Stock Assessment Using a Dividend Discount Model with Growth Rate Following a Time Series Pattern

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Abstract

Determination of the theoretical price of a stock using a dividend discount model is done by setting various levels of dividend growth. The problem is what if dividend growth is assumed to follow a time series. In this paper it aims to discuss stock valuation using a fluctuating dividend discount model along with the time series. It is assumed that the expected dividend fluctuate with time series model. To estimate the magnitude the expected dividend was performed using a Autoregressive Integrated Moving Average (ARIMA) model. As for determining the theoretical price of the stock is done by using the dividend discount models, which include some level of growth. Based on the dividend discount model of stock prices in the period to $n+1$ shows the current value of all dividend payments over a period of 2($n+1$ through infinite time).

Keywords:
Dividend, ARIMA model, dividend discount models, the growth rate of dividends.

1. Introduction

One form of investment that is often chosen by investors to invest is stocks. In order for the investment decision to generate returns as expected, investors need to make a prior assessment of the shares they will choose (Adebiyi, Adewumi& Ayo, 2014; Charumathi&Suraj, 2014). This stock valuation is important to produce information on intrinsic value, and then it will be compared with the stock market price to determine the buy or sell position of a company's stock. The discount dividend model is one of the useful tools for determining the intrinsic price of shares.The assessment of the intrinsic price of shares is carried out by establishing various assumptions about the level of dividend growth (Olweny, 2011). The usual assumptions used are starting dividends without growth, dividends with constant growth, dividends with multiple growth rates, dividends with two levels of growth, and dividends with three growth rates (Gray & Hull, 2013). The problem is what if it is assumed that the dividend growth rate follows the time series model.

With regard to price valuation, Gottwald (2010) measures stock price volatility using a dividend discount model. Olweny (2011) evaluates the reliability of the dividend discount model in the valuation of capital market share prices in Nairobi. Gray & Hall (2013) estimated the cost of equity using a discounted dividend model. Both Gottwald and Olweny and Gray & Hall, determine the returns required by using the Capital Asset Pricing Model

(CAPM) regression.Furthermore, related to the time series model, Adebiyi, et al. (2014) predict stock prices using the autoregressive integrated moving average (ARIMA) model. Whereas, Mondal, et al. (2014) conducted a study of the effectiveness of time series models (ARIMA) in forecasting stock prices. The results of the study show that the ARIMA model is effective enough to predict the price of shares being analyzed. Therefore, the authors suspect that the rate of dividend growth can also be predicted using the time series model (ARIMA).

Based on the description above, in this paper a stock valuation analysis is carried out using a fluctuating dividend discount model along with changes in time, using the ARIMA model approach. The aim is to get an alternative method of valuing stock prices using a more suitable dividend discount. As a numerical illustration, in this paper analyzed a stock traded on the capital market in Indonesia.

2. Research Method

The discussion in this section is explained about the dividend discount model which includes: zero growth, constant growth, not constant growth, and growth following a time series, and determining the required rate of return.

2.1 Dividend Discount Model

Dividend discount model to determine the estimated stock price by discounting all dividend flows that will be received in the future. Mathematically, the dividend discount model can be stated as follows:

$$\widetilde{P}_0 = \frac{D_1}{(1+k)} + \frac{D_2}{(1+k)^2} + \frac{D_3}{(1+k)^3} + ... + \frac{D_\infty}{(1+k)^\infty}$$

$$\widetilde{P}_0 = \sum_{t=1}^{\infty} \frac{D_t}{(1+k)^t}, \tag{1}$$

where $\widetilde{P}_0$ intrinsic value of shares with a discounted dividend model, D_t ($t = 1,2,...,\infty$) dividends that will be received in the future, and k the level of return required (Nag& Liu, 2004).

2.2 Zero Growth Dividend Discount Model

In the dividend discount model with zero growth, it is assumed that the company divides dividends in the same amount over the life of the stock. Mathematically, a dividend discount model with zero growth can be expressed as:

$$\widetilde{P}_0 = \frac{D_0}{k}, \tag{2}$$

where $\widetilde{P}_0$ intrinsic value of shares with a discounted dividend model, D_0 dividends that will be received in the future, and k level of return required (Gottwald, 2012; Mungikar & Muralidhar, 2014).

2.3 Discount Dividend Model with Constant Growth

The dividend discount model with constant growth assumes that dividends grow constantly (fixed) throughout the life of the stock, where $g_{t+1} = g_t$ for all time $t = 1,2,...,\infty$. Mathematically, the dividend discount model with constant growth can be expressed as:

$$\widetilde{P}_0 = \frac{D_0(1+g)}{(1+k)} + \frac{D_0(1+g)^2}{(1+k)^2} + \frac{D_0(1+g)^3}{(1+k)^3} + ... + \frac{D_0(1+g)^\infty}{(1+k)^\infty},$$

$$\widetilde{P}_0 = \sum_{t=1}^{\infty} \frac{D_0(1+g)^t}{(1+k)^t}. \tag{3}$$

If $k > g$, then equation (3) can be simplified to be:

$$\widetilde{P}_0 = \frac{D_1}{k-g}, \tag{4}$$

where g the rate of dividend growth, and k level of return required (Gottwald, 2012; Mungikar&Muralidhar, 2014).

