these two regimes are around 1.1-1.5% while that of remaining in their own regime is approximately 99%. Since the high growth regime has a duration of approximately 90.909 weeks while the low growth regime has a duration of 66.667 weeks, we can say that the Japanese economy stays in high growth economy longer than in low growth economy.

Table 3.8 Estimated MS(2)-VECM(1): Korea

	KOSPI	**KRW**	**KI**	**KBY**
Regime-dependent intercepts				
Regime 1	9.701(1.741) [a]	0.624(1.283)	6.076 (6.405)	-27.490(5.770) [a]
Regime 2	-12.609(2.658) [a]	11.435(1.275) [a]	-5.812(4.888)	2.753(3.208)
Regime-dependent Autoregressive parameters at lag 1				
Regime 1				
KOSPI	0.380(0.172) [a]	-0.224(0.184)	0.610(1.010)	-0.518(0.820)
KRW	0.326(0.272)	0.436(0.304)	-2.597(1.744)	-3.541(1.423) [a]
KI	0.011(0.115)	-0.013(0.129)	0.620(0.746)	0.533(0.608)
KBY	0.141(0.095)	-0.242(0.101) [a]	0.680(0.568)	0.577(0.461)
ECT(1)	-0.008(0.007)	0.024(0.005) [a]	-0.020(0.024)	0.109(0.022) [a]
Regime 2				
KOSPI	-0.778(0.421)	0.539(0.200) [a]	-1.022(0.888)	-0.029(0.531)
KRW	-0.540(0.707)	0.556(0.331)	0.220(1.507)	-1.028(0.917)
KI	-0.013(0.537)	0.011(0.251)	0.420(1.147)	-0.097(0.692)
KBY	-0.492(0.405)	0.197(0.191)	-0.482(0.871)	0.707(0.520)
ECT(1)	0.076(0.010) [a]	-0.017(0.005) [a]	0.026(0.019)	0.016(0.012)

	p_{1t}	p_{2t}	**Duration**	**Observations**
Regime 1	0.986	0.024	71.428	157
Regime 2	0.014	0.976	41.667	204

() is standard deviation, a is significant

Table 3.8 presents the estimated results of Korea. It is difficult to identify the regime for Korea case. However, we can look at the sign of the intercept term and it shows that the negative signs mostly take place in regime 2. Hence, we can conclude regime 2 as low growth economic state and regime 1 as high growth one. Consider regime 1, we can interpret that the coefficients of KRW and KBY equations demonstrate that the lagged KBY and KRW seem to have significant bidirectional influence (KRW and KBY, respectively). In addition, the error correction term (ECT(1)) of KRW and KBY shows a significant adjustment after the short-run deviation; however, the values of the ECT(1) of these equations are positive, which means they diverge from the long run equilibrium. For regime 2, we can see that the coefficients of KRW equation demonstrate that KOSPI seems to significantly influence KRW. Consider the ECT(1) of this regime, the error correction term of KRW is statistically significant negative and lies between 0 and -1, meaning only Korean Won is co-integrated with South Korea KOSPI Index, Korean bond yield and interest rate. In addition, the error correction term (ECT(1)) of KOSPI indicates a significant adjustment in the short-run deviation; however, the value of the ECT(1) of KOSPI is positive, which means the divergence from the long run equilibrium. The results furthermore show that KOSPI is significantly affected by its own lag in regime 1.

Consider the matrix of transition probability parameters in Table 3.8. The result demonstrates that both regime 1 and regime 2 are persistent since the probabilities of staying in their regimes are approximately 98%. While the high growth regime has a duration of approximately 71.428 weeks, the low growth regime has a duration of 41.667 weeks meaning that Korea economy mostly stays in high growth economy more than in low growth economy.

