Dividend Discount Model (DDM) : A study based on select companies from India.

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***Abstract*— Knowledge about the intrinsic value of stock will help the investors to make the right decision – whether to go long, short or hold a particular stock at a particular time. Researchers have come up with different methods for finding out the intrinsic value of common stock. One of the methods is 'Dividend Discount Model' (DDM), also known as Gordon growth model (GGM), which was proposed by Myron J. Gordon in 1960s. The model uses the basic principle of time value of money and portrays the value of a common stock as the present value of all its expected future dividends. Many studies have been conducted to test the relevance and reliability of the DDM model which showed mixed results. While reviewing the literature, the authors of this paper came across studies testing the applicability of DDM in selected stocks of Nairobi and Ghana Stock Exchange but could not find studies with respect to Indian Companies. This study is aimed to check the applicability of DDM in the valuation of top 5 dividend paying companies in National Stock Exchange (NSE), India. To check the accuracy of predictions, different Absolute Percentage Error (APE) measures were used and the result showed that the GGM model has low prediction accuracy in the case of some companies, whereas for other companies, there are considerable differences. But when the actual and predicted share prices of all the selected companies were clubbed into one to represent the data of a fictitious company, the result showed that GGM tend to reflect actual share prices.**

***Keywords*— Stock Valuation, Dividend Discount Model, India, NSE, Gordon Growth Model**

I. INTRODUCTION

Valuation of companies and stocks is one area which has attracted the interests of researchers, academicians, business houses, investors as well as government and policy makers across the world. An investor is keen to know the intrinsic value of a stock which will help him/her to make the right financial decision. There are different techniques of calculating the intrinsic value of common stock. The techniques of equity valuation could be broadly classified in to three broad categories viz., Balance Sheet Techniques, Discounted Cash Flow Techniques and Relative Valuation Techniques. (Chandra, 2017)[1]

A. Balance Sheet Techniques

The methods of stock valuation under Balance Sheet techniques include Book Value approach, Liquidation Value Approach and Replacement Cost Approach. Under Book value approach, the value of a stock is found out by dividing the sum total of the book value of the net worth of a company by the number of equity shares outstanding on a particular day. Net worth is calculated either by using the formula Total Assets – Outside Liabilities or by taking the total funds available to equity share holders which includes the paid up equity capital and reserves and surplus. The biggest disadvantage of this method is that, book value, being historical in nature, rarely reflects the real economic value of the business. Also, it does not portray the future earnings power and growth potential of a business. In Liquidation value method, the value per share is found out using the formula (Value realized by liquidating the assets of the firm – Amount payable to outsiders and preference shareholders) / Number of equity shares. Just like book value method, this method too does not reflect the earnings power and growth potential of a business. Also, it is difficult to estimate the realizable value while liquidating the assets of a business and those values too may not reflect the current real worth of the assets of the business. This method is more suitable for a company or a firm which goes in to liquidation and not for stable or growing firms. While making investing decisions, investors may not be interested in investing in 'dying' firms or firms which are in the verge of liquidation. In replacement cost method, value of a share is found out using the cost involved in replacing the net assets (Assets – Liabilities) instead of taking either the book value or liquidation values. Even though this method is more realistic than book value and liquidation methods of stock valuation, this too does not reflect the future earnings power and growth potential of a business. [1]

B. Discounted Cash Flow Techniques

Discounted Cash Flow techniques are the most popular techniques of stock valuation as these take in to consideration the basic premise of time value of money. Here, value of a share is found out by taking the present value of all future cash flows. Unlike Balance Sheet techniques, Discounted cash flow techniques consider the future earnings and growth potential of a business while valuing the shares. This technique is further classified in to two – Dividend Discount Model (DDM) and Free Cash Flow (FCF) Model.

