Empirical Assessment of the Present Value Model of Stock Prices Using the Data from Thailand's Stock Market

Jiranyakul, Komain

National Institute of Development Administration

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Komain Jiranyakul

School of Development Economics
National Institute of Development Administration
Serithai Road, Klong-Chan, Bangkapi
Bangkok, Thailand 10240.
Email: jkomain@yahoo.com

Abstract

This study examines whether bubbles are present in the Stock Exchange of Thailand. Three different methods are employed: variance bounds test, equity price bubbles test, and cointegration tests. The results from the variance bounds tests show that stock prices (proxied by the stock market index) diverge from their fundamental values. Speculative bubbles exist using the West's two-step test. There is no cointegration between stock prices and dividends from the results of both Engle-Granger cointegration test and the bounds testing for cointegration. The divergence of stock prices from their fundamental value and no cointegration between stock prices and dividend may indicate the presence of bubbles in the stock market during the period of investigation.

บทคัดย่อ

การศึกษานี้เป็นการทดสอบว่าตลาดหลักทรัพย์แห่งประเทศไทยมีภาวะฟองสบู่หรือไม่ วิธีการศึกษาที่ใช้ในการทดสอบมี 3 วิธีคือ variance bounds test, equity price bubbles test และ cointegration tests ผลการศึกษาแสดงให้เห็นว่าราคาหลักทรัพย์มวลรวมในตลาดแตกต่างจากราคาหลักทรัพย์ที่กะประมาณโดยปัจจัยพื้นฐาน นอกจากนี้ยังไม่มีความสัมพันธ์ระยะยาวระหว่างราคาหลักทรัพย์และเงินปันผล จึงทำให้คาดการณ์ได้ว่ามีภาวะฟองสบู่ในตลาดหลักทรัพย์ในช่วงที่ทำการศึกษา

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Keywords: Stock prices, Present Value model, Variance Bounds Test, Cointegration, Equity Price Bubbles.

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1. Introduction

According to the present value of stock prices, the intrinsic value of a stock is determined by the discounted dividend stream. The most popular used in stock price valuation is the Gordon model which is the version of the constant growth dividend discounted model. This model assumes the constant growth of dividend in the future and the constant discount factor. One can use this model to evaluate whether the current market price of each stock is deviated from its intrinsic value from fundamental analysis. The fundamental value is the present value of all stocks' future cash flows. The deviation of the actual prices from the fundamental prices is called a bubble. The presence of intrinsic bubble stems from sound and rational expectations of investors that can cause stock market booms and bust. If speculative bubble is present, positive excess returns from bubble will force prices to diverge from their fundamental values.[1]

Since its inauguration, the Stock Exchange of Thailand (SET) has played an important part as an investment venue in Thailand's financial market. A number of stocks have been increased substantially. Active trading has been observed recently. Like other emerging stock markets, financial liberalization in 1992 reduced the obstacles to foreign investors who were interested to invest in local money and capital markets in Thailand. Capital inflows in terms of portfolio and foreign direct investment have been encouraged. Thailand saw large capital inflows in the form of portfolio investment prior to the financial crisis in mid-1997.

As can be seen in Figure 1, real SET index was increasing substantially until the end of 1996, and then declined to the lowest point in mid-1998. Beside the negative impact on real GDP, the crisis also distorted investment decision in common stocks due to a switch from fixed to flexible exchange rate regime that caused exchange rate risk in domestic financial assets in the views of foreign investors. The real stock market index slightly increased with some slight fluctuations from 1999 onwards. Prior to the financial crisis, the stock market might be overvalued due to a speculative bubble. The decline of stock prices after the financial crisis might have been due to a change in economic fundamentals.