2.4 Dividend Discount Model with Non-Constant Growth (Double)

The dividend discount model of growth is not constant (double), it is assumed that dividend payments increase with several growth rates. In particular, dividend growth is grouped in several time frames. Each time span has a certain growth rate, different from the growth rate in other time frames. In the last span of time, dividends have grown constantly. Another assumption, that dividend growth in the earlier period, is higher than the growth rate in the next time span (Norman et al., 2012).

The process of valuing stock prices using a dividend discount model, not constant growth can be done with the equation:

$$\widetilde{P}_0 = \sum_{t=1}^{n} \frac{D_0(1+g_1)^t}{(1+k)^t} + \frac{D_n(1+g_c)}{k-g_c} \frac{1}{(1+k)^n}, \tag{5}$$

where $\widetilde{P}_0$ intrinsic value of shares with growth is not constant, n number of years during the period of supernormal dividend payments (dividends above normal), D_0 first year dividend (initial), g_1 supernormal dividend growth, D_n dividends at the end of the year supernormal growth, g_c constant dividend growth, and k the level of return required (Gottwald, 2012; Mungikar&Muralidhar, 2014).

The weakness of the method of valuing stock prices using a dividend discount model of non-constant growth is that the division of time span depends on the subjectivity of the analyst.

2.5 Dividend Discount Model with Growth Following Time Series

The estimated rate of dividend growth that follows the time series is done using the approach of the autoregressive moving average (ARMA) model. Suppose D_t is a dividend growth rate data that follows the time series pattern, the ARMA degree model p and q written as ARMA(p , q), which generally has an equation (Mondal, Shit &Goswami, 2014):

$$D_t = \phi_0 + \sum_{i=1}^{p} \phi_i D_{t-i} + a_t - \sum_{j=1}^{q} \theta_j a_{t-1}, \tag{6}$$

Where $\{a_t\}$ residual squence that are white noise, as well as p and q non-negative integer. As well ϕ_i ($i = 0,1,...,p$) autoregressive coefficient parameters, and θ_j ($j = 1,...,q$) moving average coefficient parameter.

The process of estimating the dividend growth rate that follows the time series is carried out with the following stages: (i) Stationary data return testing; (ii) Model identification; (iii) Estimated model parameters; (iv) Model diagnostic testing; and (v) Future l-period predictions (Tsay, 2005; Sukono et al., 2017; Sukono et al., 2016).

So, based on equation (5) the estimator of the rate of dividend growth can be stated as:

$$\hat{D}_t = \hat{\phi}_0 + \sum_{i=1}^{p} \hat{\phi}_i D_{t-i} - \sum_{j=1}^{q} \hat{\theta}_j a_{t-1}. \tag{7}$$

Furthermore, using equation (7), the prediction of the rate of dividend growth in the future *l*-period the future is:

$$\hat{D}_{T+l} = \hat{\phi}_0 + \sum_{i=1}^{p} \hat{\phi}_i D_{T-i+l} - \sum_{j=1}^{q} \hat{\theta}_j a_{T-j+l}. \tag{8}$$

where T the starting point of the prediction is done (Sukono et al., 2017; 2016).

Referring to equation (1), the dividend discount model that follows the time series can be stated as follows:

$$\widetilde{P}_0 = \frac{\hat{D}_{T+1}}{(1+k)} + \frac{\hat{D}_{T+2}}{(1+k)^2} + \frac{\hat{D}_{T+3}}{(1+k)^3} + ... + \frac{\hat{D}_\infty}{(1+k)^\infty}$$

$$\widetilde{P}_0 = \sum_{l=1}^{\infty} \frac{D_{T+1}}{(1+k)^l}, \tag{9}$$

where $\widetilde{P}_0$ intrinsic value of shares with a discounted dividend model, $\hat{D}_{T+l}$ ($l = 1,2,...,\infty$) dividends that will be received in the future, T starting point of predictions, and the level of return required.

But keep in mind, that the prediction for the future *l*-period is increasingly far from the starting point T , the value will be more biased. So that this condition is a weakness in the valuation of stock prices using a dividend discount model that follows the time series.

2.6 Determine the Required Return

Determination of the required rate of return k, one of which can be done by predicting the CAPM model, namely:

$$\hat{k} = k_f + \beta(k_m - k_f), \quad (10)$$

with k_f risk free return, and k_m market returns, as well as β slope coefficient parameter. Determining the level of return required by using this CAPM, it is assumed that fundamental factors are included as reflected by market returns (Shamim, Abid & Shaikh, 2014; Wakyiku, 2010).

3. Results and Discussion

In this section are discussed about: first, numerical illustration of the valuation of stock prices using a dividend discount model and second, valuation of stock prices is using a dividend discount model that follows the time series.

3.1 Illustration Stock Price Valuation Using the Dividend Discount Model

- *Fixed dividend model*

The shares of a company each year distribute dividends of IDR750.00 per share. If the investor sets a discount rate of 15% p.a., calculate the fair price of the stock.

