Empirical evidence of the Gordon's growth model accuracy on US stocks' valuation

Alfredo Resende

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Abstract

Research findings suggest that the Gordon's growth model is not an accurate tool to value US companies in the twenty-first century (regardless of the economic cycle) and, its growing underestimation tendency throughout the analyzed period (2002-2018), may lead investors to engage in wrong investment decisions.

Both company's dividend payout ratio and share repurchase activities were not considered statistically significant to explain the observed difference in prices, in contrary to the company's dividend yield ratio, profitability level and some GIC sectors (information technology, consumer discretionary and utility) that proved to be significant. However, neither of these variables were able to control Gordon's growth model lack of accuracy. Dividend yield and profitability variables did not denote a particular range that ensures a superior accuracy of the model results (overpricing outcome closer to 0%) and, accurate overpricing results across different GIC Sectors were always a minority, although it is possible to identify specific sectors with a higher underestimation propensity (information technology and consumer discretionary) and others with a higher overestimation propensity (utility and real estate).

Keywords: Dividends, Gordon's growth model, US stock market

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Abstrato

Os resultados desta pesquisa sugerem que o modelo de crescimnento de Gordon não é um mecanismo preciso para avaliar empresas americanas no século XXI e, a sua crescente propensão para subvalorizar empresas no período analizado (2002-2018), pode levar investidores a tomarem decisões de investimento erradas.

Tanto o rácio de pagamento de dividendos, como a atividade de recompra de ações da empresa não foram considerados estatisticamente significantes para explicar a diferença de preços evidenciada, ao contrário da taxa de rendimento do dividendo (DPS/P), rentabilidade da empresa e alguns setor GIC (tecnologias de informação, bens de luxo e serviços públicos), que provaram ser significativos. No entanto, nenhuma dessas variáveis foi capaz de controlar a falta de precisão do modelo de crescimnento de Gordon. A taxa de rendimento do dividendo (DPS/P) e a rentabilidade da empresa não verificaram um intervalo específico que garanta uma maior precisão dos resultados do modelo e, resultados “overpricing” precisos foram sempre uma minoria em diferentes setores GIC, apesar de ser possível identificar setores com uma maior propensão para estarem subvalorizados (tecnologias de informação e bens de luxo) e outros com uma maior propensão para estarem sobrevalorizados (serviços públicos e imobiliário).

Palavras chave: Dividendos, Modelo de crescimento de Gordon, Mercado Americano de ações

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1. Introduction

Since the 20th century, several valuation models were designed to support investors on their investment decisions. One of the oldest and most known models is the Gordon's growth model (Gordon and Shapiro, 1956; Gordon, 1962), which values a stock by discounting shareholders' future dividend cash flows, at a rate Ke, while assuming a perpetual and constant growth of those dividends payments (g).

$$P_t^{model} = \frac{Dividend\ per\ share_t * (1+g)}{k_e - g}$$

Although several researchers have studied the impact of dividend payments on the market stock price (Modigliani and Miller, 1961; Lintner, 1962; Shiller, 1981), there is no empirical evidence of the Gordon's growth model (GGM) accuracy among US stocks.

This paper aims to test that relationship by valuing US stocks traded on the NYSE, Amex and Nasdaq, and compare it with the observed market stock price on the same period. The variable representing the difference between the GGM price and the market stock price will be called "overpricing".

$$Overpricing_t = \frac{P_t^{model} - P_t^{market}}{P_t^{market}}$$

This variable, measures Gordon's growth model accuracy on predicting US companies market stock price: "How much higher is the GGM price, when comparing to the corresponding company's market stock price". A positive overpricing is called "overestimation", whereas a negative overpricing corresponds to a model "underestimation". The closer the overpricing is to zero, the more accurate will be the model estimation.

Gordon considers, in his model, dividends as the only cash flow stream that a company returns to its equity holders. This was probably a reasonable statement in 1962 (when the model was created), because firms were not relying on additional ways to return cash to shareholders (Fama and French, 2001; Skinner, 2008). But, is it really the case nowadays? Fama and French (2001) showed that since 1978, dividend payments started to decrease, and in 1999, there were only 20.8% of US companies distributing dividends. While Skinner (2008) presented an evolving relation between dividend payments and stock repurchase activities, initiated in 1980.

Given the high dependency of the Gordon's growth model on future dividend cash flows, it would be important to investigate if, under these circumstances, the model can still be considered as a valid valuation technique for the US market. Consequently, the GGM effectiveness in valuing US stocks, will be tested by measuring the amplitude of the overpricing variable throughout a 17-year period horizon (from 2002 to 2018).

Subsequentially, it is essential to assess if the model works better for some type of firms than others, meaning, the reliability of the model across stocks. Accordingly, this paper explores the impact that seven meticulously selected variables (based on past theoretical studies and furthered explained on the methodology section) have on the overpricing variable, through a multiple linear regression analysis.

If this research identifies a specific pattern among companies where the overpricing is relatively small, the Gordon's growth model could be further perceived as a more accurate valuation technique for those particular US stocks. In addition, since the GGM is a comparatively easier model to be applied, this study can represent an incremental contribution for all investors aiming to save time and money, that is much often lost when working with more complex valuation models.

Conversely, if the Gordon's growth model does not appear to be appropriate to value a certain type of US stocks, then it might be considered of questionable use for future valuation practices on those cases.

2. Literature review

2.1 Dividend impact on firm valuation

When analyzing the impact that dividend payments have on the valuation of a given stock, one can argue that there is no consensus regarding past literature. Modigliani and Miller (1961) claim that, in an "efficient and perfect market", there should be no difference in the value of a firm that pays dividends and another that does not rely on any dividend payment. According to the authors, shareholders should be indifferent towards dividend payments, since the share price would be solely connected with the overall earnings generation capability of the company. Additionally, the authors stated that, there are enough investors with different dividend preferences, and that is the reason why they assume companies to be fairly valued, regardless of their dividend policies (*clientele effect theory*). This argument assumes that there are enough investors for every dividend segment. Thus, a firm that pays low dividends (or does not pay at all) should not be penalized for doing so, because its investors do not value dividends. Conversely, a firm that pays high dividends should not be overvalued simply because its investors like dividend payments. Later, Higgins (1972) strengthen M&M position, arguing that investors can create "home-made dividends" by buying additional stock, if dividend payments are over investor's expectations, or by selling stock if the dividend stream is considered to be below the desired levels. In other words, investors are able to replicate their own "optimal cash flow stream".

Yet, in the meantime, several studies were built to prove dividend impact on stock valuation, arguing that, under imperfect market conditions (as the ones we live in), the assumptions outlined by M&M do not hold. Lintner (1962) and Gordon (1963) were the first to claim that investors have a preference for dividends instead of capital gains. Both authors argue that, due to investors' general risk aversion, they prefer a certain dividend payment today than having to wait for a possible capital gain somewhere in the future. Meaning, investors prefer to have an expectable and constant stream of cash throughout the periods (dividends), than to wait for a potentially higher cash stream (capital gains) that is highly dependent on the company's management decisions (*bird-in-hand theory*). Jensen and Meckling (1976) corroborates Gordon's and Lintner's view on dividends preferences, by refuting M&M proposition that assumes managers as perfect agents aiming to maximize shareholders' value. According to them, there are possible conflicts of interest between a firm's managers and its shareholders (agency costs), arriving from the firsts' decisions. Jensen and Meckling (1976) argue that managers do not always act on behalf of shareholders, because of a potential misalignment between the firm's control and ownership incentives.

Moreover, Bhattacharya (1979), John and Williams (1985) and Miller and Rock (1985) studies discovered that investors perceived the firm's dividend policy as a signaling of its earnings prospects. According to the authors, the firm's management team is perceived as an insider and accordingly, investors believe they possess more reliable information on the firm's future prospects than themselves. By being aware of such information asymmetry, investors trust that high dividend payments or high dividend growths reflect managers' positive prospects on the future activities of the firm, and vice versa. Subsequently, several authors focused their studies on trying to empirically prove this relation between dividend payments and stock price. Shiller

(1981) and LeRoy and Porter (1981) are two examples of those studies that investigated how changes in dividend payments or policies, might explain observed changes in the asset prices.

2.2 Different approaches to the dividend discount model

According to Damodaran (2007), there are four existing methods to perform a valuation. The first, discounted cash flow (DCF), values an asset by discounting future cash flows to the present value. The second, relative valuation, consists in valuing an asset through relative comparison with another firm's variable such as sales, book values, earnings or cash flows. The third one, contingent claim valuation, utilizes option pricing models to assess the value of assets with similar option characteristics. The final method, accounting valuation, access the value of an asset through accounting estimates of book value.

When performing a valuation through the DCF method, stocks can either be valued by the firm's expected profitability (earnings or cash flows) or through the expected distribution of those profits to shareholders (dividends), (Hurley and Johnson, 1994). Williams (1938) settled the dividend discount model (DDM), a first application of the DCF method used to discount future dividend payments. According to the author, the intrinsic value of a stock should equal the future dividend payments to its equity holders.

After this initial approach, several deviations were designed in order to simplify the model and make it more practical. Gordon (1962) designed a one-stage model, where he assumes a single perpetual and constant growth rate to discount all future dividend payments. The Gordon's growth model (GGM) is seen as a simplistic adaptation of the DDM that, according to Bulan and Subramanian (2009), deliver better results for more matured firms that continuously rely on dividend payments as a way of distributing cash to its equity holders. Damodaran (1999) proposes the two-stage DDM alternative, where future dividend payments are divided into two different subset-groups, given their growth pace. A first stage/period where dividends are assumed to grow at a higher rate until it achieves a "steady growth stage", and a subsequent phase where dividends grow at a lower stabilized rate, in perpetuity.

Similarly, to the two-stage model, Cornell (1999) suggests a three-stage version of the DDM, where the author includes a transition period, in which the growth rate declines linearly to a lower, stable growth, which is then maintained forever. Both the two and three stage-models allow for a better control of the time variable. Not all firms have already achieved a steady growth stage of their life cycle, and according to Mueller (1972), this is a crucial subject to determine the optimal dividend policy of a company.

2.3 Previous applications of the Gordon's growth model

The Gordon's growth model accuracy on predicting stock prices have been tested throughout the years for a number of stock exchanges, some specific sectors/industries, or for a given listed company. Sapp and Foerster (2005) compared the market stock price of a single firm, the Bank of Montreal, with the stock price computed thorough some of the most known DCF techniques, the DDM and GGM (based on dividend cash flows), as well as a Fed model (based on stocks' earnings). The authors found that the accuracy of both DDM and GGM was consistently superior to the Fed's model, when predicting the Bank of Montreal market stock price for a 119-year range period (1885-2003). Despite several fluctuations of the GGM overpricing across the analyzed period, Sapp and Foerster (2005) results show a "reasonable" performance of the Gordon's growth model, when compared to other valuation models that were also studied. Bujang and Nassir (2007) tested the Gordon's growth model accuracy across some selected stocks from the Bursa Malaysia Stock Exchange. The authors described the model as a relevant valuation tool for the Malaysian stock market, that could yet be dependent on the country's economic cycle in order to achieve more accurate predictions.

Conversely, researches conducted on the Nairobi Stock Exchange (Olweny and Shipho, 2011; Aduda and Kimathi, 2011) reveal a lack of efficiency of the Gordon's growth model on predicting the market stock price of those firms. Olweny and Shipho (2011) studies concluded that the GGM was not a reliable valuation technique for neither of the eighteen analyzed common stocks of the Nairobi Stock Exchange. Whereas, Aduda and Kimathi (2011) determined a non-existent relationship between the market stock price and the GGM stock price for a sample of eighteen companies traded on the Nairobi Stock Exchange. Throughout the 7-year period analyzed (2002-2008), overpricing results were extremely diverse, and no relationship was verified between the dividend per share amounts and the collected market stock price, on those years.