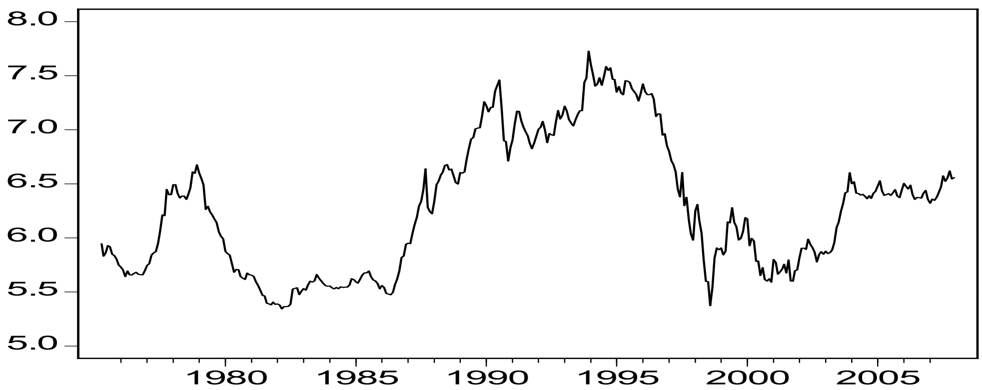

Figure 1. Movements of Real SET index, April 1975-December 2007

Figure 2 show the movements of market dividend yield. However, the diagram showed only a slight impact of financial crisis on dividend yield. The trend of this yield seemed to be downward during 1994 and 2003.

By comparison, the movements of market dividend yield and stock index exhibit different patterns.

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[1] The theory of bubbles in stock market is described in details by Brooks and Katsaris (2003).

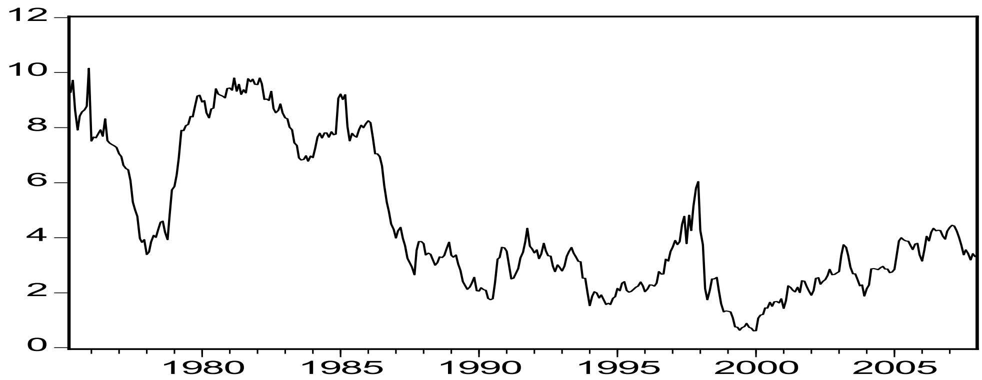

Figure 2. Dividend Yield from SET Index, April 1975-December 2007

This study aims to investigate the relationship between actual stock prices (using the SET index as a proxy) and their fundamental values or test the present value model. Section 2 presents the analytical framework which includes model specification, data and empirical methods. Section 3 presents the results from this study, and the last section concludes.

2. Analytical Framework

2.1 Model Specification

Stock price may deviate from its fundamental value. In most empirical asset pricing tests, the stock price is defined as:

$$P_t = \sum_{i=1}^{\infty} \left(\frac{1}{1+r} \right)^i E_t(d_{t+i}) + B_t \qquad (1)$$

where P is the stock price, d is the dividend received, and r is the one period discount rate, which is assumed to be constant over time.

The asset price has two components: the discounted value of expected future dividends (the market fundamental part), and the bubble part which is B.[2] The bubble part is the rational bubble. In this formulation, the price of the asset can be higher than its fundamental price as long as agents expect that they can sell the asset at a higher price at a future date.

In a regression form, the pricing equation can be written as:

$$P_t = \left(\frac{1}{1+r} \right)(P_{t+1} + d_{t+1}) + u_t \qquad (2)$$

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2 Detailed explanation of the formulation is in Gurkaynak (2008). Assuming that an agent's expectations are rational and there is no arbitrage opportunity, the pricing equation is obtained. This author thoroughly presents various econometric methods and econometrics problems of bubble tests.

