

Stock Market Bubbles and the Role of Monetary Policy in Thailand

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Abstract

Dividend discounted models with rational expectations under a perfect expectation model, CAPM, ICAPM and APT are used for the study. The results show that there are no bubbles in Thailand under Engle and Granger cointegration test and ARDL Bound test during 2002-2012. For the monetary policy effects, there are monetary policy transmissions from the policy rate on the real money supply, deposit rates and lending rates under the Granger causality test. There are monetary effects from policy rates, deposit rates and lending rates on the bond market, but there is no liquidity effect of the real money supply on the bond market. The results show significant long term effects of monetary policy on asset prices. The negative effects of monetary policy on asset prices are conformed for all three models including CAPM, ICAPM and APT. For CAPM, the explanation would be that beta is less than one, so the effect of interest rates will be negative on asset price valuation. For the magnitude of sensitivity effect, RP rates have a higher impact on asset price valuation than deposit rates and lending rates because of the direct effect of monetary policy through all monetary transmission mechanisms. The results also show that there are asymmetric monetary policy effects on asset prices with larger impacts during the expansionary policy than during the contractionary policy.

Keyword: Stock Market Bubbles, Monetary Policy, Asset Prices

1. Introduction

Asset price bubbles are the processes that occur when asset prices are traded at valuation levels that deviate from intrinsic values. The first bubbles originated in the Tulip mania in 1636-37, followed by the Mississippi bubble in 1719-20 and South Sea prices bubbles in 1720. Stock market bubbles play an important role on many occasions during economic cycles and economic crises. The bubbles in asset prices also play an important role on the business cycle and economic crises in Thailand. The crisis in 1997 also came after the collapse of the real estate and stock market bubbles. It is important to identify and measure the bubbles in asset prices. Therefore, The first part of this study is to find whether there are stock market bubbles in Thailand during 2002-2012 to ensure whether the rising stock market prices during this period are going to be bubbles or not. For the role of monetary policy in asset prices, declining interest rates could stimulate the economy and reduce the cost of investment. However, the monetary tightening also affects negatively on asset prices. The low interest environment after the NASDAQ bubble in 2000 and the subprime crises in 2008 caused rising equity markets, including Thailand during 2002-2012. It would be helpful to find the effect of monetary policy on the equity prices and to find whether monetary policy plays an important role on the movement of asset prices or not. Therefore, the second part of the study is to find the effect of monetary policy on the stock.

For asset bubbles studies, there are four major approaches to detect asset prices bubbles. First, the variance bound test is introduced by Shiller (1981) and another approach is West (1987)'s two-step test. The most popular and superior methodology is the cointegration test and the last is the intrinsic bubble test by Froot and Obstfeld (1991). For monetary policy effects on asset prices, there are many studies including Bordo and Lane (2012) and Patelis (1997) who used Vector Autoregressive Model (VAR) for the study. Many studies followed Bernanke and Gertler (1999) who used the New Keynesian model, initially developed from the Bernanke-Gertler-Gilchrist (BGG) model for the study. Other studies include Eichengreen and Tong (2003), Thorbecke (1997), and Baillie and DeGennaro (1990). For Thailand, Disyatat and Vongsinsirikul (2002) studied the effect of 14-day RP rate on asset prices and other monetary policy transmission effects. They found that monetary

tightening would cause lower asset price. For the asset pricing theory, the paper uses the intrinsic value of the stock market under dividend discounted model, with the expected return under rational expectation followed by the perfect expectation model, capital asset pricing model (CAPM), intertemporal capital asset pricing model (ICAPM) and arbitrage pricing theory model (APT). For monetary policy effect, It starts with the monetary theory of money market equilibrium to find the relationship between policy rates and money supply. The model shows the negative effect of monetary policy on asset price valuations under ICAPM and APT. For CAPM, if beta of equity is less than one, there is negative effect of monetary policy on the asset price valuation but if beta of equity is more than one, there is positive effect of monetary policy on the asset price valuation.

For methodology, GARCH estimation is used for equity return volatility and inflation volatility estimation. The Engle-Granger cointegration test and the ARDL bound test are used for detecting the stock market bubbles. The error correction models are used for finding the long term and short term effects of the role of monetary policy on asset prices. For monetary policy study, Vector autoregressive (VAR) model is used to find Granger causality effect and impulse response function effect between policy rates and real money supply, deposit rates and lending rates and the tests were also used for finding the monetary policy transmission effect on bond market rate. Error correction models were also used to find the long term and short term effects of monetary policies on asset prices.

The results show the cointegration between actual value of log of price-to-dividend and fundamental values under all four models including perfect expectation model, CAPM, ICAPM and APT model and it is concluded that there is no bubble for Thailand stock market during 2002-2012. For monetary policy study, the results show the significant long term effects from RP rates, deposit rates and lending rates on asset prices. For the short term effect, RP rates, deposit rates and lending rates have no effect on asset price valuation.

2. Literature reviews

Asset price bubbles are the processes where asset prices are traded at valuation that deviates from intrinsic value or the fundamental value. The fundamental value usually comes from the value from the discounted future dividends and the price of the asset when it is sold in the indefinite future. Under rational expectation, the bubbles should not arise because if the actual market price is above the fundamental value, investors will never buy an asset at more than what they consider the fundamental price, and investors holding assets will sell that asset until the actual market drops back to the fundamental price. Therefore, bubbles should be impossible. Nevertheless, the asset price bubbles actually occurred in the past till the present and the first originated in the Tulip mania in 1636-37, followed by the Mississippi bubble in 1719-20 and South Sea prices bubbles in 1720.

There are the several methods for testing the equity bubbles. Firstly, the variance bounds tests for equity prices were initiated by Shiller (1981). Shiller's test was to evaluate the variance bounds test from actual price and price from observed value of dividends. Shiller found that actual price variance was much higher than the variance of ex post rational price calculated from observed dividends and lower bound of stock prices variability was also much higher than upper bound of observed variability of dividends; therefore, he concluded that there was a failure of market efficiency. However, the variance bound test may not suitable for stock bubble tests, especially the problem of non-stationary. March and Merton (1983) found the variance bound test may be failed because there were non-stationary dividend and stock prices. The second method is West's two-step test developed by West (1987). West's test is to compare coefficients from two methods of asset price estimation under Hausman coefficient restriction. West found that the hypothesis of equality between two coefficients was strongly rejected; therefore, there was the presence of bubble. The other test is the cointegration test and autoregressive distributed lag (ARDL) cointegration test. Herrera and Perry (2003) used the relationship between price and dividend under dividend discounted model. They used Johansen cointegration, residuals-augmented least square (RALS) and autoregressive distributed lag (ARDL) tests for the bubble test and they found the bubble in the Latin America equity bubble.

The intrinsic bubble study is suggested by Froot and Obstfeld (1991). They used the estimation of asset price based on 1) present value of the stock price assuming that log dividends follow a random walk with trends (fundamental value) 2) the intrinsic bubble model depending on dividend and time 3) the bubble component that overreacts on dividends. They found there should be the intrinsic bubble. Intrinsic bubbles model can provide a plausible explanation of deviations from present-value model. Their potential explanation came from persistent deviations that appear to be moderately stable over long periods. For the test of stock market bubbles in Thailand, Jiranyakul (2008) applied three different methods, including variance bounds test, equity price bubbles test, and cointegration tests to test the bubble in The Stock Exchange of Thailand Index (SET) and he found that there should be a bubble in Thailand's stock market.

For monetary policy in Thailand, RP rate is used for the policy rate from Bank of Thailand (BOT). The development of policy rate under inflation started from 14-day RP rate. From 16 January 2007, policy rate was changed into one-day repurchase rate and one-day bilateral repurchase rate has been used since 12 February 2008. For monetary policy instrument, BOT uses range of monetary policy instruments including reserve requirement, open market operation from bilateral repurchase operation, issuance of BOT bills/bonds, FX-swap and outright purchase/sales of securities and standing facilities.

The New Keynesian model is used to study the role of monetary policy on the asset price. The prominent study is from Bernanke and Gertler (1999) who used Bernanke-Gertler-Gilchrist model (BGG model) under a dynamic New Keynesian model to calibrate the effect of monetary policy under different conditions, with and without asset price consideration. They found that monetary rules that directly targeted asset prices appeared to give undesirable side effects; therefore, it is appropriate to focus on price stability rather than asset prices. However, the central bank should consider asset prices in the case where the asset prices significantly affect the economy. Another paper using the New Keynesian model of BGG model is from Gilchrist and Leahy (2002) and Kontonikas and Ioannidis (2005). However, finding the opposite conclusion with former studies, Cecchetti, Genberg, Lipsky and Wadhvani (2000) employed simulations of the New Keynesian

model and optimized the policy rule with respect to a bubble shock. They concluded that a proactive response by central banks on the asset price will reduce the possibility of asset price bubbles, thus reducing the risk of boom–bust cycles in the economy. Other methodologies to study the role of monetary policy on the asset price include Rigobon and Sach (2001) using the technique based on heteroskedasticity of stock market return to find the reaction of policy rates. Their results found that there was a significant reaction of monetary policy on stock market movements, if the movement impacted the economy. Bordo and Lane (2012) studied the effect of monetary policy on asset prices. They studied house prices, stock market and commodity prices in 18 OECD countries. They measured the effect of asset price booms from the expansionary monetary policy that deviates from Taylor rules and monetary aggregate growth. They also used VAR model techniques to control other determinants of asset booms to find the monetary effect. They found that the loosening of monetary policy did contribute to significant bubbles in house prices, commodity prices and to lessen bubbles in stock prices. Eichengreen and Tong (2003) used GARCH model to estimate the volatility. They also used the regression to find the effect of monetary policy on the stock return volatility. Patelis (1997) used VAR model under long and short periods in the US stock market to find the relationship between the excess return and monetary policy indicators including the fed fund rate, bond spread and reserve balance and used variance decomposition to find the effect on the individual components of excess returns. The monetary policy was significant in predicting the future excess return. Variance de-compositions indicated that monetary policy shocks play an important role on the expected excess returns, followed by expected dividend growth, but had little effect on expected real returns. Thorbecke (1997) studied the monetary policy effects of Fed fund rate on asset price return. He found the changes in returns of Dow Jones Industrial Average Index and Dow Jones Composite Average Index were impacted negatively from the change on Fed Fund rates. He also found that innovation of Fed fund rate positively affected stock returns. Baillie and DeGennaro (1990) studied the asset pricing model to study the relationship between risk and return. They used the Federal Fund Rate as risk free rate under GARCH model and they found the weak relationship between mean returns and own variance but the Federal Fund Rate very significantly

impacted asset price return. Bernanke and Kuttner (2005) studied the impact of unexpected changes of Federal Fund rate targets on equity prices. They found that the unexpected change of Federal Fund rate has a negative impact on asset prices and equity prices across industries. For Thailand, Disyatat and Vongsinsirikul (2002) studied the effect of the 14-day RP rate on asset prices and other monetary policy transmission. They used the VAR model to find the impulse response function of SET index on 14-day RP rate and they found that monetary tightening by a 2% increase in interest rates will cause lower asset prices by 4% over six quarters and that rising asset prices also supported rising economic growth. Charoenseang and Manakit (2007) also studied the monetary transmission of policy rates on other financial interest rates, including interbank rate, lending rate and deposit rate. They found a long term relationship between policy rates and financial interest rates; however, there was a weak transmission effect of policy rates on financial interest rates.

3. Theory of Asset Price Valuation

Herrera and Perry (2003) and Cogley (2005) value the stock prices by using Gordon model. Firstly,

$$1 + R_{t+1} = \frac{(P_{t+1} + D_{t+1})}{P_t} \tag{1}$$

Where P_{t+1} is the equity price, R_{t+1} is the equity return and D_{t+1} is the dividend payment.