In Dividend Discount Model, the value of a share is equal to the present value of all its expected future dividends plus the present value of the expected sale price when the shares are sold. DDMs normally assume that all the future dividend payments are made annually and the first dividend is received one year after the shares are bought. DDMs are of two categories viz., Single – Period Valuation Model which assumes that the shares will be held only for a single period normally for one year and the more realistic and complex Multi-Period Valuation Model which considers all the future streams of dividends and the final sale price of the share. Multi – Period Valuation model is further categorized in to Zero Growth Model, Constant Growth Model (Gordon Growth Model), Two Stage growth model, three stage growth model and H Model. Single period valuation model, just like the name suggests, has much limited practical significance especially for long term investors. Zero Growth model assumes that a firm will pay a constant dividend per share every year and will not grow at all which is a rarity [1]. The investors expect their investments to grow in the future and therefore, a model which considers the future growth potential has more practical relevance than a model which does not consider growth at all.

Gordon's model assumes that the growth rate of the firm will be stable in perpetuity. In other words, this model is applicable for steady firms who are capable of paying dividends at a steady rate forever. Two stage growth model is an extension of GGM which assumes an extraordinary growth for a firm for a finite number of years and a normal growth in perpetuity thereafter. H Model is similar to two stage growth model but instead of having a sharp shift from one growth rate to another, this model assumes a linear decline in supernormal growth rate to arrive at a normal growth rate for a firm in 2H years [1]. In Three stage growth model, there are three stages of growth for a firm: an initial period of high growth, a second period of declining growth and a third period of stable growth. [2]

Free Cash Flow Model of equity valuation involves valuing the firms based on the present value of all its expected future free cash flows. Free Cash Flow is the cash flow which is freely available to the investors of funds after meeting the long term and working capital investment requirements of a firm. Thus FCF = NOPAT – Net Investment. The enterprise value is found out by discounting the free cash flows at the firm's overall cost of capital and equity value is arrived at by deducting the preference value and debt value from the enterprise value. Value of an equity share as per FCF model is simply the equity value divided by the number of outstanding equity shares [1].The major limitation of FCF model is the complexity in arriving at the Free Cash Flows.

C. Relative Valuation Techniques

In relative valuation, a company is valued on the basis of the performance of comparable companies. Different multiples like Price-Earnings Ratio, Price-Book Value Ratio, Price – Sales Ratio, EV-EBITDA ratio, EV – Book Value ratio, EV-Sales ratio etc are used in this technique. An appropriate multiple of a comparable company is calculated and the same is for valuing the subject company's stock with appropriate modifications required [3]. The major drawback of this method is in identifying the comparable companies as it may be difficult to find out companies which are completely comparable.

II. GORDON GROWTH MODEL (GGM)

Gordon Growth Model (GGM) was proposed by Myron J. Gordon in 1960s. It portrays the value of a common stock as the present value of all its expected future dividends. The model uses three variables viz., expected dividend, growth rate and cost of capital to determine the value of stock on a particular date. The following formula is used to find out the value of a stock.

$$\text{Value of the stock } (P_o) = \frac{D_0 * (1+g)}{K_e - g} \quad \text{or} \quad \frac{D_1}{K_e - g}$$

Where in, D_0 stands for current dividend, g stands for growth rate, K_e stands for Cost of equity and D_1 stands for expected dividend for the next period.

GGM, the simplest among the valuation models, is suitable for firms in a steady state with dividends having a sustainable stable growth rate in perpetuity [2]. While estimating the value of a share, identifying the growth rate is a crucial component. While fixing the growth rates, three important points could be kept in mind by an analyst. Firstly, if the expectation about inflation in the long term is high, it is better to keep a high growth rate. Secondly, since company is only a part of the economy, normally

the growth rate of the company will be less than the economy. Thirdly, even if a firm is expected to have an above-stable growth for a few years, that growth rate cannot be more than 1 – 2 % above the growth rate of the economy. Also, while estimating the growth rate, an analyst could assume that the earnings may also be expected to grow at the same rate for a steady firm having a stable growth rate and an average growth rate could be taken instead of year on year change in growth rate.
An appropriate discount rate needs to be used while estimating the present value of expected future dividends. Cost of Equity (K_e) could be employed as the rate for discounting the future dividends [4]. To calculate Cost of Equity, Capital Asset Pricing Model (CAPM) could be adopted. Cost of Equity is nothing but the expected returns of the investors when they invest in an equity stock of a company. The formula to calculate K_e as per CAPM model is as follows:
$K_e = R_f + \beta*(R_m - R_f)$, where R_f stands for Risk Free rate, β is the beta of the investment and R_m is the expected return of the market.

