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How Do Interest Rates Affect Market Capitalization Growth Rates in the US?

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Abstract

This paper investigates how interest rates affect the market capitalization growth rate of individual companies in the US. The research will distinguish itself from previous literature as it analyzes company and macroeconomic data after the 2008 recession. This is particularly interesting as interest rates have been historically low in this time period. Previous research suggests that since the Great Recession the effects of interest rate changes have decreased. On the contrary I will argue that the effects of interest rates still appear to be significant and substantial when explaining the market capitalization growth rate.

Keywords

great recession, interest rates, federal funds rate, market capitalization, gdp, lagged timeseries, finance

Cover Page Footnote

I would like to thank Dr. Craig Brett for his guidance throughout the production of this paper. I would also like to thank Isaac Doucette for providing valuable feedback on an initial draft.

1. Introduction

Since the Great Recession, interest rates in the United States have been historically low. The federal funds rate has been below 0.25 percent since the end of the 2008 recession in July 2009. It was not until the start of 2016 that the federal funds rate started increasing again and has steadily increased to its current level of 2.20% in November 2018. In the over 60 years that the Federal Reserve Bank of St. Louis has data, there has never been a time where we have experienced such low rates of interest (FRED, 2018). In his research Frkovich (2016) finds that over the past few decades there has been a consistent trend of decreasing interest rates. Craig and Millington (2017) find that although the Federal Funds market still continues to operate, however, since the 2008 recession there has been a change in its effects. As a result of the interest rate being nearly zero, they claim that different methods are being used to achieve goals traditionally achieved through interest rate manipulation. As such the interest rate as a tool has lost some of its pre-2008 effectiveness.

This research will focus on analyzing the effectiveness of the federal funds rate on changing investment in the US since the 2008 recession. I will try to estimate the effects of the interest rates on 25 US companies. The companies are selected from the S&P Consumer Discretionary and Consumer Staples sectors. I chose the 15 largest of each sector, of which 25 companies had available data. The unavailable data was mostly due to companies being founded after 2010, and as such sufficient historical data was unavailable. Further discussion of consumer discretionary and consumer staples is found in section 2.6.

Choe (1994) finds that the sensitivity to debt maturity changed the perceived value of a company, and that capital structure had an influence on the effects of interest rate changes. As such I will include measures of capital structure and debt in my research to see if the level of debt has any influence on the effectiveness of interest rates, to see whether a company with high levels of debt will be more or less impacted by a change in the federal funds rate. Previous research by Elsendiony (2000) finds that sensitivity of company valuation was negatively related to debt-to-equity ratio. His research, however, concluded in 2000, and this paper will distinguish itself from previous literature by trying to outline the effects of debt on interest rate sensitivity of US companies in the post-2008 climate of historically low interest rates. Elsendiony (2000) finds that payout ratio was statistically significant when looking at sensitivity of US companies to changes in interest rates. As such I will include measure of dividend-payout ratios in my research.

This paper will continue with a literary review of the chosen variables and discussions of how they have been measured in similar, previous economic research in section 2. In section 3 I will discuss the data collected and define the variables chosen for this paper. Further in section 4 I go through econometric results. Section 5 summarizes the final model developed. In this section I will also discuss the statistical and economic significance of the variables. In section 6, I will elaborate on my interpretation of the model and evaluate how the results relate to past literature on similar topics. Finally, in section 7 there will be the conclusion of this paper.

2. Literary Review

2.1 Market Capitalization

Market capitalization will be used in this paper as the value of a company, and by extension the value of investment in the economy. It will be the response variable in the multiple regression model developed later. Brealey et al. define market capitalization in Fundamentals of Corporate Finance (2016) as “the total market value of equity, equal to share price times

numbers of shares outstanding". Market capitalization is often used as a measure of market value of companies, as price of companies vary due to other policies such as stock dilution. One can look at market capitalization as a way to measure the entire cake, whereas price represents the size of each piece. Ellaboudy (2008) uses market capitalization in his analysis of stock market development due to changes in macroeconomic determinants. Ellaboudy finds that "market capitalization is an essential measure of […] of financial development".

In Kenneth Ko's 2018 *Multiple Regression Model for Market Capitalization* he explores methods in which one can measure market capitalization as it is of vital importance for any stakeholder within a company. It is one of the most valuable, single-value estimates of a company including profit and stock price. Kenneth Ko (2018) claims that market capitalization may perhaps be the ultimate bottom line for a public company, and closest to its true value.

Reinganum (1999) concludes in his research of the significance of market capitalization in portfolio management that market capitalization was a great addition to any company value analysis as it represents total company value as measured by market participants. Market capitalization is also used in research of social responsibility versus financial performance in Sean Stanley's 2011 paper on the topic, further suggesting that market capitalization is an often used, and well-established measure of company value.

2.2 Interest rates

Interest rates will be a key independent variable in this analysis. I will be using the federal funds rate as per the Federal Reserve Bank of St. Louis. The bank defines the federal funds rate as "the interest rate at which depository institutions trade federal funds (balances held at Federal Reserve Banks) with each other overnight." I have already established the importance of interest rates to the level of investment, however the selection of the federal funds rate was due to it being highly used in interest rate research and finance. In Bijan Bidabad and Abul Hassan's (2017) research of *dynamic lag structure of deposits and loans interest rates for business cycles formation* they find that the short-term interest rates such as the federal funds rate are a source of oscillation which consequently helps form the typical foscillation of the business cycle. The federal funds rate is an important factor in the changing of business cycles.

Seiler, Shyu, and Sharma (1998) conclude in their research that markets interpret changes in company discount rate no differently than changes in the federal funds rate. Conversely Miller and Choi find that prior to the Great Recession the U.S federal funds rate was a great and highly effective tool for US monetary policy. They claim that the federal funds rate maintained its effectiveness during the 2008 recession, however found that after the recession the importance of the rate dropped.

The relationship between investment and interest rates are explored greatly prior to 2008 by Economists such as Coxwell in her 2000 paper where she determines that investment is a function of both interest rates and aggregate demand. She studied the relationship between business fixed investment, residential fixed investment, and interest rates, and concludes that there was a negative relationship between interest rates and the two types of investment. She suggests that there is an element of lag from when the interest rate are changed until it has an effect on investment and aggregate demand, and as such it will be interesting to add lags to the interest rates to see whether there is some difference in effect.

