CHAPTER V

EMPIRICAL RESULTS

This section presents preliminary analysis for stock and government bond data, which is composed of summary statistics for stock and government bond excess returns, testing for ARCH and GARCH effect, and the day of week effect on stock and government bond returns. The empirical results based on the methodology discussed earlier are shown in this section.

5.1 Preliminary Analysis

Table 5.1 shows summary statistics for daily excess returns of stock and government bond, and separates daily excess returns on macroeconomic announcement, pre-announcement, post-announcement, and individual announcement, which include BOT press release on economic conditions, consumer confidence index, inflation, GDP, and trade balance announcements. On average excess return of the SET index is 0.034% per trading day, while excess return of the government bond index is approximately 0.016% per trading day. Obviously, stock return is more volatile than government bond return. The magnitude of daily excess returns of the SET index is quite large, with the highest excess return of 10.216% and the lowest of –7.353%.

Excess returns of both stock and bond on macroeconomic announcement days are higher than those of non-announcement days. On average, the SET index yielded 0.082% over risk free asset on announcement days, whereas the government bond index yielded 0.028% over risk free asset. Similarly, risk premiums of stock and government bond, in terms of Sharpe measure, are 0.050% and 0.141% respectively on announcement days compared to 0.022% and 0.084% over the entire period. Table 5.1 also shows stock and government bond excess returns on the days around macroeconomic announcement, which include the day before announcement (one day lead) and the day after announcement (one day lag). Average excess return of the SET index on the day before announcement are quite low compared to that on announcement days, while on the day after announcement, average excess return of the SET index is much higher than that on announcement days and over the entire period. In contrast with the stock market, average government bond excess return on the day before announcement is slightly higher than that over the entire period, while on the day after announcement average excess return of government bond is much lower than that over the entire period. However, mean excess returns may not reflect any impact of announcement. I therefore switch to focus on an analysis of volatility.

For initial analysis, this paper measures volatility using absolute excess returns and squared excess returns. In Table 5.1, absolute and squared excess returns of stock and government bond on announcement days are not different from those on non-announcement days. Thus, it seems that stock and government bond returns do not exhibit higher volatility on announcement days. However, absolute and squared excess return of stock on the day after announcement is much higher than that over the entire period. In addition, covariance of stock and government bond excess returns indicates a decrease on announcement days. This suggests that macroeconomic announcement force investors to rebalance their portfolio causing simultaneous reaction in stock and bond markets. Notably, the relationship between stock and government bond excess returns seems to be negative.

The bottom half of Table 5.1 separates excess returns of the SET index and the government bond index into each type of announcements. The SET index exhibits high volatility on inflation and GDP announcements dates. Stock risk premium is also considerably high on inflation releases dates. Meanwhile, the government bond index exhibits high excess returns on inflation and GDP announcements dates compared to those over the entire period.

Panel A of Table 5.2 presents the autocorrelation of the excess return, absolute excess return, and squared excess return. There is an evidence of autocorrelation of excess returns of the SET index and government bond index. The significant autocorrelation of the absolute and squared excess returns provides support for the use of ARCH class model. In panel B of Table 5.2, I also present the cross correlation between excess returns of the SET index and the government bond index. The results indicate the significant lead correlation from stock excess return to government bond excess return. In addition, cross correlation for absolute and squared excess returns also suggests significant dependence in the volatility. Thus, the significant contemporaneous correlation between the stock and government bond return provides evidence of integration of stock and bond markets, as well as the use of multivariate GARCH model.

Table 5.3, panel A indicates the test for ARCH effect in returns data, using Q-statisitics and LM test. Ljung-Box Q-statistics at lag k is a test statistics for the null hypothesis that there is no autocorrelation up to order k and is computed as;

$$Q = T(T+2) \Sigma T^2_j/(T-J) \quad ; \quad T_j = \text{the j-th autocorrelation}$$

T = number of observations

For daily data, researchers have generally chosen to test the significance of the lag 20, which corresponds to a period of approximately one calendar month. Lagrange multiplier (LM) test for the presence of ARCH effects consists of running an auxiliary regression of the squared residuals on the lagged squared residuals;

$$\varepsilon^2_t = \alpha_0 + \Sigma \beta_i \varepsilon^2_{t-1}$$

The results indicate a significant Q_{20}-statistics for both stock and bond excess returns. Also, LM test for n=1 indicates significant estimates for stock and bond excess returns. Thus, there is evidence of ARCH effect in excess returns of stock and bond.

Panel B and C in Table 5.3 provide ARCH and GARCH estimation for stock and bond excess returns. The lower is Akaike Info Criterion (AIC) and Schwarz Criterion (SC) test score, the greater is the efficiency of the model. In addition, the ARCH process should be stationary, in other words, the sum of ARCH and GARCH parameters should be less than unity. The results indicates that GARCH (1,1) provides the best fit for returns data of both stock and government bond.