The rate on government securities preferably, long term, can be taken as the risk free rate[2] and the duration of the risk free asset (government security here), can be matched up with the duration of the cash flows in the analysis. Beta could be estimated either using historical data on market prices or using fundamental characteristics of investment or using accounting data. In historical beta calculation method, a company's historical returns could be regressed against the historical returns on the market index for calculating beta. While taking the return interval for estimating betas, weekly or monthly returns could be taken as it reduces the chances of non-trading biases. While choosing the market index for beta estimation, the standard practice is to take the index of the market in which the company's stock trades.

Mwangi [5] tested the theoretical values of dividend as per GGM with that of actual values of Safaricom Limited, a leading communications company in Kenya for the period 2008- 2017. Since the company is leveraged, the author used Ko to drive Ke, which is an important variable for GGM. A Paired sample t test was done to check whether there is any difference and the study concluded that GGM is not applicable for estimating the stock price of Safaricom Ltd and the model is more suitable for matured companies with steady dividend growth rather than young companies with less predictable dividend patterns. Ana & Saša [6] studied the reliability of DDM especially the stable growth model in the valuation of stocks in European Equity Market for the period 2010-2013 due to the influence of global financial crisis. Out of a firm level data of 4788 publicly traded companies of European Equity market, a sample of 199 companies was used in the study which compared the estimated and actual values of stocks and the statistical difference is tested using the tests of equality (equality of average value and variance). Since the data time series did not have normal distribution, the authors used two non-parametric tests viz., Wilcoxon Signed-Rank test and Kruskal–Wallis test for testing. The result showed that GGM is a reliable measure of stock price valuation. Gacus & Hinlo [7] studied the reliability of constant growth dividend discount model in valuation of 19 companies traded in Philippine Stock Exchange. The different variables used in this study are DPS, EPS, ROE and stock prices of these selected companies from the year 2012 to 2016. The reliability of the model in predicting the stock prices in comparison with the actual stock prices is checked using Symmetric Median Absolute Percentage Error (sMdAPE) and tested using Wilcoxon Signed Rank Test. (testing is done by finding the difference between actual and predicted prices and seeing whether the difference is significant). The study found that out of 19 companies, the predicted values of 4 companies were significantly different to the actual values while for the remaining 15 companies (sMdAPE values less than 30%), there was no statistical median difference between predicted and actual values. The paper concluded that DDM is reliable tool for predicting the prices of 15 stocks in PSE. Acheampong & Agalega [8] examined whether the predicted stock prices of 5 banks traded in Ghana Stock Exchange match their actual prices for the period 2006-2010. Growth rate is taken as 5.15% which is the average GDP growth rate of Ghana from 1999 to 2008. Base year for D_0 is taken as 2006. CAPM is used to find out Ke. Risk Free rate is taken as the T Bill rate of Government of Ghana, market return is taken from the monthly Data Bankstock Index (DSI) of Ghana stock Exchange and Beta is calculated by regressing the monthly returns of the selected companies' stocks with the market return. A paired t test was done to check whether there is difference between actual prices and predicted prices based on Gordon's growth Model. The test result rejected the null hypothesis and concluded that the stock predictions using Gordon Growth model and the actual prices of the selected stocks were indeed different. Charumathi & Suraj [9] studied the reliability of DDM in valuation of 14 bank stocks in BSE for the periods 2001-02 to 2010-11. They collected market prices and dividends for the selected stocks and calculated the correlation coefficient between stock returns and dividend yields. CAPM method was used to estimate cost of equity which is used in valuation of stock using DDM. Growth rate is found out using the formula $g = b*r$. The study predicted the stock values using DDM and compared the values with actual market values. T test was done for testing the differences and the study rejected the null hypothesis and concluded that DDM is not a reliable model for predicting the stock values for bank stocks in BSE. The authors state that the non-reliability could be attributed to the stock market (BSE here) inefficiency, inappropriate discounting factors, information differentials and measurement problems.
GGM, on account of its simplicity, is generally used by companies which are stable, normally, the blue chip companies [10]. Since these companies are well established and have steady cash flows, they generally pay consistent dividends. Dividend is the only cash flow which the equity investors consistently receive from a company which adds to the popularity of this model in equity valuation.