In addition, in Stowe's 1991 analysis of the interest rate sensitivity of stock prices conducted on behalf of the Federal Reserve Bank of Atlanta he finds that interest rates changes affect nearly all financial securities. He found that business cash flows are very likely affected by changes in interest rates. However, he also argues that although there is an expectation for interest rates to fall, stock prices do not necessarily increase in response. Even though interest rates are important in any analysis of stock prices, analyzing changes in interest rates explain

only a portion of the security's variability (Stowe, 1991). The current literature has explored in great detail the changes in interest rates prior to the 2008 recession, however lacks in part an exploration of its effects in the current, post 2008 economic climate. In addition, consideration of a bidirectional relationship between interest rates and market capitalization growth rates as established by Elsendiony and Ratanapakorn (2000) should be explored.

2.3 Gross Domestic Product

The US gross domestic product will be analyzed with quarterly data, as published by the Federal Reserve Bank of St. Louis. FRED defines GDP as measure of U.S. output, is the market value of the goods and services produced by labor and property located in the United States. GDP and GDP growth are often used as a measure of monetary conditions in general. It is a well-established measure of the economy, and although problematic at times, GDP is the best, single-measure of economic activity in a country.

This is reflected in research by Diebold and Yilmaz (2008) in which they conclude that there is a clear link between macroeconomic fundamentals such as GDP and stock market volatility. Diebold and Yilmaz's 2008 research is echoed by Kaloudis and Tsolis (2018) who use GDP as a measure of overall monetary environment when analyzing capital structure and speed of adjustment in US firms. Consequently, including GDP in an analysis of stock market securities will add weight to the investigation. Ratanapakorn (2000) concluded that GDP has a significant effect on the US financial market. Ratanapakorn again reinforces the norm of using GDP as a measure of general monetary conditions and emphasizes the value of adding it to the model.

2.4 Debt-to-equity

Debt-to-equity is defined by Brealey et al. in Fundamentals of Corporate Finance as the total debt as a ratio of total equity of a company. The ratio shows how much of a company's finance is debt sourced. The debt-to-equity ratio is a well-established ratio highly used in company research (Miller and Choi, 202014). In his 2006 paper on federal funds rate and its effect on probability of repurchasing of stocks, Frkovich finds that a low interest rate encourages investment. This is a result of companies being able to issue bonds at lower interest rates, which in turn lowers the costs of capital for companies with debt. Management knows that lower interest rates suggest easier access to capital. Low interest rates induce companies to use profits more aggressively in order to further improve profits. If interest rates were to increase this behavior would be considered riskier.

I choose to include debt-to-equity as a part of my variables as I am interested in seeing if a change in debt will be at all reflected in overall value of the company. In addition, it will be interesting to see whether the capital structure of a company will have any effect on interest rate sensitivity. Previous research by Elsendiony (2000) suggests that there is a negative relationship between sensitivity of company stock price on interest rates and the debt-to-equity ratio. Choe studies the substitution effect of short- and long-term debt on expected returns of common stocks. He suggests the that the choice and level of corporate borrowing should be two of the most important concerns of management, as it is highly important in further growth and, consequently, the value of the company.

Guo, Wang, and Wu (2011) find in their investigation of financial leverage and market volatility that an increasing debt-to-equity ratio causes stock prices to increase in the short term through a "leverage effect" in which companies will borrow more and purchase more stock which consequently pumps up the stock price, however in the longer term there will be a "depyramiding effect" in which the price falls because lenders issue marginal loans, and will

force stock sales, subsequently lowering the stock price. In their research they also found that lowering debt-to-equity ratios will lower stock price volatility. In our case I will see how lower or higher debt-to-equity ratios will affect market capitalization. Guo, Wang, and Wu's research suggest that we should see that as debt-to-equity decreases, market capitalization volatility should decrease as well.

A negative effect of the change in a firm's leverage ratio and debt-to-equity on its stock prices is documented by Cai and Zhang (2011). Further they suggest that the negative effects of a higher debt-to-equity ratio increases when debt-to-equity is already high, as there is a higher chance of default. As such there could be a non-linear relationship to be discovered in the model. Firms with a higher debt-to-equity ratio tend to have fewer future investments from external sources, further lowering the price of a stock and its market capitalization. In general, they find that company with higher debt-to-equity ratio face more severe financial constraints.

Contrasting other research on debt-to-equity and capital structure, Shiyu (2002) researches the performance of publicly traded companies and their capital structures during business cycles, in which he found that capital structure and the amount of debt-to-equity in a company in fact had a little to negligible effect on a company's stock price. Perhaps counterintuitively he suggests that the amount of debt a company has does not greatly affect its growth in market capitalization during contracting and expanding business cycles. His research examined four economic periods in the US, all prior to 2002. We again have research that was concluded prior to 2008, and lacks an analysis of data from the last decade, which will be the distinction of this paper.

2.5 Dividend-payout ratio

A company's dividend-payout ratio is defined by Brealey et al. (2016) as the total dividends paid out by a company as a ratio of total earnings of a company in a given time period. In Ko Kenneth's (2009) *Multiple Regression Model for Market Capitalization* he finds that the best model of market capitalization, in terms of adjusted R^2 values, included a dividend-payout ratio. As such a dividend-payout ratio could be central in the investigation of market capitalization and its sensitivity to interest rates. Kenneth Ko's research concluded in 2009, and as such does not include any study in regard to the most recent years of data.

Company sensitivity to interest rates is negatively related to payout ratio (Elsendiony, 2000), and it is found that a dividend-payout ratio was the only statistically significant variable to have an effect on the stock price sensitivity to interest rates, amongst a plethora of other examined ratios. Elsendiony's research is echoed by Cole, Ying, and Hemley's *Dividend Policy: Determining the Relevancy in Three U.S. Sectors* in which they found that "there is a statistically significant relationship between stock prices and dividend policy". Their conclusions further emphasize the apparent importance of dividend-payout policies on interest rate sensitivity in US companies. A dividend-payout ratio is found to be less risky to own as an investment, and as such increases their market capitalization as lower risk is a positive incentive on investments (Profilet and Bacon, 2013). Finally, in their 2012 paper *Stock Price Reactions to Dividend Announcements* Gupta et al. find that stock prices react positively to increase in dividend announcements. As such an increased payout ratio could have a potential impact on market capitalization growth rates.

2.6 Consumer Discretionary vs Consumer Staple Goods

Consumer discretionary and consumer staple goods will be included in the regression as indicator variables. The two classes of goods are categorized by Morgan Stanley Capital International (MSCI), and is used by S&P in their classifications of sectors. The consumer

discretionary sector consists of industries that tend to be the most sensitive to economic cycles. Its industries include automobiles, household durable goods, restaurants, and other goods often deemed non-essential. Consumer staples contrarily are considered essential goods and are less sensitive to business cycles. Consumer staple industries include food, beverages, non-durable household goods, and drug companies (MSCI, 2018). Although there is not much US research on consumer discretionary and staple goods specifically, I will add these variables out of interest to see whether there is any significant relationship between the effects of interest rates changes and the company's respected industry.