Table 3.9 Estimated MS(2)-VECM(1): China

	SSE	**CHY**	**CHI**	**CHBY**
Regime-dependent intercepts				
Regime 1	0.0005(0.0058)	0.0052(0.0238)	0.0246(0.0264)	0.02315(0.0321)
Regime 2	-0.0007 (0.0059)	-0.0029(0.0242)	0.0377(0.0269)	0.0010(0.0329)
Regime-dependent Autoregressive parameters at lag 1				
Regime 1				
SSE	1.0020(0.0042) [a]	0.0001(0.0175)	-0.0132(0.0195)	-0.444(0.224) [a]
CHY	-0.0129(0.0178)	0.9084(0.0775) [a]	0.0024(0.0861)	-1.218(0.765)
CHI	0.0171(0.0154)	0.0855(0.0711)	1.1070(0.0781) [a]	0.332(0.205)
CHBY	-0.0144(0.0198)	0.0055(0.0819)	-0.0808(0.0907)	0.571(0.180) [a]
Regime 2				
SSE	0.9943(0.0042) [a]	0.0255(0.0178)	-0.0318(0.0194)	0.0070(0.0239)
CHY	0.0379(0.0194) [a]	0.8433(0.0744) [a]	0.0496(0.0851)	0.0004(0.1062)
CHI	0.0002(0.0171)	0.0748(0.0699)	1.0360(0.0784) [a]	0.0911(0.0981)
CHBY	-0.0217(0.0195)	-0.0431(0.0819)	0.04122(0.0914)	0.8289(0.1138) [a]
SSE	1.0020(0.0042) [a]	0.0001(0.0175)	-0.0132(0.0195)	-0.444(0.224) [a]
CHY	-0.0129(0.0178)	0.9084(0.0775) [a]	0.0024(0.0861)	-1.218(0.765)

Table 3.9 (Continued)

	p_{1t}	p_{2t}	**Duration**	**Observations**
Regime 1	0.9703	0.0298	33.670	290
Regime 2	0.0297	0.9702	33.557	71

() is standard deviation, a is significant

Table 3.9 presents the estimated results of MS(2)-VAR(1) model which is different from the other cases since there is no cointegration term in this model. Table 3.9 provides a result of China's financial market for two regimes and found that the values of the intercept term in regime 1 are mostly higher than in regime 2 thus we can interpret regime 1 as high growth state and regime 2 as low growth state. Consider regime 1, we can see that the coefficients of CHBY equations demonstrate that SSE seem to significantly influence CHBY. For regime 2, we can see that the coefficients of SSE equation demonstrate that CHY seems to significantly influence SSE. The results furthermore show that all these four variables are significantly affected by their own lag in both regime 1 and regime 2.

Consider the matrix of transition probability parameters. The similar result is obtained from the MS(2)-VAR(1) model. the probabilities of switching between these two regimes are around 2.97-2.98% while remaining in their own regime approximately 97%, this means that the two regimes are persistent. While the high growth regime has a duration of approximately 33.67 weeks, the low growth regime has a duration of 33.557 weeks. This signifies that China's economy stays in low growth economy and high growth economy for virtually equal length of time.

3.4.5 Regime probabilities

The estimated MS-VECM model generates smoothed probabilities as well, which can be seen, using the full-sample information, as the optimal inference on the regime. We plot the regime probabilities for the six countries, in Figures 3.1- 3.6. Each Figure shows the smooth probability, remaining in either regime 1 or regime 2, during the period of 2009 – 2016.

Figure 3.1 exhibits that the model is in compliance with the hypothesis, which means low growth and high growth stand for different financial outcomes. Figure 3.1 shows the regime 1 of the model, which we illustrated this regime as the era of the expansion. According to this result, we can observe that from late 2011 to 2012, the Thai economy stayed in low growth regime. Apparently at that period of time, Thailand was in trouble with the flood crisis. World Bank gave an estimation that the damages were around THB 1,440 billion because of the closure of multiple factories. Since the flood influence had decreased the confidence of investors and insurance companies, the economy displays a delicate position continually, which would ultimately result in poor economy and unemployment. As a significant income generator in the economy, tourism suffered a loss of THB 3.71 billion and a decrease of 3.2 million tourists, according to the Tourism Ministry. We can see this flooding resulted in the low growth regime from late 2011 to the middle of 2012. In addition, domestic political crisis which gave rise to a period of political instability in Thailand from late 2013 onward also became another factor causing the Thai economy to slow down. Subsequently, between November 2013 and May 2014 civilians went out into the streets to protest the government; and the government was unseated by a coup d'état staged by the Royal Thai Armed Forces on 22 May 2014. Some countries advised tourists to postpone trips and stopped non-essential visits. The Ministry of Tourism and Sports annouced that the arrival of "foreign tourists declined by 20%" resulting in a low growth regime after November 2013.