Table 5.1: Summary statistics for stock and government bond daily excess returns

	SET index			Government bond index		
	R_t	$\|R_t\|$	R_t^2	R_t	$\|R_t\|$	R_t^2
Full Sample (N=1718)						
Mean	0.034	1.161	2.529	0.016	0.122	0.038
S.D.	1.590	1.087	5.914	0.193	0.151	0.126
Min	-7.353			-1.514		
Max	10.216			0.979		
Skewness	0.238			-1.277		
Kurtosis	6.446			12.690		
Sharpe measure	0.037			-0.101		
Covariance with SET index				-0.008		
Announcement Days (N=351)						
Mean	0.082	1.166	2.635	0.028	0.119	0.040
S.D.	1.623	1.130	6.556	0.197	0.160	0.154
Min	-6.271			-1.422		
Max	9.613			0.903		
Sharpe measure	0.050			0.141		
Covariance with SET index				-0.014		
Non-announcement Days (N=1367)						
Mean	0.022	1.159	2.502	0.013	0.122	0.037
S.D.	1.582	1.076	5.740	0.192	0.149	0.117
Min	-7.353			-1.514		
Max	10.216			0.979		
Sharpe measure	0.014			0.069		
Covariance with SET index				-0.007		
Pre-announcement Days (N=352)						
Mean	0.047	1.031	2.010	0.022	0.123	0.041
S.D.	1.419	0.975	4.249	0.202	0.161	0.145
Min	-6.742			-1.422		
Max	6.016			0.901		
Sharpe measure	0.033			0.110		
Covariance with SET index				-0.003		
Post-announcement Days (N=351)						
Mean	0.201	1.293	3.291	0.005	0.124	0.038
S.D.	1.805	1.274	8.093	0.195	0.151	0.110
Min	-6.964			-0.990		
Max	9.613			0.634		
Sharpe measure	0.112			0.028		
Covariance with SET index				-0.001		

Note: Returns are expressed in percent.

Table 5.1 (Continued): Summary statistics for stock and government bond daily excess returns

	SET index			Government bond index		
	R_t	$\|R_t\|$	R_t^2	R_t	$\|R_t\|$	R_t^2
BOT Announcement Days (N=84)						
Mean	0.299	1.027	2.210	0.026	0.117	0.043
S.D.	1.465	1.082	5.095	0.206	0.171	0.144
Min	-3.698			-0.990		
Max	6.016			0.901		
Sharpe measure	0.204			0.128		
Covariance with SET index				0.013		
Consumer Confidence Index Announcement Days (N=84)						
Mean	-0.228	1.136	2.099	0.028	0.130	0.050
S.D.	1.439	0.904	2.885	0.222	0.182	0.165
Min	-3.478			-1.069		
Max	3.652			0.903		
Sharpe measure	-0.159			0.126		
Covariance with SET index				0.024		
Inflation Announcement Days (N=83)						
Mean	0.436	1.353	3.782	0.039	0.116	0.042
S.D.	1.907	1.405	10.760	0.154	0.107	0.142
Min	-4.625			-0.410		
Max	9.613			0.430		
Sharpe measure	0.229			0.253		
Covariance with SET index				-0.028		
GDP Announcement Days (N=28)						
Mean	-0.061	1.423	3.979	0.053	0.122	0.036
S.D.	2.030	1.423	8.159	0.185	0.148	0.081
Min	-6.271			-0.339		
Max	4.259			0.602		
Sharpe measure	-0.030			0.286		
Covariance with SET index				-0.167		
Trade Balance Announcement Days (N=84)						
Mean	-0.086	1.143	2.347	0.004	0.102	0.037
S.D.	1.539	1.026	4.044	0.194	0.165	0.220
Min	-4.449			-1.422		
Max	4.897			0.327		
Sharpe measure	-0.056			0.019		
Covariance with SET index				-0.014		

Note: Returns are expressed in percent.

Table 5.2

Panel A: Autocorrelation of excess returns, absolute excess returns, and squared excess returns of stock and government bond

	SET index			Government bond index		
	R_t	$\|R_t\|$	R_t^2	R_t	$\|R_t\|$	R_t^2
ρ1	0.078**	0.178***	0.194***	0.434***	0.375***	0.260***
ρ2	0.069**	0.195***	0.154***	0.197***	0.183***	0.081**
ρ3	-0.021	0.156***	0.114***	0.128***	0.182***	0.111***
ρ4	0.012	0.139***	0.089**	0.136***	0.156***	0.076**
ρ5	0.021	0.147***	0.074**	0.117***	0.204***	0.130***
ρ6	0.003	0.101**	0.045**	0.073**	0.119***	0.038*
ρ7	-0.034*	0.137***	0.075**	0.031*	0.062**	0.014
ρ8	0.014	0.080**	0.035*	0.039*	0.068**	0.025*

* Significantly different from zero at 10% level

** Significantly different from zero at 5% level

*** Significantly different from zero at 1% level

Panel B: Cross-correlation of excess returns, absolute excess returns, and squared excess returns of stock and government bond

	SET index			Government bond index		
Lag	R_t	$\|R_t\|$	R_t^2	R_t	$\|R_t\|$	R_t^2
8				0.008	0.024	0.007
7				-0.034*	-0.001	-0.003
6				-0.016	-0.036*	-0.009
5				0.007	-0.037*	-0.016
4				0.015	0.004	-0.005
3				-0.005	-0.013	-0.018
2				-0.003	-0.024*	-0.027*
1				0.008	0.014	-0.015
0				-0.026*	0.000	0.003
-1				-0.025*	0.011	0.011
-2				-0.031*	0.016	0.021
-3				-0.024*	-0.014	-0.008
-4				-0.045**	-0.004	-0.010
-5				-0.026*	0.014	0.049**
-6				-0.028*	-0.001	0.005
-7				-0.010	-0.012	-0.003
-8				-0.007	-0.037*	-0.027*

* Significantly different from zero at 10% level

** Significantly different from zero at 5% level

*** Significantly different from zero at 1% level

Table 5.3

Panel A: Testing for ARCH effect in returns data

	Squared residuals Q_{20}-statistics (p-value)	ARCH LM test Lag = 1 (p-value)
SET index	236.260 0.000	49.792 0.000
Government bond index	301.230 0.000	94.797 0.000

Panel B: Estimated ARCH (p) on returns data

	(p)	α_1	α_2	α_3	α_4	α_5	$\Sigma\alpha_i$	AIC	SC
SET index	(1)	0.172 (7.055)					0.172	3.718	3.728
	(2)	0.160 (6.875)	0.310 (9.533)				0.470	3.663	3.676
	(3)	0.138 (6.315)	0.266 (8.176)	0.129 (5.814)			0.533	3.649	3.665
	(4)	0.120 (5.890)	0.237 (7.107)	0.111 (4.767)	0.111 (4.190)		0.579	3.642	3.661
	(5)	0.109 (5.320)	0.232 (7.292)	0.102 (4.799)	0.108 (4.107)	0.142 (4.857)	0.693	3.623	3.645
Government bond index	(1)	0.933 (22.285)					0.933	-0.919	-0.907