III. OBJECTIVES OF THE STUDY

The objective of the study is to test the applicability of Gordon Growth Model on the valuation of selected dividend paying stocks in National Stock Exchange (NSE), India. The objectives undertaken could be enlisted as follows:

- Estimate the variables required to predict the stock prices of selected dividend paying companies using GGM
- Predict the stock prices of selected companies using GGM
- Test whether there is significant difference between actual prices and predicted prices of the selected dividend paying companies.

IV. METHODOLGY, RESULTS & DISCUSSION

This study uses the data of 5 dividend paying companies of India chosen from the data of top dividend paying stocks in India as per Nifty Trading Academy[11] and tries to predict the stock prices from 2009 to 2018. The companies are Hindustan Petroleum Corporation Ltd (HPCL), Indian Oil Corporation Ltd (IOC), Power Finance Corporation Ltd (PFC), Reliance Industries Ltd (RIL) and National Aluminium Company Ltd (NALCO). Vedanta Ltd, though stands at the top in terms of dividend payment, does not show consistency and is excluded from the study. Since dividend details of the years 2009 and 2010 are not available for Coal India, the same too is excluded from the study. Dividend details of the selected companies are taken from the website 'moneycontrol.com' [12] and the historical stock price details are taken from 'Yahoo Finance'[13]. The period for this study is from 2009 to 2018. The steady growth rate is taken at 7% (rounded off) which is derived from the average GDP growth rate of the Indian economy (taken from the World Bank data) [14] for the years 2009-2018.

This study employed cost of equity (Ke) as the discount rate for calculating present value of expected future dividends. CAPM formula is used to calculate Ke. The variables required to calculate Ke are R_f, R_m and Beta. R_f is found out for all the 10 years by taking the average of the risk free rates of 10 years previous to each year under analysis. The rates are taken from the website 'Investing.com'[16]. Market returns (R_m) is taken as the average of the market returns of 10 previous years corresponding to each year under analysis. The average market returns (R_m) and risk free rates (R_f) for all the years used in this study are as follows:

TABLE I

R_m and R_f for the years 2009-2018

Years	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
R_m	20.99%	24.25%	23.41%	25.85%	19.34%	21.41%	17.37%	13.69%	11.07%	16.57%
R_f	6.95%	7.85%	8.37%	8.30%	8.20%	8.56%	7.75%	7.18%	6.75%	7.72%

For beta calculation, historical market price method is used. The selected company's monthly returns are regressed with NIFTY's monthly returns for all the years to calculate betas for each year for each company. The values arrived at are detailed as under:

TABLE II

β, k_e, Expected dividend, Actual dividend, Predicted P_0 as per GGM & Actual P_0 of companies

HPCL										
Years	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Beta	2.28	0.17	1.19	1.50	2.24	1.90	(16.68)	2.11	0.40	0.40
Ke	0.39	0.11	0.26	0.35	0.33	0.33	(1.53)	0.21	0.08	0.11
Expected Dividend D_0*(1+g)	3.21	5.62	12.84	14.98	9.10	9.10	16.59	26.22	36.92	32.10
Actual Dividend	5.25	12.00	14.00	8.50	8.50	15.50	24.50	34.50	30.00	17.00