Equation (2) shows that the intertemporal relationship between stock price in period t and period t+1 is independent of the presence of a bubble. In this case, there are no arbitrage opportunities with or without a bubble.

Suppose that dividends are exogenous and follow a stationary AR(1) process, the dividend process will be of the form:

$$d_t = \varphi d_{t-1} + u_t^d \tag{3}$$

Given this setup, the market fundamental stock price should be:

$$P_t^f = \sum_{i=1}^{\infty} \left(\frac{1}{1+r}\right)^i E_t(d_{t+1} \mid \Omega_t) = \overline{\beta} d_t \tag{4}$$

where

$$\overline{\beta} = \frac{\varphi/(1+r)}{1-\varphi/(1+r)}$$

The actual stock price may contain a bubble. If the bubble component is zero, the equation used to estimate stock price should be:

$$P_t = \beta d_t + B_t \tag{5}$$

Equation (5) can be estimated using time series data. Regressing stock price variable on dividend variable will give the estimated coefficient β.

Based on the assumption that the expected dividend in a given period grows at a constant rate, g, and required rate of return of investors, r, is greater than g. the Gordon model by Gordon (1962) gives the fundamental price as:

$$P_t^f = \frac{d_{t+1}}{k-g} \tag{6}$$

The required rate of return will be equal to the estimated risk premium (or equity premium) plus the riskless rate of return.

2.2 Data

Monthly data from April 1975 to December 2007 and annual data from 1975 to 2007[3] are obtained from the Stock Exchange of Thailand. The series included in this study are SET index and its dividend. Since the dividend is in the form of percentage of the index, it is converted to dividend attached to the index. There are 393 and 33 observations in monthly and annual data respectively. The summary statistics for the two variables are reported in Table 1.

[3] The annual stock prices and dividends are the closing values in December of each year.

The statistics in Table 1 show that the mean of log of real stock market index was 650.720 per month with very high standard deviation of 443.851. For real dividend, the mean was 23.246 per month with the standard deviation of 10.101. On average, the dividend yield accounted for 3.575 percent of the stock market index. The Jarque-Bera statatistics show that both real SET index and real dividend are not normally distributed. For annual data, similar statistics are observed. However, real dividend exhibits normal distribution.

Table 1. Summary Statistics on Real SET Index and Real Dividend		
a. Monthly Data (April 1975-December 2007)		
	Real SET Index	Real Dividend
Mean	650.720	23.246
S.D.	443.851	10.101
Skewness	1.279	-0.181
Kurtosis	3.753	2.593
Jarque-Bera	116.381***	4.857*
b. Annual Data (1975-2007)		
	Real SET Index	Real Dividend
Mean	674.969	23.964
S.D.	520.628	11.250
Skewness	1.840	0.059
Kurtosis	6.401	2.824
Jarque-Bera	34.524***	0.061
Note: *** denotes significance at the 1% level, and * denotes significant at the 10% level.		

The augmented Dickey and Fuller test (ADF test) developed by Dickey and Fuller (1979 and 1981) is used to test for unit root in both series for monthly data, and the results are reported in Table 2.

Table 2. ADF Tests for Unit Root in SET index and Dividend Index Series (April 1975-December 2007)		
	Constant	Constant and Linear Trend
Log of Real SET index	-1.783 [7] (0.389)	-1.808[7] (0.699)
Log of Real Dividend	-2.550[12] (0.105)	-2.793[12] (0.201)
Δ Log of Real SET index	-6.478[6] (0.000)***	-6.472[6] (0.000)***
Δ Log of Real Dividend	-15.615[0] (0.000)***	-15.612[0] (0.000)***
Note: The number in brackets is the optimal lag length determined by AIC, and the number in parenthesis is the probability provided by MacKinnon (1996). *** denotes 1 % significance level.		