Note: t-statistics in parenthesis

Panel C: Estimated GARCH (p,q) on returns data

	(p,q)	α_1	β_1	$(\alpha_1+\beta_1)$	AIC	SBC
SET index	(1,1)	0.104 (8.149)	0.878 (59.517)	0.981	3.594	3.613
Government bond index	(1,1)	0.434 (30.045)	0.505 (66.067)	0.939	-1.052	-1.036

Note: t-statistics in parenthesis

The next step is to examine the day of week effect on returns data. One interesting question is whether abnormally high stock and government bond returns on macroeconomic announcement days are due to the releases themselves or other phenomena causing the day of week effect. Table 5.4 shows daily excess returns of stock and government bond classified by day of week. The evidence appears that average daily excess return of the SET index is highest on Friday and lowest on Monday.

Table 5.5 reports the tests of daily excess returns for the day of week effect, as well as macroeconomic announcement using simple Ordinary Least Square regression with dummy variables for weekdays and announcement days. The results indicate that excess return of the SET index is generally high on Friday and low on Monday. The results are consistent with the findings of Tangkathach that the SET index has Monday negative return effect during 1994-1998. However, there is no evidence of Friday effect on the SET index during such period. Meanwhile, excess return of the government bond index is significantly high on Thursday and Friday.[1]

Volatilities of the SET index and the government bond index, measured by absolute and squared excess returns, are significantly different from zero on everyday. The results indicate that controlling for day of week effects, stock volatility, in terms of both absolute and squared excess returns, is significantly higher than average on the day after announcement. This may imply a lag adjustment to new information in the stock market. In addition, stock volatility exhibits a significant decrease on the day prior to announcement. This is consistent with Jones, Lamont, and Lumsdaine (1998), who find that conditional volatility in the US treasury market tends to be lower in the days leading up to releases of economic data, called 'calm-before-the-storm effect'. Meanwhile, government bond do not exhibit any significant change in volatility on the period of macroeconomic announcements. The results seem inconsistent with empirical literature, which find that stock and bond return experience significantly higher volatility

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[1] There is no empirical literature about the day of week effect in the bond markets. This may be an interesting topic for future work.

on macroeconomic announcement days. However, the estimation in Table 5.5 has limited power of explanation, as the OLS regression fails to account for conditional heteroskedasticity.

Table 5.6 shows the OLS estimates for each individual announcement and the day of week effect. Volatility of the SET index, in terms of absolute and squared excess returns, exhibits significant higher than average on inflation announcement days. Meanwhile, the government bond index does not exhibit any significant change in volatility on each individual announcement days. Notably, excess return of the SET index also increases significantly on inflation announcement days. However, excess return should not exhibit a significant change on such announcement days, as the positive shock effect that occurs on announcement dates should be offset by the negative shock effect.

Table 5.4: Mean daily excess returns of stock and government bond by days of week

	SET index			Government bond index		
	R_t	$\|R_t\|$	R_t^2	R_t	$\|R_t\|$	R_t^2
Monday (324)	-0.332	1.238	2.629	0.021	0.117	0.038
Tuesday (348)	0.062	1.123	2.399	-0.007	0.121	0.034
Wednesday (349)	0.089	1.241	2.766	0.010	0.149	0.060
Thursday (348)	-0.041	1.084	2.144	0.029	0.112	0.029
Friday (349)	0.367	1.123	2.711	0.030	0.108	0.026

Table 5.5: Test of daily excess return for days of week and announcement days

The results in the table show the day of week effect as well as impact from macroeconomic announcements on daily excess returns, absolute and squared excess returns of stock and government bond, using the Ordinary Least Square estimation. The sample extends from 4 Jan 1999 to 30 December 2005. Returns are expressed in percent. Robust t-statistics are given in parentheses.

	SET index			Government bond index		
	R_t	$\|R_t\|$	R_t^2	R_t	$\|R_t\|$	R_t^2
Monday	-0.386***	1.240***	2.561***	0.018	0.116***	0.036***
	(-4.080)	(19.626)	(8.667)	(1.558)	(12.109)	(3.549)
Tuesday	-0.008	1.105***	2.227***	-0.008	0.121***	0.033***
	(-0.092)	(19.033)	(7.152)	(-0.768)	(14.894)	(5.634)
Wednesday	0.033	1.236***	2.667***	0.010	0.149***	0.059***
	(0.351)	(19.771)	(8.973)	(0.724)	(13.870)	(6.150)
Thursday	-0.089	1.086***	2.083***	0.027***	0.111***	0.028***
	(-1.060)	(19.071)	(8.140)	(2.859)	(15.204)	(5.627)
Friday	0.315***	1.136***	2.691***	0.028***	0.107***	0.024***
	(3.306)	(16.138)	(5.644)	(2.728)	(13.481)	(4.518)
Announcement day	0.076	0.006	0.121	0.016	-0.002	0.003
	(0.791)	(0.089)	(0.330)	(1.358)	(-0.248)	(0.348)
Pre-announcement	0.003	-0.144**	-0.577**	0.002	0.004	0.005
	(0.033)	(-2.376)	(-2.055)	(0.147)	(0.372)	(0.646)
Post-announcement	0.195*	0.146**	0.871**	-0.012	0.003	0.000
	(1.849)	(1.987)	(1.978)	(-0.997)	(0.286)	(0.046)
R-squared	0.023	0.010	0.007	0.007	0.010	0.010

* Significantly different from zero at 10% level

** Significantly different from zero at 5% level

*** Significantly different from zero at 1% level

Table 5.6: Test of daily excess return for days of week and individual announcement days

The results in the table show the day of week effect as well as impact from individual macroeconomic announcements on excess returns, absolute and squared excess returns of stock and government bond, using Ordinary Least Square estimation. The sample extends from 4 Jan 1999 to 30 December 2005. Note that Returns are expressed in percent. Robust t-statistics are given in parentheses.