Predicted Price as per GGM	17.55	359.56	77.80	32.83	34.84	63.84	(16.41)	265.04	2,142.87	426.45
Actual Price	23.11	25.46	23.98	25.63	24.25	54.03	137.97	201.87	356.74	275.27
IOC										
Years	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Beta	1.90	(0.06)	0.98	0.25	0.62	2.32	0.63	1.31	0.20	0.17
Ke	0.34	0.07	0.23	0.13	0.15	0.38	0.14	0.16	0.08	0.09
Expected Dividend $D_0*(1+g)$	5.89	8.03	13.91	10.17	5.35	6.63	9.31	7.06	14.98	20.33
Actual Dividend	7.5	13	9.5	5	6.2	8.7	6.6	14	19	27.75
Predicted Price as per GGM	52.20	-10059.44	62.89	94.54	81.89	29.67	103.60	172.44	3276.18	1309.49
Actual Price	27.00	33.29	32.77	32.23	32.69	48.72	63.59	96.80	168.79	149.75
PFC										
Years	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Beta	0.37	0.57	0.93	2.29	1.46	4.22	(4.61)	1.40	1.28	0.49
Ke	0.12	0.17	0.22	0.48	0.25	0.63	(0.37)	0.16	0.12	0.12
Expected Dividend $D_0*(1+g)$	3.75	4.28	4.82	5.35	6.42	7.49	9.63	19.15	5.46	11.77
Actual Dividend	4.00	4.50	5.00	6.00	7.00	9.00	17.90	5.10	11.00	1.80
Predicted Price as per GGM	83.14	47.13	34.77	15.50	42.78	17.28	-43.98	58.77	223.48	37.92
Actual Price	55.42	79.38	52.19	53.71	50.12	89.80	100.81	94.70	122.30	91.43
RIL										
Years	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Beta	1.09	1.06	1.09	0.95	0.83	1.82	(4.44)	(0.67)	2.06	1.70
Ke	0.22	0.25	0.25	0.25	0.17	0.32	(0.35)	0.03	0.16	0.23
Expected Dividend $D_0*(1+g)$	13.91	13.91	7.49	8.56	9.095	9.63	10.165	10.7	11.235	11.77
Actual Dividend	13.00	7.00	8.00	8.50	9.00	9.50	10.00	10.50	11.00	6.00
Predicted Price as per GGM	91.07	41.02	48.26	50.62	92.22	40.71	(25.48)	(269.15)	136.34	40.76
Actual Price	397.68	437.58	380.74	351.63	385.25	441.40	472.40	534.81	758.60	1,067.98

NALCO										
Years	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Beta	1.49	0.09	0.69	0.54	0.79	2.28	1.87	0.91	1.55	1.46
Ke	0.28	0.09	0.19	0.18	0.17	0.38	0.26	0.13	0.13	0.21
Expected Dividend $D_0*(1+g)$	3.21	2.675	1.3375	1.605	1.07	1.3375	1.605	1.8725	2.14	2.996
Actual Dividend	2.50	1.25	1.50	1.00	1.25	1.50	1.75	2.00	2.80	5.70
Predicted Price as per GGM	12.78	56.60	13.58	9.91	13.32	5.20	9.97	34.89	46.38	44.72
Actual Price	53.49	72.10	55.98	40.08	27.37	40.13	34.10	42.40	69.94	67.51

In order to check the accuracy in predictions, different Absolute Percentage Error (APE) measures were calculated and later different averages of APEs were calculated for each company's predictions.

Absolute percentage error for a given observation is calculated as

$$APE = \left| \frac{Actual - Forecast}{Actual} \right|$$

he different average APEs employed were Mean Absolute percentage error (MAPE), Median Absolute Percentage Error (MdAPE) and Symmetric Median Absolute Percentage Error (sMdAPE).

MAPE shows the average of absolute percentage differences. It is calculated using the formula

$$\left(\frac{1}{n} \sum \frac{|Actual - Forecast|}{|Actual|} \right) * 100$$

MdAPE is the middle value of APEs when they are ordered by size.

sMdAPE is the median of Symmetric Absolute Percentage Errors (SAPE). SAPE is calculated using the formula

$$SAPE = \left| \frac{Actual - Forecast}{Actual + Forecast} \right|$$

The calculated measures of all the selected companies are given below.