2.7 Inflation

Finally, I have decided to keep all variables in real terms. As such, market capitalization, federal funds rate, and GDP have all been adjusted in real terms using the consumer price index (CPI) Less Energy published by the Federal Reserve Bank of St. Louis. FRED defines CPI Less Energy as a measure of the average quarterly change in the price for goods and services paid by urban consumers between any two time periods, less the change in price of energy. I chose the CPI Less Energy as energy and food is often considered very volatile and could create unwanted noise in the estimates as noted by Sinclair, Jansen, and Bradley (2009) and Tatom (2002). Still, I have decided to include food, as amongst the companies I have selected there are companies who are greatly affected by prices of food such as Target and Walmart, amongst others.

3. Data

The data is that will be used in this paper is sourced from various online databanks. The Federal Reserve Bank of St. Louis is an official economic databank of the United States, and as such the data is considered accurate and true. Debt-to-equity ratio, and dividend-payout ratio is provided by Intrinio, an online databank which provides an Application Programming Interface (API) for the R statistical software package granting access quarterly historical fundamentals data for US registered companies. Data was available for most companies since the last quarter of 2009, until 2018. As such my data will consist of quarterly data from the last quarter of 2009 until last quarter of 2017, totaling 32 quarters.

I have selected 30 companies in my analysis, of which 25 had available data. The selected companies are the 15 companies with the highest market capitalization in each of the two sectors chosen; consumer discretionary and consumer staples. Of the 5 companies where data was unavailable, 4 were founded in the time period 2009-2018, and had insufficient data to be included or recently changed their stock structure so that data was misrepresentative. The last company the data was unavailable in the database for unknown reasons. I have decided to continue with the selected data as it represents 25 companies, with 32 time periods, which equals 800 data points per variable.

3.1 Market Capitalization Growth Rate

Market capitalization growth rate will be the response variable in the multiple-variable regression model. The market capitalization growth rate in time period *t* is calculated by taking the natural logarithm of market capitalization of a firm in time period *t* and subtracting the natural logarithm in time period *t-1*:

$$Market\ Capitalization\ Growth\ Rate = \ln(Market\ Cap_t) - \ln(Market\ Cap_{t-1})$$

I have adjusted for inflation using CPI less energy with first quarter 2010 as base period. Market capitalization functions as a measure of company value consequently making market capitalization growth rates a way to measure the growth rate of the total value of US companies. Average growth rate across the sample was 3.3% per quarter, with an average standard deviation of 9.8% per quarter.

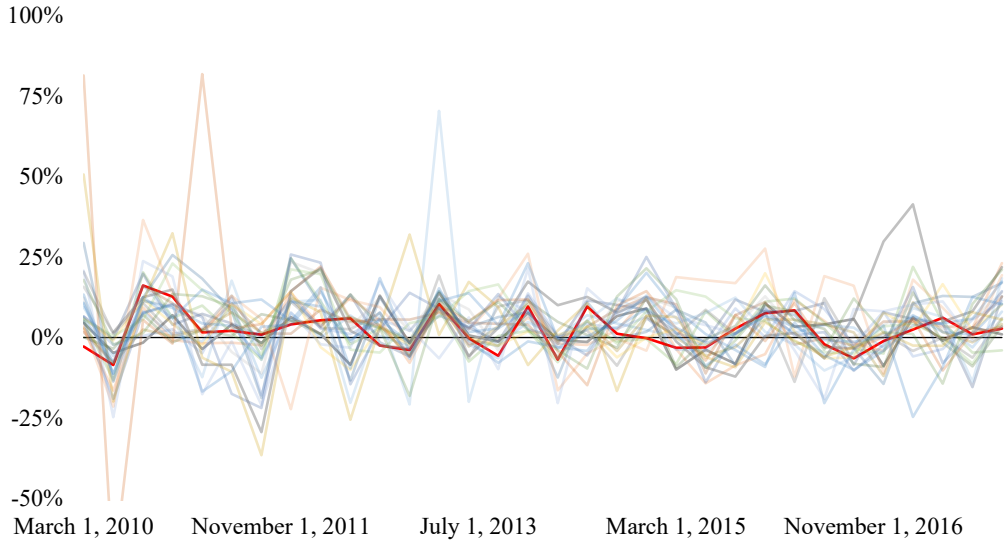

Figure 1: Quarterly market capitalization growth for a portfolio of 25 US companies since 2010.

The average growth rate is shown by the red series in Figure 1, along with the portfolio of 25 selected companies. There appears to be a general co-movement in the market capitalization in the portfolio of companies across the selected years.

Figure 2 shows the market capitalization cumulative growth since 2010, again with the average growth shown by the red series. There is a general upwards trend across the portfolio and all the firms have increased market capitalization since 2010, notably *Amazon* being the sole company growing over 200% in the time period.

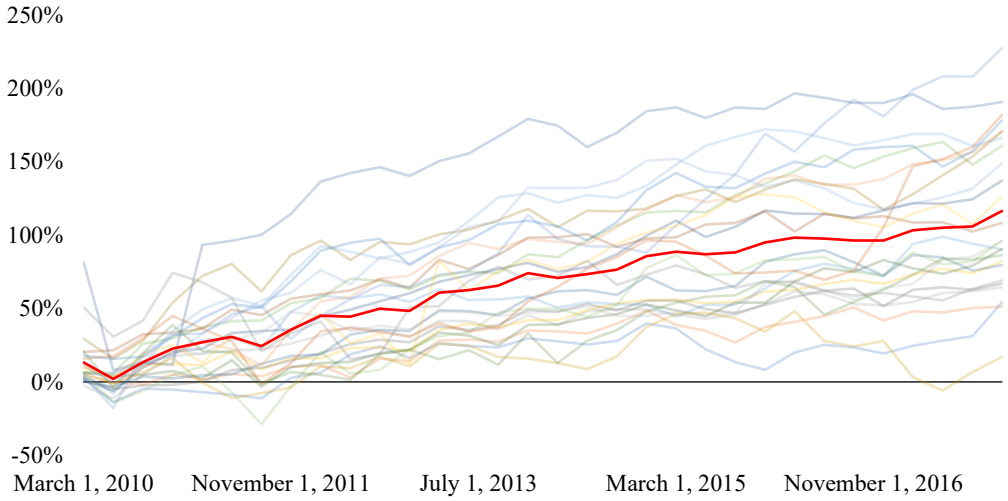

Figure 2: Cumulative market capitalization growth for a portfolio of 25 US companies since 2010.