	SET index			Government bond index		
	R_t	$\|R_t\|$	R_t^2	R_t	$\|R_t\|$	R_t^2
Monday	-0.398***	1.209***	2.409***	0.016	0.118***	0.039***
	(-4.247)	(19.826)	(8.935)	(1.358)	(12.598)	(3.961)
Tuesday	0.059	1.115***	2.364***	-0.011	0.122***	0.033***
	(0.712)	(19.617)	(7.252)	(-1.073)	(15.851)	(6.643)
Wednesday	0.080	1.238***	2.747***	0.009	0.151***	0.060***
	(0.882)	(20.596)	(9.890)	(0.667)	(14.509)	(6.492)
Thursday	-0.037	1.082***	2.144***	0.026***	0.112***	0.028***
	(-0.448)	(19.520)	(8.679)	(2.728)	(15.114)	(5.571)
Friday	0.335***	1.129***	2.706***	0.028***	0.109***	0.025***
	(3.733)	(16.759)	(5.932)	(3.032)	(15.686)	(6.506)
BOT announcement	0.192	-0.116	-0.317	0.009	0.002	0.010
	(1.185)	(-0.957)	(-0.543)	(0.393)	(0.083)	(0.581)
CCI announcement	-0.263	0.013	-0.260	0.020	0.008	0.014
	(-1.606)	(0.122)	(-0.733)	(0.786)	(0.393)	(0.779)
Inflation announcement	0.499**	0.189**	1.320*	0.027	-0.005	-0.003
	(2.389)	(1.983)	(1.776)	(1.526)	(-0.415)	(-0.610)
GDP announcement	0.312	0.223	1.585	0.040	0.006	-0.003
	(0.808)	(0.823)	(1.036)	(1.112)	(0.194)	(-0.146)
TB announcement	-0.102	-0.017	-0.163	-0.012	-0.022	-0.002
	(-0.609)	(-0.148)	(-0.361)	(-0.551)	(-1.202)	(-0.097)
R-squared	0.027	0.006	0.005	0.007	0.011	0.011

* Significantly different from zero at 10% level

** Significantly different from zero at 5% level

*** Significantly different from zero at 1% level

5.2 The Impact of Macroeconomic Announcements on Risk Premiums of Thai Stocks and Government Bonds

This paper first investigates the significance of contemporaneous effect of macroeconomic announcements on stock and bond markets. To test the impact of macroeconomic announcements on stock and government bond risk premiums separately, I present the estimation results based on the univariate GARCH-M, where risk premium is modeled as the conditional variance. Consequently, the bivariate GARCH-M model, similar to Arshanapalli, Switzer, and Vezina (2003), is employed to model the conditional covariance matrix of excess returns, which allows testing the impact of macroeconomic announcements on stock and government bond simultaneously. In addition, the GARCH-M model is able to capture how risk premium responds to volatility risks, as measured by variance and covariance.

Parameter estimates are obtained by maximizing the log likelihood function with the BHHH algorithm (Berndt, Hall, Hall, and Hausman, 1974). Robust standard errors and t-statistics are computed from quasi-maximum likelihood estimation. In addition, the likelihood ratio test is used to test the null hypothesis that the estimated coefficients are equal to zero. For large sample sizes,

$$-2\,[L(\beta_R) - L(\beta_{UR})] \sim \chi^2_m \;;$$

m - number of restrictions

R - restricted model

UR - unrestricted model

Table 5.7 reports the results on the univariate GARCH-M model for stock and government bond. ARCH-M model is proposed by Engle, Lilien, and Robins (1987) to capture time-varying risk premium by allowing conditional variance to directly affect mean return. The theory predicts that conditional means should be positively related to the conditional variances. However, the coefficients θ_{10} and θ_{20} are negative for both stock and government bond, but statistically insignificant. As in Glosten, Jagannathan, and Runkle (1993), they find a significant negative relation between conditional expected return and conditional variance. This may be the case that a larger risk premium may not be required because time periods which are relatively more risky could coincide with time periods when investors are better able to bear particular types of risk.

Primarily, the results in Table 5.7 suggest that when each asset is estimated with the univariate GARCH-M without macroeconomic announcement dummy variables, no evidence of time-varying risk premiums on stock and government bond is found.[2] A possible explanation is that the observable ingredients in the risk premium models do not vary sufficiently to explain the high degree of variability in asset returns. Note that both stock and government bond excess returns exhibit significant ARCH and GARCH effect in variance equation. This indicates time-varying volatilities of stock and government bond excess returns.

When including macroeconomic announcement dummy variables on the univariate GARCH-M, no evidence of time-varying risk premiums of stock and government bond is found. Positive coefficient for stock implies that the SET index exhibits positive risk premium when exposed to macroeconomic risks. On the other hand, government bond exhibits negative relationship between excess return and conditional variance. This result is contrast with the findings of Jones, Lamont, and Lumsdaine (1998), which indicates that bonds earn positive risk premium on macroeconomic releases dates. However, the estimated coefficients, θ_{11} and θ_{21} are insignificantly different from zero. In addition, on a regular trading day risk premiums to variance risks of stock and government bond remain negative, with insignificant estimated coefficients, θ_{10} and θ_{20}.