Gordon's growth model accuracy was also tested on the Ghana Stock Exchange. Acheampong and Agalega (2013) observed a considerable difference between the actual market stock price and the GGM stock price from the selected companies of the Ghana Stock Exchange. For the five years analyzed (2006-2010), there was an underestimation tendency of the Gordon's growth model stock price. Only in 2010, the result observed was different, with the GGM price surpassing the corresponding market stock price. The model was also tested on the Bombay Stock Exchange (BSE). Charumati and Suraj (2014) studied the accuracy of several valuation methods on a selected sample of 14 banks that constituted the BSE Bankex index. Results showed that the GGM model should not be relied on by investors, when trying to predict the real value of BSE's banks, due to market inefficiencies, information differentials and measurement problems that were found.

Ivanovski, Ivanovska and Narasanov (2015) studied the accuracy of the GGM, between 2006 and 2011, for two specific industries (Banking and Pharmaceutical) of the Macedonian Stock Exchange (MSE). The authors characterized the GGM as a reliable valuation model for the MSE's banks. According to them, the computed price was considerably close to the corresponding market stock price in every occasion, except for the period of the MSE's "boom". On the contrary, the model was not accurate on estimating the market stock price of pharmaceutical companies. Significant deviations between the market stock price and the GGM price were observed, with an extensive underestimation tendency of the GGM predictions.

Even though the GGM accuracy was tested for several markets, there is no empirical evidence of the Gordon's growth model (GGM) accuracy among US stocks. This research aims to test that same relationship but for a bigger market (US stock market), with a larger and broader stocks' sample.

2.4 The rising of alternative ways to distribute cash to shareholders

In the beginning of the twenty-first century, several economists started to be concern about the possible "disappearing of dividend payments" as a way of distributing cash to the company's shareholders (Fama and French, 2001).

Skinner study (2008) proved that share repurchases is already "the dominant form of payout" for equity holders. The author shows that companies who merely rely on dividend payments, as a way of returning cash to shareholders, are mostly extinct, and firms which often rely on both dividend and buyback payments, are shifting towards the second form of payment. Explanations for this rise in repurchases have included: tax efficiency (Farrar and Selwyn, 1967; Brennan, 1971), flexibility (Guay and Harford, 2000; Jagannathan, Stephens, and Weisbach, 2000), lack of dividend protection on executive options (Fenn and Liang, 2001), and funding of employee stock option exercises (Kahle, 2002).

Recent studies show that times are changing and, in the meantime, the media and politicians are exposing their concerns on the magnitude of corporate payouts, driven by substantial increases of stock repurchases. Senator Marco Rubio complained that “Wall Street promotes stock buybacks, temporarily increasing the companies’ stock prices at the expense of prolific investments” and recommends taxing share repurchases (CNN Business, 2019). Senators Chuck Schumer and Bernie Sanders corroborates Rubio’s complains and suggest a quantified restriction on stock repurchases, since they see repurchases as a form of “corporate self-indulgence”. According to both Senators, “Rather than investing in ways to make their businesses more resilient or their workers more productive, companies have been dedicating ever-larger shares of their profits to dividends and corporate share repurchases.” (The New York Times, 2019). Also, academics expressed their concerns on how this mentioned growth of repurchases has contributed to a decrease in capital expenditures among firms (Almeida, Fos, and Kronlund, 2016; Gutiérrez and Philippon, 2017).

While repurchases have indeed snowballed over the past decades, several authors have pointed an increasing impact of mergers and acquisitions activities as an additional way of distributing cash to shareholders (Bagwell and Shoven, 1989; Ackert and Smith, 1993; Mehra, 1998). The authors claim that, after an M&A activity, the share value of the acquiring firm tend to capitalize the new investment with a consequential increase in its stock valuation, offering existing shareholders the possibility to cash-out their initial investment and generate a subsequent return flow.

Given the rising of these alternative cash flow streams to equity holders, it would be interesting and also recommendable, to test the validity of the Gordon’s growth model in a more recent period, and that is the main proposition of this empirical research. Despite being a valuation model extremely dependent on dividend flows to shareholders, the GGM is still being used by analysts and investors worldwide, as a tool for correctly valuing a stock, and consequentially engage in investment decisions. However, recent studies have suggested that this may no longer be the case.

3. Data and methodology

The data and methodology section are divided into two parts. The first part will describe the procedures and rationale used to develop the variables needed for the determination of the Gordon's growth model stock price (P^{model}) and consequentially, the overpricing variable. Whereas, on the second part, it will be explained the rationale behind all independent variables of the multiple linear regression (MLR) used to explain the observed differences in prices.

3.1 GGM stock price and overpricing computation

The research study was narrowed to US common stocks included on the CRSP/Compustat annual database, that were traded on the NYSE, Amex and Nasdaq (Stock exchange codes: 11, 12 and 14 respectively), from the year 2002 to 2018 (17-year period horizon). Furthermore, only stocks traded in US dollars were considered for research purposes, excluding stocks that were traded in Canadian dollars in order to avoid possible effects of currencies' appreciation/depreciation over time. All data collected and variables needed for the computation of the annual GGM stock price and the annual market stock price, will be further explained.

For the GGM stock price computation, three different variables had to be considered: the actual dividend per share, the forecasted growth rate, and the cost of equity used to discount the cash flows.

$$P_t{}^{model} = \frac{DPS_t * (1 + g)}{k_e - g}$$

The annual dividend per share variable (DPS) extracted from CRSP/Compustat Merged database is expressed in US dollars amounts, and corresponds to the total dividend amount received by a company's equity holder, on a specific year. So, a shareholder that possesses one share of the company, would be entitled to receive the mentioned dividend payment (DPS).

Given the unquestionable dependence of the Gordon's growth model on the initial DPS payment (DPS_0), in order to calculate the corresponding stock price at the same point in time (t), all stocks that displayed incompatible data with the model proposed were discharged. Meaning, firms that presented missing values of the DPS (blank DPS cells), or did not engage in any dividend payment (DPS = 0), were excluded from the final sample of that specific period.

Nevertheless, a company that was not considered for test on a given period because any DPS payment was observed, can still be considered for the following periods, if the above condition is met. Consequentially, the yearly sample will end up being different throughout the 17-year period, due to these initial criteria set.

As for the growth rate variable (g), IBES annual database was used to extract analysts' forecast on future DPS payments, and the correspondence with the actual DPS values were ensured through the exchange ticker symbol, first 6-digit CUSIP number and year variables' matches. Analysts' forecasts were then utilized to calculate the expected growth rate for each identified period (t).

$$g_t = \frac{DPS\ Analyst\ Forecast_{t+1} - \ DPS_t}{DPS_t}$$

Such method is also used by other researchers (Sorensen & Williamson, 1985), bracing the assumption that, analysts' forecasts on future DPS payments, are perceived as a good proxy of investors' future expectations on those respective cash flows. Accordingly, if the actual yearly cash flow is expected to increase on the subsequent period (t+1), investors will tend to adapt their stock valuation according to it, and the stock price will most likely rise over that period (t), and vice versa.

Finally, the cost of equity (k_e) was driven from the very well-known CAPM model. According to Damodaran (2012), the CAPM model has been recognized as a standard and reliable technique for cost of equity calculations. The CAPM determines the risk level of a specific company considering its sensitivity to the stock market. It does so by taking into account the risk-free rate (rf); the market risk premium (MRP), that represents the difference between the return of the market and the risk-free investment return; and the risk of a particular company when compared to the average company's risk (B_i).

$$CAPM\colon\ Ke = rf + B * (MRP)$$

In order to obtain the annual rf value, the monthly rates extracted from the Kenneth French data library corresponding to the one-month Treasury bill rate, were annualized. As for the yearly company Beta, it was considered the value observed on the last trading day of each year, that was obtained from the Beta Suite WRDS database, following a 252 trading days estimation window. Lastly, the market risk premium corresponds to the implied annual MRP for the US equity market, that was drawn from the Damodaran's annual database.

Additionally, in order to ensure the applicability of the model, it was imperative to certify that the cost of equity was higher than the growth rate (ke > g), for every period being analyzed. After meeting these required criteria, it was possible to attain a final sample with 3,572 different observations.

Regarding the market stock price variable, the annual closing price from the CRSP/Compustat Merged database was adjusted for stock splits (price adjustment factor) and considered to be the P_t^{market}. Meaning, the annual market stock price (P_t^{market}) utilized, corresponds to the result drove from the ratio between the annual Price variable (P) and the corresponding Cumulative Factor to Adjust Price (CFAP).

The overpricing variable was subsequentially computed by dividing the difference in two prices ($P_t^{model} - P_t^{market}$) and the market stock price (P_t^{market}). Consequently, the values will be expressed as a percentual deviation from the market stock price.

$$Overpricing_t = \frac{P_t^{model} - P_t^{market}}{P_t^{market}}$$

Finally, in order to exclude some extreme values that could be distorting the final results, overpricing values were winsorized at 1 (left side) and 99 (right side) percentile levels. This is considered to be a standard procedure which ensures that, further analyzed results, will not be biased by spurious outliers. Furthermore, results will be divided into three different time frames: the period before the subprime crisis (2002-2006), the crisis period (2007-2010) and the period after (2011-2018). The time frame was determined according to US GDP annual growth rates. The crisis horizon (2007-2010) corresponds to 2008 and 2009, where the US GDP annual growth rate revealed negative values (-0.137% and -2.537% respectively) typical from a recession period, plus one year before (2007) and one year after (2010) the described horizon, in order to capture both leading and lagging crisis' effects. Those figures (Annual % GDP growth – US) were extracted from the World Bank national accounts data, and corroborated through the OECD national accounts data files.

The objective is to analyze possible differences on the performance of the model being tested, that were driven by the subprime crisis, as well as to safeguard that precedent and subsequent results were not being distorted by results observed during the crisis.

3.2 Multiple linear regression variables - selection process

For the multiple regression test, the initial sample size of 3,572 observations was reduced by 70 units summing a total of 3,502 observations, due to the non-existence of values from 26 different companies on the CRSP/Compustat Merged database. Additionally, as mentioned before, the final sample will only include US common stocks traded on the NYSE, Amex and Nasdaq (Stock exchange codes: 11, 12 and 14 respectively) in US dollars amounts, from the year 2002 to 2018 (17-year period horizon).

The primary purpose of the regression is to identify any specific pattern regarding: stock characteristics, dividend payments, industry in which it operates, and others, that could better explain the price deviation that was observed through the overpricing variable. It would certainly be important to understand if the model works better for some type of firms than others. Consequentially, the second part of the study will explore the impact that several selected variables (based on past literature) have on the observed overpricing (dependent variable), through the analysis of a multiple linear regression (MLR).

Seven independent variables were developed and divided into four control variables: Log (Sales), Debt/Assets, Net Income/Sales and Stock's Industry, plus three explanatory variables: DPS/EPS (dividend payout ratio), DPS/P (dividend yield) and Share Repurchases.

$$Overpricing = \alpha + B_1 * Log(Sales) + B_2 * \frac{Debt}{Assets} + B_3 * \frac{Net\ Income}{Sales} + B_4 * Energy + B_5 * Materials + B_6 * Industrials + B_7 * C.Discret. + B_8 * C.Staples + B_9 * Health\ Care + B_{10} * Financials + B_{11} * Inf.Tech. + B_{12} * Com.Services + B_{13} * Utilities + B_{14} * \frac{DPS}{EPS} + B_{15} * \frac{DPS}{P} + B_{16} * Share\ Repurchases + \varepsilon$$

A correlation matrix was built in order to guarantee the non-existence of multicollinearity relationships within independent variables, as well as between independent variables and the dependent one. No multicollinearity was verified (Evidence on Appendix C.1), and the highest correlation coefficient of 0.32 was observed between the Debt/Assets and the Financial sector variables.