TABLE III
APE, SAPE, MAPE, MdAPE & sMdAPE of HPCL

Yr	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Predicted Price	17.55	359.56	77.80	32.83	34.84	63.84	-16.41	265.04	2142.87	426.45
Actual Price	23.11	25.46	23.98	25.63	24.25	54.03	137.97	201.87	356.74	275.27
APE	0.24	13.12	2.24	0.28	0.44	0.18	1.12	0.31	5.01	0.55
SAPE	0.14	0.87	0.53	0.12	0.18	0.08	1.27	0.14	0.71	0.22
			MAPE	234.92%	MdAPE	49.28%	sMdAPE	0.197		

HPCL's MAPE came to 234.92%, MdAPE came to 49.28% and sMdAPE came to 0.197

TABLE IV

APE, SAPE, MAPE, MdAPE & sMdAPE of IOC

Yr	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Predicted Price	52.20	(10059.44)	62.89	94.54	81.89	29.67	103.60	172.44	3276.18	1309.49
Actual Price	27.00	33.29	32.77	32.23	32.69	48.72	63.59	96.80	168.79	149.75
APE	0.93	303.20	0.92	1.93	1.50	0.39	0.63	0.78	18.41	7.74
SAPE	0.32	1.01	0.31	0.49	0.43	0.24	0.24	0.28	0.90	0.79
		MAPE	33.64	MdAPE	122.00%	sMdAPE	0.37			

IOC's MAPE came to 33.64%, MdAPE came to 122% and sMdAPE came to 0.37

TABLE V

APE, SAPE, MAPE, MdAPE & sMdAPE of PFC

Yr	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Predicted Price	83.14	47.13	34.77	15.50	42.78	17.28	(43.98)	58.77	223.48	37.92
Actual Price	55.42	79.38	52.19	53.71	50.12	89.80	100.81	94.70	122.30	91.43
APE	50%	41%	33%	71%	15%	81%	144%	38%	83%	59%
SAPE	0.20	0.25	0.20	0.55	0.08	0.68	2.55	0.23	0.29	0.41
		MAPE	61%	MdAPE	54.00%	sMdAPE	0.27			

PFC's MAPE came to 61%, MdAPE came to 54% and sMdAPE came to 0.27

TABLE VI

APE, SAPE, MAPE, MdAPE & sMdAPE of RIL

Yr	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Predicted Price	91.07	41.02	48.26	50.62	92.22	40.71	(25.48)	(269.15)	136.34	40.76
Actual Price	397.68	437.58	380.74	351.63	385.25	441.40	472.40	534.81	758.60	1,067.98
APE	0.77	0.91	0.87	0.86	0.76	0.91	1.05	1.50	0.82	0.96
SAPE	0.63	0.83	0.78	0.75	0.61	0.83	1.11	3.03	0.70	0.93
		MAPE	0.94	MdAPE	0.89	sMdAPE	0.8			

RIL's MAPE came to 91%, MdAPE came to 89% and sMdAPE came to 0.80

TABLE VII

APE, SAPE, MAPE, MdAPE & sMdAPE of NALCO

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Predicted Price	12.78	56.60	13.58	9.91	13.32	5.20	9.97	34.89	46.38	44.72
Actual Price	53.49	72.10	55.98	40.08	27.37	40.13	34.10	42.40	69.94	67.51
APE	0.76	0.22	0.76	0.75	0.51	0.87	0.71	0.18	0.34	0.34
SAPE	0.61	0.12	0.61	0.60	0.35	0.77	0.55	0.10	0.20	0.20

	MAPE	0.54	MdAPE	0.61	sMdAPE	0.45	

NALCO's MAPE came to 54%, MdAPE came to 61% and sMdAPE came to 0.45.

The prediction efficiency measures of individual share prices using MAPE, MdAPE ,sMdAPE, shows that the GGM model has low prediction accuracy in the case of some companies, whereas for other companies, there is considerable differences. To see if GGM is a good model in general for predicting the share prices, the data (actual and predicted) of all companies is clubbed into one, to represent the data of a fictitious company. The clubbing of data is proposed as the intention of the study is to check whether GGM model is a good predictor of actual share prices in general, and not for any particular company's share price. While it may look like there is no practical significance in clubbing the data, the exercise of clubbing the data is not inconsistent with the theoretical possibility of a single company having different share prices and dividend at different time periods. After eliminating negative prices, clubbed data and prediction efficiency measure of the clubbed data is given below.