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[2] I extend the sample period for the SET index to 4 January 1994 to test time-varying risk premium. The results indicate the same conclusion that there is no time-varying risk premium on the SET index based on the univariate GARCH-M model. However, the government bond data is limited on 4 January 1999.

Note that the likelihood ratio statistics, calculated from the univariate GARCH model with and without dummy variables, are greater than critical value at 1% and 5% for stock and government bond, respectively.

I now turn to the discussion of the bivariate GARCH-M model, the results of which are shown in Table 5.8. Based on the bivariate GARCH-M estimation without macroeconomic news dummy variables, the results do not exhibit time-varying risk premiums of stock and government bond, evidenced by insignificant estimated coefficient β_{10}, β_{20}, δ_{10}, and δ_{20}. The results are similar to the univariate GARCH-M estimation.

When the bivariate GARCH-M is estimated with macroeconomic news dummy variables, risk premium of government bond is time-varying with covariance risk on macroeconomic announcement days. Specifically, government bond exhibits significant positive risk premium to conditional covariance on macroeconomic announcement days, as evidenced by significant estimated coefficient δ_{21} at 5% level. However, government bond risk premium is insignificantly negative to its own conditional variance. This finding suggests that government bond is rewarded for the common component of risk sharing with stock, while it is not rewarded for its specific component of risk.

Meanwhile, stock excess return does not exhibit significant relation to conditional variance and covariance on macroeconomic announcement days. In other words, macroeconomic announcements cannot explain time-varying risk premium of the SET index.

Note that the likelihood ratio, calculated from the bivariate GARCH-M model with and without dummy variables, is greater than the critical value at 1%. This indicates that macroeconomic announcements are source of temporary regime shifts. In addition, significant estimated coefficients in variance equation indicate time-varying variances as well as covariance for stock and government bond.

In conclusion, conditional covariance on macroeconomic announcement days can explain time-varying risk premium of the government bond index. The result suggests that macroeconomic announcement has explanatory power and thus could act as proxies for components in time-varying risk premium of government bond. However, the SET index does not exhibit time-varying risk premium with macroeconomic announcements.

Table 5.7: Univariate GARCH-M estimation of daily excess returns of stock and government bond: The impact of macroeconomic announcements

The results in table show the impact of macroeconomic announcements on daily excess returns of the SET index and the government bond index using the univariate GARCH-M model. The sample extends from 4 Jan 1999 to 30 December 2005. Returns are expressed in percent. Robust t-statistics are given in parentheses. The model is shown in the following equations:

$$R_{stock,t} = \mu_1 + (\theta_{10} + \theta_{11} I^A_t) * h_{stock,t} + \varepsilon_{stock,t} \quad (1)$$

$$R_{bond,t} = \mu_2 + (\theta_{20} + \theta_{21} I^A_t) * h_{bond,t} + \varepsilon_{bond,t} \quad (2)$$

	Stock		Bond	
	without dummy	with dummy	without dummy	with dummy
Mean equation				
μ_i	0.086*	0.071*	0.030***	0.030***
	(1.655)	(1.721)	(9.295)	(9.272)
θ_{i0}	-0.008	-0.003	-0.101	-0.128
	(-0.279)	(-0.141)	(-1.351)	(-1.548)
θ_{i1}		0.002		-0.004
		(0.053)		(-0.023)
Variance equation				
Constant	0.045***	0.038**	0.001***	0.001***
	(2.831)	(2.462)	(4.194)	(4.134)
ARCH term	0.092***	0.079***	0.688***	0.683***
	(5.338)	(4.693)	(4.956)	(4.932)
GARCH term	0.892***	0.906***	0.530***	0.535***
	(51.571)	(48.338)	(9.905)	(9.979)
Log likelihood	-3099.259	-3094.050	800.291	803.059
Likelihood ratio		10.418***		5.536**

* Significantly different from zero at 10% level

** Significantly different from zero at 5% level

*** Significantly different from zero at 1% level

Table 5.8: Bivariate GARCH-M estimation of daily excess returns of stock and government bond: The impact of macroeconomic announcements

The results in table show the impact of macroeconomic announcements on daily excess returns of the SET index and the government bond index using the bivariate GARCH-M model. The sample extends from 4 Jan 1999 to 30 December 2005. Returns are expressed in percent. Robust t-statistics are given in parentheses. The model is shown in the following equations:

$$R_{stock,t} = \alpha_1 + (\beta_{10}+\beta_{11} I_t^A) * h_{stock,t} + (\delta_{10}+ \delta_{11} I_t^A) * h_{stock.bond,t} + \varepsilon_{stock,t} \quad (3)$$

$$R_{bond,t} = \alpha_2 + (\beta_{20}+\beta_{21} I_t^A) * h_{bond,t} + (\delta_{20}+ \delta_{21} I_t^A) * h_{stock.bond,t} + \varepsilon_{bond,t} \quad (4)$$

	Without dummy		With dummy	
	Stock	Bond	Stock	Bond
Mean equation				
α_i	0.098*	0.029***	0.099*	0.029***
	(1.701)	(12.914)	(1.720)	(12.379)
β_{i0}	-0.025	-0.097	-0.031	-0.075
	(-0.768)	(-1.041)	(-0.953)	(-0.714)
β_{i1}			0.026	-0.056
			(0.683)	(-0.272)
δ_{i0}	0.413	-0.003	0.297	0.065
	(0.643)	(-0.033)	(0.430)	(0.669)
δ_{i1}			1.204	0.501**
			(0.677)	(2.444)
Variance equation				
c_{11}	0.053**		0.053**	
	(2.511)		(2.488)	
c_{21}	-0.005**		-0.005**	
	(-2.578)		(-2.418)	
c_{22}	0.036***		0.035***	
	(12.254)		(12.922)	
a_{11}	0.990***		0.989***	
	(639.660)		(632.267)	
a_{22}	0.734***		0.736***	
	(106.518)		(106.524)	
b_{11}	0.138***		0.139***	
	(14.208)		(14.217)	
b_{22}	0.829***		0.824***	
	(62.243)		(60.137)	
Log likelihood	-2309.766		-2302.590	
Likelihood ratio			14.352***	