Log (Sales): This item represents gross sales, reduced by cash discounts, trade discounts, and returned sales. The logarithmic scale was applied due to the high variation of the Sales values, and will enable a clearer analysis of the selected variable. Other researchers commonly use the Log (Sales) as an appropriate control variable of the firms' size. According to Dang, Li, and Yang (2018) empirical studies, the Log (Sales) is among one of the most used proxies for company's size, and it is considered to be a robust and significant measure.

Debt/Assets: The total debt to total assets ratio, represents the percentage of a firm's total debt in comparison to its total assets' value. Debt level is often used as a financial risk measure. High leverage means that principal and interest payments will be reflected on a company's cash flow statement, and have a direct impact on the firm's financial performance. Fosberg and Ghosh (2006), use Debt/Assets as a capital structure proxy for US companies traded on the Amex and NYSE, when testing the relationship between a firm's capital structure and its profitability levels.

Net Income/Sales: The Net Income over Sales ratio measures the profitability level of a given firm. Profitability can influence the dividends' amount a firm can distribute to its shareholders, and may influence the overall Gordon's growth model performance. Consequentially, it is essential to create a variable (NI/Sales) capable of controlling the impact that different profitability levels might produce on the model stock price predictions.

Stock's Industry: Several studies including Michel (1979), Baker and Powell (1999) and Baker and Powell (2000) suggest that the industry in which a company operates, affects its dividend policy, and might generate a direct impact on a company's stock price. Accordingly, the Global Industry Classification Standard (GICS) MSCI Structure, was used to divide stocks into their corresponding sectors (first two GICS's digits – eleven sectors). Ten dummies were created, being the eleventh (Real Estate) the omitted one. The Global Industry Classification Standard is considered to be the primary classifier of a firm's industry. Weiner studies (2005) classified the GICS scheme as being more reliable than the Standard Industrial Classification (SIC) code, since fewer firms were changing its GICS's code throughout the time. Additionally, Hrazdil and Zhang (2012), found that GICS-based measures presented a better proxy of the actual industry concentration, when compared to SICS-based measures.

DPS/EPS: The dividend payout ratio measures the percentage of earnings per share that is being used to distribute dividends to a company's equity holders. The ratio may reflect the importance that current shareholders give to dividend payments, in detriment to the firm's future investments. Since the overpricing variable represents a difference between the price of a model based on future dividend cash flows and the market stock price, the DPS/EPS ratio might indicate how the model accuracy varies between firms with different payout policies.

DPS/P: The dividend yield represents the one-year dividend return on a stock investment. In other words, the ratio measures the percentage of dividend per share payments, in proportion to the price per share. The purpose is to analyze if a relationship between the dividend yield of a firm and the model predictions exist. Meaning, if firms with high dividend yields prove a more accurate estimation or vice-versa.

Share Repurchases: This item represents the purchases of common and preferred stock (CRSP/Compustat Merged database), that according to Kahle, Dyl and Banyi study on measuring share repurchases (2005), is the most accurate measure available regarding a firms' actual repurchases amount. For the purpose, a dummy variable was created. The value 1 was attributed to firms that engaged on annual repurchases (share repurchases > 0 US dollars; 2,205 observations), and 0 to firms that did not verify any share repurchase activity throughout the entire year (share repurchases = 0 US dollars; 1,297 observations). According to several researchers (Jagannathan, Stephens and Weisbach, 2000; Skinner, 2008) and politics (Rubio, 2019; Schumer and Sanders, 2019), share repurchase activities have been denoting a substantial growth in recent years, and this is one of the variables capable of influencing the Gordon's growth model price predictions (which only takes dividend cash flows into account when valuing a stock).

4. Overpricing analysis

4.1 Descriptive statistics

Table 1
Overpricing analysis, over a three-period range division (% values)

	2002-2006	**2007-2010**	**2011-2018**
Mean	206.00	95.50	135.33
Standard Error	25.63	12.52	13.28
Median	-8.65	-19.10	-25.11
Standard Dev	736.14	361.20	581.21
Sample Variance	5 418.98	1 304.64	3 378.03

Kurtosis	24.70	22.83	30.26
Skewness	4.78	4.41	5.23
MIN	-98.02	-96.88	-97.94
MAX	4 954.65	2 438.67	4 232.05
Count Observations	825	832	1 915

Descriptive statistics on the Overpricing variable, divided into three different periods: pre-crisis (2002-2006), crisis (2007-2010) and post-crisis (2011-2018). The mean, St. Error, median, St. Dev., Sample variance and min/max values are represented as percentage values.

Table 1 provides the overpricing analysis among three different range periods. The first period defined from 2002 to 2006 (pre subprime crisis), the second from 2007 to 2010 (subprime crisis) and the third from 2011 to 2018 (post subprime crisis) – division explained on the "data and methodology" section 3.1. The main purpose was to identify potential deviations caused by the 2007-2008 subprime crisis, as well as to safeguard that precedent and subsequent results were not being distorted by the crisis' impact.

Due to the methodology applied, the yearly sample will end up being different throughout the 17-year period. For the first period range (2002-2006), the sample size account for 825 observations, for the second (2007-2010), 832 observations and 1,915 for the post-crisis period.

The average overpricing percentage during the pre-crisis period equaled 206.00%, which is higher than the average overpricing of the crisis period (95.50%), as well as the average of the post-crisis period (135.33%). Indeed, both mean and max overestimation results of the period preceding the subprime crisis, may reflect the model incapacity to predict the actual market stock price. On the contrary, it is possible to denote a lower difference between the price of the model (${P_t}^{model}$) and the market stock price (${P_t}^{market}$) during the 2007-2010 period, that is represented by the lower mean, min and max values. Such overpricing reduction was driven by the considerably lower annual values of the GGM stock price, during the crisis period (Evidence on Appendix A.1). Several companies were pressured to re-adapt their dividend payout policies to an entirely new situation, as the one verified on the 2007-2008 financial crisis.

However, when looking at the median values of all three-period ranges, the observed marks were negative (-8.65% in 2002-2006, -19.10 in 2007-2010 and -25.11 in 2011-2018). Those results may indicate that, despite the existence of some extreme positive overpricing values, where the price model tend to overshoot and completely miss the target, the majority of overpricing observations display negative percentages. The model might actually tend to undervalue the company's stock price for a greater number of cases.

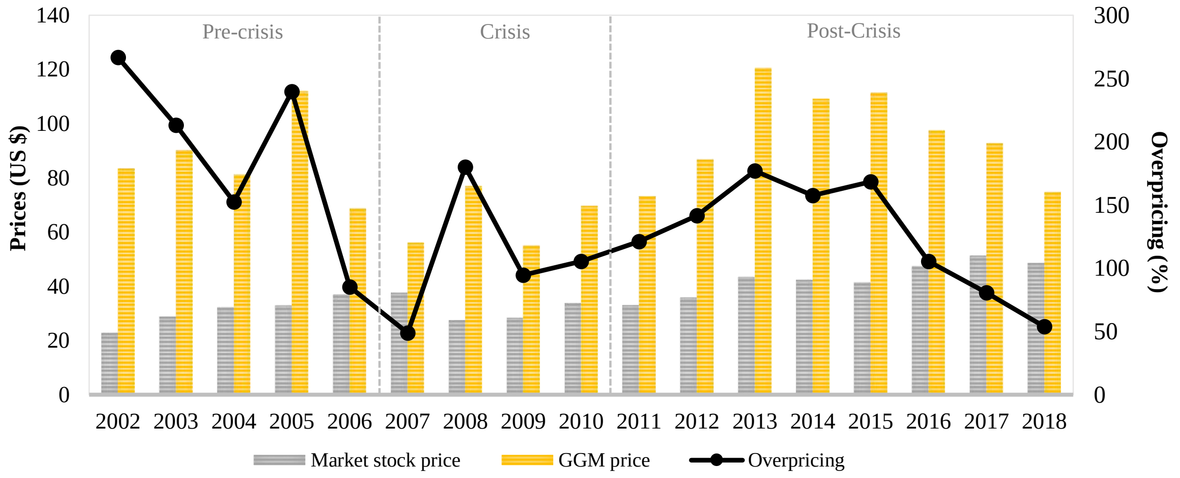
Moreover, the Kurtosis, even though positive for all sub-set periods, is considerably lower during the crisis period. The performance of the average companies dropped because of the financial crisis, decreasing the overpricing mean, and flattering the distribution, when compared to the previous and following periods.

The skewness, which indicates the level of non-symmetry over the periods observed, is higher for the post-crisis period. A value such as 5.23, indicates a more skewed distribution in the after-crisis period than in the pre-crisis or crisis periods. Nevertheless, results displayed an extended positive skewness for all three range periods analyzed. Furthermore, the standard deviation is relatively high during the pre-crisis and post-crisis periods, taking over 736.14% and 581.21% respectively. However, during the crisis, when the grand majority of the firms denoted a uniformed and generalized crash on its stock price, thus a lower discrepancy among prices, the standard deviation value fell to 361.20%.

4.2 Year-Over-Year (YOY) mean evolution

Figure 1

YOY evolution of the market stock price, GGM price and overpricing mean values



Annual evolution of the market stock price, GGM price and overpricing mean values (winsorized at 1 and 99 percentile levels). Results are displayed over a 17-year period horizon, from 2002 to 2018. The market stock price (grey bar) and GGM stock price (yellow bar) are both expressed in US dollars amounts (left y-axis reference), while the overpricing evolution is presented through the black color line and expressed in percentage terms (right y-axis reference). Note: Full results displayed in Appendix A.1.