The results show that both series are integrated of order one, or they are I(1) series, i.e., they are non-stationary in level, but stationary in first differences.[4]

The stationary property of annual data is test using Dickey-Fuller generalized least squares (DF-GLS) method developed by Elliott, Rothenberg, and Stock (1996)**.** It is believed that this test can increase the power of test, especially for small sample size, i.e., 33 observations in this study. The results are reported in Table 3.

Table 3 DF-GLS Unit Root Test for Annual Prices and Dividends Series	
	Constant without Linear Trend
Log of Real SET index	-2.085 [0]
Log of Real Dividend	-2.006 [0]
Note: The critical value at the 5% percent level provided by MacKinnon (1996) is -1.952. The number in brackets is the optimal lag length determined by AIC.	

The results in Table 3 show that both price and dividend series are integrated of order zero (I(0)), i.e., they are stationary at level.[5]

2.3 Methodology

The methods used in this study are the variance bound tests and cointegration tests of the present value model.

2.3.1 Variance Bound Test

The first variance bound tests are performed by Shiller (1981).[6] The asset price is specified as:

$$P_t = \sum_{i=1}^{\infty} \left(\frac{1}{1+r} \right)^i E_t(d_{t+i}) \tag{7}$$

This is the one specified in equation (1) without the bubble term. The ex post rational price can be defined as the present value of actual dividend in the form:

$$P_t^* = \sum_{i=1}^{\infty} \left(\frac{1}{1+r} \right)^i d_{t+i} \tag{8}$$

The difference between actual and expected dividend under rational expectations is $d_{t+i} = E_t(d_{t+i}) + \varepsilon_{t+i}$. By substituting this into equation (7), the equation is in the form:

4 The PP test proposed by Phillips and Perron (1988) are also used and the same results is obtained, i.e., the series are I(1).

5 With the sample size of 33, the ADF test without a linear trend show that both series are I(1).

6 LeRoy and Porter (1981) use the same test.

$$P_t^* = \sum_{i=1}^{\infty}\left(\frac{1}{1+r}\right)^i [E_t(d_{t+i}) + \varepsilon_{t+i}] = P_t + \sum_{i=1}^{\infty}\left(\frac{1}{1+r}\right)^i \varepsilon_{t+i} \qquad (9)$$

This difference is unforecastable. Since rational expectations is the perfect-foresight expectation with error, the actual ex post prices (P*) deviate from its rationally expected value (P) only by a random error.

The variance bound test of Shiller based on the difference between volatility (variance) of ex post rational price and the observed price, which is in the form:

$$V(P_t^*) = V(P_t) + \varphi V(\varepsilon_t) \geq V(P_t) \qquad (10)$$

where $\varphi = [1/(1+r)^2 / (1-(1/(1+r))^2]$.

If ε_t is uncorrelated with all information at time t including the market fundamental price at time t, the variance as a measure of volatility of P_t^* can be expressed in the form of equation (9). The test using equation (10) places an upper bound on the variance of the observed price series when it is formed according to equation (6). In other words, the theory of rational stock market prices implies that the variance of actual market prices (P_t) should be equal to or less than that of the ex post rational price (P_t^*). The variance bounds tests show that if a bubble is present in the market, equation (10) will be violated.

2.3.2 West's Two-Step Test

West's (1987) test of equity price bubbles is an alternative to the variance bounds test. If dividends can be represented by an autoregressive (AR) process, the relationship between dividends and stock prices can be estimated using equation (3) and (5). This is a test under the null hypothesis that when there are no bubbles, the actual relationship will not differ from the constructed fundamental prices, i.e., $\beta = \overline{\beta}$.