Equation (1) can be written in log form as follows:

$$p_t = p_{t+1} + \log[1 + e^{(d_{t+1} - p_{t+1})}] - r_{t+1} \tag{2}$$

Where p_t is the log of equity price, d_{t+1} is the log of dividend payment and r_{t+1} is the log of return $(1 + R_{t+1})$

There are the non-linear relationships between log of prices, log of dividends, and log of returns; however, using a first order Taylor expansion to generate approximately the linear relationship is as follows:

$$p_t = k + \rho p_{t+1} + (1 - \rho)d_{t+1} - r_{t+1} \tag{3}$$

Where $\rho = 1/[1 + e^{E_t(d_t - p_t)}]$ and $k = -\log \rho - (1 - \rho)\log(1/\rho - 1)$ and assume $e^{E_t(d_t - p_t)}$ to be constant over time.

To adjust the price-dividend ratio, subtract d_t from both sides of (3) and take the expectation as follows:

$$E_t(p_t - d_t) = E_t \sum_{j=0}^{k-1} \rho^j (k + \Delta d_{t+j+1} - r_{t+j+1}) + \rho^k E_t(p_{t+k} - d_{t+k}) \quad (4)$$

$\lim_{k \rightarrow \infty} \rho^k E_t(p_{t+k} - d_{t+k}) = 0$, as K grows large to infinity. The expected log of price-to-dividend can be expressed in fundamental value from the present value of expected dividend growths and returns,

$$E_t(p_t - d_t) = F_t = k(1 - \rho)^{-1} + E_t \sum_{j=0}^{k-1} \rho^j (\Delta d_{t+j+1} - r_{t+j+1}) \quad (5)$$

F_t is the fundamental value of log of price-to-dividend. Assume that r_t , $\log(1 - R_t)$ is about R_t . The equation (5) is as follows:

$$(p_t - d_t) = F_t - B_t \quad (6)$$

Where $F_t = k(1 - \rho)^{-1} + E_t \sum_{j=0}^{k-1} \rho^j (\Delta d_{t+j+1} - R_{t+j+1})$ and

$B_t = \lim_{k \rightarrow \infty} \rho^k E_t(p_{t+k} - d_{t+k}) > 0$ represents a bubble component.

Assume D_t to D_{t+n} to be from earnings and dividend payout ratio and dividend growth is extracted from earnings growth. Lee, David Ng, and Bhaskaran (2009) used the sustainable growth rate assumption to formulate the asset prices from free cash flow model. Therefore, it is assumed that the expected earnings growths in the future period come from long term sustainable earning growth rate; therefore,

$$E_t \sum_{j=0}^k (\Delta d_{t+j+1}) = E_t \sum_{j=0}^k (\Delta e_{t+j+1}) = \sum_{j=0}^k (G_t) = \sum_{j=0}^k ((1 - O_t) ROE_t) \quad (7)$$

Where e_t is log of earnings (E_t) for period t , $G_t =$ Long-term sustainable earnings growth rate, O_t is dividend payout ratio, and $ROE_t =$ Return on equities.

Conrad and Kaul (1988) modeled the expected return as first-order autoregressive process to study time variation in expected return. Fama and French (1988) also used the dividend yield in form of autocorrelation to forecast the stock returns. Therefore, assume that R_t is under AR(1) ($R_{t+1} = c + \theta R_t - v_t$ and $E_t(R_{t+1}) = c + \theta E_t(R_t)$) Therefore insert R_t and (7) on (6),

$$(p_t - d_t) = K + \sum_{j=0}^k \rho^j (G_t - \theta^{j+1} E_t(R_t)) + B_t \quad (8)$$

Where $K = [c(1 - \theta)^{-1} + k(1 - \rho)^{-1}]$, $F_t = K + \sum_{j=0}^k \rho^j (G_t - \theta^{j+1} E_t(R_t))$ and B_t is bubble component

3.1 Rational expectation as perfect expectation at time t

Under assumption of perfect expectation of rational expectation, $E_t(R_t) = R_t$ put $E_t(R_t)$ into equation (8) as follows:

$$(p_t - d_t) = K + \sum_{j=0}^k \rho^j (G_t - \theta^{j+1} R_t) + B_t \quad (9)$$

3.2 Rational expectation as Capital Asset Pricing Model (CAPM)

Under capital asset pricing model by Sharpe (1964), the return generating process is from risk free rate and risk premium as $[E_t(R_t) = R_f + B(R_m - R_f)]$. Damodaran (2008, 2012) and Pratt and Grabowski (2010) recommended the long term interest rate as risk free rate was used for long term valuation consideration and the short term interest rate as risk free rate was used for short term valuation consideration to match the cash flow. Put CAPM formation into equation (8) as follows:

$$(p_t - d_t) = K + \sum_{j=0}^k \rho^j [G_t - \theta^{j+1} (R_f + B(R_m - R_f))] + B_t \quad (10)$$

Where R_f is risk free rate, R_m is market return and B is beta.

For R_f effect on asset price valuation under CAPM, $\frac{\partial(p_t - d_t)}{\partial R_f} = -\sum_{j=0}^k \rho^j \theta^{j+1} (1 - B)$; therefore, $\frac{\partial(p_t - d_t)}{\partial R_f}$ is negative if $B < 1$, no effect if $B = 1$ and positive if $B > 1$

3.3 Rational expectation as Intertemporal Capital Asset Pricing Model (ICAPM)

Merton (1973) developed Intertemporal Capital Asset Pricing with the expected return of asset pricing depending on state variables as $[E_t(R_t) = R_f + B_m \sigma_{im} + B_z]$, where σ_{im} is covariance between excess returns risky asset i and market portfolio and σ_{iz} is covariance between excess returns risky asset i and state z. Merton (1980) showed that for market portfolio,

under the specific condition that variance of change in wealth is much larger than variance of change in state variable, the excess expected return can be represented on variance of market portfolio $E_t(R_i) = R_f + B_m \sigma_m^2$. Therefore,

$$(p_t - d_t) = K + \sum_{j=0}^k \rho^j [G_t - \theta^{j+1} (R_f + B_m \sigma_m^2)] + B_t \quad (11)$$

Where σ_m^2 = Variance of the market portfolio

For the effect of R_f on asset price valuation under ICAPM, $\frac{\partial(p_t - d_t)}{\partial R_f} = -\sum_{j=0}^k \rho^j \theta^{j+1}$; therefore, $\frac{\partial(p_t - d_t)}{\partial R_f}$ is negative on asset price.

3.4 Rational expectation as Arbitrage Pricing Theory (APT)

Under Arbitrage pricing model by Ross (1976), the return generating process is from risk factor premium; therefore,

$$(p_t - d_t) = K + \sum_{j=0}^k \rho^j [G_t - \theta^{j+1} (R_f + B \lambda_t)] + B_t \quad (12)$$

Where λ_t = risk factor premium

For the effect of R_f on asset price valuation under APT, $\frac{\partial(p_t - d_t)}{\partial R_f} = -\sum_{j=0}^k \rho^j \theta^{j+1}$; therefore, $\frac{\partial(p_t - d_t)}{\partial R_f}$ is negative on asset price.

3.5 Theory of money market equilibrium

Under IS-LM model, the money market equilibrium for LM curve contribution is from the aggregate money demand as follows:

$$M_t^d / AP_t = L(Y_t, i_t) \quad (13)$$

Where AP_t is the price level, M_t^d is money demand, Y_t is real national income, i_t is a measure of interest rates on non-monetary assets and $L(Y_t, i_t)$ is the aggregate demand of real monetary assets

For money market equilibrium, the money demand is equal to money supply $M_t^d = M_t^s$ where M_t^s is the money supply. Therefore, the money market equilibrium is as follows:

$$M_t^s / AP_t = L(Y_t, i_t) \quad (14)$$

Under money market equilibrium, Dornbusch (1976) represented the money demand function as per the following:

$$m - ap = \emptyset y - \gamma i \tag{15}$$

Where m is log of nominal quantity of money, ap is the log of aggregate price level, y is the log of real income and i is the interest rate.

4. Methodology of Study

4.1 GARCH model

Engle (1982) developed the ARCH (Autoregressive Conditional Heteroscedasticity) model that the conditional variance was time-varying and then Bollerslev (1986) extended to GARCH (Generalized Autoregressive Conditional Heteroscedasticity), which the conditional variance was dependent upon previous own lags. Lunde and Hansen (2005) found that GARCH(1,1) was superior to forecast volatility models compared to other 330 volatility models; therefore, GARCH(1,1) is used for equity return volatilities and inflation volatilities. The models are as per the following:

$$R_{i,t} = \sum_{j=0}^J B_j R_{i,t-j} + \varepsilon_{R,t} \tag{16}$$

$$\sigma_{R,t}^2 = C + \lambda_1 \varepsilon_{R,t-1}^2 + \theta_1 \sigma_{R,t-1}^2 \tag{17}$$

$$Inf_t = \sum_{j=0}^J B_j Inf_{t-j} + \varepsilon_{inf,t} \tag{18}$$

$$\sigma_{inf,t}^2 = C + \lambda_1 \varepsilon_{inf,t-1}^2 + \theta_1 \sigma_{inf,t-1}^2 \tag{19}$$

Where $\sigma_{R,t}^2$ is the conditional variance for equities market return, Inf_t is inflation and $\sigma_{inf,t}^2$ is the conditional variance for inflation.

4.2 Engle-Granger Cointegration

Engle and Granger (1987) developed residual based test for cointegration. The cointegration test is used for the variables y and x which are non-stationary series. To test for cointegration between two or more non-stationary time series, the residuals μ_t from the equation estimation is tested by the Augmented Dickey-Fuller Test (ADF) to determine whether it is stationary or non-stationary as per the following:

$$\Delta\mu_t = (\rho - 1)\mu_{t-1} + \sum_{i=1}^p \alpha_i \Delta\mu_{t-1} + \nu_t \tag{20}$$

4.3 Cointegration Test for long term relationship

According to equation (9)-(12), the null and alternative hypotheses tested of the cointegration test are as follows:

$$(p_t - d_t) = \delta + \beta_1 G_t + \beta_2 R_t + \varepsilon_t \quad (21)$$

$$(p_t - d_t) = \delta + \beta_1 G_t + \beta_2 R_f + \beta_3 R_m + \varepsilon_t \quad (22)$$

$$(p_t - d_t) = \delta + \beta_1 G_t + \beta_2 R_f + \beta_3 \sigma_{Ri}^2 + \varepsilon_t \quad (23)$$

$$(p_t - d_t) = \delta + \beta_1 G_t + \beta_2 R_f + \sum_{i=2}^J \beta_i R p_i + \varepsilon_t \quad (24)$$

H₀: ADF Test (τ -statistics) for ε_t is non-stationary (no cointegration) and

H_a: ADF Test (τ -statistics) for ε_t is stationary (cointegration)

4.4 ARDL Bound Test

Pesaran, Shin and Smith (2001) found that when there were both I(1) and I(0), a normal cointegration test on the long-run relation would create the biased results in the long term relationship between the variables. In order to solve the bias problem due to the co-existence between I(1) and I(0), the autoregressive distributed lag (ARDL) model, also known as bounds testing approach, is suggested. According to Pesaran, Shin and Smith (2001), the dependent variable must be I(1), while the exogenous variables can be either I(1) or I(0) ARDL are as follows:

$$\Delta y_t = \delta + \beta_0 y_{t-1} + \sum_{j=1}^J \beta_j x_{j,t-1} + \sum_{i=1}^p \alpha_i \Delta y_{t-i} + \sum_{i=0}^q \sum_{j=1}^J \theta_j \Delta x_{j,t-i} + \eta_t \quad (25)$$

Where y_t is a vector of the dependent variable, $x_{j,t-1}$ are exogenous variables, α_i is a matrix of VAR parameters to be estimated and ε_t is a white noise error term.