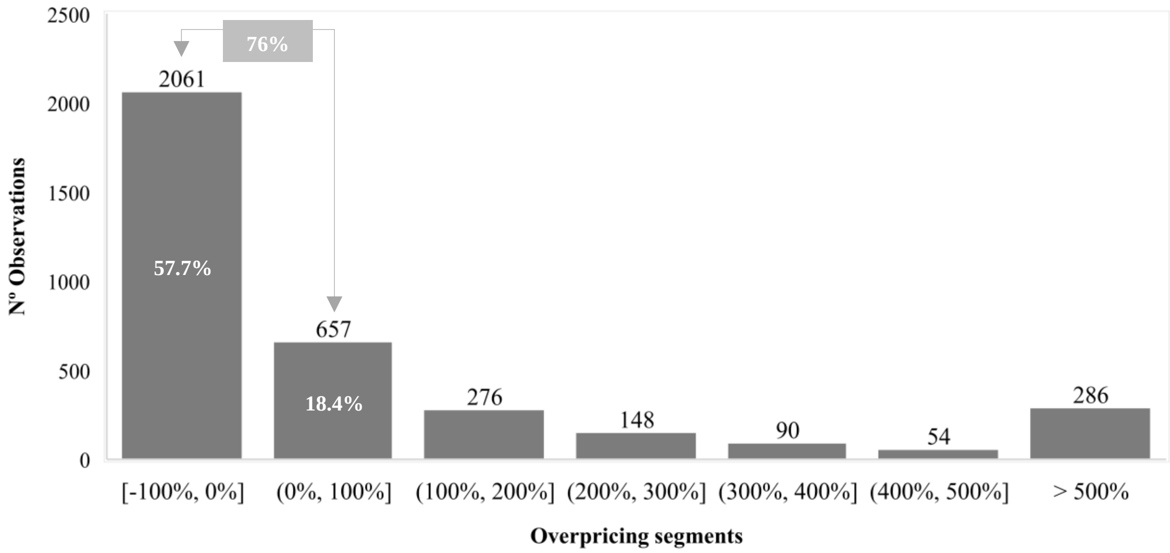
Through the analysis of Figure 1, it is possible to denote a significant decrease on the market stock price in 2008, where the latest verified its lowest value of $27.46. Such variation was somehow expected, since that period corresponds to the subprime crisis boom. However, the lower GGM price was only observed one period later in 2009. This minimum value was driven by the lowest DPS payment and a negative forecasted growth rate (Appendix A.2). After the crisis boom, analysts were predicting a substantial decrease of the dividend payments (lower g), which were verified on the following years (2009 and 2010) through the actual DPS values. Besides, it is possible to observe on Appendix A.2, that the cost of equity noticed a considerable increase on the periods preceding the crisis (2005 and 2006), indicating that US companies were starting to raise equity at a higher cost and, at the same time, equity-investors were demanding superior returns on their investments, when compared to the previous periods of 2003 or 2004. Such results revealed the cost of equity as a leading indicator, suggesting a general increase in the companies' perceived risk even before the crisis arise. Subsequently, from 2009 to 2013, a growing trend was observed (Figure 1) on both the market stock price and the GGM stock price, while in 2014 and 2015, both values stabilized. From 2016 onwards, the GGM price started to decrease, reaching in 2018 values similar to the ones observed in 2011. On the contrary, the market stock price revealed a strong growth, achieving its maximum value of $51.27 in the year 2017.

Regarding the overpricing evolution, it is possible to identify three different range periods, according to its growth curve trend. The first one until 2007, which includes the crisis period plus the year of 2007 (descending growth curve). The second from 2008 to 2015 (ascending growth curve) and the third from 2016 to 2018 (descending growth curve).

Until 2007, there was a generalized decrease of the overpricing values (exception made to the year 2005, where the model estimation completely deviates from the target price). Such reduction was reached through the cumulative effect of a continuous increase on the market stock price and, at the same time, a descendant trend of the GGM stock price. On the second period-set (2008-2015), there was a positive evolution of the curve, that was substantiated by a more robust GGM stock price growth over the market stock price. While on the third period-set (2016-2018), there was a decline of the overpricing curve, where the last 2018 value of 53.84% reflects the mix between a moderated growth of the market stock price and a significant decrease of the GGM stock price. Moreover, some studies' suggestions on the "dividends' disappearance" do not seem to be confirmed in the analyzed period. The observed DPS payments have actually experienced an increase over (2016-2018] (Evidence on Appendix A.2 – DPS rising), supporting the Gordon's growth model as a valid valuation method.

4.3 Distribution by segments

Figure 2
Overpricing distribution results, by equally-sized segments of 100 percentual points



Distribution of the 3,572 overpricing results, over seven segments. All overpricing values, from the year of 2002 until 2018, were exhibited and presented according to their deviation from the market stock price. (Example: Segment (-100%, 0%] contains all values where the price deviation was comprised between -100 % and 0% interval.

Figure 2 shows how all 3,572 overpricing results were distributed, according to the observed deviation of the price model from the actual market stock price. Those results were divided into six equally-sized segments of 100 percentual points each, plus one (> 500% segment) with the remaining observations, and the number of observations verified in every interval is displayed above the bars. A negative segment means that the GGM stock price estimation was below the corresponding market stock price ($P_{model} < P_{market}$), while a positive interval represents an overestimation of the GGM stock price when compared to the market stock price ($P_{model} > P_{market}$).

Through the analysis of Figure 2, it is possible to verify that 57.7% of the observations belong to the (-100%, 0%] interval, and 76% are comprised between (-100% and 100%]. While the remaining 23.9% of observations were overestimations above 100%.

Even though the aforementioned overpricing mean values (Figure 1 – YOY evolution) might suggest that the model tends to significantly overestimate the actual market stock price, actually more than fifty percent of the observed results represented a price underestimation (negative results). It became clear that the majority of pricing estimations were below the market stock price, which represents a surprising conclusion after a first analysis on the overpricing mean evolution.

Looking deeper into the 76% of observations comprised between [-100%, 100%] (Appendix B.1), it is possible to denote the same trend observed on the overall sample (Figure 2). Indeed, most of the values are negative and comprised between the [-100%, -50%] interval. Additionally, there are only 6% of total observations (corresponding to 7.8% on the zoomed sample) within the [-10%, 10%] range, and 12.4% (corresponding to 16.3% on the zoomed sample) comprised between [-20%, 20%]. Those results might suggest the model incapacity to estimate the actual market stock price. Furthermore, Appendix B.2 shows that the overpricing distribution is similar across the three range periods analyzed (pre-crisis, crisis and post-crisis), with the (-100%, 0%] segment accounting for 52.7% of observations on the pre-crisis period, 56.7% on the crisis, and 60.3% on the post-crisis. These results may indicate a growing underestimation pattern of the model, that became more prevalent on the post-crisis period (2011-2018), but that is verified across all analyzed periods (pre-crisis, crisis and post-crisis), regardless of the economic cycle.

The following section will be dedicated to test several stocks' characteristics that might be influencing the model accuracy. By identifying certain commonalities among stocks which performed better or worse under the Gordon's growth model, it would be possible to make a more solid assessment regarding the "type of US stocks" that should or should not be valued through this method.

5. Regression results

5.1 Coefficients and statistically significance

Table 2
Regression results

	Coefficients	**SE**	**t Stat**	**p-value**
Intercept	0,49	0,62	0,79	0,43
Log (Sales)	-0,13	0,15	-0,87	0,38
NI/Sales	1,62	0,68	2,39	0,02
D/A	-0,30	0,60	-0,50	0,61

Energy	-0,03	0,54	-0,06	0,95
Materials	-0,91	0,49	-1,84	0,07
Industrials	-0,58	0,45	-1,30	0,19
Consumer discretionary	-1,21	0,48	-2,53	0,01
Consumer staples	1,20	0,64	1,88	0,06
Health care	-0,83	0,56	-1,48	0,14
Financials	-0,71	0,42	-1,67	0,09
Information technology	-1,45	0,53	-2,75	0,01
Communication services	0,08	0,73	0,11	0,92
Utilities	2,26	0,53	4,24	0,00
DPS/P	40,94	3,86	10,59	0,00
DPS/EPS	0,00	0,01	0,05	0,96
Share repurchase	0,24	0,21	1,15	0,25

Beta coefficients, SE, t Stat and p-value values for all independent variables and interception of the regression model. All values are displayed in decimal terms, and the statically significant p-values (for a 5% significance level) are presented in a grey box. In addition, the regression output of the 3,502 observations verified a R Squared value of 8.1%, an Adjusted R Squared of 7.7%, and a statically significant F-test of 19.15.

Table 2 presents the coefficient, SE, t Stat and p-value results, observed from the multiple linear regression ran on the 3,502 observations (70 units' sample reduction explained on the "data and methodology" section 3.2). The outcome provides a look at the statically significance (t Stat and p-value) of the independent variables selected, and their corresponding impact (beta coefficient) on the overpricing.

Out of the tested variables, the profitability ratio (NI/Sales) and the dividend yield (DPS/P) were proven to be statistically significant at a 5% significance level, as well as some of the GIC Sectors (consumer discretionary, information technology and utilities).

Both consumer discretionary and information technology sectors verified negative beta coefficients of -1.21 and -1.45, respectively, which means that those stocks tend to denote a lower overpricing value, ceteris paribus. While companies within the utility sector, display a positive relationship with the dependent variable (beta coefficient of 2.26), meaning that, everything else constant, the corresponding overpricing tend to be higher for those stocks.

Also, the variable selected to control for different profitability levels (NI/Sales), denote a positive relationship with the dependent variable (beta coefficient of 1.62), which means that companies with higher profitability rates tend to present higher overpricing values. This may be related to the fact that firms with higher profitability levels, can engage into more ambitious dividend payments, leading to a possible inflation of the Gordon's growth model predictions and consequentially increase the overpricing outcome.

Regarding the explanatory variables purposed in the study (dividend payout ratio, dividend yield and share repurchase activity), only the dividend yield (DPS/P) was considered statistically significant. According to these results, neither the company's dividend payout ratio nor it repurchase activity were considered significant to explain the difference in prices observed. This is a fundamental finding because it shows that both company's payout principles (DPS/EPS) and annual share repurchase activity will not influence the accuracy of a valuation model that is purely based on discounted dividend cash flows (GGM). However, firms that engaged in share repurchase activities, do have a higher propensity to be undervalued (Evidence on Appendix C.2).

On the other hand, the dividend yield displayed a statistically significance t-test result, with a very high beta coefficient of 40.94. Such result reveals that, previously observed overestimations, might be driven by higher dividend yield companies. As shown in Table 2, one-unit increase on the firm's DPS/P ratio, lead to a substantial increase of 40.94 percentage points on the overpricing output.

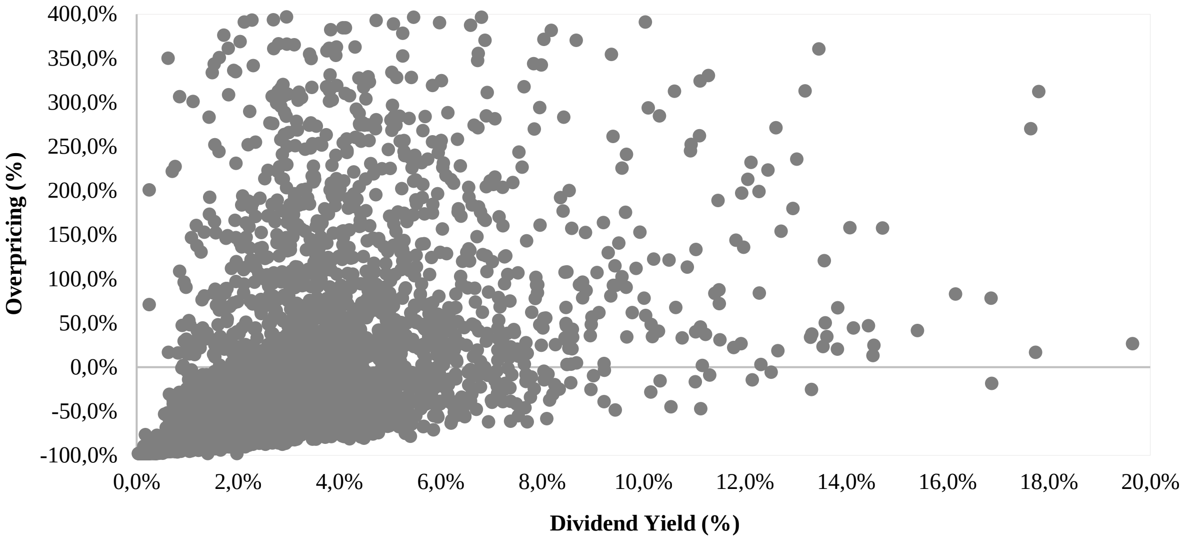
In addition, the regression output verified a R Squared value of 8.1%, an Adjusted R Squared of 7.7% and a statistically significant F-test of 19.15, meaning that the data provided sufficient evidence to conclude that the used regression model fits the data better than the one with no independent variables.