On the other hand, *Target* managed barely to get onto the positive side of the curve, having a negative cumulative growth as late as in the second quarter of 2017. Average cumulative market capitalization growth over the period was 116.37%, with a standard deviation of 49%.

3.2 Interest Rates, GDP, and Inflation

The federal funds rate and GDP have been adjusted for inflation using CPI less energy, with the first quarter of 2010 as base period. The federal funds rate used in the model is the quarterly averaged effective federal funds rate. Quarterly averages calculated by averaging the monthly effective federal funds rates for the respective quarter. In the selected time period from 2010 to the end of 2017 average quarterly real federal funds rate has been -0.15% with a standard deviation of 0.38%. The real federal funds rate is shown in Figure 3
In Figure 3 we see how the real federal funds rate has been negative for the larger parts of the earlier parts of the current decade, having been as low as -0.68% in the second quarter of 2011, before starting to increase until the time period peak at 0.77% at the end of 2017.

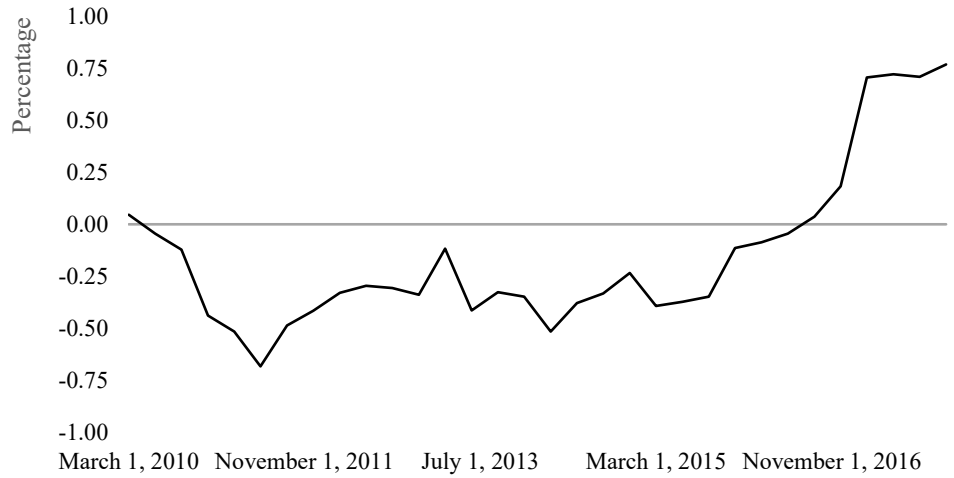

Figure 3: Quarterly real effective federal funds rate since 2010.

Real GDP in time period *t* was calculated by taking the cumulative GDP from the last 4 quarters and adjusting for inflation. As such real GDP in period *t* will represent the market value of goods and services produced within a year from period *t*. Just like the market capitalization growth rates I calculate real GDP growth rates as the change in natural logarithms. In Figure 4 we see the generally positive growth in real GDP. Real GDP has been increasing steadily since first quarter of 2010 at $US 15.6 trillion to $US 18.32 in the final quarter of 2017. This yields an average growth 0.52% per quarter.

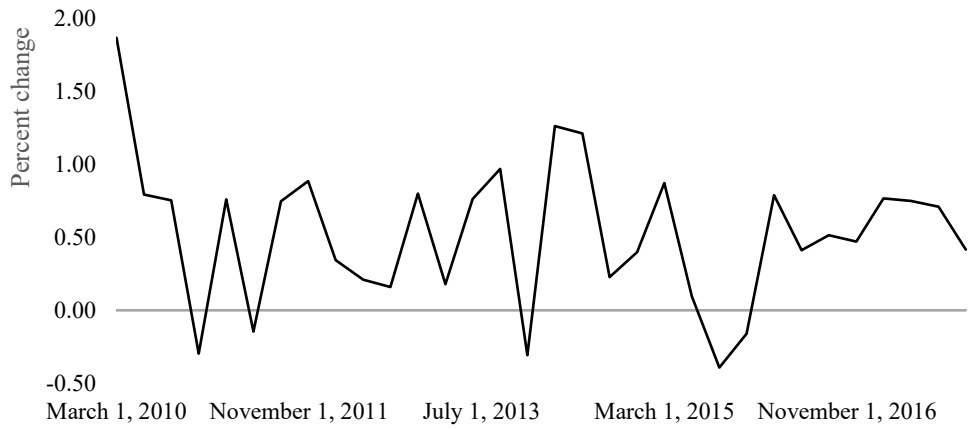

Figure 4: Real US GDP growth since 2010.

In addition to real GDP and real interest rates, I will be using lagged values for interest rates to see how changes in interest rates at time *t* changes market capitalization growth rates at time *t+1,* through *t+4*. I simply assign real interest rate in period *t* to market capitalization growth rates at time *t+1* to *t+4.* This way we may be able to observe delayed reactions to real interest rate changes.

3.3 Debt-to-equity Ratio, Dividend-payout Ratio, and Leverage Ratio

All ratios were gathered from Intrinio, an API which gathers data from US companies' quarterly financial documents. As these are all ratios, we assume most, if not all would be between 0 and 1. Average ratios were 0.63, 0.56, and 3.12 for debt-to-equity (DE) ratio, dividend-payout (DP) ratio, and leverage ratio respectively. There were a few extreme cases in which the DE ratios were significantly higher than the average, such as DE ratio of 194 for *Colgate Palmolive* and similar magnitudes for other companies. I have chosen to keep the data as it is as extreme DE ratios will contribute to estimations of DE effects on market capitalization growth rates. Another extreme case is negative DE, DP, and leverage ratios. Although it is fully possible to have negative ratios in all three cases, this does hinder our ability to research logarithmic functional forms as log(x) is defined only for x>0.

3.4 Indicator Variables

I have created indicator variables for all companies and an indicator variable for company classification. Company classification distinguishes between *Consumer Discretionaries* and *Consumer Staples*. By having an indicator variable for individual companies, I will check if there is any inherent significant difference in company market capitalization growth. Indicator variables will also allow for the exploration of differences in differences. By interacting a company classification indicator variable and interest rates we may find evidence to suggest there is a difference in the effects of changes in interest rates on market capitalization growth rate given the company classification.