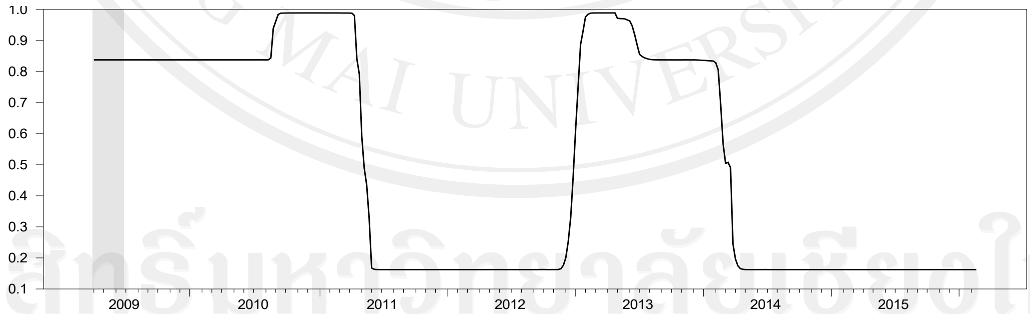

Figure 3.1 Regime 1 probabilites of Thailand's Market

Figure 3.2 displays the probabilities for the MS-VECM of Malaysia, which is a single MS chain of two regimes. To reach high revenue status by 2020, Malaysia launched the New Economic Model (NEM) in 2010. The Malaysian government initiated the Economic Transformation Program, which aims to turn Malaysia into a high income economy by 2020, launched on September 25, 2010. There are some costs and also some risk for the Economic Transformation Program, such as declining oil price and the fluctuation in capital flows from the normalization of US monetary policy. In Figure 3.2, we can see all of these risks resulting in the low growth regime from early of 2010 to middle of 2014.

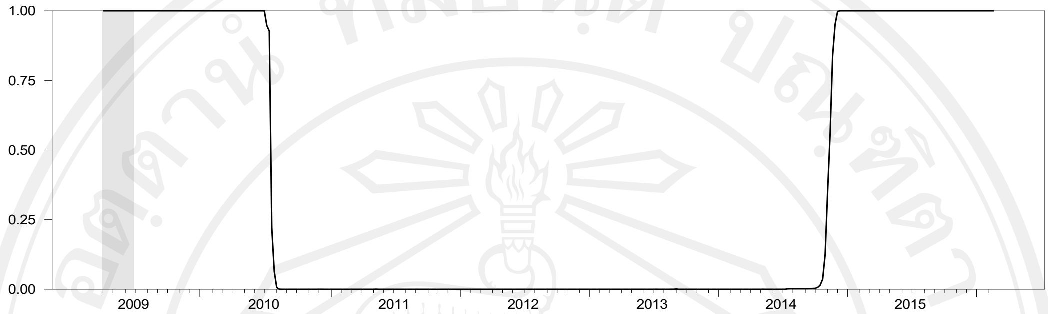

Figure 3.2 Regime 1 probabilites of Malaysia’s Market

The regime probabilities of Singapore for regime 1 are presented in Figure 3.3. From the estimated results of Singapore, we interpret regime 1 as low growth economy and regime 2 as high growth economy. Singapore has turned into the largest foreign exchange trading center in Asia and enjoys second in interest rate derivatives trading. Singapore is a leading global financial center in the world, particularly in Southeast Asia. Given its open economy, Singapore is extremely fragile to the global economy. Therefore, the world economic crisis can bring a massive effect on Singapore’s economy. As we can observe from Figure 3.3, the low growth regime was during 2009-2016. Over that period, there were severe crises in the United States of America (USA) and Euro zone called hamburger crisis and European debt crisis, respectively. We expect that Singapore’s economy would be influenced by those crises from aboard and probably slowed down in economic growth along our sample period. There are some economic reports that could reflect the four recession periods in the graph. In the first period, 2009-2010, we found that it was corresponding to the hamburger crisis in the USA. The second period in 2011 was corresponding to the beginning of European (EU) debt crisis. In the third period, between 2013 and 2014, the government reported that unemployment rate in Singapore was approximately 1.9% and the country's economy suffered a lower growth rate, when compared with the year 2010. Finally, the last period was corresponding to the announcement of the tightened policy and constrained exports of EU that contracted the export of Singapore. Overall, Singapore's economy stays in low growth economy more than in high growth economy.