The relationship between the dependent variable (overpricing) and the independent variables considered to be statistically significant (NI/Sales, GIC Sector and Dividend Yield) will be further analyzed in the following sections. The objective is to reach a more robust result regarding US stocks' characteristics that could influence the accuracy of the model being tested.

5.2 Dividend yield

The dividend yield was the first variable analyzed, due to its higher impact on the overpricing outcome (highest beta coefficient).

Figure 3
Overpricing distribution across dividend yield levels



Overpricing observations distributed across different dividend yield levels. The y-axis expresses the overpricing results in percentual terms from -100% to 400%, while the x-axis represents the dividend yield ratios from 0% to 20%. For a better comprehension of the figure, only 90% of the overpricing results are being displayed, while the total distribution is exhibited on appendix C3, figure C3.1.

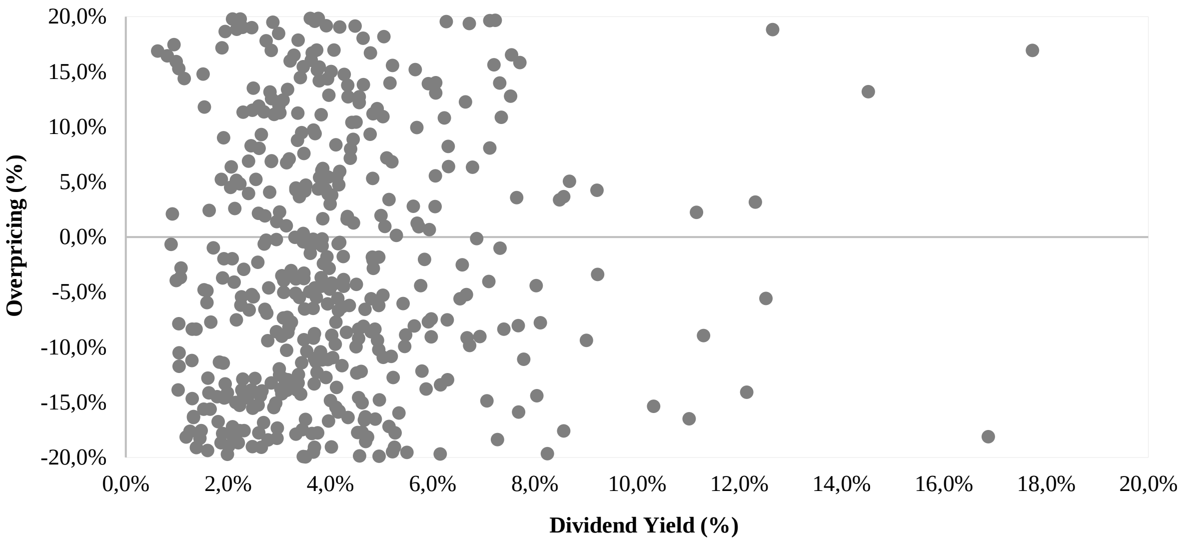
Results displayed in figure 3, illustrate a positive relationship between a company's dividend yield level and the corresponding overpricing value; an outcome that goes in line with the regression outcome. For the lowest dividend yield ratios (0% to 1%), underestimations are predominant, and the number of overestimations only start to rise afterwards. Moreover, overestimations are distributed within a very large overpricing interval, and high values are observed across almost all dividend yield levels.

Subsequentially, it will be important to look deeper on the most accurate overpricing observations, in order to understand if those tend to follow any specific pattern regarding their DPS/P ratio. For the purpose, observations comprised within the [-20%, 20%] overpricing interval will be isolated and further analyzed according to their respective dividend yield level.

Figure 4 was created with the objective of better understanding how most accurate overpricing results are distributed across different dividend yield levels. Observations comprised within the [-20%, 20%] overpricing interval represent 12.7% (or 444 observations) of the total results.

Out of this sub-sample, there were 39% overestimations against 61% underestimations, with only one observation matching the exact 0.0% overpricing value. When comparing these values with the total overpricing distribution, it is possible to verify that those, tend to follow the overall sample pattern (42% overestimations vs 58% underestimations).

Figure 4
Zoom-in on the [-20%, 20%] overpricing interval, displayed across different dividend yield levels

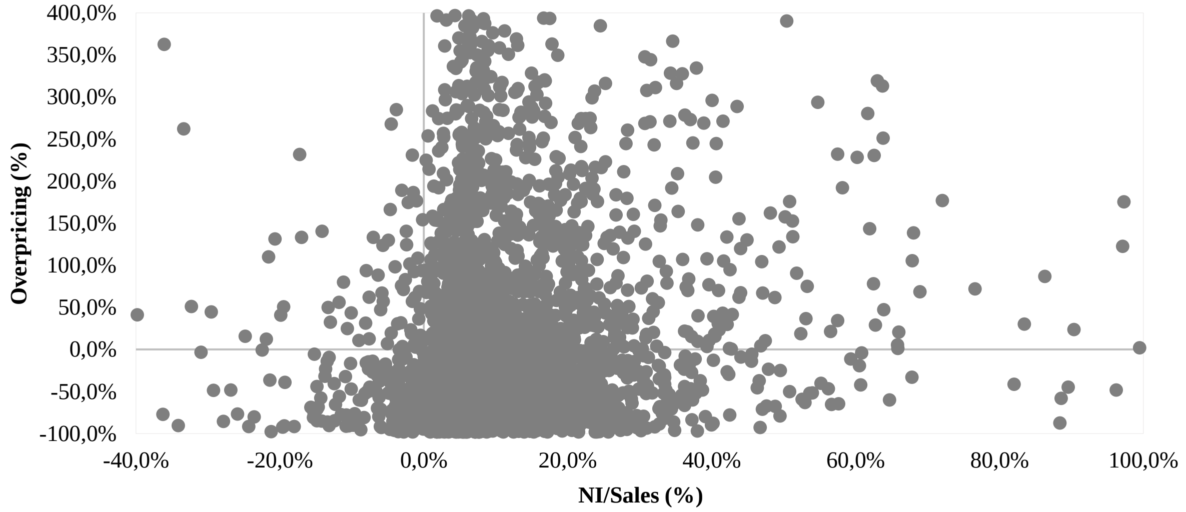


Overpricing observations comprised within the [-20%, 20%] interval. The y-axis expresses the overpricing results in percentual terms, while the x-axis represents the dividend yield ratios from 0% to 20%.

Furthermore, when looking to figure 4 results, we may argue that the dividend yield variable is not able to regulate the Gordon's growth model accuracy. Despite being the most impactful variable of the regression model (beta coefficient equal to 40.94), there is no specific dividend yield interval that ensures a more accurate overpricing outcome. Overpricing values are displayed across several different dividend yield ratios, and do not seem to follow any explicit pattern.

5.3 Profitability

Figure 5
Overpricing distribution across profitability levels

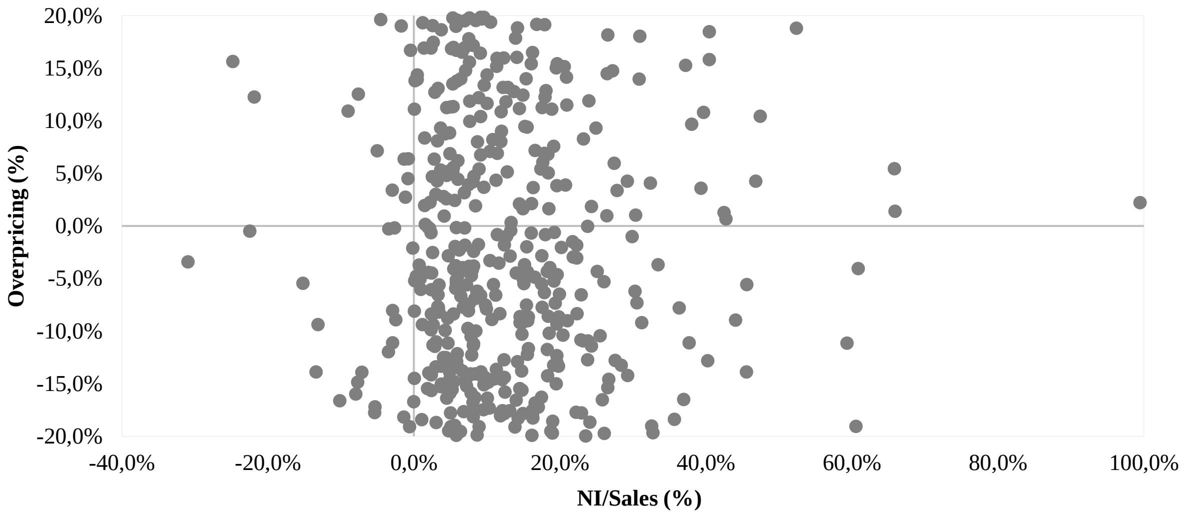


Overpricing observations distributed across different profitability levels. The y-axis expresses the overpricing results in percentual terms from -100% to 400%, while the x-axis represents the NI/Sales ratios from -40% to 100%. For a better comprehension of the figure, only 90% of the overpricing results are being displayed, while the total distribution is exhibited on appendix C3, figure C3.2.

Figure 5 shows the distribution of the overpricing variable across different stocks' profitability levels. Observations tend to follow an upward movement approximately until the 10/15% profitability level, followed by a downward trend from thereon. Moreover, despite being mainly predominant on the [0%, 40%] profitability interval, high overestimation values, are also observed across all other profitability levels.

Following the same approach as before, most accurate overpricing results will be examined across different profitability ratios. The objective is to realize if those observations tend to follow any specific pattern regarding their NI/Sales ratio. Accordingly, observations comprised within the [-20%, 20%] overpricing interval will be isolated and further analyzed according to their respective profitability level.

Figure 6
Zoom-in on the [-20%, 20%] overpricing interval, displayed across different profitability levels



Overpricing observations comprised within the [-20%, 20%] interval. The y-axis expresses the overpricing results in percentual terms, while the x-axis represents the profitability ratios from -40% to 100%.

Figure 6 shows how the 444 most accurate overpricing observations are distributed across different profitability levels. Those observations comprised within the [-20%, 20%] overpricing interval represent 12.7% of the total results, and most accurate results tend to follow the same overestimation/underestimation pattern as the overall sample (39/61% vs 42/58%, respectively).

When analyzing figure 6 results, the same outcome is observed. The variable being tested (NI/Sales), does not regulate Gordon's growth model accuracy. Meaning, there is no particular profitability interval capable of ensuring a more accurate overpricing outcome.

Overpricing values are distributed across several different profitability ratios, and do not seem to follow any explicit pattern.

5.4 GIC Sector

Overpricing results were also analyzed across statistically significant GIC Sectors (information technology, consumer discretionary and utility sectors). Figure 7 presents the overpricing distribution among information technology stocks (238 observations), Figure 8 displays results for the consumer discretionary stocks (356 observations), while Figure 9 exhibits results for the utility stocks (319 observations).