2.3.3 Cointegration Tests

It has been widely known that Engle and Granger (1987) proposed the two-step cointegration test, which is later called EG cointegration test. If the two series are cointegrated or have a long-run relationship, there exists a linear combination of these series. According to the two-step cointegration test, the unit root test for stationarity property of time series data is determined prior to conintegration test. Augmented Dickey-Fuller test or ADF test prososed by Dickey and Fuller (1979 and 1981) is usually used to test for stationarity of time series. This test determines the existence of a unit root of each series. The series are examined whether they are stationary or integrated of the same order. If the two variables are non-stationary in level but stationary in first differences, the series are integrated of order one, i.e., they are I(1) series. In such a case, cointegration test can be performed by using ADF test on the residual series of the ordinary least square (OLS) regression. MacKinnon (1990) provided the critical values for unit root test for cointegration.

As specified in equation (5), stock market index (P) depends on dividend (d). If stock prices and dividend are integrated of the same order, i.e., I(1), there may be a long-run relationship between these two variables. The equation used can be specified as:

$$P_t = a_0 + a_1 d_t + e_t \tag{11}$$

The residual series from the OLS estimate of equation (11) is used to test for unit root using ADF test. If the series does not contain a unit root, cointegration between stock prices and dividends exits.

Recently developed method that can be used to test for the long-run relationship between overall stock prices (stock market index) is the bounds testing for cointegration or autoregressive distributed lag (ARDL) cointegration procedure proposed by Pesaran and Pesaran (1997) and Pesaran, Shin, and Smith (2001). This test is adopted because it does not require that variables in the equation be purely I(0) or I(1) or mutually cointegrated.

Given the assumption that there is no feedback from dividend to stock index, log of dividend is a long-run forcing for stock index, the ARDL(p,q) model can be written as:

$$\Delta P_t = \alpha + \beta P_{t-1} + \gamma d_{t-1} + \sum_{i=1}^{p} \varphi_i P_{t-i} + \sum_{j=1}^{q} \delta_j d_{t-j} + \varepsilon_t \tag{12}$$

where P is the log of stock market index (SET index), and d s the log of dividend from SET index. Equation (1) is the ARDL(p,q) model since p is the number of lagged first differences of log of stock index and q is the number of lagged first differences of log of dividend. In estimation, p and q do not have to be the same. The search for the optimal orders of p and q is based on the conditions that the ARDL(p,q) model must be parsimonious and free of serial correlation. The long-run relationship between the two variable is:

$$P_t = \pi_0 + \pi_1 d_t + u_t \tag{13}$$

which is the same as that of Engle-Granger cointegration test.

One an appropriate ARDL equation is defined, adding the variable P_{t-1} and d_{t-1} into the equation will yield equation (10). Then the calculated F-statistic is obtained. This statistic is then used to test for a joint significance of the coefficients of lagged variables. The null hypothesis of no cointegration among variables is $H_0 : \beta = \gamma = 0$ while the alternative hypothesis of cointegration: $H_a : \beta \neq \gamma \neq 0$. The computed F-statistic that can be compared to two asymptotic critical values. If the computed F-statistic is above the upper critical value, then the null hypothesis of no cointegration between stock prices and dividends can be rejected regardless of whether the series are I(1) or I(0). On the contrary, if the computed F-statistic is below the lower critical value, the null hypothesis cannot be rejected.[7] However, if

[7] The computed F-statistic is obtained by adding lag level of each series into the ARDL equation which is different from the F-statistic from the least square method.

the computed F-statistic is between the upper and lower critical values, the result is inconclusive.

3. Empirical Results

The results in Section 3.1 and 3.2 are obtained from annual data while the results of Section 3.3 are obtained from monthly data.

3.1 Results from Variance Bound Tests

The Gordon model in equation (6) is used to estimate the fundamental prices.[8] The difference between k and g is selected. The cutoff point is k-g = 0.08. This will give the lowest divergence between the actual prices and estimated fundamental prices. If the difference is above 0.08, this divergence will be higher.