To test long run, the null and alternative hypotheses tested are as: H₀: $\sum_{i=0}^I \beta_i = 0$ (no long-run relationship) and H_a: $\sum_{i=0}^I \beta_i \neq 0$ (long-run relationship exists)

According to equation (9)-(12), the null and alternative hypotheses tested of ARDL bound test are as follows:

$$\Delta(p_t - d_t) = \delta + \beta_0 \Delta(p_t - d_t) + \sum_{j=1}^J \beta_j x_{j,t-1} + \sum_{i=1}^p \alpha_i \Delta(p_{t-i} - d_{t-i}) + \sum_{i=0}^q \sum_{j=1}^J \theta_j \Delta x_{j,t-i} + \eta_t \quad (26)$$

Where $x_{i,t-1}$ includes G_t and $R_{i,t}$ for perfect expectation Model, $x_{i,t-1}$ includes G_p , $R_{f,t}$ and $R_{m,t}$ for CAPM, $x_{i,t-1}$ includes G_p , $R_{f,t}$ and $\sigma_{Ri,t}^2$ for ICAPM and $x_{i,t-1}$ includes G_p , $R_{f,t}$ and $R_{pi,t}$ for APT.

$H_0: \sum_{i=0}^I \beta_i = 0$ (no long-run relationship) and $H_a: \sum_{i=0}^I \beta_i \neq 0$ (long-run relationship exists)

4.5 Error Correction Model (ECM)

The error correction models are as per the following:

$$\Delta y_t = \delta + \beta ECT_{t-1} + \sum_{i=1}^p \alpha_i \Delta y_{t-i} + \sum_{i=0}^q \sum_{j=1}^J \theta_j \Delta x_{j,t-i} + \eta_t \quad (27)$$

In the case of long term relationship of log of price-to-dividend and risk factor, error correction models (ECM) are developed by:

$$\Delta(p_t - d_t) = \delta + \beta ECT_{t-1} + \sum_{i=1}^p \alpha_i \Delta(p_{t-i} - d_{t-i}) + \sum_{i=0}^q \sum_{j=1}^J \theta_j \Delta x_{j,t-i} + \eta_t \quad (28)$$

Where ECT_{t-1} is error correction term for long term relationship, $\Delta(p_t - d_t)$ is the difference between $(p_t - d_t)$ and $(p_{t-1} - d_{t-1})$, $x_{j,t}$ (independent variables) include G_p , R_f and R_m for CAPM, $x_{j,t}$ include G_p , R_f and $\sigma_{Ri,t}^2$ for ICAPM and $x_{j,t}$ include G_p , R_f and $R_{pi,t}$ for APT.

4.6 Long Term Relationship between Risk Free Rates and Asset Prices under ECM

$$(p_t - d_t) = \delta + \beta_1 G_t + \beta_2 R_f + \beta_3 R_m + ECT_t \quad (29)$$

$$(p_t - d_t) = \delta + \beta_1 G_t + \beta_2 R_f + \beta_3 \sigma_{Ri}^2 + ECT_t \quad (30)$$

$$(p_t - d_t) = \delta + \beta_1 G_t + \beta_2 R_f + \sum_{i=3}^J \beta_i R_{pi} + ECT_t \quad (31)$$

Where β_2 is coefficient of long term relationship between log of price-to-dividend and risk free rate and for monetary policy effect on asset prices study, RP rate as policy rate, deposit rates and lending rates (MLR rate) are used as the risk free rates.

4.7 Short Term Relationship between Risk Free Rates and Asset Prices under ECM

$$\Delta(p_t - d_t) = \delta + \beta_0 \Delta(p_t - d_t) + \sum_{j=1}^J \beta_j x_{j,t-1} + \sum_{i=1}^p \alpha_i \Delta(p_{t-i} - d_{t-i}) + \sum_{i=0}^q \sum_{j=1}^J \theta_j \Delta x_{j,t-i} + \eta_t \quad (32)$$

Where $x_{i,t-1}$ include G_p , $R_{f,t}$ and $R_{m,t}$ for CAPM, $x_{i,t-1}$ include G_p , $R_{f,t}$ and $\sigma^2_{Ri,t}$ for ICAPM, $x_{i,t-1}$ include G_p , $R_{f,t}$ and $R_{pi,t}$ for APT. For the short term effect of monetary policy on asset price, ΔR_f is used for study under Wald test.

4.8 Granger Causality Test

The Granger (1969) used VAR model to find that how much past values can explain the current values. The models are as follows:

$$y_t = \alpha_0 + \sum_{i=1}^p \alpha_i y_{t-i} + \sum_{i=1}^q \pi_{xi} x_{t-i} + \varepsilon_t \quad (33)$$

$$x_t = \alpha_0 + \sum_{i=1}^p \alpha_i x_{t-i} + \sum_{i=1}^q \pi_{yi} y_{t-i} + \varepsilon_t \quad (34)$$

The reported F-statistics are the Wald test statistics for the joint hypothesis that x does not granger cause y are as: $H_0: \sum_{i=1}^q \pi_{xi} = 0$ and $H_a: \sum_{i=1}^q \pi_{xi} \neq 0$

The reported F-statistics are the Wald statistics for the joint hypothesis that does not granger cause x are as: $H_0: \sum_{i=1}^q \pi_{yi} = 0$ and $H_a: \sum_{i=1}^q \pi_{yi} \neq 0$

For the study, the Granger causality test is used to study the effects of the RP rates on real money supply, deposit rates and lending rates and the Granger causality test is used to study the effects of the RP rates, real money supply, deposit rates and lending rates on short term bond market yields including three month and one year bond yields to find the monetary policy effects as the risk free rate.

4.9 Impulse Response Function

Under VAR model, an impulse response function is to find the shock impact of a variable to one of the innovations on current and future values of the endogenous variables. Lutkepohl and Reimers (1992) initiated that the traditional impulse response analysis used the orthogonalization of shocks;

therefore, the results were dependent on the ordering of the variables in the VAR. In order to solve this failure, Pesaran and Shin (1998) developed the generalized impulse response functions which overcome the different ordering effect of the variables on impulse response functions. The impulse response functions are as per the following:

$$V_t = \alpha_0 + \sum_{i=1}^q \alpha_i V_{t-i} + \varepsilon_t \quad (35)$$

Where V_t is a vector of endogenous variables and $V_t = \Psi(L)\varepsilon_t$ where $E(\varepsilon_t \varepsilon_t') = H$

The generalized impulse response function of V_i to a unit (one standard deviation) shock in V_j is given by:

$$\Psi_{ij,h} = \sigma_{ii}^{-1/2} (e_j' H e_i) \quad (36)$$

Where σ_{ii} is the i th diagonal element of H , e_i is a selection vector with the i th element equal to one and all other elements equal to zero, and h is the horizon.

5. Scope of study and data

The study covers the monthly stock market data in Thailand from April 2002-December 2012. The data are Log of price-to-dividend ($p_t - d_t$), Sustainable growth rate (G_t), Rate of return ($R_{i,t}$), 10year treasury yield ($R_{f,t}$), Three month treasury yield ($R_{3m,t}$), One year treasury yield ($R_{1y,t}$), Inflation rate (Inf_t), RP rate (RP_t), Log of real money supply ($m_{r,t}$), Deposit rate (DR_t), Minimum lending rate (MLR_t), Industrial production index (IP_t), World market rate of return ($R_{m,t}$), VIX Index (VIX_t) and JP Morgan emerging market spread ($SPREAD_t$).

5.1 Real money adjustment

The money supply is adjusted to the same base level as the consumer prices to calculate the real money supply. The 2011 base level is calculated for the money supply to conform to the consumer price with base level from the Ministry of Commerce.

5.2 Seasonal data adjustment

The equity return found the monthly seasonal effects from many studies including Gultekin M.N and Gultekin N.B (1983), Boudreaux (1995) and Yakob, Beal and Delpachitra (2005). The monthly seasonal pattern on both short term and long term interest rates due to the seasonal effect of credit demand and supply was also found from Diller (1970). Miron (1986) also explained no seasonal effect on the interest rate after World War II because Federal Reserve used the open market operation to adjust money supply seasonally or without seasonal money stock, the interest rate will be seasonal. Therefore, all financial data have been seasonally adjusted for the study under Additive moving average.

5.3 GARCH Estimation Result

GARCH(1,1) is used for the stock return and inflation volatility estimation from conditional variance with the result in Table 1. The equity return volatility is estimated from lag period of t-1 and t-3 with minimization of Akaike info criterion (AIC). For variance equation, residual square ($\varepsilon_{R,t-1}^2$) has significant effect on conditional variance ($\sigma_{R,t}^2$) but lag of conditional variance ($\sigma_{R,t-1}^2$) has no significant effect on conditional variance ($\sigma_{R,t}^2$). The inflation volatility is estimated from lag period of t-8 with minimization of AIC. For variance equation, residual square ($\varepsilon_{inf,t-1}^2$) and lag of conditional variance ($\sigma_{inf,t-1}^2$) have significant effect on conditional variance ($\sigma_{R,t}^2$).

5.4 Unit Root Test

The results of the unit root test are in Table 2. The ADF test with and without trends are used for the test. The test found that, under a test without trend assumption, Log of price-to-dividend, Sustainable growth rate, 10 year treasury yield, RP rate, Deposit rate, MLR rate, 3month treasury yield, One year treasury yield and JP Morgan emerging market spread failed to reject the hypothesis that there are unit root processes. Therefore, Log of price-to-dividend, Sustainable growth rate, 10 year treasury yield, RP rate, Deposit rate, MLR rate, 3month treasury yield, One year treasury yield, and JP Morgan emerging market spread are non-stationary. Under the ADF test with a trend assumption, Log of Industrial production index, Log of adjusted

money supply, Log of consumer price index and Log of real money supply are failed to reject the hypothesis that there are a unit root processes. Therefore, Log of Industrial production index, Log of adjusted money supply, Log of consumer price index and Log of real money supply are non-stationary. Rate of stock return, Equity return volatility, Inflation volatility, Inflation rate, VIX index and World market rate of return under the ADF test rejected the hypothesis that there is a unit root process. Therefore, Rate of stock return, Equity return volatility, Inflation volatility, Inflation rate, VIX Index and World market rate of return are on the stationary process.

6. Empirical Result of Asset Price Bubble Test

The results of the Engle-Granger cointegration test are in Table 3. For the asset pricing valuation under the perfect expectation model, the ADF test statistic is -3.95 that reject the unit root hypothesis at 1% significance level. For the asset pricing valuation under CAPM, the ADF test statistic is -2.92 that reject the unit root hypothesis at 5% significance level. For the asset pricing valuation under ICAPM, the ADF test statistic is -3.60 that reject the unit root hypothesis at 1% significance level and for the asset pricing valuation under APT model, the ADF test statistic is -4.66 that reject the unit root hypothesis at 1% significance level. Therefore, the Engle-Granger cointegration test found that ADF tests for the error term of the regression under assumption of all four models rejected the hypothesis of a unit root process and it is concluded that there are cointegrations under all four models. Although the Engle-Granger cointegration test indicates the long term relationship between log of price-to-dividend and fundamental value under all four assumptions, including perfect expectation model, CAPM, ICAPM and APT, some variables are $I(1)$ or $I(0)$, autoregressive distributed lag model (ARDL) bound test can solve the test of a relationship between variables with $I(1)$ and $I(0)$. The lag length selection criteria under the VAR model, with consideration of Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Information Criterion (SC) and Hannan-Quinn Information Criterion (HQ), is used for the estimation of the ARDL bound test model. For the ARDL bound test under the perfect expectation model, Wald test is at 7.15 that reject the hypothesis at 1% significance

level. For CAPM, the Wald test is at 9.25 that reject the hypothesis at 1% significance level. For ICAPM, the Wald test is at 2.95 that reject the hypothesis at 10% significance level and the Wald test for APT is at 4.06 that reject hypothesis at 1% significance level. Therefore, the ARDL Bound test also found that there were the cointegrations under all models. Therefore, from both Engle-Granger cointegration test and ARDL bound test, it is concluded that there are no bubbles in Thailand stock market.