4. Results

I start my exploration of the data by running initial regressions using all simple variables, excluding alternative functional forms, lagged values, or interaction terms. By removing obvious insignificant variables I will be able to narrow down and make strides towards the final model. The initial regression will be a regression with market capitalization growth rate as the dependent variable and the real federal funds rate, real GDP in billions, DE ratio, DP ratio, leverage ratio and all the interaction terms with *Walmart* and *Consumer Staples* as company and company classification base cases respectively.

Coefficient	Estimate	Std. Error	t-value	P (>|t|)	Sig. Code	#
(Intercept)	0.02053432	0.0201644	1.018	0.3088		1
R_Federal_Funds_Rate	0.01782962	0.01050938	1.697	0.0902	·	2
R_GDP_Growth	-0.0115677	0.00810586	-1.427	0.154		3
D_E	-0.0001156	0.00007824	-1.477	0.14		4
DPR	0.00153425	0.00157425	0.975	0.3301		5
LVR	0.00001647	0.00006241	0.264	0.7919		6
Consumer_Discretionary	0.02951046	0.02769114	1.066	0.2869		7
PG	-0.0012433	0.02769297	-0.045	0.9642		8
KO	0.00267808	0.02769756	0.097	0.923		9
PEP	0.0084773	0.02769331	0.306	0.7596		10
PM	0.01224911	0.02777028	0.441	0.6593		11
MO	0.03300302	0.02769946	1.191	0.2338		12
COST	0.02546058	0.02769392	0.919	0.3582		13
MDLZ	0.01678152	0.02769131	0.606	0.5447		14
CL	0.00133378	0.02778091	0.048	0.9617		15
EL	0.03643715	0.02769108	1.316	0.1886		16
KMB	0.00873099	0.02773109	0.315	0.753		17
SYY	0.01099979	0.02769421	0.397	0.6913		18
AMZN	0.02509345	0.02770057	0.906	0.3653		19
HD	0.00696865	0.0276918	0.252	0.8014		20
MCD	-0.0168956	0.02769151	-0.61	0.542		21
NKE	-0.0070511	0.02769241	-0.255	0.7991		22
SBUX	0.00150662	0.02797037	0.054	0.9571		23
LOW	-0.0161891	0.02769178	-0.585	0.559		24
TJX	0.0133493	0.02769371	0.482	0.6299		25
MAR	0.0097346	0.02780441	0.35	0.7264		26
F	-0.0252602	0.02769487	-0.912	0.362		27

Table 1: Initial regression of selected variables using R studio statistical computing environment.

TGT	-0.0407472	0.02769475	-1.471	0.1416		28
ROST	0.00947523	0.02769469	0.342	0.7323		29
CCL	-0.0195966	0.02769089	-0.708	0.4794		30

Table 1 shows results from regressing the selected variables on market capitalization growth rate. First, we note that real federal funds rate (R_Federal_Funds_Rate) is the only variable appearing to be statistically significant (row 2). Real GDP Growth (R_GDP_Growth) is not statistically significant with a p-value at 0.154 (row 3). DE ratio (D_E) and DP ratio (DPR), and leverage ratio (LVR) (row 4,5,6) are all statistically insignificant, all with p-values > 0.14. Leverage ratio has a p-value > 0.75, and as such I will not keep leverage ratio in the development of my model. DE and DP ratios I will keep to check for joint significance in later tests. Consumer discretionary indicator variable (row 7) and all company indicator variables (row 8-30) are statistically insignificant.

I check the initial model for heteroskedasticity through a studentized Breush-Pagan test. The BP test gives a p-value ≈ 0 which strongly suggests heteroskedasticity in the initial model. I will continue the construction of the model with this in mind. As we have evidence of heteroskedasticity, when checking joint significance of the initial model, I add Robust estimators to adjust for heteroskedasticity. I check joint significance of the company indicators using both regular and robust-adjusted F-tests. Both joint significance tests give p-values > 0.5. Thus I remove company indicator variables from the model.

I repeat the process for DE ratio and DP ratio, checking for joint significance through both regular and robust-adjusted F-tests. I have chosen not to include leverage ratio in the joint significance test as its t-value ≈ 0, and including the term in a joint significance test may falsely give the impression of significance. The regular joint significance test gives p-value of 0.210, however robust adjusted F-test give p-values > 0.0001. As the BP test suggested strong evidence of heteroskedasticity I continue by keeping DE ratio and DP ratio as variables in the model.

Coefficient	**Estimate**	**Std. Error**	**t-value**	**Pr(>t|)**	**Sig. Code**	**#**
(Intercept)	0.0335	0.00741	4.518	0.00001	***	1
R_Federal_Funds_Rate	0.0179	0.01045	1.709	0.08780	.	2
R_GDP_Growth	-0.0116	0.00806	-1.443	0.14950		3
D_E	-0.0001	0.00008	-1.423	0.15500		4
DPR	0.0015	0.00153	1.005	0.31510		5
Consumer_Discretionary	0.0121	0.00780	1.554	0.12060		6

Table 2: Updated initial regression of selected variables using R studio statistical computing environment.

The updated initial regression results based on the prior discussion is as seen in Table 2. I have now selected the primary variables. Prior to exploring lagged forms, alternative functional forms, and interaction terms, I will check for Granger-Causality between the market capitalization growth rate and interest rates.

Elsendiony and Ratanapakorn (2000) suggest a bidirectional relationship between market capitalization growth rates and interest rates. By running a Granger Causality test I may check whether the bidirectional relationship exists.

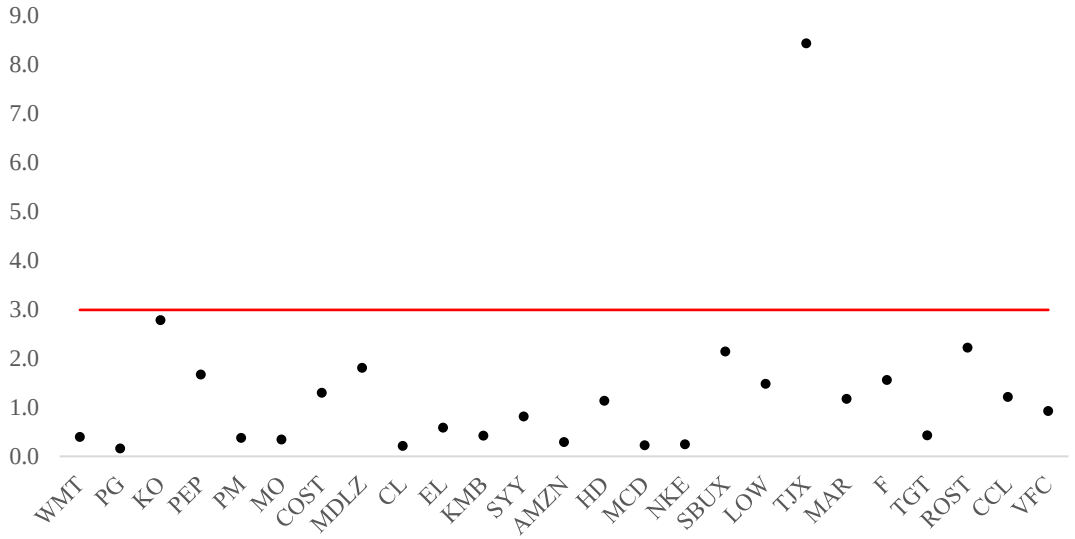

Figure 7: Results of Granger Causality test on the effects of company market capitalization growth rates on the real federal funds rate.