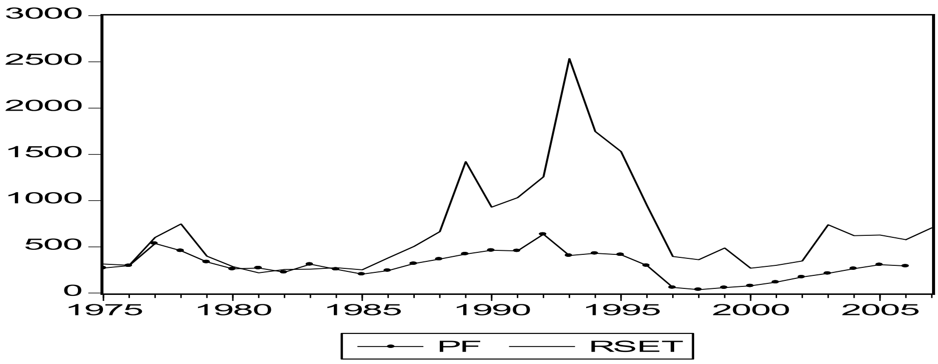

Figure 3 Actual Stock Prices and Fundamental Prices from Gordon Model (k-g = 0.08)

The fundamental prices (PF) and the actual prices (RSET) slightly diverge during 1976 to 1980, which shows small intrinsic bubbles. The bubbles are increased from 1984 to 1993, and decline thereafter. However, the bubbles are seen until 2007. The computed variance of the fundamental prices is 20,086.825 while that of the actual prices is 271,053.510. Therefore, equation (10) is violated. In other words, the actual prices contain the fundamental prices plus bubbles. Marsh and Merton (1983) show that the variance bounds tests fail when stock prices and dividend are non-stationary series. In this study, the test fails even though both series are stationary using DF-GLS test.

3.2 West's two-step test

The fundamental price is computed by first estimating equation (3) to obtain the estimated coefficient φ, the result is reported in Table 4.

[8] There are various alternatives to use, but Gordon model seems to be more convenient.

Table 4 Estimated AR(1) Process of Real Dividend using Annual Data				
Dependent Variable: d_t				
Variable	Coefficient	Standard Error	t-Statistic	Prob.
C	5.586	3.107	1.798	0.082
d_{t-1}	0.756	0.117	6.445	0.000
$R^2 = 0.581$ F = 41.542 $\chi^2_{(1)} = 0.690$ (prob. = 0.406)				

Since real dividend series is stationary and follows the AR(1) process, the estimated φ is 0.756 and is significant at the 1% level. Assuming the risk-free rate of return is 5 percent per annum, this give the calculated $\bar{\beta} = 2.571$. Therefore, $P_t^f = 2.571 d_t$. Regressing p^f on d gives the estimated coefficient of 2.584 with a significance of 1 percent level.[9] However, the coefficient of determination is one, and standard error is zero.

The stationary series of real stock prices and real dividend based upon DF-GLS test are used to estimate equation (5), the results is shown in Table 5.

Table 5 Estimate the Stock Price Variable using Annual Data				
Dependent Variable: P_t				
Variable	Coefficient	Standard Error	t-Statistic	Prob.
C	-47.085	166.549	-0.283	0.779
d_t	30.131	6.309	4.776	0.000
$R^2 = 0.424$ F = 22.812				

The estimated β is 30.131 and significant at the 1% level. However, $\bar{\beta} = 2.584$, which is much lower than the estimated one. The results do not support the hypothesis of no bubbles. Using a Hausman coefficient restriction test with the formula: $H = (\beta - \bar{\beta})' V(\beta - \bar{\beta})^{-1}(\beta - \bar{\beta})$, the Chi-square statistic is 19.057 which is greater than the critical value of 9.21 with degree of freedom of 2, and thus the equality of $\bar{\beta}$ and the estimated β is rejected. Therefore, the existence of speculative bubbles is observed. In addition, regressing the fundamental prices from the two-step estimation above on the actual prices gives the estimated coefficient is 0.036 with the t-statistic of 4.776, which is significant at the 1% level. This result confirms the divergence between the actual and fundamental prices. If there is no bubble, the estimated coefficient will take the value of one.