Figure 7
Information technology stocks – overpricing observations

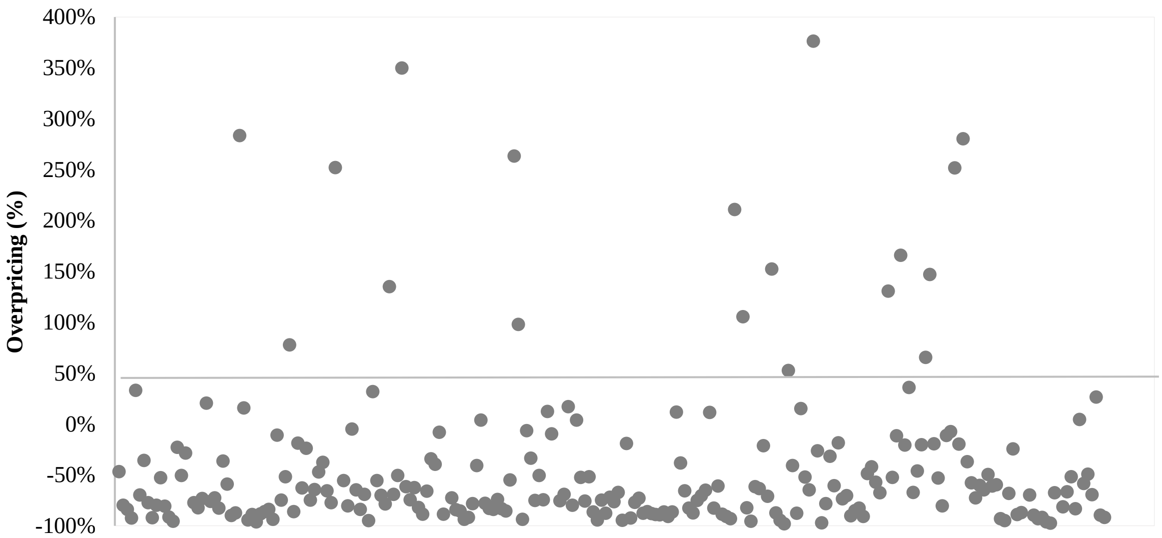


Figure 8
Consumer discretionary stocks – overpricing observations

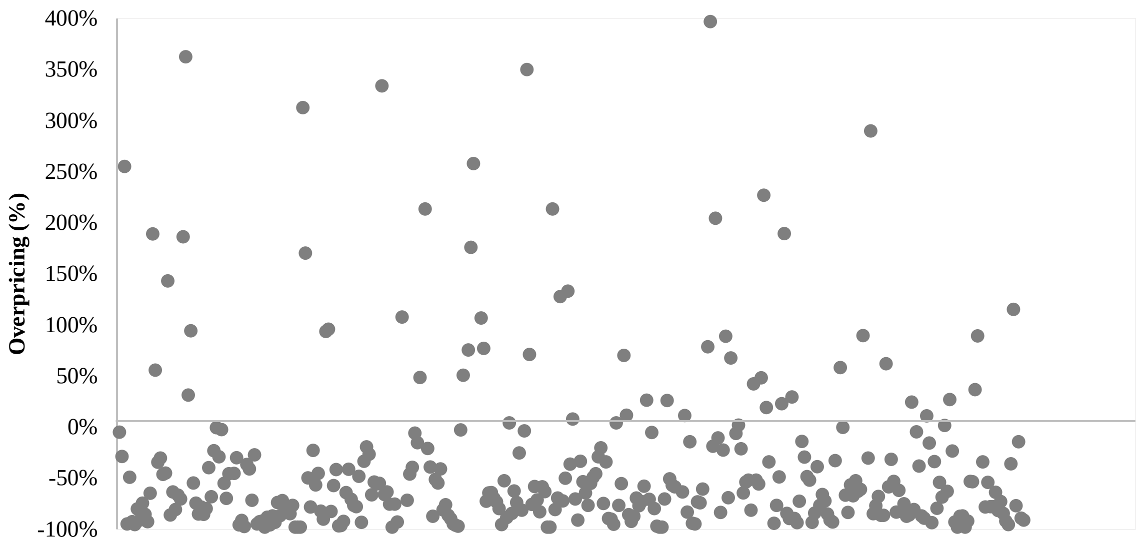
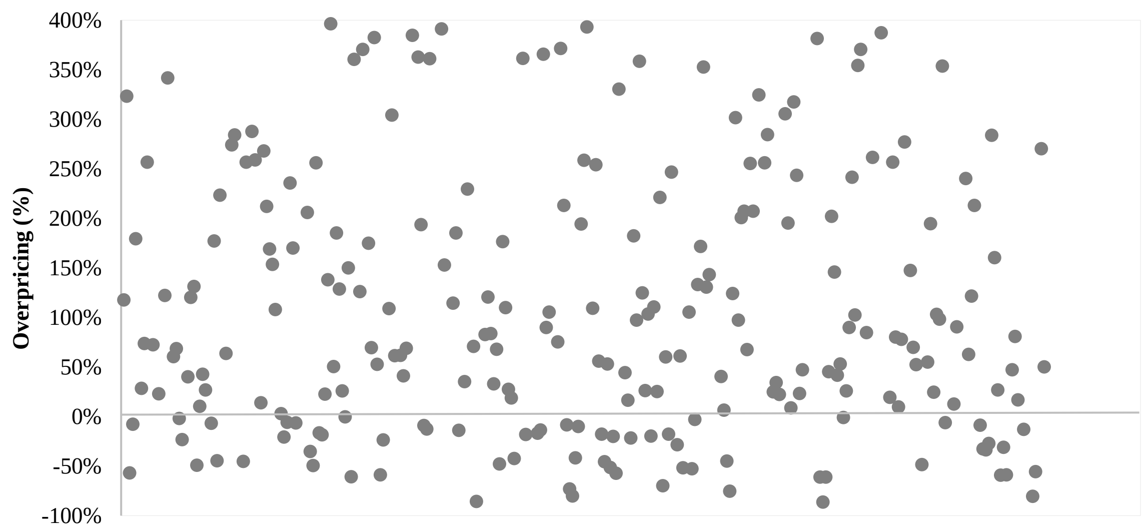


Figure 9
Utility stocks – overpricing observations



Overpricing observations across different significant GIC Sectors. Figure 7 – information technology stocks; Figure 8 – consumer discretionary stocks; Figure 9 – utility stocks. There is only one axis (y-axis) representing overpricing results (in percentual terms), from -100% to 400% deviation.

Overpricing distribution for the information technology and consumer discretionary sectors displays similar results. On both cases, a generalized underestimation tendency between [-50%, -100%] is observed (67% of the observations on the information technology sector and 60% on the consumer discretionary sector, Evidence on Appendix C.4). In addition, there are only sporadic overestimations, particularly for the information technology stocks.

On the contrary, when looking at the overpricing distribution across utility stocks, a completely different result was observed. US utility stocks did not denote any underestimation propensity. In fact, overestimations accounted for 80% of the total observations (Evidence on Appendix C.4). Results were widely dispersed among all positive overpricing segments, and there was no specific pattern regarding their value distribution. Accordingly, results displayed in Figure 9, suggest that the GGM is a valuation model that tend to significantly overvalue US utility stocks.

Furthermore, when these three statistically significant GIC Sectors are compared with all other sectors, some similarities are denoted.

Table 3
GGM variables and overpricing analysis, across GIC Sectors

GIC Sector	% Observations within [-20%, +20%]	Under-estimations (%)	Over-estimations (%)	Mean DPS ($)	Mean g (%)	Mean Ke (%)	ke-g (%)
Com. services	16,3%	61%	39%	1,27	0,4%	6,5%	6,2%
C. discretionary	7,6%	81%	19%	0,88	0,7%	7,2%	6,5%
C. staples	13,6%	53%	47%	1,21	0,9%	4,8%	3,9%
Energy	11,8%	60%	40%	1,68	-0,3%	5,6%	5,9%
Financials	16%	51%	49%	1,01	0,7%	5,3%	4,6%
Health care	7%	70%	30%	1,04	-0,1%	5,1%	5,3%
Industrials	12,7%	71%	29%	0,98	1,3%	6,5%	5,2%
Inf. technology	9,2%	83%	17%	0,79	1,3%	9,1%	7,9%
Materials	9,6%	74%	26%	0,96	0,6%	6,4%	5,8%
Real estate	18%	36%	64%	1,76	0,7%	5,1%	4,4%
Utilities	11,3%	20%	80%	1,45	0,6%	3,4%	2,8%
Average	12,1%	60%	40%	1,15	0,7%	5,9%	5,3%

Table 3 presents the overpricing tendency (Underestimations vs Overestimations) and accuracy ([-20%, +20%] overpricing interval) across GIC Sectors, as well as the mean values of the variables used to compute the GGM price (DPS, g and ke). All variables are expressed in percentage terms (%), except for the mean DPS that is expressed in US dollar amounts ($).

Utility and real estate were the only sectors exhibiting a clear GGM overestimation propensity, although for different reasons. Utility stocks because of its lowest cost of equity mean (3.4%, against an average ke of 5.9%). On average, utility companies raise equity at a lower cost, when compared with companies operating in different sectors.

Whereas real estate stocks verified the highest DPS payment mean (1.76, against an average DPS of 1.15) meaning that, on average, real estate companies tend to engage in superior dividend payments, when compared with companies from other GIC Sectors.

Moreover, financial and consumer staple's stocks were the ones that evidenced a more balanced overestimations/underestimations ratio (51/49% and 53/47%, respectively). However, this equilibrium is not substantially translated into more accurate overpricing results (Evidence on Table 3, [-20%, +20%] column).

For all other sectors, a strong underestimation tendency is denoted. Both consumer discretionary and information technology (two significant GIC Sectors) proved to be the most underestimated sectors (but not the most accurate ones), especially due to lower DPS payments and higher ke rates.

In general, the model's lack of accuracy was corroborated across different GIC Sectors. There was no particular GIC Sector more susceptible to be accurately priced, according to the Gordon's growth model valuation method. As a matter of fact, the percentage of observations comprised within the [-20%, +20%] most accurate overpricing interval, represent a minority in relation to the total number of observations (minimum: 7%; maximum: 18%; and an average value of 12.1%).

6. Conclusion

Even though the Gordon's growth model accuracy was tested for several markets, including the Ghana SE, Nairobi SE, Bombay SE and Macedonian SE, there is no empirical evidence of the Gordon's growth model accuracy in predicting US stock prices. This research tested the model accuracy on a broader and larger stocks' sample (NYSE, Amex and Nasdaq).

This study showed that the average DPS payments have actually increased 70% throughout the analyzed period (from $0.91 in 2002 to $1.55 in 2018), contradicting Fama and French (2001) "dividends disappearing" prediction in the 21st century. However, it would be important to further explore if this increase is being pushed by the DPS payments rise in some particular US companies, or if otherwise, this DPS payments increase is a common trend throughout the US stock market.

Regarding the overpricing test, a systematic and growing GGM underestimation tendency was denoted across different economic cycles (pre-crisis, crisis and post-crisis periods). More than half of the overpricing results were comprised within the [-100%, 0%] negative segment, in all three period-range settled. Representing 52.6% of the total pre subprime crisis observations, 56.7% of the subprime crisis observations, and 60.3% of the post subprime crisis observations. Overall results (including all three periods' observations) followed the same pattern, 58% underestimations against 42% overestimations, with 8% of the total observations being considerably high overestimations superior to 500%.

Nevertheless, it is crucial to denote that this research assumes the CAPM model in order to compute the cost of equity (ke), and analysts' forecasts on future DPS payments to compute the DPS growth rate (g), which might represent a potential limitation. In addition, it would be important to test the Gordon's growth model sensitivity under different ke and g calculation techniques.

The multiple linear regression applied, denoted that the dividend yield ratio, the profitability level and some GIC Sectors (information technology, consumer discretionary and utilities) were considered statistically significant variables. Share repurchases and dividend payout ratios did not prove to be significant variables. Although firms that engage in share repurchase activities do have a higher propensity to be undervalued according to the Gordon's growth model.