Figure 7 shows the results of the Granger Causality test to check whether company market capitalization growth rates Granger cause the real federal funds rate, with the 1% critical value represented as a horizontal line. Only one company's timeseries, *TJX*, suggested that relationship. Consequently, the data contradicts the notion of the bidirectional relationship in the selected 25 companies

Further I start exploring lagged forms of the data in the model, in particular quarterly lagged versions of the real federal funds rate. I apply one through four quarter lagged data to the model. As such I will see if there is any significance to the changes that happened to the real federal funds rate up to one year ago to the market capitalization growth rate. Table 3 shows the regression results after adding the lagged variables of interest rates.

Coefficients	**Estimate**	**Std. Error**	**t-value**	**Pr(>|t|)**	**Sig. Code**	**#**
(Intercept)	0.02688836	0.00894314	3.007	0.002726	**	1
R_Federal_Funds_Rate	0.03786403	0.02520519	1.502	0.133437		2
R_GDP_Growth	-0.0117731	0.00810691	-1.452	0.146833		3
D_E	-0.0001036	0.00007655	-1.353	0.176295		4
DPR	0.00198809	0.00151983	1.308	0.191219		5
Consumer_Discretionary	0.01215884	0.00770902	1.577	0.115145		6
R_Federal_Funds_Rate_1Q	0.03763779	0.03476128	1.083	0.27925		7
R_Federal_Funds_Rate_2Q	-0.0979471	0.02859524	-3.425	0.000646	***	8
R_Federal_Funds_Rate_3Q	0.05003255	0.01492848	3.351	0.000842	***	9
R_Federal_Funds_Rate_4Q	-0.0121992	0.02692523	-0.453	0.650618		10

Table 3: OLS regression with lagged variables using R studio statistical computing environment.

The two and three quarter lagged real interest rates are shown to be highly statistically significant with p-values > 0.001 (row 8,9). The four-quarter lagged real interest rates (row 10) is shown to not be significant. As per convention, I will proceed by including lagged up to and including the longest statistically significant one. I will discuss the implications of this in later discussion of the final model.

I may be able to identify functional form misspecification by running a Ramsey RESET test. The RESET test suggests whether there are non-linear combinations of the explanatory variables that help explain the response variable. The RESET test has been specified to check for significance of second and third powers of the variables. The p-value of the RESET test is less than 0.0000001, providing strong evidence that there is explanatory power in exponential versions of the independent variables.

By adding squared forms of GDP growth, debt-to-equity ratio, and dividend-payout ratio the RESET test p-value increases to 0.0063, still suggesting that there is explanatory power in higher order terms. When adding squared real federal funds rate the p-value increases further up to 0.011. When running OLS on the selected newly added squared terms, the squared federal funds rate term is shown to have little significance on the overall result, with an individual significance test p-value of 0.48. Likewise, squared dividend-payout ratio and debt-to-equity ratio have both give t-tests suggesting they have little significance. In addition, the estimated coefficients of the squared ratios are very small, both less than 0.001. The economic significance of the squared ratios is estimated to be negligible. As a result of the Ramsey RESET test I will proceed with adding squared GDP growth to the model.

Further it is possible to explore non-linear combinations of the explanatory variables through a Davidson-Mackinnon test. I have chosen not to explore logarithmic forms of the variables as they are all negative at times. There are methods in which one could add the absolute value of the largest negative observation of a variable to all observations of that particular variable, however I have chosen not to do this as most of the observations of real federal funds rate, GDP growth rate, debt-to-equity ratio, and dividend-payout ratio are between 0 and 1, however the values which are negative are at times significantly greater in magnitude and as such the proposed transformation would no longer properly represent the original observations.

Finally, I explore adding interacting terms to the model of market capitalization growth rates. The *Consumer Discretionary* indicator variable appears to be insignificant in the model, with a p-value > 0.10 (row 6, table 3). The reason I have kept this so far is to explore interacting it with the real federal funds rate, and its lagged transformations. Consumer Discretionaries indicator variable intersected with the real federal funds rate has a p-value = 0.69. As it is insignificant, I do not include it in the model. Interacting consumer discretionaries with the lagged real federal funds rate instead all give p-values greater than 0.40, and again I do not include either of the interaction terms in the model. The results suggest there is not a significant difference between the change in effects between consumer discretionaries and consumer staples to a change in the real federal funds rate on the market capitalization growth rate.

Throughout this section I have mostly used statistical significance to determine whether to include a variable or not. As a final part of the development of the model there should be a discussion of the economic significance of the individual variables. In particular I found that DE ratio was jointly significant when using Robust-adjusted F-tests. However, I see that the estimated coefficient for DE ratio in table 3 (row 4) is -0.0001036. As most DE ratios are within 0 and 1, the estimated effects of DE ratio are negligible. In the final model I do not include the ratio as an independent variable.

As I now have established a final model, I run a Durbin-Watson (DW) test to check for autocorrelation in the model. Autocorrelation is the presence of correlation between the errors in different time periods in a timeseries model (Wooldridge, 2016). The model passes the DW test for serial correlation, and so I continue without augmenting the variables further.