* Significantly different from zero at 10% level

** Significantly different from zero at 5% level

*** Significantly different from zero at 1% level

5.3 The Impact of Macroeconomic Announcements on Volatilities of Thai Stocks and Government Bonds

Earlier results in Table 5.5 and 5.6 based on the OLS estimation of absolute and squared excess returns are the tests of macroeconomic news effect on unconditional volatilities. In this section, the ordinary least squares estimation is employed to investigate the impact of macroeconomic announcements on conditional variances as well as covariance of stock and government bond, which are derived from the bivariate GARCH-M model estimated above. In addition, the OLS model is used to test pre-announcement effects, as captured by dummy variables I^A_{t-1} (one day prior to the releases) and I^A_{t-2} (two day prior to the releases), and post-announcement effects, as captured by dummy variables I^A_{t+1} (one day after the releases) and I^A_{t+2} (two day after the releases). The model includes the first lag of dependent variables to capture autocorrelation component of conditional variances as well as covariance. Trading volume is also included as an independent variable to capture possible volatility changes caused by trading per se. The empirical results are shown in Table 5.9.

First, the null hypothesis that all coefficient estimates are simultaneously zero can be rejected, as F-statistics are higher than critical value at 1% significant level. The goodness of fit, measured by adjusted R-square, are generally quite high, particularly for the model of stock variance with adjusted R-square of 99.3%.

It is evident that macroeconomic announcement is a meaningful explanatory variable for stock variance. Stock variance exhibits significant increase on macroeconomic announcements days, as evidenced by significant estimated coefficient ρ_{12} at 5% level. This supports the hypothesis that market participants adjust their expectation according to the new information released. Meanwhile, government bond variance does not exhibit significant change on macroeconomic announcement days. The result is in contrast with Jones, Lamont, and Lumsdaine (1998), who find that macroeconomic news cause higher volatility of the US treasury bond on the release dates. However, government bond variance indicates significant increase on the day prior to macroeconomic news releases, supported by significant estimated coefficient

ρ_{13} at 10% level. The result suggests that macroeconomic announcements can explain time-varying variance of government bond.

Macroeconomic news releases are a significant source of time-varying covariance, as evidenced by significant estimated coefficients ρ_{32} at 10% level. This is in contrast with Arshanapalli, Switzer, and Vezina (2003), who find that the bond-stock covariance is not significantly influenced by macroeconomic news effect. This result may imply that linkage between stock and bond markets arises on macroeconomic news release dates. According to Fleming, Kirby, and Ostdiek (1998), market linkage comes from two distinct sources. The first is common information that simultaneously affects expectations in more than one market. The second source is information spillover caused by cross-market hedging. Intuitively, considering an investor who operates in both stock and bond markets, an information event that alters expectations about stock return directly affects demand for stocks. This event may also affect demand for bond even if it does not alter expectations about bond returns. This occurs because an investor considers the correlation between stock and bond returns when rebalancing his portfolio, and thus takes a position in bonds to hedge position in stocks.

There is an evidence that shocks to volatility that occur on announcement days have a subsequent impact on daily volatility of the SET index. The ρ_{15} coefficient is significantly positive at 5% level. This is in contrast with the findings of Jones, Lamont, and Lumsdaine (1998), and Balduzzi, Elton, and Green (2001) that announcement day volatility does not persist at all reflecting the immediate incorporation of information into prices. Furthermore, stock variance exhibits a significant decrease during two days before macroeconomic announcements, supported by significant estimated coefficient ρ_{14} at 1% level. This is somewhat consistent with the evidence of Jones, Lamont, and Lumsdaine (1998) that there is a calm before the storm effect in the US treasury bond market, on the other hand, volatility of bond returns is lower than average on day preceding macroeconomic announcements. When the market knows that a large shock is forthcoming, return volatility decreases.

In addition, covariance between stock and government bond exhibits a significant decrease on macroeconomic announcements dates. This is consistent with the findings of Christiansen and Ranaldo (2005), who indicate that bond-stock correlation is significantly influenced by macroeconomic announcement effects. Note that stock and government bond are negatively correlated on regular trading days, as evidenced by negative coefficient ρ_{30}. This may be explained by the "flight-to-quality" pattern, when risk aversion increases, investors adjust their portfolio to include more safe assets and fewer risky assets. As a result, government bond prices go up and stock prices fall. As evidenced by Christiansen and Ranaldo (2005), although the bond-stock return correlation is generally positive, the relation might be negative in periods of "flight-to-quality" and that is influenced by the state of economy (the business cycle).

In summary, macroeconomic announcements are found to be sources of time-varying variances of stock and government bond, as well as time-varying covariance between stock and government bond.

Table 5.9: Conditional variances and covariance regression with macroeconomic announcements.