7. Empirical Study on Effect of the Role of Monetary Policy on Asset Prices

7.1 Monetary Policy Transmission Mechanism

For monetary policy tools and transmission, the VAR models between policy rate and monetary transmission effects including real money supply, deposit rates and lending rates are estimated for the study. Granger causality test shows that there are the effects of policy rates on the real money supply, deposit rates and lending rates in Table 4. The Chi-square statistics from Granger causality test of the effect of policy rates on the real money supply, deposit rates and lending rates are 29.31, 9.36, and 16.69, respectively, that significantly reject the hypothesis. The impulse response function in Figure 1 shows that there are the negative effects of policy rate shock on real money supply and positive effects of policy rate shock on deposit and lending rates. For the study the effect of policy rates, real money supply, deposit rates and lending rates on bond market rates including three month and one year bond yields, the results are from the Granger causality test in Table 5 and the impulse response function in Figure 2. The result indicates that the RP rate has Granger caused the effect on one year treasury yield with Chi-square statistic at 12.71 that reject the hypothesis at 1% significance level. But there is no effect of the RP rate on three month treasury yield with Chi-square statistic at 3.47 that is insignificant. For impulse response function, The RP rate has the positive effects on one year and three month treasury yields. Real money supply has no Granger causality on one year treasury yield and three month treasury yield with Chi-square statistics at 0.97 and 4.46, respectively. For impulse response function, the real money supply has the negative effects on one year and three month treasury yields for the first six months and the

negative effect diminishes after six months. Deposit rates have Granger caused the effects on one year and three month treasury yields with Chi-square statistics at 9.79 and 9.80 that reject the hypothesis at 5% significance level, respectively. For impulse response function, the deposit rates have the positive effects on one year and three month treasury yields and the effect starts to decline after four months. Finally, the lending rates have Granger caused the effect on one year and three month treasury yields with Chi-square statistics at 12.37 and 11.10 that reject the hypothesis at 5% and 1% significance level, respectively. For impulse response function, the lending rates have the positive effects on one year and three month treasury yields and the effect starts to decline after four months.

The results show that policy rates, deposit rates and lending rates have the significant positive effects on the bond market interest rate; therefore, BOT's monetary policy is effective to use the policy rates as tools on monetary policy transmission mechanisms. For liquidity effect, the real money supply has a temporary negative effect on bond market interest rates from impulse response function but there is no permanent effect on bond market interest rate from Granger causality test. Because BOT uses the liquidity management to support the effectiveness of the policy rate to meet BOT objective, the market is confident that BOT will control any shock of money supply like capital inflows and outflows that affect financial markets overall. The BOT will use monetary tools to manage liquidity to support BOT policy rates and objectives. Therefore, there is the effectiveness of BOT monetary policy to manage liquidity to ensure that the policy rates play an important role on monetary transmission, although the shock of money supply will cause temporary effects on bond market but not have any permanent effect. From the study monetary policy transmission, policy rates, deposit rates and lending rates will have effects on bond market rates and can be used as proxies of risk free rates to study the effect of monetary policy on asset prices; however, the real money supply as a liquidity effect has no effect on bond market rates; therefore, the real money supply should not be used as a proxy of risk free rates to study the effect of monetary policy on asset prices.

7.2 Monetary Policy Effects on Asset Prices

For long term relationship, the Engle-Granger cointegration test and the ARDL bound test are used for this study. Table 6 shows that, for RP rate, there is cointegration between the actual log of price-to-dividend and fundamental values for all three models from the Engle-Granger cointegration tests and the ARDL bound tests. For deposit rate and MLR rate, there are cointegrations between the actual log of price-to-dividend and fundamental values for all three models from the Engle-Granger cointegration tests. But under the ARDL bound test, there are cointegrations between the actual log of price-to-dividend and fundamental values for CAPM and APT but there are no cointegrations between the actual log of price-to-dividend and fundamental values for ICAPM.

For the long term effects of monetary policy on asset prices, there are significant effects from the RP rate, deposit rates and lending rates. For sensitivity effect in Table 7, the effect of the RP rate on log of price-to-dividend on average is -0.0905 or the increase of the RP rate by 1% will have a negative effect on price-to-dividend by an average of 8.65%. The effect of deposit rate on log of price-to-dividend on average is -0.062 or the increase of deposit rate by 1% will have a negative effect on price-to-dividend by an average of 6.02% that is a lower effect than the RP rate. The effect of MLR rate on log of price-to-dividend on average is -0.0752 or the increase of MLR rate by 1% will have a negative effect on price-to-dividend by an average of 7.24% that is a lower effect than the RP rate.

For the short term effect in Table 8, for the RP rate effect, the Wald test on coefficients of differentials in the RP rate found that the F-value statistics for CAPM, ICAPM and APT model are insignificant at 1.55, 1.85 and 1.96 respectively. Therefore, there is no short term effect of the RP rate on log of price-to-dividend. For the deposit rate effect, the Wald test on coefficients of differentials in the deposit rates found that the F-value statistics for CAPM, ICAPM and APT model are insignificant at 1.80, 1.50 and 1.37 respectively. Therefore, there is no short term effect of the deposit rates on log of price-to-dividend. For lending rate, the F-value statistics for CAPM, ICAPM and APT model are 1.35, 1.96 and 1.79 respectively. Therefore, there is only ICAPM model that have the short term effect on differentials in MLR rate on

differentials of asset price valuation at 10% significance level. Therefore, on overall, there is no short term effect of MLR rate on log of price-to-dividend.

7.3 Asymmetric Effects of Contractionary and Expansionary Monetary Policy on Asset Prices

The above studies are assumed that the coefficients of monetary policy effect on asset price valuation are constant over time as $\rho = 1/[1 + e^{E_t(d_t - p_t)}]$, where $e^{E_t(d_t - p_t)}$ is assumed to be stable over period; therefore, $\frac{\partial(p_t - d_t)}{\partial R_f} = -\sum_{j=0}^k \rho^j \theta^{j+1}$ is stable. Nevertheless, in the case that $e^{E_t(d_t - p_t)}$ depends on the change in the investor perception of expected dividend yield varying on the interest rate. During the expansionary monetary policy (decreasing interest rate), investors would expect lower dividend yield; therefore, ρ is higher and, during the contractionary monetary policy (increasing interest rate), investors would expect higher dividend yield; therefore, ρ is lower. For conclusion, the asymmetric effects of contractionary and expansionary monetary policy are as follows:

$$\begin{aligned} \frac{\partial(p_t - d_t)}{\partial R_f} &= -\sum_{j=0}^k \rho_T^j \theta^{j+1} \quad \text{under contractionary monetary policy} \\ \frac{\partial(p_t - d_t)}{\partial R_f} &= -\sum_{j=0}^k \rho_E^j \theta^{j+1} \quad \text{under expansionary monetary policy} \end{aligned} \quad (37)$$

Where ρ_T^j is smaller than ρ_E^j or the effect of contractionary monetary policy on asset price valuation is lower than the effect of expansionary monetary policy on asset price valuation.

For the empirical study on the asymmetric effects on contractionary and expansionary monetary policy on asset prices, it is separated into the contractionary monetary policy period and the expansionary monetary policy period during 2002-2012. The dummy variable is used for controlling the effects of the contractionary or expansionary monetary policy. The result of monetary policy effect is found in Table 9. The effect of the RP rate on log of price-to-dividend during the contractionary monetary policy period is by an average of -0.064 or the increase of the RP rate by 1% will have a negative effect on price-to-dividend by 6.21%. For the expansionary monetary policy period, the effect of the RP rate on log of price-to-dividend is by an average

of -0.143 or the increase of the RP rate by 1% will have a negative effect on price-to-dividend by 13.31%. For the specific period of contractionary monetary policy during October 2003 to June 2006, the effect of the RP rate on log of price-to-dividend is by an average of -0.101 or the increase of the RP rate by 1% will have a negative effect on price-to-dividend by 9.64%. For the specific period of expansionary monetary policy during June 2006 to October 2009, the effect of the RP rate on log of price-to-dividend is by an average of -0.198 or the increase of the RP rate by 1% will have a negative effect on price-to-dividend by 17.94%. Therefore, the results conform to the assumption of varying expectation of dividend yield under the asymmetric monetary policy effect.

8. Discussion

For asset price bubbles discussion, the limitation of the study is from the requirement of dividend data. The requirement of dividend payment is important information in calculating the log of price-to-dividend; therefore, the periods of study have been limited for the short period after the Asian crises. An alternative study is to use other relative valuation ratios. If it is assumed that the earnings and operating cash flow are relatively stable to dividends. The earnings can be easily calculated and usually be positive but will be much more volatile during an economic cycle than dividends. The operating cash flow would be more representative of a relative valuation study because of less volatility during the boom-bust cycle; however, the operating cash flow data may fluctuate from asset/liability increase/decrease that may not represent the asset price value. The model can be adjusted for price-to-earnings or price-to-operating cash flow valuation from (8 as per the following:

$$(p_t - e_t) = K + \sum_{j=0}^k \rho^j (G_t - \theta^{j+1} E_t(R_t)) + B_t + C \quad (38)$$

$$(p_t - cf_t) = K + \sum_{j=0}^k \rho^j (G_t - \theta^{j+1} E_t(R_t)) + B_t - Q \quad (39)$$

Where e_t is Log of earnings (E_t), O_t is constant payout ratio; therefore, $D_t = E_t O_t$, $cf_t =$ Log of operating cash flow (CF_t), Q_t is constant cash flow-to-dividend; therefore, $CF_t = D_t Q_t$,

Although there is no sign of asset bubble on the equities market indices, some individual stocks especially low beta stocks increased aggressively from low interest environment after quantitative easing. The bubble tests for the individual stocks would be interesting for further studies. There are many factors that cause the individual stocks traded at different relative valuation from the equity market. Relative price valuation asset *i* to market *m* is as follows:

$$\begin{aligned}
 (p_{i,t} - d_{i,t}) - (p_{m,t} - d_{m,t}) &= (K_i - K_m) + \left(\sum_{j=0}^k \rho_i^j G_{i,t} - \sum_{j=0}^k \rho_m^j G_{m,t} \right) \\
 &\quad - \left[\left(\sum_{j=0}^k \rho_i^j \theta^{j+1} (R_f + B_i (R_m - R_f)) - \left(\sum_{j=0}^k \rho_m^j \theta^{j+1} (R_m) \right) \right) \right] + \\
 &\quad (B_{i,t} - B_{m,t})
 \end{aligned} \tag{40}$$

Therefore, $\frac{\partial \Delta(p_{i-m} - d_{i-m})}{\partial R_f}$ is negative if $B_i < 1$ and positive if $B_i > 1$.

Lastly, there are other factors that affect Log of Price-dividend ratio including the liquidity effects or the change in shareholders benefit payments like treasury stocks. Those factors could be significantly affecting the valuation and further studies may help to clarify the possibility of asset bubbles.

The monetary transmission mechanism from BOT is effective with the target policy rate as the policy to meet the BOT objective. The policy rates affect directly and indirectly through other interest rate channels on banking interest rates to money and bond market but the liquidity effect has no significant role for monetary transmission because BOT manages liquidity to commit the policy rate target. For monetary policy effect on asset prices, the Engle-Granger cointegration test and the ARDL bound test found the relationship between the log of price-to-dividend and monetary policy effects as a proxy of risk free rates. Interest rate from the RP rate, deposit rate and MLR rate negatively impact asset price valuation. For the sensitivity effect, the RP rates have higher impact on asset price valuation than the deposit rates and lending rates because the deposit rates and lending rates are monetary transmission mechanism that will have a second-round impact on asset prices but the RP rate will directly affect on asset prices and from all other monetary transmission mechanisms including interest channel, expectation channel, asset price channel and credit channel. The negative effects of monetary

policy rate on asset prices conform to all three models, including CAPM, ICAPM and APT. For CAPM, some explanation is that if beta is less than one, the effect of interest rate will be negative on asset price valuations. For beta estimation in Table 10, beta of market is 0.91, less than one; therefore, the interest rate will have a negative effect from the monetary policy rate on asset prices.