From these problems can be said that D = IDR750.00; and k = 15% = 0.15. So, using equation (2) it can be determined that:

$$P_0 = \frac{D}{k} = \frac{\text{IDR750.00}}{0.15} = \text{IDR 5,000.00 per sheet}$$

- *Dividend model with constant growth*

A stock has just distributed dividends of IDR750.00. Next year's dividends are projected to grow by 12% per year. If investors project a 20% share return on the investment made, determine the fair price of the stock.

This problem can be stated that D_0 = IDR750.00; g = 12% = 0.12; and k = 20% = 0.20. So, using equation (4) it can be determined that:

$$D_1 = D_0(1+g) = \text{IDR750.00}(1+0.12) = \text{IDR840.00}$$

$$P_0 = \frac{D_1}{k-g} = \frac{\text{IDR840.00}}{(0.20-0.12)} = \text{IDR10,500.00}$$

- *Dividends by growing are not fixed*

A stock has just distributed dividends of IDR250.00 predicted to grow 30% annually for the next 2 years. After this normal period, dividends only grow by 12% per year. If investors expect an annual return of 20%, determine the fair price of this stock.

Based on the description of the problem above, it can be stated that:
D_0 = IDR250.00; g_s = 30% = 0.30; g = 12%= 0.12; k = 20% = 0.20; and n =2 years.

So, using equation (5) the determination of stock prices can be done in the following stages:

$$D_1 = D_0(1+g_s) = \text{IDR250.00}(1+0.30) = \text{IDR325.00}$$

$$D_2 = D_1(1+g_s) = \text{IDR325.00 } (1+0.30) = \text{IDR422.50}$$

$$D_{n+1} = D_2(1+g) = \text{IDR422.50}(1+0.12) = \text{IDR473.20}$$

$$P_0 = \frac{D_1}{k - g_s}\left[1 - \left(\frac{1+g_s}{1+k}\right)^n\right] + \frac{D_{n+1}}{(k-g)(1+k)^n}$$

$$P_0 = \frac{\text{IDR}325.00}{(0.20-0.30)}\left[1 - \left(\frac{1+0.30}{1+0.20}\right)^2\right] + \frac{\text{IDR}473.20}{(0.20-0.12)(1+0.20)^2} = \text{IDR}4{,}671.88$$

3.2 Determination of Stock Prices with Dividends Growing Following Time Series

The data of a bank's shares amount to n = 2489 which is the result of observations from 14 July 2004 to 25 March 2014. Furthermore, the stock price data is determined by return values. Using the data return estimation of the average model with a time series approach. First, stationarity tests are conducted on stock return data using unit root test statistics. Stationarity test is done with the help of Eviws 7 software, and the results show that the stock return data is stationary.Second, the stationary data return is then estimated by the average model. The estimation is done using the ARMA model referring to equation (6). Estimates carried out include stages: identification of the average model, estimation of model parameters, parameter verification test, and diagnostic test. All stages are carried out using the software Eviews 7, and the estimation results of the mean model have been significant. Based on the estimation process obtained ARMA (3,3) model with the equation:

$$D_t = 0.542394 D_{t-3} - 0.581179\varepsilon_{t-3} + \varepsilon_t$$

So the predictor model is:

$$\widehat{D}_t = 0.542394 D_{t-3} - 0.581179\varepsilon_{t-3}$$

Using a predictor model, predictions are made for the next 5 periods and the results are as follows:

l	1	2	3	4	5
$\hat{D}_{T+l}$ (1000)	0.1193479	0.0900207	0.1004083	0.0693625	0.0523181

If we assume the required return k = 15% = 0.15 the theoretical price of these shares is:

$$P_0 = \frac{119.3479}{(1+0.15)} + \frac{90.0207}{(1+0.15)^2} + \frac{100.4083}{(1+0.15)^3} + \frac{69.3625}{(1+0.15)^4} + \frac{52.3181}{(1+0.15)^5}$$
$$= \text{IDR}303.539$$

Analysis of time series data can be used to predict capital market conditions and to determine investment decisions (eg when to sell or buy shares). Analysts will advise investors of a stock if the rate of return is above the level of return required. On the other hand, analysts will suggest selling a stock if the rate of return is below the level of return required. This method is useful if historical data shows a random fluctuation, which is sometimes the price rises and there are times when prices fall.

From the discussion of technical analysis above, it can be said that stock prices are the main object of analysis. Technical analysts do not pay attention to the fundamental factors that cause changes in stock prices. This is because analysts assume that these factors have been reflected in the stock price at the time of the analysis.

4. Conclusion

In this paper, stock valuation has been discussed using a dividend discount model with a growth rate following a time series. In the dividend discount approach grows to follow the time series model, dividends will grow or decay fluctuating with changes in time. Analysis of dividend growth follows a time series, including technical analysis that does not pay attention to fundamental factors, because it has been assumed to be reflected in stock prices during the analysis. Analysis of dividend growth following a series of times, has a weakness in the mass of predictions, namely the prediction of dividends for the time farther from the starting point, the greater the deviation.

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