The results in table show the impact of macroeconomic announcements on daily volatilities of the SET index and the government bond index using the Ordinary Least Square estimation. The sample extends from 4 Jan 1999 to 30 December 2005. Returns are expressed in percent. Robust t-statistics are given in parentheses. The model is shown in the following equations:

$$h_{stock,t} = \rho_{10} + \rho_{11}h_{stock,t-1} + \rho_{12}I^A_t + \rho_{13}I^A_{t-1} + \rho_{14}I^A_{t-2} + \rho_{15}I^A_{t+1} + \rho_{16}I^A_{t+2} + \rho_{17}Volume_t + \varepsilon_t \quad (6)$$

$$h_{bond,t} = \rho_{20} + \rho_{21}h_{bond,t-1} + \rho_{22}I^A_t + \rho_{23}I^A_{t-1} + \rho_{24}I^A_{t-2} + \rho_{25}I^A_{t+1} + \rho_{26}I^A_{t+2} + \rho_{27}Volume_t + \varepsilon_t \quad (7)$$

$$h_{stock.bond,t} = \rho_{30} + \rho_{31}h_{stock.bond,t-1} + \rho_{32}I^A_t + \rho_{33}I^A_{t-1} + \rho_{34}I^A_{t-2} + \rho_{35}I^A_{t+1} + \rho_{36}I^A_{t+2} + \rho_{37}Volume_t + \varepsilon_t \quad (8)$$

	Stock variance	Bond variance	Covariance
ρ_{i0}	0.012* (1.744)	0.009*** (3.292)	-0.002* (-1.657)
ρ_{i1} (h_{t-1})	0.998*** (325.419)	0.720*** (17.607)	0.728*** (27.622)
ρ_{i2} (I^A_t)	0.011** (1.994)	0.001 (0.281)	-0.001* (-1.797)
ρ_{i3} (I^A_{t-1})	-0.006 (-1.084)	0.009* (1.678)	0.002 (0.643)
ρ_{i4} (I^A_{t-2})	-0.013*** (-2.621)	-0.002 (-0.625)	0.001 (0.504)
ρ_{i5} (I^A_{t+1})	0.017** (1.972)	0.000 (0.018)	-0.001 (-0.210)
ρ_{i6} (I^A_{t+2})	0.001 (0.186)	0.000 (0.088)	0.001 (0.397)
ρ_{i7}	0.001** (2.033)	0.001** (2.359)	0.000 (0.446)
R-squared	0.993	0.526	0.533
F-statistics (p-value)	33649.510 (0.000)	270.576 (0.000)	278.497 (0.000)

* Significantly different from zero at 10% level

** Significantly different from zero at 5% level

*** Significantly different from zero at 1% level

Finally, this paper examines whether stock and government bond react differently to news content of macroeconomic news releases, the results of which are shown in Table 5.10. Macroeconomic news in this study include BOT press release on economic conditions, consumer confidence index (CCI), gross domestic product (GDP), inflation, and trade balance announcements. Likewise, the ordinary least squares estimation is employed to investigate the impact of individual macroeconomic announcement on conditional variances and covariance of stock and government bond.

First, the null hypothesis that all coefficient estimates are simultaneously zero can be rejected, as F-statistics are higher than critical value at 1% significant level. The goodness of fit, measured by adjusted R-squared, is generally high, particularly for the model of stock variance with adjusted R-squared of 99.3%.

The results show that conditional variance of stock exhibits a significant increase on inflation announcement dates, as evidenced by significant estimated coefficient ρ_{151} at 10% level. Stock variance continues to increase after inflation data release, as evidenced by significant estimated coefficient ρ_{153} at 10% level. There is also high volatility of stock excess returns on the day after BOT press release on economic conditions, as evidenced by significant estimated coefficient ρ_{123} at 10% level. Meanwhile, conditional variance of government bond is significantly higher than average on the day prior to inflation announcement, supported by significant estimated coefficient ρ_{152} at 10% level.

It is straightforward that government bond is generally influenced by news about inflation. There are two most plausible hypotheses regarding bond market reaction to inflation announcements. The first is the expected inflation hypothesis, which states that positive inflation surprises lead to an upward revision of inflation expectations, raising interest rates and also bond yield. The second is the policy anticipation hypothesis, which states that higher than expected inflation makes agents in the financial market expect a tightening of monetary policy. Again, interest rates should increase.

A significant impact of inflation announcement on stock volatility is consistent with Kim, McKenzie, and Faff (2003), who find that consumer and producer price information is significant for the US stock market. The impact of inflation announcement on the stock market is connected with the impact on interest rates. Higher than expected inflation should lead to higher interest rates and thus imply higher discount factor for stock prices.

The news about inflation may be becoming important to Thai economy since 2000. After the IMF program, the BOT made an extensive reappraisal of both the domestic and the external environment and concluded that the targeting of money supply would be less effective than the targeting of inflation. The BOT therefore announced the adoption of inflation targeting in May 2000. As a result, market participants in the stock and government bond markets take a close look at inflation announcement.

The BOT press release on economic conditions reveal the information about real economic activity, such as, manufacturing production index, industrial capacity utilization, private consumption indicators. This real macroeconomic shock generally affects expected cash flow of firms, for example, a positive macroeconomic shock increases expected cash flows, which finally increase stock price. The result implies that movement of the SET index is closely tied to the state of economy.

Furthermore, GDP announcement is a significant determinant of conditional covariance movement, as evidenced by significant estimated coefficient ρ_{341} at 10% level. Specifically, covariance between stock and government bond significantly decreases on GDP announcement dates. This may explain that stock and government bond react differently to news about GDP. A positive real shock will generally affect bond prices negatively, for example, higher than expected GDP will lead to an increase in interest rates and thus a decrease in bond prices. The factors determining stock prices are the discount rate, the expected future cash flows, and the equity risk premium. This implies a decrease in stock price coming from an increase in interest rate. However, positive real shock affects the expected rate of growth positively, and hence implies an increase in stock prices. The result implies that the growth effect overwhelms interest rate effect. As a result, stock and government bond excess returns move in an opposite direction when exposed to GDP news release.

Notably, news about consumer confidence index and trade balance does not appear to have a significant impact on any of the assets examined.

In summary, BOT press release on economic conditions and inflation announcement are sources of time-varying conditional variance of the SET index. Meanwhile, news release on inflation can explain time-varying conditional variance of the government bond index. In addition, GDP announcement generates a significant change in conditional covariance between stock and government bond. The results suggest that the degree of market efficiency with respect to the release and incorporation of information content will vary across market.