The monetary policy effects on asset prices are asymmetric, mainly due to varying dividend yield expectation depending on interest rate. Under varying investor expectation of dividend yield, during the expansionary monetary policy (decreasing interest rate), investors would expect lower dividend yield; therefore, the monetary policy effect on asset prices is more negative and, during the contractionary monetary policy (increasing interest rate), investors would expect higher dividend yield; therefore, the monetary policy effect on asset prices is less negative. These results indicate that dividend yield plays an important role on the investment decision. These results also conform to the former studies that show the larger effects of monetary policy during the bear market. Napolitano (2006) found that the ECB monetary policy effect was higher impacting the EMU stock market returns during bear market than the bull market and Chen (2007) found that monetary policy effect on S&P500 returns was higher during the bear market under the Markov-switching models. The asymmetric monetary policy effects on asset prices would partly explain that the contractionary policy would be ineffective to tackle the asset bubbles during the economic boom but the expansionary monetary policy would be much effective to support the wealth effect from rising asset prices during the recession and economic downturn.

For further study of individual markets, sector indices and individual stocks, CAPM can explain that the lower risk assets will have a negative effect of interest rates and that higher risk assets will have a positive effect on interest rates.

Conclusion

The studies are to 1) detect asset price bubbles in the Thailand Stock Exchange Market during 2002-2012 due to significantly rising stock market during that period 2 to find the long term and short term effect of monetary

policy on asset prices in Thailand because there are many debates on effect of monetary policy on asset prices, especially during low interest rate with rising stock market during 2002-2012.

The dividend discounted model using expected stock return from perfect expectation model, CAPM, ICAPM and APT Model. The cointegration test under the Engle-Granger method and the ARDL Bound test are used to detect bubbles and find a long term relationship between the actual log of price-to-dividend and its fundamental value. For monetary policy studies, the VAR model is used to study the effect of the policy rates for monetary transmission on the real money supply, deposit rates and lending rates and their monetary transmissions on the bond market rates. The error correction model is also used to find long term and short term relationship between the monetary policy impacts including the RP rate, deposit rates and lending rates; and asset price valuation.

For asset price bubble detection, the results show a cointegration between actual value of log of price-to-dividend and fundamental values under all four models including perfect expectation Model, CAPM, ICAPM and APT model. It can be concluded that there were no bubble signs for Thailand stock market during 2002-2012. An alternative study method is to use other relative valuation ratios, including the price-to-earnings and price-to-operating-cash flow that are more stable than dividends. For further study, although there is no sign of an asset bubble on the equities market indices, some individual stock valuation increased aggressively after 2008; therefore, an individual stock bubble study should be considered for further study.

For the monetary policy study on monetary policy tools and transmission, there are the effects of the policy rate (RP rate) on the money supply, deposit rates and lending rates and there are also the effects of policy rates, deposit rates and lending rates on bond market rates under the Granger causality test and impulse response function; however, the real money supply has a temporary negative effect on bond market interest rates from the impulse response function but has no permanent effect from the Granger causality test, mainly because BOT uses liquidity management to support the effectiveness of the policy rates to ensure that policy rates play an important

role on the monetary transmission. It is concluded that policy rates, deposit rates and lending rates will have an effect on bond market rates and can be used as proxies of the risk free rates to study the effect of monetary policy on the asset prices; however, the real money supply as a liquidity effect has no effect on bond market rates and the real money supply should not be used as a proxy of risk free rate to study the effect of monetary policy on asset prices.

For long term relationship between monetary policies and asset prices, I found the significant effects from policy rates, deposit rates and lending rates on asset prices. For the short term effect, policy rates, deposit rates and lending rates have no short term effect on asset price valuation. For the magnitude of sensitivity effect, the RP rate has higher impact on asset price valuation than the deposit rates and the lending rates because the deposit rates and the lending rates will have the second-round monetary transmission mechanism impacting on the asset prices but the RP rate will directly affect asset prices from all other monetary transmission mechanisms, including interest channel, expectation channel, asset price channel and credit channel. The negative effects of monetary policy rates on asset prices conform to all three models including CAPM, ICAPM and APT. For CAPM, some explanation is that if beta is less than one, the effect of interest rates will be negative on asset price valuations. The monetary policy effects on asset prices are asymmetric. Under varying investor expectation of dividend yield, during the expansionary monetary policy (decreasing interest rate), investors would expect lower dividend yield; therefore, the monetary policy effect on asset prices is more negative and, during the contractionary monetary policy (increasing interest rate), investors would expect higher dividend yield; therefore, the monetary policy effect on asset prices is less negative. For further study on individual markets, sector indices and individual stocks, CAPM can help explain that lower risk assets will have a negative effect from the interest rate and the higher risk assets will have the positive effect from the interest rate.

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Table 1 GARCH(1,1) for equity return volatility and inflation volatility estimation

	$R_{i,t}$		$Inf_{i,t}$
Constant <i>t-statistics</i>	1.254** (2.14)	Constant <i>t-statistics</i>	0.003* (6.05)
$R_{i,t-1}$ <i>t-statistics</i>	0.226** (2.13)	Inf_{t-8} <i>t-statistics</i>	-0.165** (-2.06)
$R_{i,t-3}$ <i>t-statistics</i>	0.156 (1.59)		
Variance Equation			
Constant <i>t-statistics</i>	16.363 (1.43)	Constant <i>t-statistics</i>	0.00*** (1.77)
$\epsilon_{R,t-1}^2$ <i>t-statistics</i>	0.277** (2.24)	$\epsilon_{inf,t-1}^2$ <i>t-statistics</i>	0.254** (2.20)
$\sigma_{R,t-1}^2$ <i>t-statistics</i>	0.285 (0.83)	$\sigma_{inf,t-1}^2$ <i>t-statistics</i>	0.616* (3.71)
R-squared	0.081	R-squared	0.020
AIC	6.469	AIC	-7.935
SC	6.604	SC	-7.819
HQ	6.524	HQ	-7.888

* 1%, ** 5%, *** 10% Significance level

Table 2 Unit root test for data

Variables	Without trend			With trend		
	ADF test	P-Value	Result	ADF test	P-Value	Result
$p_t - d_t$	-2.54	0.110	I(1)	-2.28	0.443	I(1)
G_t	-1.88	0.340	I(1)	-2.21	0.482	I(1)
$R_{i,t}$	-9.25	0.000	I(0)	-9.21	0.000	I(0)
$R_{f,t}$	-2.81	0.060	I(1)	-2.90	0.165	I(1)
$R_{3m,t}$	-2.07	0.256	I(1)	-2.10	0.540	I(1)
$R_{1y,t}$	-2.02	0.280	I(1)	-2.00	0.600	I(1)
RP_t	-2.28	0.179	I(1)	-2.27	0.447	I(1)
$\sigma_{R,t}^2$	-7.14	0.000	I(0)	-7.12	0.000	I(0)
$\sigma_{inf,t}^2$	-3.55	0.008	I(0)	-3.53	0.041	I(0)
Inf_t	-8.36	0.000	I(0)	-8.33	0.000	I(0)
Log of IP_t	-2.40	0.143	I(1)	-3.06	0.120	I(1)
Log Money MI	-0.58	0.869	I(1)	-2.09	0.545	I(1)
Log CPI	-0.33	0.915	I(1)	-2.74	0.222	I(1)
$m_{r,t}$	-0.71	0.839	I(1)	-1.86	0.668	I(1)
DR_t	-2.61	0.093	I(1)	-2.65	0.259	I(1)
MLR_t	-2.65	0.085	I(1)	-2.89	0.168	I(1)
$R_{m,t}$	-8.99	0.000	I(0)	-8.96	0.000	I(0)
VIX_t	-2.96	0.042	I(0)	-2.99	0.140	I(1)
$SPREAD_t$	-2.23	0.198	I(1)	-2.26	0.452	I(1)

* 5% Significance level

Table 3 Engle-Granger cointegration test and ARDL bound test

	Perfect Expectation	CAPM	ICAPM	APT
Constant	3.034*	3.066*	3.346*	3.427*
<i>t</i> -Statistics	(61.00)	(29.92)	(31.69)	(26.04)
P-Value	[0.00]	[0.00]	[0.00]	[0.00]
G_t	0.0213*	0.0199*	0.021*	0.007***
<i>t</i> -Statistics	(5.04)	(4.34)	(4.79)	(1.68)
P-Value	[0.00]	[0.00]	[0.00]	[0.10]
R_{it}	0.010*			
t-Statistics	(3.38)			
P-Value	[0.00]			
R_{ft}		-0.0017	-0.043*	-0.021
t-Statistics		(-0.07)	(-1.78)	(-0.93)
P-Value		[0.95]	[0.00]	[0.36]
R_{m,t}		0.0086**		
<i>t</i> -Statistics		(2.18)		
P-Value		[0.03]		
σ_{R,t}²			-0.003*	
<i>t</i> -Statistics			(-3.64)	
P-Value			[0.00]	
VIX_t				-0.009*
<i>t</i> -Statistics				(-3.13)
P-Value				[0.00]
SPREAD_t				0.00035**
<i>t</i> -Statistics				(2.20)
P-Value				[0.03]
σ_{inf,t}²				-3,255.2*
<i>t</i> -Statistics				(5.62)
P-Value				[0.00]
R-squared	0.206	0.166	0.248	0.540
Akaike info criterion	-0.264	-0.200	-0.373	-0.902
Schwarz criterion	-0.198	-0.111	-0.283	-0.763
Engle-Granger Test	Cointegration	Cointegration	Cointegration	Cointegration
ADF Test	-3.95*	-2.92**	-3.60*	-4.66*
<i>P</i> -Value	[0.00]	[0.05]	[0.01]	[0.00]
ARDL Bound Test	Cointegration	Cointegration	Cointegration	Cointegration
Wald Test (F-Value)	7.15*	9.25*	2.95***	4.06*

* 1%, ** 5%, *** 10% Significance level

Table 4 Effect of RP rate on transmission

Test	$m_{r,t}$	DR_t	MLR_t
Granger Causality Test	29.31*	9.36***	16.69**
<i>P-Value</i>	[0.00]	[0.05]	[0.01]
Impulse Response Function	Negative	Positive	Positive

* 1%, ** 5%, *** 10% Significance level

Figure 1 Generalized Impulse Response of monetary transmission from policy rate

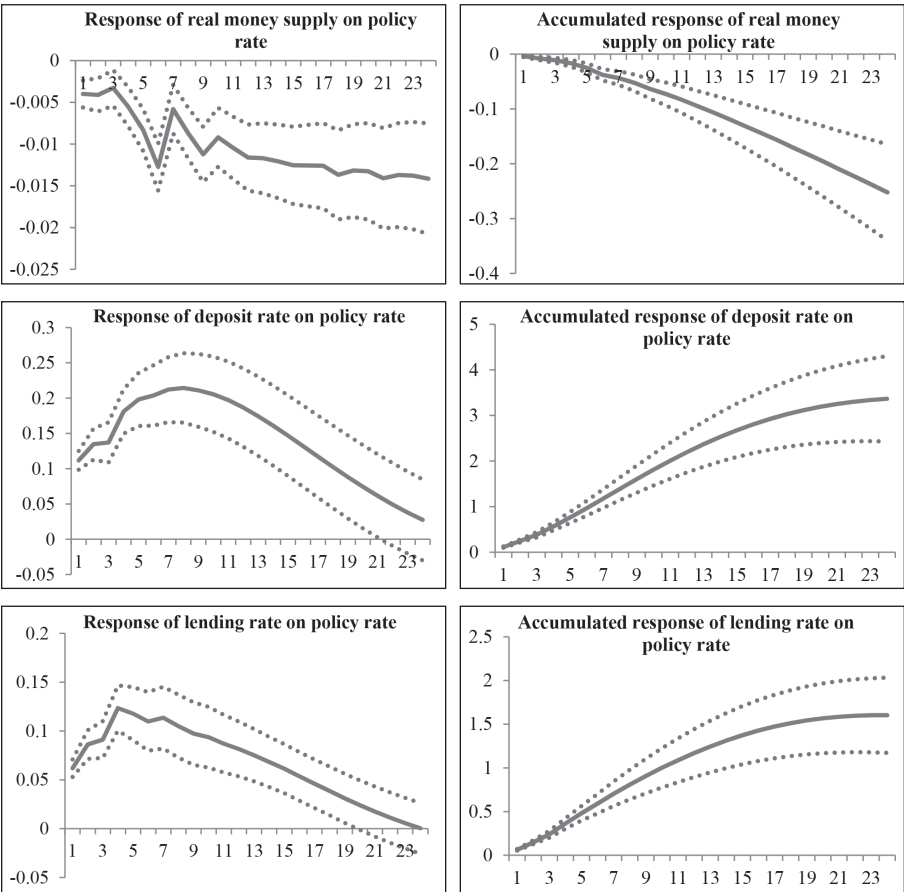


Table 5 Effect of monetary policy effects on bond market

	RP_t	$m_{r,t}$	DR_t	MLR_t
One year bond yields ($R_{1y,t}$)				
Granger Causality Test <i>P-Value</i>	12.71* [0.00]	0.97 [0.81]	9.79** [0.04]	12.37** [0.05]
Impulse Response Function	Positive	Negative	Positive	Positive
Three month bond yields ($R_{3m,t}$)				
Granger Causality Test <i>P-Value</i>	3.47 [0.32]	4.46 [0.22]	9.80** [0.02]	11.10* [0.01]
Impulse Response Function	Positive	Negative	Positive	Positive