Besides, neither the dividend yield nor profitability level were able to control Gordon's growth model accuracy, meaning, there was no particular dividend yield or profitability range capable of guaranteeing an overpricing outcome closer to 0%. When observing most accurate overpricing results (between -20% and +20%) across different dividend yield ratios (variable with the highest beta coefficient of 40.94), it was possible to confirm that overpricing observations were displayed across several dividend yield levels, and there were only some couple of observations with an overpricing matching the 0% outcome.

While for the GIC Sector analysis, it was possible to identify particular sectors with a higher propensity to be either under or overvalued. However, overpricing results close to 0% were always a minority in relation to the total number of observations.

Both information technology and consumer discretionary sectors denoted a clear underestimation tendency (83% and 81% of the total observations, respectively), driven by lower DPS payments and higher cost of equity rates (mean values). On the other hand, utility and real estate sectors proved to be the ones with the highest overestimation tendency (80% and 64% of the total observations, respectively), although for different reasons. On average, utility companies raised equity at a lower cost, when compared with companies operating in different sectors, whereas real estate companies paid the highest DPS (ceteris paribus).

Altogether, research findings suggest that the Gordon's growth model is not an accurate tool to value US companies. Despite being possible to identify specific underestimation or overestimation patterns across stocks, the model is not able to deliver accurate overpricing results. Consequently, this valuation method, should be considered of questionable use for future valuation practices and investment decisions.

Moreover, this paper represents an important empirical contribution to the US stocks' valuation field, because it creates a fundamental alert that should be taken into account by all investors that frequently rely on the GGM as an effective practice to value stocks.

7. Appendixes

A GGM stock price (P model) and market stock price (P market) impact on the overpricing variable

A.1 Mean evolution and Year-Over-Year (YOY) variations

Table A1
YOY variation of the P market, P model and overpricing annual mean values

Year	**P market** (US $)	P market, YOY variation (%)	**P model** (US $)	P model, YOY variation (%)	**Overpricing** (%)
2002	22.74		83.36		266.60
2003	28.77	26.5	90.10	8.1	213.20
2004	32.17	11.8	81.22	-9.9	152.45
2005	32.97	2.5	111.96	37.9	239.60
2006	37.09	12.5	68.69	-38.7	85.18
2007	37.67	1.6	56.08	-18.4	48.86
2008	27.46	-27.1	76.89	37.1	180.04
2009	28.27	3.0	54.98	-28.5	94.48
2010	33.88	19.8	69.57	26.5	105.37
2011	33.10	-2.3	73.21	5.2	121.16
2012	35.91	8.5	86.76	18.5	141.61
2013	43.48	21.1	120.42	38.8	176.99
2014	42.35	-2.6	109.11	-9.4	157.63
2015	41.46	-2.1	111.32	2.0	168.49
2016	47.43	14.4	97.45	-12.5	105.45
2017	51.27	8.1	92.68	-4.9	80.76
2018	48.57	-5.3	74.73	-19.4	53.84

Table A1 reports the mean evolution of the price calculated through the Gordon's growth model (P_{model}), as well as the market stock price (P_{market}), and the percentual YOY variations of both prices. The overpricing computation was presented in the last column of Table A1, in order to follow the impact that both drivers' variations (P_{market} and P_{model}) were causing on the variable evolution.

Results displayed on Table A1, illustrates the stock market overconfidence on the periods preceding the subprime crisis, with the maximum mean of the 2002-2006 period-set being observed in the year of 2006 ($P_{market\ 2006}$). Additionally, it is possible to verify substantial lower P_{model} values during the second period-set (2007-2010), where companies were forced to re-adapt their dividend payout policies to the 2007-2008 financial crisis' unstable reality.

A.2 Mean evolution of the GGM stock price variables

Table A2
Analysis of the P model factors – YOY mean values evolution

Year	**DPS** (US $)	**DPS YOY variation** (%)	**Analysts' Forecasted g**	**Ke**	**Ke-g**	**(Ke-g) YOY variation** (%)
2002	0.91		0.93	4.72	3.79	
2003	0.96	5.8	0.11	3.68	3.57	-5.8
2004	1.09	13.2	0.26	3.77	3.50	-1.8
2005	1.01	-7.3	1.45	5.65	4.20	19.7
2006	1.04	3.5	1.93	7.61	5.67	35.2
2007	1.06	2.0	1.68	7.73	6.05	6.6
2008	1.07	0.9	0.57	6.51	5.94	-1.8
2009	0.95	-11.9	-0.69	3.84	4.53	-23.7
2010	0.98	3.7	0.25	4.62	4.37	-3.5
2011	1.12	13.9	-0.04	5.18	5.22	19.2
2012	1.15	3.0	0.20	5.18	4.97	-4.6
2013	1.09	-5.4	-0.14	4.46	4.60	-7.5
2014	1.19	8.8	0.42	5.43	5.00	8.7
2015	1.33	12.4	0.79	6.34	5.55	10.9
2016	1.18	-11.8	0.59	6.23	5.65	1.8
2017	1.32	12.1	0.84	6.23	5.40	-4.5
2018	1.55	17.8	1.71	7.97	6.26	16.0

Table A2 reports the mean evolution of the P_{model} components: DPS, g and ke. The DPS variable is expressed in US dollars amount and corresponds to the annual dividend per share amount. The g variable equals the annual dividend's growth rate and the ke corresponds to the annual cost of equity (both mean values are expressed in percentage terms). Table 2 results express the different annual factors influencing overpricing values (DPS and Ke-g), as well as their YOY and overall impact on the GGM stock price evolution (last column).

Lower overpricing values during the crisis, were explained by the mix of two factors: the significant rise of the differential coefficient (ke-g), which started in the year of 2005 and reached its maximum value of 6.05% in 2007 (only surpassed afterwards in the year of 2018), and the very low mean values of DPS payments in the years of 2009 and 2010 (second-half of the considered crisis period). This last factor may reflect the dividend payout policies re-adjustments that were felt right after the crisis boom.

B Overpricing distribution

B.1 Zoom-in on the overpricing distribution

Figure B1
Distribution of overpricing results, over the [-100%, 100%] interval

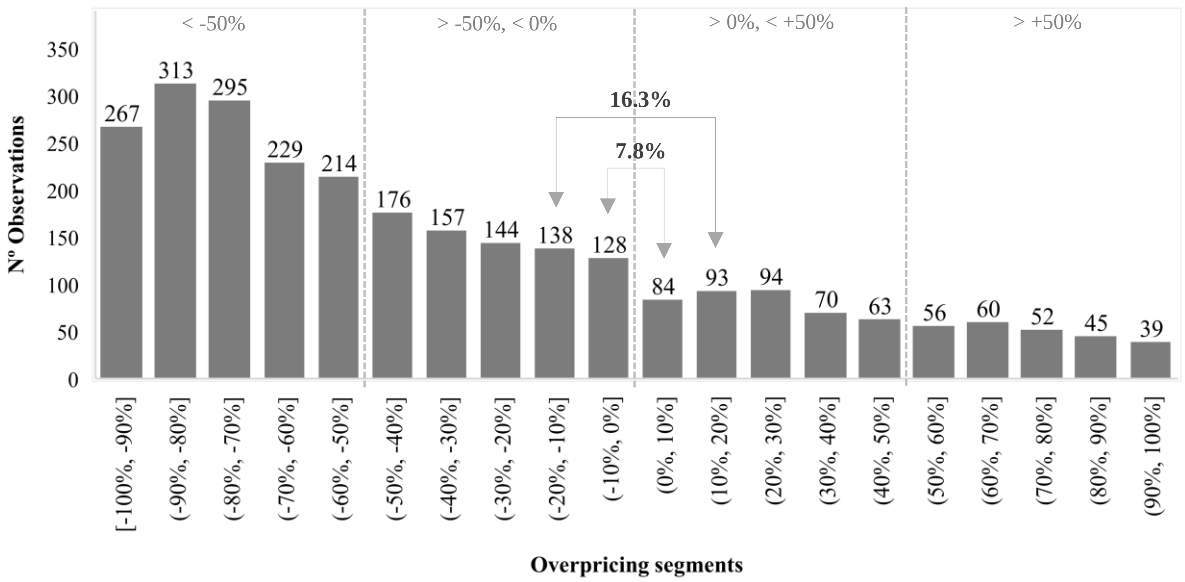


Figure B1 presents the overpricing distribution values on the [-100%, 100%] interval. The same was divided into four groups of 50 percentual points each: lower than 50%, between -50 and 0%, from 0 (excluded) to 50% and above 50%.

Results show that 75.9% of the zoomed sample exhibit negative values. Moreover, 48.5% (almost half of this sub-sample) represent negative deviations below -50% [-100%, -50%], and only 42,2% of the results are comprised within the [-50%, 50%] interval closest to 0%. Indeed, the majority of the results are concentrated on the left side of the distribution, and the number of observations tends to follow the same descending curve of the overall sample.

Furthermore, there are only 7.8% of values verified withing the [-10%, 10%] interval and 16.3% between [-20%, 20%]. Such results might reveal the model inefficiency in estimating the actual market stock prices.