TABLE VIII

APE, SAPE, MAPE, MdAPE & sMdAPE of clubbed data

Yr	Predicted Price	Actual Price	APE	SAPE
1	5.20	40.13	0.87	0.77
2	9.91	40.08	0.75	0.60
3	9.97	34.10	0.71	0.55
4	12.78	53.49	0.76	0.61
5	13.32	27.37	0.51	0.35
6	13.58	55.98	0.76	0.61
7	15.50	53.71	71%	0.55
8	17.28	89.80	81%	0.68
9	17.55	23.11	0.24	0.14
10	29.67	48.72	0.39	0.24
11	32.83	25.63	0.28	0.12
12	34.77	52.19	33%	0.20
13	34.84	24.25	0.44	0.18
14	34.89	42.40	0.18	0.10
15	37.92	91.43	59%	0.41
16	40.71	441.40	0.91	0.83
17	40.76	1,067.98	0.96	0.93
18	41.02	437.58	0.91	0.83
19	42.78	50.12	15%	0.08
20	44.72	67.51	0.34	0.20
21	46.38	69.94	0.34	0.20
22	47.13	79.38	41%	0.25
23	48.26	380.74	0.87	0.78
24	50.62	351.63	0.86	0.75
25	52.20	27.00	0.93	0.32
26	56.60	72.10	0.22	0.12
27	58.77	94.70	38%	0.23
28	62.89	32.77	0.92	0.31
29	63.84	54.03	0.18	0.08
30	77.80	23.98	2.24	0.53

31	81.89	32.69	1.50	0.43
32	83.14	55.42	50%	0.20
33	91.07	397.68	0.77	0.63
34	92.22	385.25	0.76	0.61
35	94.54	32.23	1.93	0.49
36	103.60	63.59	0.63	0.24
37	136.34	758.60	0.82	0.70
38	172.44	96.80	0.78	0.28
39	223.48	122.30	83%	0.29
40	265.04	201.87	0.31	0.14
41	359.56	25.46	13.12	0.87
42	426.45	275.27	0.55	0.22
43	1309.49	149.75	7.74	0.79
44	2142.87	356.74	5.01	0.71
45	3276.18	168.79	18.41	0.90
		MAPE	1.61	
		MdAPE	0.76	
		sMdAPE	0.41	

The clubbed data also indicate divergence between actual and predicted values. For the purpose of checking whether the predicted share prices are statistically different from the actual values, we propose to run an independent sample t- test. To this effect, normality of data was checked using Shapiro-Wilk test and the result is given below.
All statistical testing was done using R (Version: 3.5.1).

Shapiro-Wilk normality test

W = 0.38853, p-value < 2.2e-16

The Shapiro Wilk test clearly indicates that the data is not normal. Hence t- test cannot be conducted, as data does not meet the parametric test assumption. To overcome this and to check whether the differences observed between predicted and actual prices are random or not, Wilcoxon Rank Sum Test with Continuity Correction was performed in R (Ver: 3.5.1). Null hypothesis while conducting the test is that the prices generated using GGM and the actual prices are not related, or to put it in statistical terms the null hypothesis of Wilcoxon Rank Sum Test is that there is no difference in the median, i.e., the hypothesised median difference is zero.

The result from the test is given below

Wilcoxon rank sum test

W = 1186, p-value = 0.1634

Alternative hypothesis: true location shift is not equal to 0

The test result suggest that the median difference for actual and predicted share prices are not statistically significantly different. The p value of the test suggest that there is 16 percent chance that the observed difference in median is random. Since the null hypothesis cannot be rejected even with 90 percent confidence, we choose to go with the claim that the share price predictions made using GGM tend to reflect actual share prices in the case of the companies selected for study.

V. CONCLUSION

The test result from the present study lend support to GGM as a method of estimating stock prices . While there are many factors that have an impact on share price, expected dividend and their present value is certainly a logical factor that can influence the prices. The study has focused only on the five highest dividend paying companies for a ten year period. Choice of different companies or same companies but different time periods could possibly give different results. For future studies the researchers wish to expand the current list of companies and time period in future research to check whether GGM predictions are statistically consistent.

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