* 1%, ** 5%, *** 10% Significance level

Figure 2 Generalized Impulse Response of bond market from monetary policy

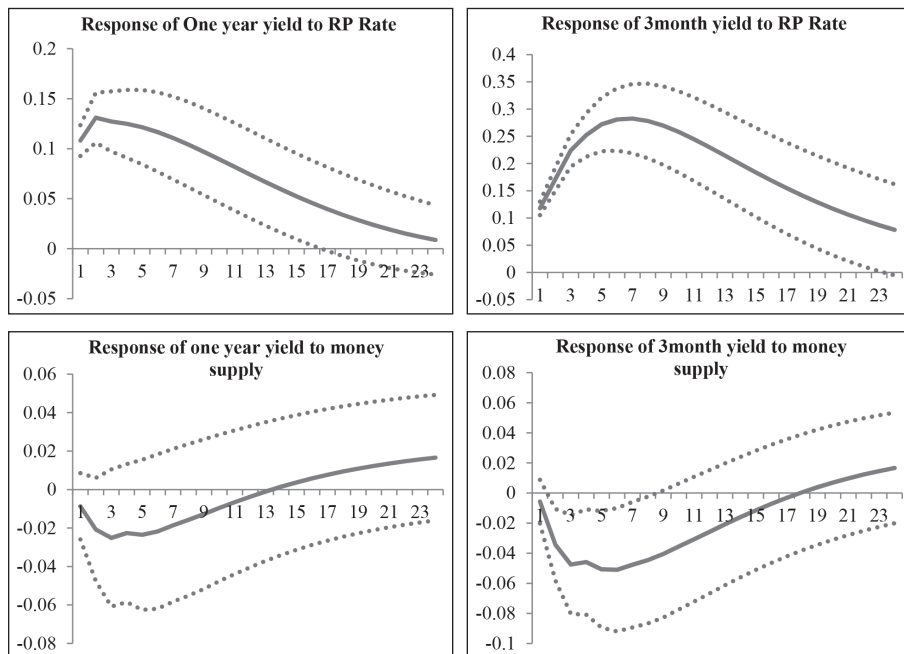


Figure 2 Generalized Impulse Response of bond market from monetary policy (cont.)

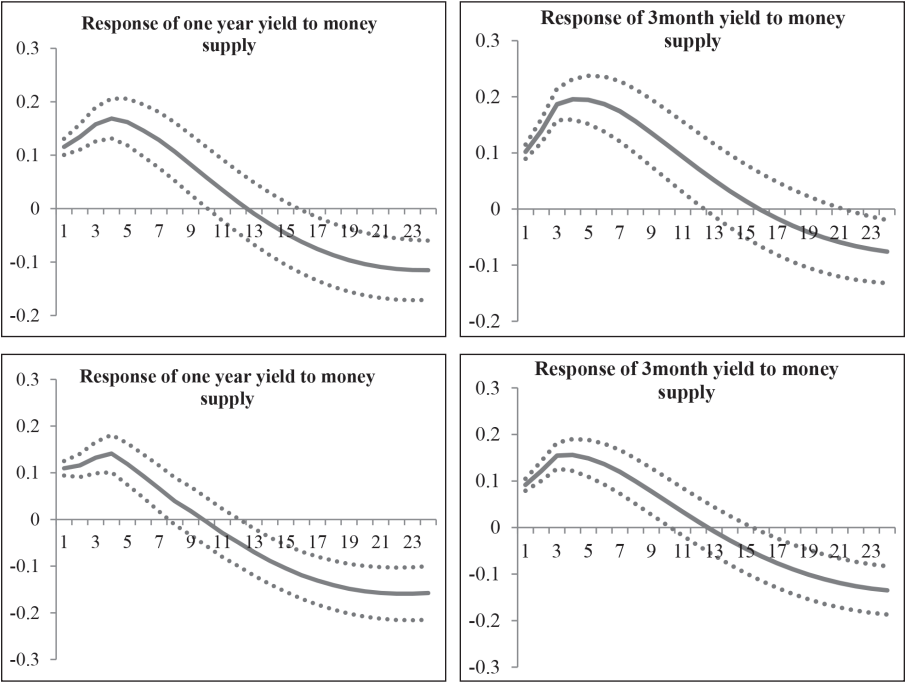


Table 6 Summary of cointegration test of monetary policy on asset prices

	CAPM	ICAPM	APT
RP Rate (RP_t)			
Engle-Granger Test	-3.09**	-3.79*	-4.74*
<i>P-Value</i>	[0.03]	[0.00]	[0.00]
ARDL Bound Test (F-Value)	9.81*	3.63**	4.29*
Deposit Rate (DR_t)			
Engle-Granger Test	-3.00**	-3.58*	-4.75*
<i>P-Value</i>	[0.04]	[0.01]	[0.00]
ARDL Bound Test (F-Value)	8.62*	2.27	4.03*
MLR Rate (MLR_t)			
Engle-Granger Test	-2.92**	-3.51*	-4.73*
<i>P-Value</i>	[0.05]	[0.01]	[0.00]
ARDL Bound Test (F-Value)	8.92*	2.38	4.53*

* 1%, ** 5%, *** 10% Significance level

Table 7 Long term relationship of monetary policy on asset prices

Y = Log of Price-to-Dividend				
	CAPM	ICAPM	APT	Average
RP Rate (RP_t)	-0.092*	-0.089**	-0.091*	-0.0905
<i>t-statistics</i>	[-6.07]	[-6.48]	[-6.41]	
Deposit Rate (DR_t)	-0.0553*	-0.0681	-0.0627*	-0.0620
<i>t-statistics</i>	[-2.80]	[-3.84]	[-4.10]	
MLR Rate (MLR_t)	-0.0672**	-0.0873	-0.0712*	-0.0752
<i>t-statistics</i>	[-2.31]	[-3.38]	[-3.15]	
% Price-to-Dividend				
	CAPM	ICAPM	APT	Average
Δ RP Rate = 1%	-8.77%*	-8.51%**	-8.68%*	-8.65%
Δ Deposit Rate = 1%	-5.38%*	-6.58%	-6.08%*	-6.02%
Δ MLR Rate = 1%	-6.50%*	-8.36%	-6.87%*	-7.24%

* 1%, ** 5%, *** 10% Significance level

Table 8 Short term relationship of monetary policy on asset prices

	CAPM	ICAPM	APT
RP Rate (RP_t)			
Wald Test Statistics <i>P-Value</i>	1.55 [0.21]	1.85 [0.14]	1.96 [0.13]
Effect of Δ RP Rate	Negative	Negative	Negative
Deposit Rate (DR_t)			
Wald Test Statistics <i>P-Value</i>	1.80 [0.11]	1.50 [0.19]	1.37 [0.24]
Effect of Δ Deposit Rate	Negative	Negative	Negative
MLR Rate (MLR_t)			
Wald Test Statistics <i>P-Value</i>	1.35 [0.24]	1.96*** [0.08]	1.79 [0.11]
Effect of Δ MLR Rate	Negative	Negative	Negative

* 1%, ** 5%, *** 10% Significance level

Table 9 Long term effects of contractionary and expansionary monetary policy on asset prices

	CAPM	ICAPM	APT	Average
Contractionary Monetary Policy Period				
RP_t on $p_t - d_t$	-0.057*	-0.077**	-0.058*	-0.064
Δ RP Rate =1% on P_t/D_t	-5.57%	-7.39%	-5.67%	-6.21%
Expansionary Monetary Policy Period				
RP_t on $p_t - d_t$	-0.138*	-0.128*	-0.162*	-0.143
Δ RP Rate =1% on P_t/D_t	-12.92%	-12.05%	-14.93%	-13.31%
Specific Periods of Contractionary and Expansionary Monetary Policies				
	CAPM	ICAPM	APT	Average
Contractionary Monetary Policy Period (October 2003 - June 2006)				
RP_t on $p_t - d_t$	-0.084*	-0.079*	-0.141*	-0.101
Δ RP Rate =1% on P_t/D_t	-8.09%	-7.57%	-13.14%	-9.64%
Expansionary Monetary Policy Period (June 2006 - October 2009)				
RP_t on $p_t - d_t$	-0.219**	-0.157***	-0.218*	-0.198
Δ RP Rate =1% on P_t/D_t	-19.65%	-14.50%	-19.57%	-17.94%

* 1%, ** 5%, *** 10% Significance level

Table 10 Beta Estimation from CAPM model

	Coefficient
Constant	1.00**
<i>t</i> -statistics	[2.49]
Risk Premium	0.91*
<i>t</i> -statistics	[11.02]
R-squared	0.49
Akaike info criterion	5.89
Schwarz criterion	5.94
Hannan-Quinn criter.	5.91

* 1%, ** 5%, *** 10% Significance level

Appendix

A1 Data description

The data descriptions are as follows:

1. Log of Price-to-Dividend ($p_t - d_t$) = Log (Stock Exchange Index/ Total Dividend 12 Months Payment of Index) of Thailand. SET Index and Total trailing dividend 12 months payment are from Bloomberg and Stock Exchange of Thailand.

2. Sustainable Growth Rate (G_t) = Return on Equities of Index * (1-Dividend Payout Ratio) of Thailand. Return on equities and dividend payout ratio are from Bloomberg and Stock Exchange of Thailand.

3. Rate of Return ($R_{i,t}$) = Monthly Stock Exchange Index Total Return of Thailand from Bloomberg and Stock Exchange of Thailand.

4. 10year treasury yield ($R_{f,t}$) = 10 Year Government Bond Yield (interpolated curve) of Thailand from Thai BMA.

5. Inflation Rate (Inf_t) = Monthly percentage change of consumer price index from the Ministry of Commerce.

6. RP Rate (RP_t) = Policy rate from the Bank of Thailand.

7. Log of Real Money Supply ($m_{r,t}$) = Log of real money supply adjusted with base level of money supply and consumer price at 2011. The money supply is M1 money supply from Bank of Thailand and consumer price index is from the Ministry of Commerce.

8. Deposit Rate (DR_t) = Average one year deposit rate of four big banks including Bangkok Bank, Siam Commercial Bank, Kasikorn Bank and Krungthai Bank from the Bank of Thailand

9. Minimum Lending Rate (MLR_t) = Average minimum lending rate of four big banks including Bangkok Bank, Siam Commercial Bank, Kasikorn Bank and Krungthai Bank from the Bank of Thailand

10. Three month treasury yield ($R_{3m,t}$) = Three months Government Bond Yield (interpolated curve) of Thailand from Thai BMA.