5. Description of model

After completing the econometric study of the data, the final model of market capitalization growth rates is a multiple OLS regression of the following variables:

$$MCGR = \beta_0 + \beta_1 RFFR_t + \beta_2 RFFR_{t-1} + \beta_3 RFFR_{t-2} + \beta_4 RFFR_{t-3} + \beta_5 RGDP + \beta_6 RGDP^2 + \beta_7 DPR + u$$

Where MCGR is market capitalization growth rate as a percent change per quarter, $RFFR_t$ is the real federal funds rate in period t, $RFFR_{t-1}$, $RFFR_{t-2}$, $RFFR_{t-3}$, is the one, two, and three quarter lagged real federal funds rate respectively, RGDP is real GDP growth, and DPR is dividend-payout ratio. Table 4 gives the estimated multiple OLS regression results:

Coefficient	Estimate	Std. Error	t value	Pr(>|t|)	Sig. Code	#
(Intercept)	0.04159	0.00660	6.299	0.00000	***	1
R_Federal_Funds_Rate	0.06344	0.02514	2.523	0.01182	*	2
R_GDP_Growth	-0.06576	0.01534	-4.285	0.00002	***	3
expR_GDP_Growth	0.04686	0.01143	4.099	0.00005	***	4
DPR	0.00185	0.00151	1.225	0.22086		5
R_Federal_Funds_Rate_1Q	-0.00430	0.03551	-0.121	0.90374		6
R_Federal_Funds_Rate_2Q	-0.06785	0.02816	-2.41	0.01618	*	7
R_Federal_Funds_Rate_3Q	0.03867	0.01384	2.795	0.00532	**	8

Table 4: Final OLS regression using R studio statistical computing environment.

The final model to estimate market capitalization growth rates is as follows:

$$\widehat{MCGR} = 0.042 + 0.063RFFR_t - 0.0043RFFR_{t-1} - 0.068RFFR_{t-2} + 0.039RFFR_{t-3} - 0.066RGDP + 0.047RGDP^2 + 0.0019DPR$$

According to the model, a percentage increase in the real federal funds rate in period t will initially have a 6.3% increase in expected market capitalization growth rate for a company. Standard deviation of the real federal funds rate in the time period has been 0.38% which suggest that if the estimates accurately model market capitalization growth the real federal funds rate have a noteworthy positive effect on market capitalization growth.

Interestingly the coefficient for the one-quarter lag in federal funds rate is 0.004 followed by the two-quarter lagged rate coefficient at -0.068. This suggests that for every percentage increase in real federal funds rate there will be an estimated 0.4% decrease in market capitalization growth rate after the first quarter followed by a 6.8% further decrease after two quarters have passed. In the third quarter the point-increase is estimated to cause a 3.9% increase in market capitalization growth rates.

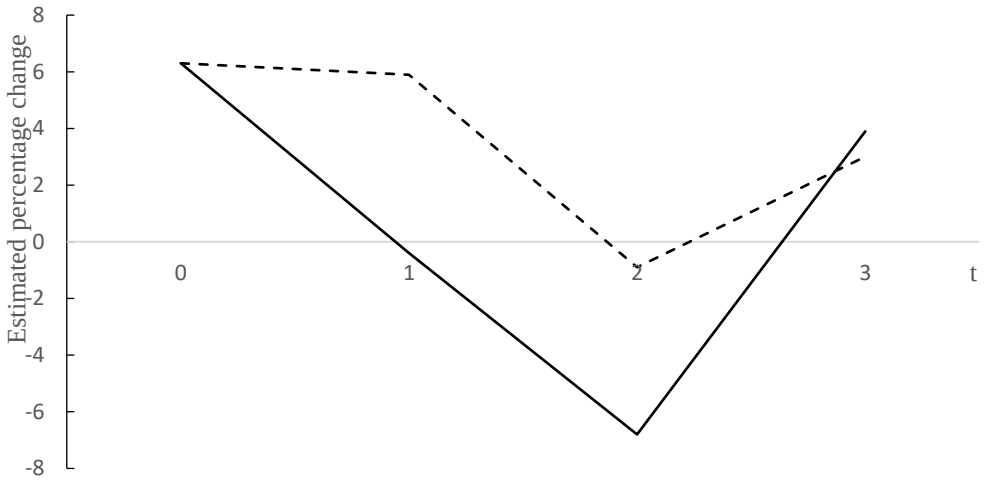

Figure 8: The estimated quarterly (solid) and cumulative (stapled) effects of a percent increase in interest rates on the market capitalization growth rate after *t* quarters

The effects of a 1-point positive shock in the federal funds rate, along with the cumulative effect represented by the stapled line is shown in Figure 7. After three quarters the total effect of a percent increase in real federal funds rate is a 3.0% increase in the market capitalization growth rate.

Further we see that a point increase in real GDP growth in fact decreases expected market capitalization growth rate by 1.9%. Figure 9 shows the estimated quadratic relationship of the effects of real GDP growth on market capitalization. In the time period of my sample real GDP growth has averaged 0.52% per quarter. As average market capitalization growth rate is 3.3% per quarter, my estimations suggest real GDP growth has a substantial effect on the response variable. According to my estimates, real GDP growth would start having a positive effect on MCGR at 1.4%. This level of real GDP growth does not occur in the data, suggesting that real GDP strictly has a negative effect on MCGR.

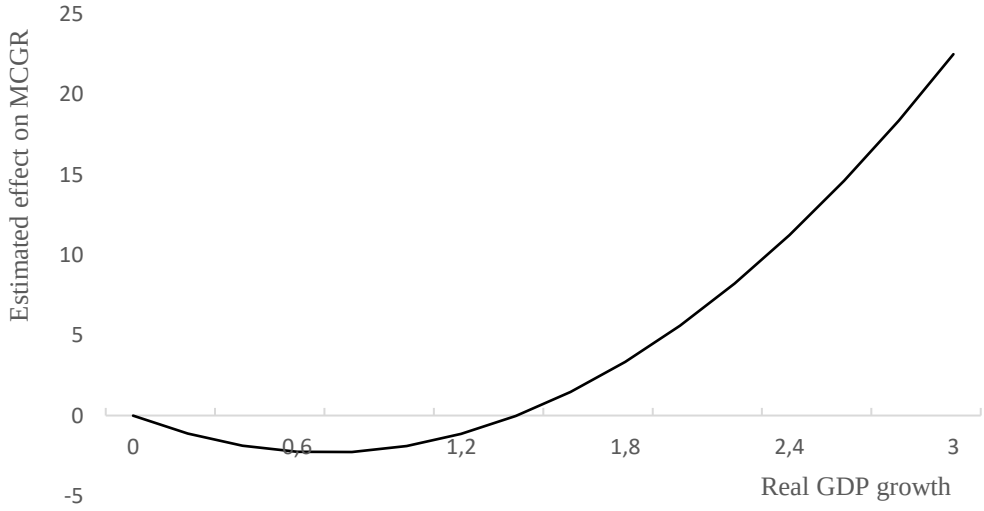

Figure 9: Estimated effects of real GDP growth on market capitalization growth rates.

Finally, we have dividend-payout ratio which in the model has a coefficient of 0.0019, suggesting that a point increase in DP ratio will decrease the quarterly market capitalization growth rate by 0.19%. I will discuss the implications of these econometric results, the implications of the model, and how my findings fit into the previous literature in the subsequent section.