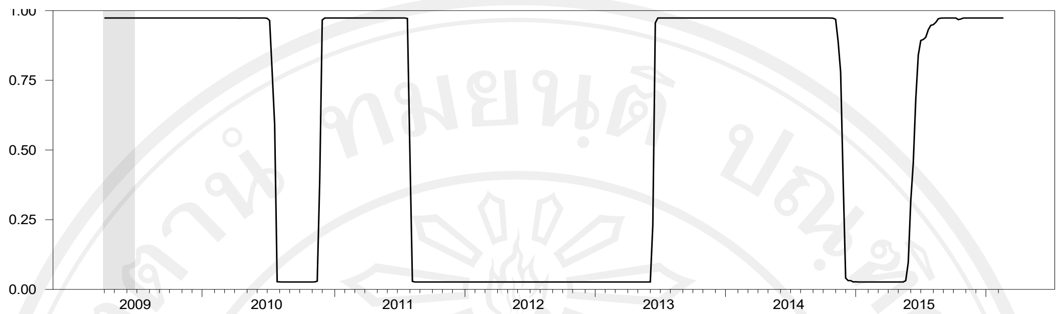

Figure 3.3 Regime 1 probabilites of Singapore's Market

The MS-VECM of Japan provides regime 1 probabilities in Figure 3.4. Similar to Singapore, from the estimated results of Japan, we interpret regime 1 as low growth economy and regime 2 as high growth economy. In Figure 3.4, we can see the low growth regime taking place in the middle of 2012. We found that Japan's economy contracted since the first quarter of 2012, due to the slowing global growth and tensions with China. Moreover, the high pressure of deflation in Japan's economy and the high debt to GDP ratio are also the factors generating the negative effect on Japan's economy. Thus, these brought the world's third-largest economy into recession. As we observed in Figure 3.4, the smoothed probabilities of low regime mostly took place along our sample periods.

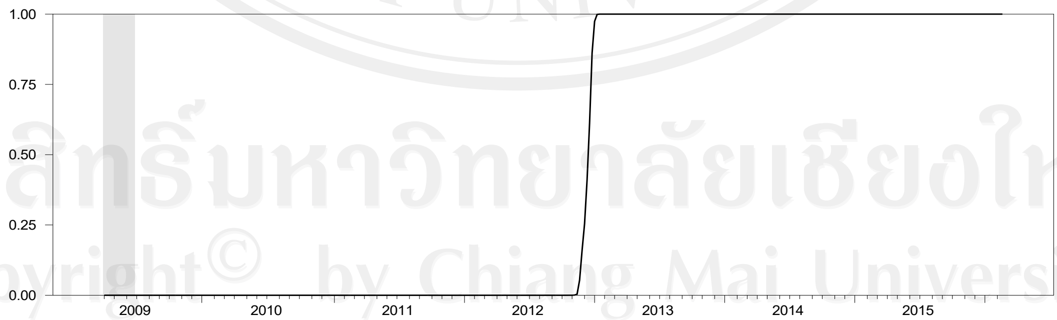

Figure 3.4 Regime 1 probabilites of Japan's Market

The regime probabilities of Korea's economy are illustrated in Figure 3.5. From the estimated results of Korea, we can interpret regime 1 as high growth economic state and regime 2 as low growth one. As the global leader of consumer electronics, Mobile Broadband and Smartphone, South Korea was a one country that was capable of avoiding a recession during the global financial crisis. The IMF gave a high praise for the recovery of the South Korean economy against various economic crises, enjoying low state debt, and high fiscal reserves. In Figure 3.5, we can see the high growth regime to present from 2009 to 2011.

Despite its economy is likely to keep high growth and obvious structural stability, South Korea has suffered everlasting impact to its credit rating in the stock market because of the bellicosity of North Korea during deep military crises, which has an negative effect on the financial markets of South Korean economy. Since 2012 North Korea has continuously trialed weapons systems, comprising a nuclear test in February 2013 and the launch of the long-range Unha-3 rocket in December 2012. In addition, the slowdown in the world economy during these times was also the factor that pushed the high pressure on the Korean economy and resulting in the low growth regime since 2012.