11. One year treasury yield ($R_{1y,t}$) = One Year Government Bond Yield (interpolated curve) of Thailand from Thai BMA.

12. Industrial production index (IP_t) = Industrial production index from Office of Industrial Economics

13. World Market Rate of Return ($R_{m,t}$) = Monthly Stock Exchange Index Return of MSCI World Index from Bloomberg

14. VIX Index (VIX_t) = Implied Volatility Index of S&P500 over 30 day period from Bloomberg.

15. JP Morgan Emerging Market Spread ($SPREAD_t$) = Emerging Market Spread of emerging market bonds calculated by JP Morgan. (spread between JP Morgan Emerging Market Bond Index yield over the United States of America's government treasury yield at the same maturity)

A2 Real money adjustment calculation

The money supply is adjusted to the same base level as the consumer prices to calculate the real money supply. The 2011 base level is calculated for the money supply to conform to the consumer price with base level from the Ministry of Commerce. The real money supply is calculated as per the following:

$$m_{r,t} = m_{sa,t} / cpi_t \quad (A.1)$$

$$m_{a,t} = \text{Log } M_{s,t} / M_{s,2011} \quad (A.2)$$

Where $m_{r,t}$ is the log of real money supply,

$m_{sa,t}$ is the seasonal log of money supply with 2011 based index =100

$m_{a,t}$ is the log money supply with 2011 based index =100

$M_{s,t}$ is the money supply at time t

$M_{s,2011}$ is the money supply at the 2011 average level = 1,353.82bn

and

cpi_t is the log of the seasonal consumer price index with a base index = 100

A3 Contractionary and expansionary monetary policy periods

The contractionary and expansionary monetary policy periods, which are used to find the asymmetric monetary policy, come from the movement of the seasonal RP rate as per the following:

Contractionary monetary policy period

November 2003 - June 2006
 November 2007 - November 2008
 November 2009 - August 2011

Expansionary monetary policy period

April 2002 - October 2003
 July 2006 - October 2007
 December 2008 - October 2009
 September 2011 - December 2012

Figure A-1 Contractionary and expansionary monetary policy periods

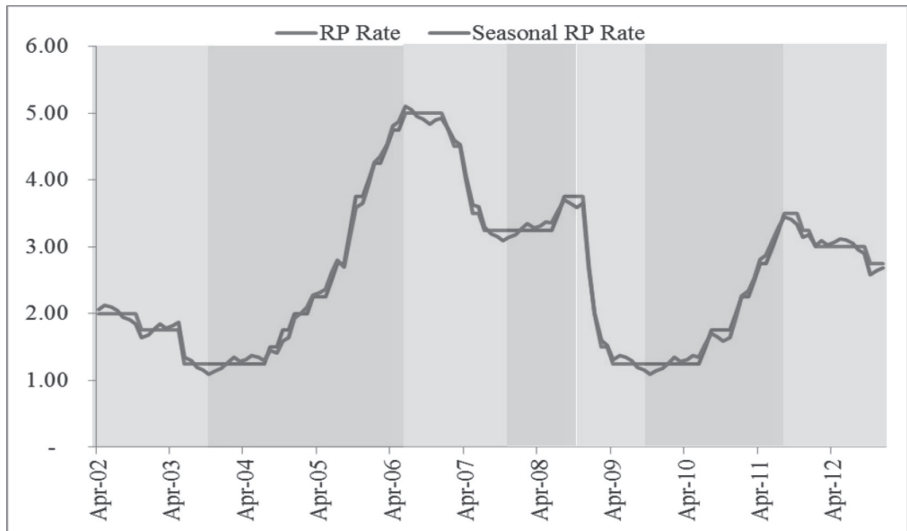


Table A-1 Long term relationship between RP rate and asset prices

	CAPM	ICAPM	APT Model
Constant	3.243*	3.356*	3.606*
<i>t</i> -Statistics	(60.73)	(57.56)	(47.40)
P-Value	[0.00]	[0.00]	[0.00]
G_t	0.025*	0.023*	0.013*
<i>t</i> -Statistics	(6.45)	(6.45)	(3.77)
P-Value	[0.00]	[0.00]	[0.00]
RP_t	-0.092*	-0.089*	-0.091*
<i>t</i> -Statistics	(-6.07)	(-6.48)	(-6.41)
P-Value	[0.00]	[0.00]	[0.00]
$R_{m,t}$	0.006**		
<i>t</i> -Statistics	(1.76)		
P-Value	[0.08]		
$\sigma_{R,t}^2$		-0.003*	
<i>t</i> -Statistics		(-3.66)	
P-Value		[0.00]	
VIX_t			-0.005**
<i>t</i> -Statistics			(-1.98)
P-Value			[0.05]
$SPREAD_t$			-0.0002
<i>t</i> -Statistics			(-1.54)
P-Value			[0.13]
$\sigma_{inf,t}^2$			-2323.20*
<i>t</i> -Statistics			(-4.68)
P-Value			[0.00]
R-squared	0.36	0.43	0.66
Akaike info criterion	-0.46	-0.64	-1.20
Schwarz criterion	-0.37	-0.55	-1.06
Engle-Granger Cointegration test	Cointegration	Cointegration	Cointegration
ADF Test	-3.09**	-3.79*	-4.74*
<i>P</i> -Value	[0.03]	[0.00]	[0.00]

* 1%, ** 5%, *** 10% Significance level

Table A-2 Long term relationship between deposit rate and asset prices

	CAPM	ICAPM	APT Model
Coefficient			
Constant	3.154*	3.297*	3.475*
<i>t</i> -Statistics	(53.30)	(51.79)	(45.15)
P-Value	[0.00]	[0.00]	[0.00]
G_t	0.021*	0.020*	0.008**
<i>t</i> -Statistics	(5.09)	(5.19)	(2.29)
P-Value	[0.00]	[0.00]	[0.02]
DR_t	-0.055*	-0.068*	-0.063*
<i>t</i> -Statistics	(-2.80)	(-3.84)	(-4.10)
P-Value	[0.01]	[0.00]	[0.00]
$R_{m,t}$	0.007***		
<i>t</i> -Statistics	(1.75)		
P-Value	[0.08]		
$\sigma_{R,t}^2$		-0.003*	
<i>t</i> -Statistics		(-3.49)	
P-Value		[0.00]	
VIX_t			-0.007*
<i>t</i> -Statistics			(-2.69)
P-Value			[0.01]
$SPREAD_t$			0.0002
<i>t</i> -Statistics			(0.81)
P-Value			[0.42]
$\sigma_{Inf,t}^2$			-2952.6*
<i>t</i> -Statistics			(-5.68)
P-Value			[0.00]
R-squared	0.21	0.31	0.60
Akaïke info criterion	-0.26	-0.46	-1.03
Schwarz criterion	-0.17	-0.37	-0.89
Engle-Granger Cointegration test	Cointegration	Cointegration	Cointegration
ADF Test	-3.00**	-3.58*	-4.75*
P-Value	[0.05]	[0.01]	[0.00]

* 1%, ** 5%, *** 10% Significance level

Table A-3 Long term relationship between lending rate and asset prices

	CAPM	ICAPM	APT Model
Coefficient			
Constant	3.509*	3.761*	3.807*
<i>t</i> -Statistics	(17.54)	(21.11)	(22.63)
P-Value	[0.00]	[0.00]	[0.00]
G_t	0.019*	0.017*	0.007***
<i>t</i> -Statistics	(4.53)	(4.46)	(1.79)
P-Value	[0.00]	[0.00]	[0.08]
MLR_t	-0.067**	-0.087*	-0.071*
<i>t</i> -Statistics	(-2.31)	(-3.38)	(-3.15)
P-Value	[0.02]	[0.00]	[0.00]
$R_{m,t}$	0.006		
<i>t</i> -Statistics	(1.62)		
P-Value	[0.11]		
$\sigma_{R,t}^2$		-0.003*	
<i>t</i> -Statistics		(-3.39)	
P-Value		[0.00]	
VIX_t			-0.007**
<i>t</i> -Statistics			(-2.31)
P-Value			[0.02]
$SPREAD_t$			0.0002
<i>t</i> -Statistics			(1.07)
P-Value			[0.29]
$\sigma_{Inf,t}^2$			-3139.0*
<i>t</i> -Statistics			(-5.94)
P-Value			[0.00]
R-squared	0.20	0.29	0.57
Akaïke info criterion	-0.24	-0.44	-0.98
Schwarz criterion	-0.15	-0.35	-0.84
Engle-Granger Cointegration test	Cointegration	Cointegration	Cointegration
ADF Test	-2.92**	-3.51*	-4.73*
P-Value	[0.05]	[0.01]	[0.00]

* 1%, ** 5%, *** 10% Significance level

Table A-4 Error correction model of RP rate effect on asset prices

	CAPM		ICAPM		APT	
	Coefficient	t-Stat.	Coefficient	t-Stat.	Coefficient	t-Stat.
Constant	-0.002	-0.26	0.000	0.02	-0.001	-0.20
ECT_{t-1}	-0.156*	-3.07	-0.194*	-3.32	-0.296*	-4.67
$\Delta(p_{t-1} - d_{t-1})$	0.087	0.92	0.045	0.45	-0.029	-0.31
$\Delta(p_{t-2} - d_{t-2})$	0.213**	2.25	0.053	0.54	0.067	0.76
$\Delta(p_{t-3} - d_{t-3})$	0.053	0.63	0.070	0.75	0.021	0.26
$\Delta(p_{t-4} - d_{t-4})$	0.209*	2.53	0.239*	2.56	0.237*	3.19
$\Delta(p_{t-5} - d_{t-5})$	0.066	0.80	0.035	0.38	0.035	0.46
ΔG_t	0.023*	4.42	0.026*	4.21	0.020*	4.22
ΔG_{t-1}	0.001	0.11	-0.004	-0.67	-0.0001	-0.03
ΔG_{t-2}	-0.001	-0.18	0.004	0.69	-0.001	-0.10
ΔG_{t-3}	-0.009	-1.61	-0.012**	-2.00	-0.007	-1.45
ΔG_{t-4}	-0.008	-1.43	-0.009	-1.56	-0.008***	-1.70
ΔG_{t-5}	0.004	0.67	-0.002	-0.29	0.001	0.11
ΔRP_t	-0.052	-1.15	-0.049	-0.93	-0.054	-1.28
ΔRP_{t-1}	0.003	0.07	-0.023	-0.41	0.009	0.22
ΔRP_{t-2}	-0.055	-1.24	-0.067	-1.24	-0.061	-1.48
$\Delta R_{m,t}$	0.007*	5.10				
$\Delta R_{m,t-1}$	0.004*	2.88				
$\Delta \sigma_{R,t}^2$			-0.0003	-0.60		
$\Delta \sigma_{R,t-1}^2$			0.001***	1.87		
$\Delta \sigma_{R,t-2}^2$			0.000	0.27		
ΔVIX_t					-0.006*	-2.48
ΔVIX_{t-1}					-0.004	-1.41
$\Delta SPREAD_t$					-0.0001	-0.28
$\Delta SPREAD_{t-1}$					0.0003	1.03
$\Delta SPREAD_{t-2}$					-0.0001	-0.27
$\Delta \sigma_{inf,t}^2$					-99.59	-0.28
$\Delta \sigma_{inf,t-1}^2$					-219.77	-0.59
R-squared	0.46		0.34		0.59	
AIC	-2.22		-2.00		-2.40	
SC	-1.81		-1.57		-1.86	
Test	F-Stat.		F-Stat.		F-Stat.	
ARDL Bound test	9.81*		3.63**		4.29*	
Short term effect test	1.55		1.85		1.96	