Table 5.10: Conditional variances and covariance regression with individual macroeconomic announcement.

The results in table show the impact of individual macroeconomic announcements on daily volatility of the SET index and the government bond index using the Ordinary Least Square estimation. The sample extends from 4 Jan 1999 to 30 December 2005. Returns are expressed in percent. Robust t-statistics are given in parentheses. The model is shown in the following equations:

$$h_{stock,t} = \rho_{10}+\rho_{11}h_{stock,t-1}+\rho_{121}I^{BOT}_{t}+\rho_{122}I^{BOT}_{t-1}+\rho_{123}I^{BOT}_{t+1}+\rho_{131}I^{CCI}_{t}+\rho_{132}I^{CCI}_{t-1}+\rho_{133}I^{CCI}_{t+1}+\rho_{141}I^{GDP}_{t}+\rho_{142}I^{GDP}_{t-1}+\rho_{143}I^{GDP}_{t+1}+\rho_{151}I^{INF}_{t}+\rho_{152}I^{INF}_{t-1}+\rho_{153}I^{INF}_{t+1}$$
$$+\rho_{161}I^{TB}_{t}+\rho_{162}I^{TB}_{t-1}+\rho_{163}I^{TB}_{t+1}+\rho_{17}Volume_{t}+\varepsilon_{t} \quad (11)$$

$$h_{bond,t} = \rho_{20}+\rho_{21}h_{bond,t-1}+\rho_{221}I^{BOT}_{t}+\rho_{222}I^{BOT}_{t-1}+\rho_{223}I^{BOT}_{t+1}+\rho_{231}I^{CCI}_{t}+\rho_{232}I^{CCI}_{t-1}+\rho_{233}I^{CCI}_{t+1}+\rho_{241}I^{GDP}_{t}+\rho_{242}I^{GDP}_{t-1}+\rho_{243}I^{GDP}_{t+1}+\rho_{251}I^{INF}_{t}+\rho_{252}I^{INF}_{t-1}+\rho_{253}I^{INF}_{t+1}$$
$$+\rho_{261}I^{TB}_{t}+\rho_{262}I^{TB}_{t-1}+\rho_{263}I^{TB}_{t+1}+\rho_{27}Volume_{t}+\varepsilon_{t} \quad (12)$$

$$h_{stock\,bond,t} = \rho_{30}+\rho_{31}h_{stock\,bond,t-1}+\rho_{321}I^{BOT}_{t}+\rho_{322}I^{BOT}_{t-1}+\rho_{323}I^{BOT}_{t+1}+\rho_{331}I^{CCI}_{t}+\rho_{332}I^{CCI}_{t-1}+\rho_{333}I^{CCI}_{t+1}+\rho_{341}I^{GDP}_{t}+\rho_{342}I^{GDP}_{t-1}+\rho_{343}I^{GDP}_{t+1}+\rho_{351}I^{INF}_{t}+\rho_{352}I^{INF}_{t-1}+\rho_{353}I^{INF}_{t+1}$$
$$+\rho_{361}I^{TB}_{t}+\rho_{362}I^{TB}_{t-1}+\rho_{363}I^{TB}_{t+1}+\rho_{37}Volume_{t}+\varepsilon_{t} \quad (13)$$

	ρ_{i0}	ρ_{i1}	ρ_{i21} BOT (t)	ρ_{i22} BOT (t-1)	ρ_{i23} BOT (t+1)	ρ_{i31} CCI (t)	ρ_{i32} CCI (t-1)	ρ_{i33} CCI (t+1)	ρ_{i41} GDP (t)	ρ_{i42} GDP (t-1)	ρ_{i43} GDP (t+1)
Stock variance	0.010*	0.998***	-0.049	-0.010	0.069*	-0.012	-0.006	-0.011	-0.003	0.017	0.025
	(1.730)	(325.553)	(-1.136)	(-1.220)	(1.655)	(-1.068)	(-0.663)	(-1.462)	(-0.089)	(0.496)	(0.918)
Bond variance	0.009***	0.718***	0.001	0.005	-0.002	0.007	0.030	0.003	-0.006	-0.012	-0.003
	(3.440)	(17.485)	(0.061)	(0.862)	(-0.081)	(0.700)	(1.402)	(0.285)	(-1.349)	(-1.033)	(-0.331)
Covariance	-0.002*	0.728***	-0.003	0.004	0.008	0.002	0.005	0.004	-0.007*	-0.003	-0.017
	(-1.652)	(27.527)	(-0.391)	(0.960)	(1.125)	(0.544)	(0.523)	(0.756)	(-1.832)	(-0.763)	(-1.376)

Table 5.10 (Continued): Conditional variance and covariance regression with individual macroeconomic announcement.

	ρ_{i51} INF (t)	ρ_{i52} INF (t-1)	ρ_{i53} INF (t+1)	ρ_{i61} TB (t)	ρ_{i62} TB (t-1)	ρ_{i63} TB (t+1)	ρ_{i8}	R-squared	F-statistics
Stock variance	0.078*	0.039	0.022*	-0.008	-0.019	-0.003	0.001**	0.993	13761.010
	(1.819)	(0.895)	(1.959)	(-0.991)	(-1.220)	(-0.360)	(2.039)		(0.000)
Bond variance	0.005	0.010*	0.008	-0.006	-0.005	0.003	0.001**	0.529	112.213
	(0.215)	(1.856)	(1.495)	(-1.283)	(-1.187)	(0.191)	(2.344)		(0.000)
Covariance	-0.005	0.002	-0.002	0.002	0.000	0.001	0.000	0.536	115.380
	(-0.725)	(0.217)	(-0.509)	(0.673)	(0.173)	(0.208)	(0.464)		(0.000)

* Significantly different from zero at 10% level

** Significantly different from zero at 5% level

*** Significantly different from zero at 1% level