3.3 Results from Cointegration Tests

Since stock prices and dividends are I(1), the OLS method is applied directly to equation (9), and the results are reported in Table 6.

[9] P^f is stationary at the 5 percent level of significance using DF-GLS test.

Table 6 OLS Estimate of Engle-Granger Cointegration (April 1975-December 2007)				
Dependent Variable: P_t				
Variable	Coefficient	Standard Error	t-Statistic	Prob.
C	2.777	0.313	8.883	0.000
d_t	0.498	0.044	11.240	0.000
R^2 = 0.244 F = 126.340				

To perform the residual-based test for cointegration, the residual series is obtained from the OLS estimate in Table 3. The ADF test on this series gives the ADF statistic of -1.771 which is lower than McKinnon critical value of -2.923 at the 10% level. The null hypothesis of no unit root cannot be rejected. Therefore, there is no cointegration between stock prices and dividends.

The bounds testing is applied to test the long-run relationship between stock prices and dividends, and the result of estimating equation (10) is shown in Table 7. The first step of the test is to find the appropriate ARDL equation using Akaike Information Criterion (AIC), then the next step is to add lag level of stock prices and dividends series into the ARDL equation. The necessary condition for this test is that the estimated equation is free from serial correlation in the residuals. The serial correlation LM test shows that there is no serial correlation in the residuals, i.e., the Chi-square statistic shows that the null hypothesis of no serial correlation is accepted.

Table 7 Bounds Testing for Cointegration between Stock Prices and Dividends (April 1975-December 2007)				
Dependent Variable: P_t				
Variable	Coefficient	Standard Error	t-Statistic	Prob.
c	0.072	0.053	1.361	0.174
ΔP_{t-1}	0.098	0.051	1.909	0.057
ΔP_{t-2}	0.114	0.052	2.207	0.028
ΔP_{t-3}	-0.001	0.052	-0.024	0.981
ΔP_{t-4}	-0.113	0.050	-2.243	0.026
Δd_t	0.210	0.060	3.499	0.001
Δd_{t-1}	-0.002	0.062	-0.034	0973
Δd_{t-2}	-0.078	0.062	-1.256	0.210
Δd_{t-3}	-0.015	0.060	0.256	0.798
P_{t-1}	-0.013	0.508	-1.564	0.119
d_{t-1}	0.001	0.009	0.139	0.890
R^2 = 0.079 F = 3.253 $\chi^2(2)$ = 0.757 (prob. = 0.470)				

The computed F-statistic from this procedure is 1.519 which is lower than 4.040 critical value at the 10 percent level.[10] Therefore, the null hypothesis of cointegration

10 The critical values are obtained from Table CI (iii) Case III in Pesaran, Shin and Smith (2001)

between stock prices and dividends is rejected. The results are the same between the two procedures of testing for cointegration between stock prices and dividends.

4. Conclusions

The present value model of stock valuation with a constant discount factor is tested using data from April 1975 to December 2007 both yearly and monthly. The data for stock market index and dividend yield are obtained from the Stock Exchange of Thailand. Even thought there are several methods for the detection of bubbles, all of them intend to examine whether actual market prices deviate from the fundamental values. The variance bounds tests, and cointegration tests are employed. The evidence in this study suggests that there are bubbles in the Thai stock market. Cointegration tests for the long-run relationship between stock prices and dividends give the results showing the possibility of an existence of explosive bubbles in the stock exchange of Thailand. This implies that there might be other economic fundamentals other than dividends that drive stock prices during the period of investigation. However, investors' irrationality might be the main cause of the divergence of actual stock prices from fundamental values.

It should be noted that the variance bounds test tends to reject the null hypothesis of no bubble in stock prices, and thus disproves the validity of the standard present value model of stock prices. However, cointegration tests show explosive bubbles, which confirms the results of variance bounds and equity price bubbles tests. The drawbacks of the present study may stem from the lack of consideration of time-varying discount rate and structural breaks.

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