* 1%, ** 5%, *** 10% Significance level

Table A-5 Error correction model of deposit rate effect on asset prices

	CAPM		ICAPM		APT	
	Coefficient	t-Stat.	Coefficient	t-Stat.	Coefficient	t-Stat.
Constant	-0.003	-0.44	-0.001	-0.16	-0.001	-0.22
ECT_{t-1}	-0.153*	-3.05	-0.157*	-2.84	-0.274*	-4.34
$\Delta(p_{t-1} - d_{t-1})$	0.110	1.13	0.025	0.24	0.007	0.07
$\Delta(p_{t-2} - d_{t-2})$	0.235**	2.37	0.053	0.52	0.069	0.75
$\Delta(p_{t-3} - d_{t-3})$	0.052	0.60	0.062	0.64	0.009	0.11
$\Delta(p_{t-4} - d_{t-4})$	0.205**	2.35	0.211	2.10	0.244*	3.06
$\Delta(p_{t-5} - d_{t-5})$	0.007	0.08	-0.047	-0.48	-0.018	-0.23
ΔG_t	0.024*	4.45	0.026*	4.17	0.021*	4.26
ΔG_{t-1}	0.002	0.29	-0.004	-0.58	0.001	0.10
ΔG_{t-2}	-0.002	-0.39	0.003	0.41	-0.001	-0.16
ΔG_{t-3}	-0.009	-1.61	-0.013**	-2.23	-0.007	-1.36
ΔG_{t-4}	-0.009	-1.57	-0.010	-1.60	-0.009***	-1.83
ΔG_{t-5}	0.008	1.38	0.002	0.24	0.004	0.81
ΔDR_t	-0.070	-1.64	-0.084***	-1.68	-0.054	-1.29
ΔDR_{t-1}	0.011	0.25	-0.007	-0.13	0.019	0.45
ΔDR_{t-2}	-0.016	-0.38	0.017	0.34	-0.040	-0.94
ΔDR_{t-3}	0.004	0.09	-0.008	-0.17	0.004	0.09
ΔDR_{t-4}	0.015	0.34	-0.029	-0.57	0.022	0.51
ΔDR_{t-5}	-0.062	-1.46	-0.059	-1.24	-0.064	-1.57
$\Delta R_{m,t}$	0.008*	5.04				
$\Delta R_{m,t-1}$	0.004*	2.85				
$\Delta \sigma_{R,t}^2$			-0.0005	-1.10		
$\Delta \sigma_{R,t-1}^2$			0.001	1.07		
$\Delta \sigma_{R,t-2}^2$			-0.0002	-0.44		
ΔVIX_t					-0.007*	-2.73
ΔVIX_{t-1}					-0.003	-1.18
$\Delta SPREAD_t$					0.00004	0.12
$\Delta SPREAD_{t-1}$					0.00030	1.03
$\Delta SPREAD_{t-2}$					-0.00009	-0.42
$\Delta \sigma_{inf,t}^2$					-246.1	-0.68
$\Delta \sigma_{inf,t-1}^2$					-324.1	-0.85
R-squared	0.47		0.34		0.60	
AIC	-2.18		-1.96		-2.35	
SC	-1.70		-1.46		-1.74	
Test	F-Stat.		F-Stat.		F-Stat.	
ARDL Bound test	8.62*		2.27		4.03*	
Short term effect test	1.80		1.50		1.37	

* 1%, ** 5%, *** 10% Significance level

Table A-6 Error correction model of lending rate effect on asset prices

	CAPM		ICAPM		APT	
	Coefficient	t-Stat.	Coefficient	t-Stat.	Coefficient	t-Stat.
Constant	-0.003	-0.44	-0.001	-0.17	-0.001	-0.15
ECT_{t-1}	-0.150*	-3.01	-0.157*	-2.90	-0.282*	-4.41
$\Delta(p_{t-1} - d_{t-1})$	0.089	0.92	0.002	0.02	0.010	0.11
$\Delta(p_{t-2} - d_{t-2})$	0.210**	2.11	0.033	0.33	0.063	0.68
$\Delta(p_{t-3} - d_{t-3})$	0.028	0.32	0.042	0.43	-0.006	-0.07
$\Delta(p_{t-4} - d_{t-4})$	0.177**	1.97	0.191**	1.86	0.217	2.63
$\Delta(p_{t-5} - d_{t-5})$	0.008	0.09	-0.048	-0.49	-0.026	-0.32
ΔG_t	0.024*	4.44	0.026*	4.22	0.021*	4.31
ΔG_{t-1}	0.002	0.38	-0.003	-0.46	0.002	0.35
ΔG_{t-2}	-0.002	-0.28	0.003	0.54	0.000	0.02
ΔG_{t-3}	-0.008	-1.40	-0.012**	-2.05	-0.005	-1.01
ΔG_{t-4}	-0.008	-1.46	-0.009	-1.55	-0.009***	-1.76
ΔG_{t-5}	0.007	1.24	0.001	0.16	0.005	0.91
ΔMLR_t	-0.080	-1.19	-0.113	-1.53	-0.062	-0.97
ΔMLR_{t-1}	0.028	0.42	0.003	0.03	0.026	0.40
ΔMLR_{t-2}	0.001	0.02	0.029	0.40	-0.016	-0.25
ΔMLR_{t-3}	-0.070	-1.07	-0.073	-0.97	-0.058	-0.87
ΔMLR_{t-4}	0.007	0.10	-0.045	-0.58	0.042	0.62
ΔMLR_{t-5}	-0.084	-1.29	-0.086	-1.21	-0.130	-1.98
$\Delta R_{m,t}$	0.007*	4.88				
$\Delta R_{m,t-1}$	0.004*	2.86				
$\Delta \sigma_{R,t}^2$			-0.0005	-1.16		
$\Delta \sigma_{R,t-1}^2$			0.0006	1.39		
$\Delta \sigma_{R,t-2}^2$			-0.0001	-0.24		
ΔVIX_t					-0.007*	-2.81
ΔVIX_{t-1}					-0.003	-0.99
$\Delta SPREAD_t$					0.00012	0.40
$\Delta SPREAD_{t-1}$					0.00025	0.86
$\Delta SPREAD_{t-2}$					-0.00003	-0.15
$\Delta \sigma_{inf,t}^2$					-172.8	-0.46
$\Delta \sigma_{inf,t-1}^2$					-352.4	-0.89
R-squared	0.47		0.36		-2.36	
AIC	-2.19		-1.98		-1.75	
SC	-1.71		-1.48		-2.11	
Test	F-Stat.		F-Stat.		F-Stat.	
ARDL Bound test	8.92*		2.38		4.53*	
Short term effect test	1.35		1.96		1.79	

* 1%, ** 5%, *** 10% Significance level

Table A-7 Long term effects of contractionary and expansionary monetary policy on asset prices

	CAPM	ICAPM	APT
Constant	3.271*	3.42*	3.784*
<i>t</i> -Statistics	(66.61)	(55.54)	(56.06)
G_t	0.041*	0.039*	0.027*
<i>t</i> -Statistics	(7.95)	(7.85)	(4.57)
G_t*Tightening	-0.028*	-0.026*	-0.035*
<i>t</i> -Statistics	(-4.65)	(-4.30)	(-4.40)
R_{f,t}	-0.138	-0.128*	-0.162*
<i>t</i> -Statistics	(-7.26)	(-6.99)	(-7.52)
R_{f,t}*Tightening	0.0811*	0.052**	0.103*
<i>t</i> -Statistics	(3.29)	(2.13)	(4.20)
R_{m,t}	-0.0014		
<i>t</i> -Statistics	(-0.32)		
R_{m,t}*Tightening	0.0192*		
<i>t</i> -Statistics	(2.94)		
σ_{R,t}²		-0.0047*	
<i>t</i> -Statistics		(-3.68)	
σ_{R,t}²*Tightening		0.0023***	
<i>t</i> -Statistics		(1.67)	
VIX_t			-0.0034
<i>t</i> -Statistics			(-0.97)
VIX_t*Tightening			-0.0076***
<i>t</i> -Statistics			(-1.68)
SPREAD_t			-0.00046***
<i>t</i> -Statistics			(-1.92)
SPREAD_t*Tightening			0.0005
<i>t</i> -Statistics			(1.56)
σ_{inf,t}²			-4,576.2*
<i>t</i> -Statistics			(-4.48)
σ_{inf,t}²*Tightening			2976.7*
<i>t</i> -Statistics			(2.75)
R-squared	0.488	0.510	0.788
Akaike info criterion	-0.642	-0.754	-1.592
Schwarz criterion	-0.487	-0.596	-1.338
Engle-Granger test	Cointegration	Cointegration	Cointegration
ADF Test	-3.91*	-4.34*	-4.13*
<i>P</i> -Value	[0.00]	[0.00]	[0.00]
ARDL Bound Text	Cointegration	Cointegration	Cointegration
Wald Test (F-Value)	5.53*	2.51***	2.79**

* 1%, ** 5%, *** 10% Significance level

Note: Tightening is dummy variable that tightening monetary policy period is equal to 1 or else equal to 0.

Table A-8 Long term effects of contractionary monetary policy (October 2003-June 2006)

	CAPM	ICAPM	APT
Constant	3.766*	3.578*	4.245*
<i>t-Statistics</i>	(36.67)	(29.59)	(13.96)
G_t	-0.014**	-0.009	-0.016**
<i>t-Statistics</i>	(-2.19)	(-1.41)	(-2.29)
$R_{f,t}$	-0.084*	-0.079*	-0.141*
<i>t-Statistics</i>	(-6.68)	(-6.57)	(-3.65)
$R_{m,t}$	0.009		
<i>t-Statistics</i>	(1.58)		
$\sigma_{R,t}^2$		0.003**	
<i>t-Statistics</i>		(2.74)	
VIX_t			0.006
<i>t-Statistics</i>			(0.64)
$SPREAD_t$			-0.0010***
<i>t-Statistics</i>			(-1.71)
$\sigma_{inf,t}^2$			-2,750.4
<i>t-Statistics</i>			(-1.44)
R-squared	0.667	0.713	0.688
Akaike info criterion	-1.830	-1.978	-1.776
Schwarz criterion	-1.648	-1.917	-1.504
Engle-Granger Test	Cointegration	Cointegration	Cointegration
ADF Test	-3.62**	-4.30*	-4.78*
<i>P-Value</i>	[0.01]	[0.00]	[0.00]
ARDL Bound Test	Cointegration	No Cointegration	Cointegration
Wald Test (F-Value)	8.34*	1.95	9.00*

* 1%, ** 5%, *** 10% Significance level

Table A-9 Long term effects of expansionary monetary policy (June 2006-October 2009)

	CAPM	ICAPM	APT
Constant	3.265*	3.407*	4.059*
<i>t</i> -Statistics	(24.10)	(24.56)	(39.55)
G_t	0.071*	0.049**	0.033*
<i>t</i> -Statistics	(3.29)	(2.37)	(3.37)
R_{f,t}	-0.219**	-0.157***	-0.218*
<i>t</i> -Statistics	(-2.63)	(-1.94)	(-5.63)
R_{m,t}	0.02*		
<i>t</i> -Statistics	(3.20)		
σ²_{R,t}		-0.0040*	
<i>t</i> -Statistics		(-3.57)	
VIX_t			0.008***
<i>t</i> -Statistics			(1.75)
SPREAD_t			-0.002*
<i>t</i> -Statistics			(-6.76)
σ²_{inf,t}			-237.3
<i>t</i> -Statistics			(-0.46)
R-squared	0.333	0.367	0.879
Akaike info criterion	-0.069	-0.121	-1.676
Schwarz criterion	0.098	0.046	-1.425
Engle-Granger Test	No Cointegration	No Cointegration	Cointegration
ADF Test	-1.93	-2.49	-3.90*
<i>P</i> -Value	[0.32]	[0.13]	[0.00]
ARDL Bound Test	Cointegration	No Cointegration	No Cointegration
Wald Test (F-Value)	4.42*	0.78	1.82

* 1%, ** 5%, *** 10% Significance level