6. Interpretation of results and model

6.1 Interest Rates

The results from the regressions suggest that the real interest rates did in fact have a significant and substantial effect on market capitalization growth. Initial reactions to real interest rates increases were positive, however after two quarters the effect was observed to be negative, market capitalization growth returned, and initial reactions to the change in real interest rates were cancelled to some extent. However, even after the re-stabilization observed after three quarters the total relationship appears to be positive.

Craig and Millington (2017) suggested the federal funds rate had appeared to have lost its effect since 2008 recession, and they may be referring to the counter-effect observed after two quarters. Exploring Coxwell's (2000) suggestions of the importance of lag in interest rates on investment is further established in the findings. Both real federal funds rate and lagged real federal funds rate is found to be statistically significant and the changes considerable.

As my research supports the importance of interest rates, it challenges the literature claiming that interest rates have lost their effect after the 2008 recession, a period in which rates have been historically low. I claim the opposite is true. My research proposes real interest rates are in fact partially effective tools for controlling market capitalization growth rates.

6.2 Gross Domestic Product

Perhaps counter intuitive I have found that an increase in real GDP has a negative effect on market capitalization growth rates. This would suggest that the businesses are countercyclical. This may be corrected in future studies by exploring the relationship between nominal and real GDP. In addition, it may be of interest to explore nominal GDP and inflation rate as two separate variables, rather than collecting them into real GDP. There are likely aspects of omitted variable bias, which may help explain the negative relationship observed in my model.

Previous literature supports the more intuitive idea that there is a clear positive link between GDP and market capitalization (Ratanapakorn, 2000), and thus conflicts my research. Although most research was concluded prior to 2008, the negative significant coefficient estimate in my model appears highly counterintuitive. Especially, the suggestion of a non-linear relationship could give results showing a positive effect of real GDP growth. Therefore, I give a suggestion to explore the relationship between real and nominal GDP in relation to market capitalization growth in future examination.

6.3 Debt-to-Equity and Leverage Ratios

I find that debt-to-equity ratio and leverage ratio have negligible and insignificant effects respectively. My research contradicts Elsendiony (2000) who proposed that debt and capital structure were two very important predictors of company growth. Quite the contrary I find that

capital structure and level of debt in fact has little to no importance when predicting company growth, as reflected in either estimated coefficients ≈ 0 or insignificance of terms in the model. I did not find evidence of the "depyramiding effect" explored by Guo, Wang, and Wu (2011), however I do acknowledge that the examination of the leverage ratio in this paper has been rather superficial, and more in-depth investigation of the leverage ratio should be considered before drawing too strong conclusions of its effect. Leverage ratio used in this paper was in simple form. The term was also excluded rather early from the research due to its estimated insignificance. Figure 10 shows a scatterplot of leverage ratios versus market capitalization growth rates. I find that there is not a relationship between the two measures.

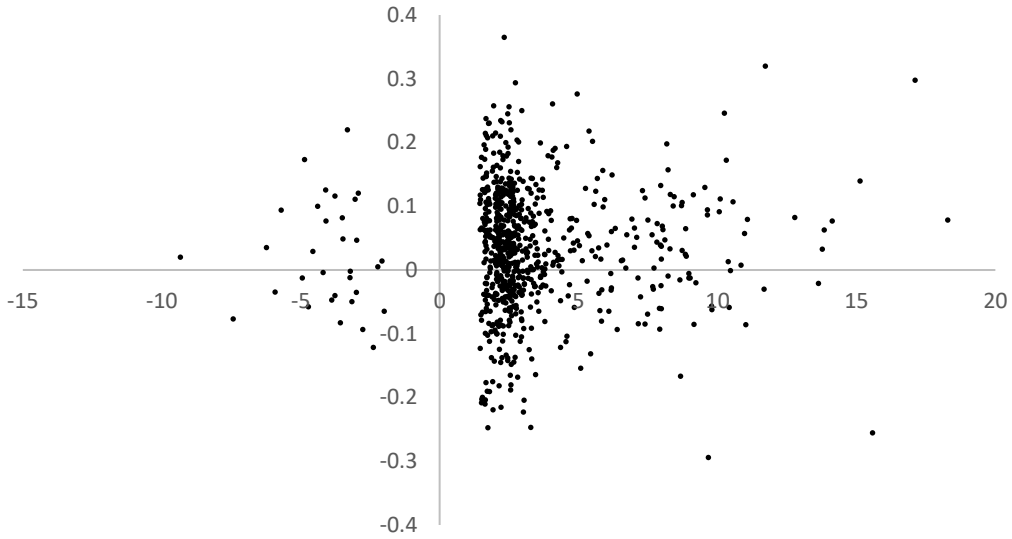

Figure 10: Scatterplot of leverage ratios versus market capitalization growth rates on the x and y axis respectively.

There have however been studies that claimed a company's capital structure and their amount of debt-to-equity had little to negligible effect on a company's stock price, and by extent its market capitalization (Shiyu, 2000). Shiyu completed this research prior to 2002 but his conclusions are supported by my findings that use data from after 2008. Interestingly my findings would suggest that a firm looking to grow market capitalization should in fact not pay attention to debt-to-equity and leverage ratios as they appear to have little to no effect on market capitalization growth.

6.4 Dividend-payout Ratio

My final independent variable is dividend-payout ratio. I concluded by keeping the variable in the regression as it appeared significant when adjusted for heteroskedasticity. In addition, there appears to be economic significance as the estimated coefficient is substantial relative to the expected variation in the variable. My estimate agrees with the general literature on dividend-payout ratio that suggest it is a central ratio in the investigation of market capitalization (Kenneth, 2009). Although Elsendiony (2000) found that dividend-payout ratio had a negative effect on stock price, and consequently market capitalization, my research suggested that relationship is positive. An increase in dividend-payout ratio could suggest strength to potential investors, which in turn would encourage an upwards trend at the end on the day.

7. Conclusion

This paper distinguishes itself from prior research as it explores market capitalization growth rates after the Great Recession, in an environment with historically low interest rates. By systematically developing a model of market capitalization growth rate I conclude that interest rates are still effective tools to predict investment in an economy, as shown by the estimation of interest rates, and its lagged transformation, as a significant and substantial variable. Contrary however to research completed prior to the 2008 financial crisis, I find capital structure to be negligible, as both leverage ratio and debt-to-equity ratios are insignificant. Dividend-payout ratio is found to have a positive relationship with market capitalization growth rates. Further studies may be improved by adding more companies to the study could increase the external validity of the model. Increased computer power would also make it possible to study more observations by adding more companies to the list.

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