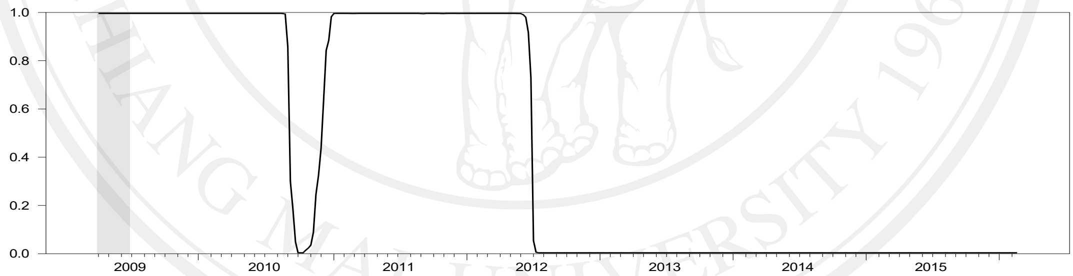

Figure 3.5 Regime 1 probabilites of South Korea's Market

The regime probabilities of Chinese economy are illustrated in Figure 3.6. From the estimated results of China, we can interpret regime 1 as high growth state and regime 2 as low growth one. We can observe that the China's economy is likely to stay in high growth regime during 2009-2011. We found that the State Council announced a CNY 4.0 trillion (USD 585 billion) stimulus package in order to shield the country from the worst effects of the financial crisis during that time. Seemingly, China withstood the financial crisis in good shape, with a sound fiscal position and low inflation. According to the International Monetary Fund, the Chinese economy grew more than 9% per year between 2009-2011. However, the global financial crisis did dramatically impact the Chinese economy. In Figure 3.5, we can see the low growth regime taking place during 2011. Since 2012, President Xi Jinping and Premier Li Keqiang have come to power. They announced an ambitious reform plan in order to alter the country's economic principles and actualize a sustainable growth model. In Figure 3.6, we can see the high growth regime occurring from 2012 to the middle of 2015. However, we observe that the Chinese economy tended to switch to low growth regime after the mid-2015. This corresponds to the speech of Premier Li Keqiang delivered at the opening of the National People's Congress parliament in China. He mentioned that the government had cut its growth target for that year to a range of 6.5% to 7%, down from 7%. We found that China's financial system had a high debt levels at both banks and local authorities and the concern over Yuan devaluation in the previous year has caused the high negative pressure on Chinese economy until present day.

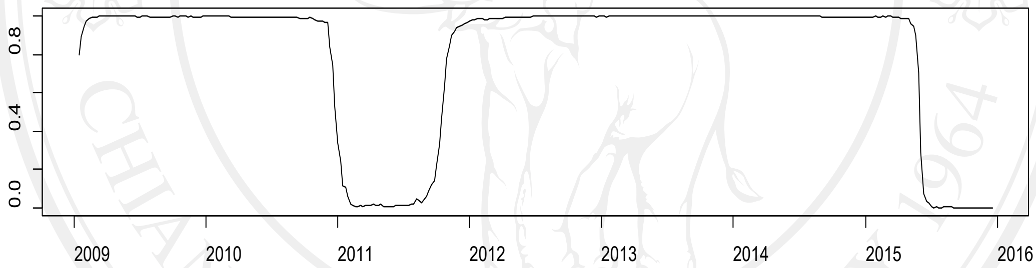

Figure 3.6 Regime 1 probabilites of China's Market

3.5 Conclusions

This chapter analyzes the relationship among the stock index, exchange rate (against US dollar), government bond yield and interest rate of six Asian countries within the Markov-Switching VECM framework. The study conducted a Bayesian estimation technique to estimate the mean of parameters of the model. Based on the results of co-integration test, the models of Thailand, Malaysia, Japan, and Korea have one co-integrating vector, while Singapore has two and China has zero co-integrating. The results of this study show that in Malaysia's low growth regime, its interest rate and government bond yield seem to significantly influence its stock market and interest rate, respectively; in Singapore's high growth regime, its interest rate seems to significantly influence its government bond yield; in Japan's low growth regime, Nikkei seems to significantly influence its exchange rate movement, and in Japan's high growth regime, its exchange rate movement seems to significantly influence its government bond yield; in Korea's high growth economies regime, its government bond yield and its exchange rate movement seem to significantly influence each other, and in Korea's low growth economic regime, its stock market KOSPI seems to significantly influence its exchange rate movement; in China's high growth economic regime, its stock market SSE seems to significantly influence it government bond yield, and in China's low growth economy regime, its exchange rate movement seems to significantly influence its stock market SSE. We also find evidence that the smooth probability, indicative of remaining in either regime 1 or regime 2, is different in each country. This can be due to global capital outflows and inflows between other possible sources. Policy-makers, fund and portfolio managers, and investors should thus pay attention to the regime switching when they carry out regulation policies and take capital budgeting decisions.