B.2 *Overpricing distribution on the pre-crisis, crisis and post-crisis periods*

Figure B2.1
Pre-crisis period: 825 observations

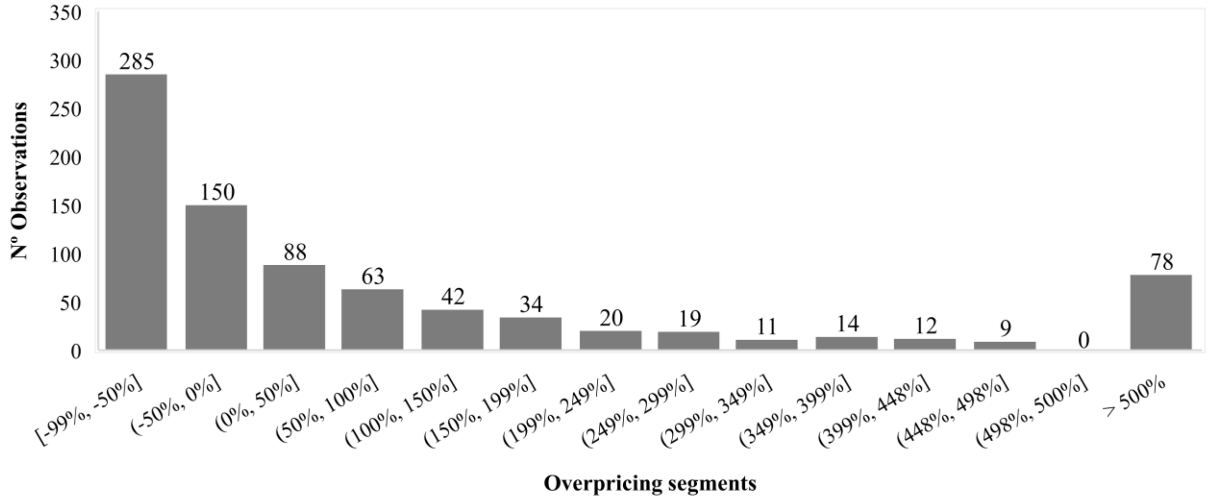


Figure B2.2
Crisis period: 832 observations

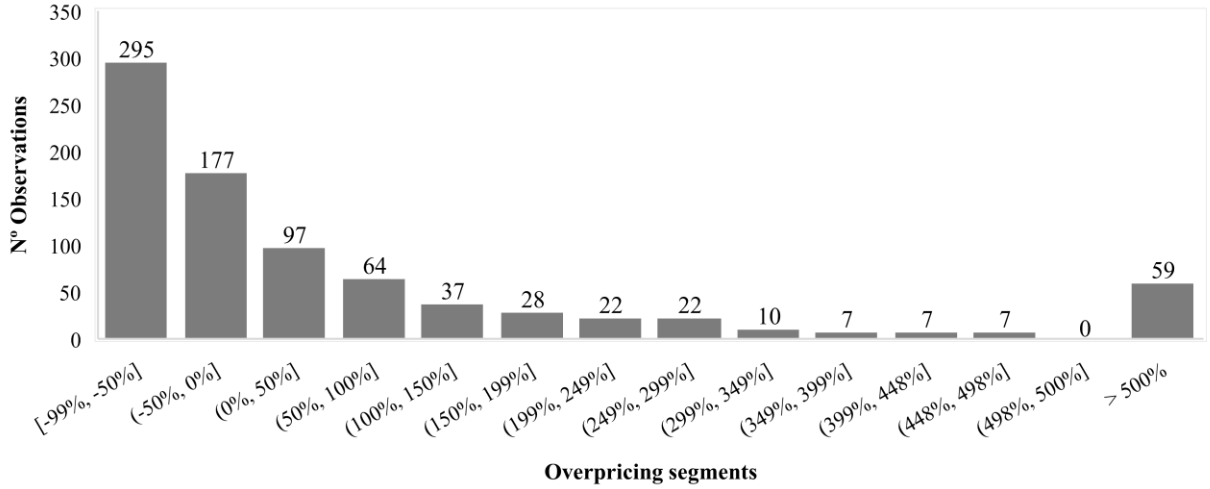
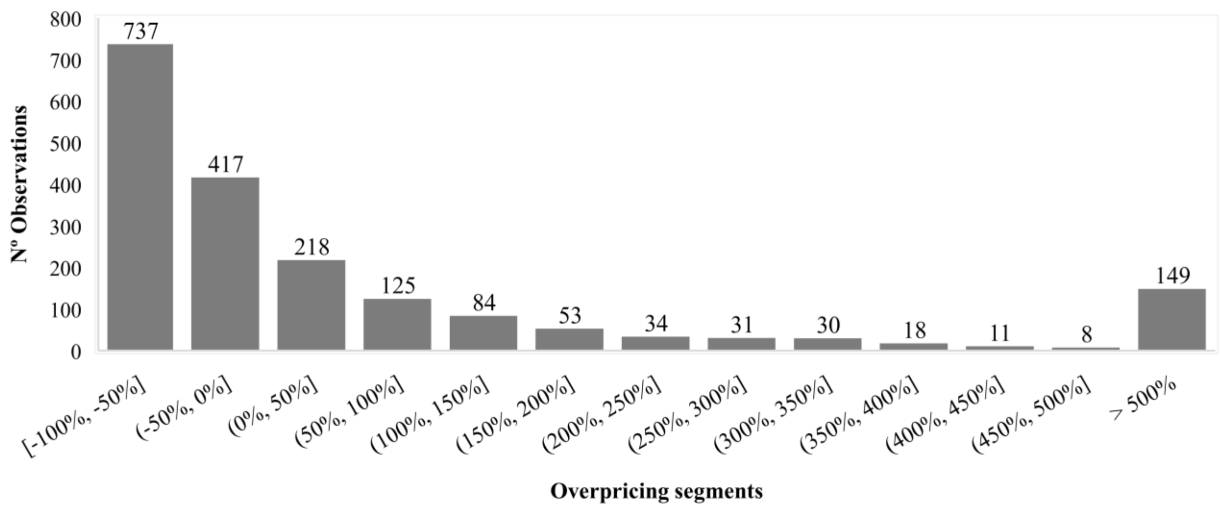


Figure B2.3
Post-crisis period: 1915 observations



C Regression analysis

C.1 Correlation coefficients

Table C1
Correlation coefficients of the regression variables

	Overpricing	*Log (Sales)*	*NI/ Sales*	*D/A*	*Energy*	*Materials*	*Industrials*	*C. Discret.*	*C. Staples*
Overpricing	1,00								
Log (Sales)	-0,05	1,00							
NI/Sales	0,07	-0,28	1,00						
D/A	0,00	-0,03	0,03	1,00					
Energy	0,02	0,15	-0,08	0,05	1,00				
Materials	-0,05	0,11	-0,10	0,08	-0,08	1,00			
Industrials	-0,05	0,09	-0,12	0,07	-0,10	-0,12	1,00		
C. Discret.	-0,08	0,11	-0,13	0,05	-0,09	-0,10	-0,13	1,00	
C. Staples	0,04	0,12	-0,03	0,07	-0,05	-0,06	-0,07	-0,06	1,00
Health Care	-0,04	0,13	-0,01	-0,02	-0,06	-0,07	-0,09	-0,08	-0,04
Financials	0,00	-0,29	0,21	-0,32	-0,14	-0,17	-0,22	-0,19	-0,11
Inf. Tech.	-0,07	0,07	-0,01	-0,06	-0,07	-0,08	-0,11	-0,09	-0,05
Com. Services	0,02	0,08	-0,02	0,07	-0,04	-0,05	-0,06	-0,05	-0,03
Utilities	0,17	0,03	-0,09	-0,28	-0,08	-0,10	-0,13	-0,11	-0,06
DPS/P	0,23	-0,14	0,13	0,15	0,10	-0,09	-0,15	-0,11	-0,02
DPS/EPS	0,01	-0,04	0,04	0,06	-0,05	0,01	-0,02	-0,02	-0,01
Share Rep.	-0,05	0,14	-0,02	0,02	-0,09	-0,02	0,07	0,12	0,06

	Health Care	*Financials*	*Inf. Tech.*	*Com. Services*	*Utilities*	*DPS/ P*	*DPS/ EPS*	*Share Rep.*
Overpricing								
Log (Sales)								
NI/Sales								
D/A								
Energy								
Materials								
Industrials								
C. Discret.								
C. Staples								
Health Care	1,00							
Financials	-0,13	1,00						
Inf. Tech.	-0,06	-0,15	1,00					
Com. Services	-0,04	-0,09	-0,04	1,00				
Utilities	-0,07	-0,18	-0,09	-0,05	1,00			
DPS/P	-0,09	0,07	-0,10	0,04	0,17	1,00		
DPS/EPS	-0,01	-0,01	-0,01	0,00	0,01	0,04	1,00	
Share Rep.	-0,01	0,04	0,08	0,04	-0,22	-0,16	-0,03	1,00

C.2 Overpricing distribution: companies that engaged in share repurchase activities vs companies that did not engage in share repurchase activities

Figure C2.1

Distribution of overpricing results - stocks with share repurchase activity

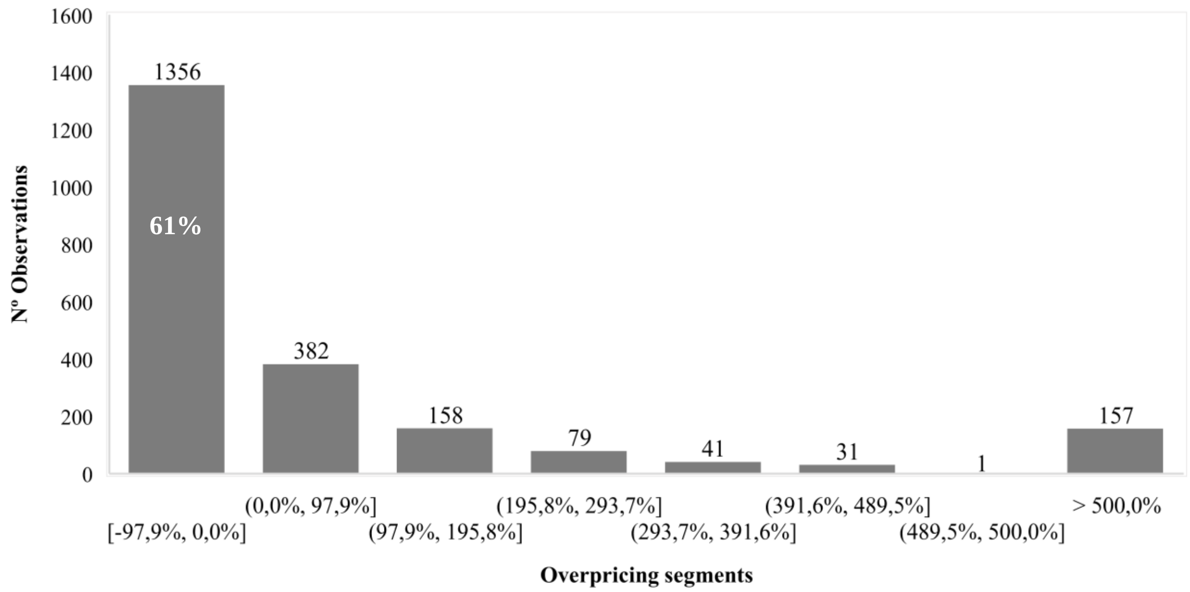
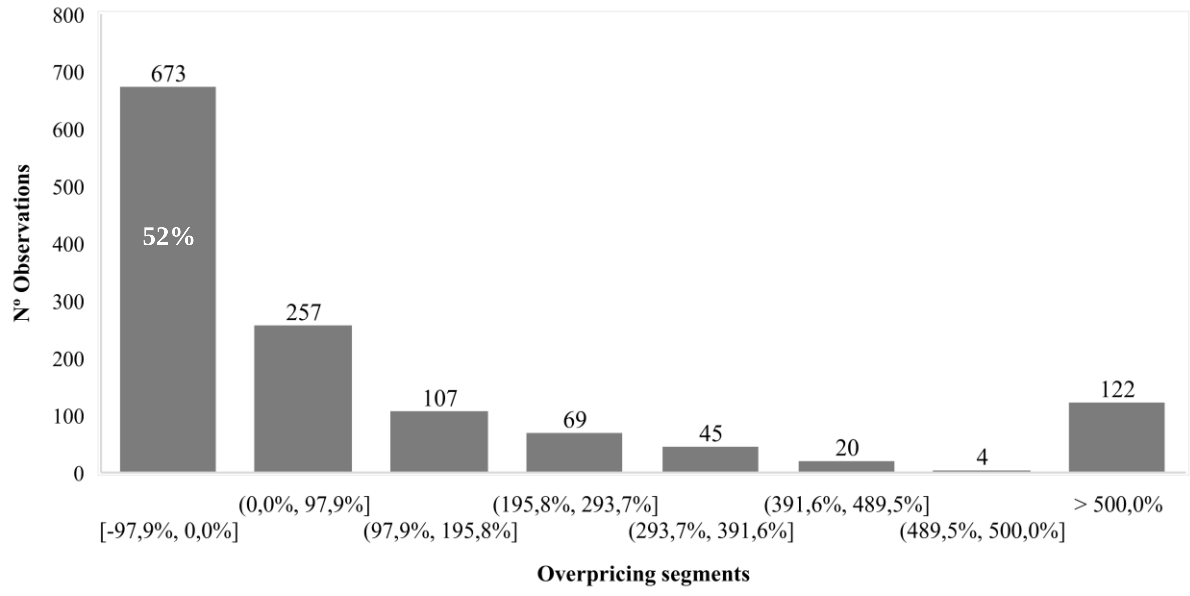


Figure C2.2

Distribution of overpricing results – stocks without share repurchase activity



C.3 Overpricing observations per dividend yield and profitability levels

Figure C3.1
Total overpricing distribution, comprised across different dividend yield ratios

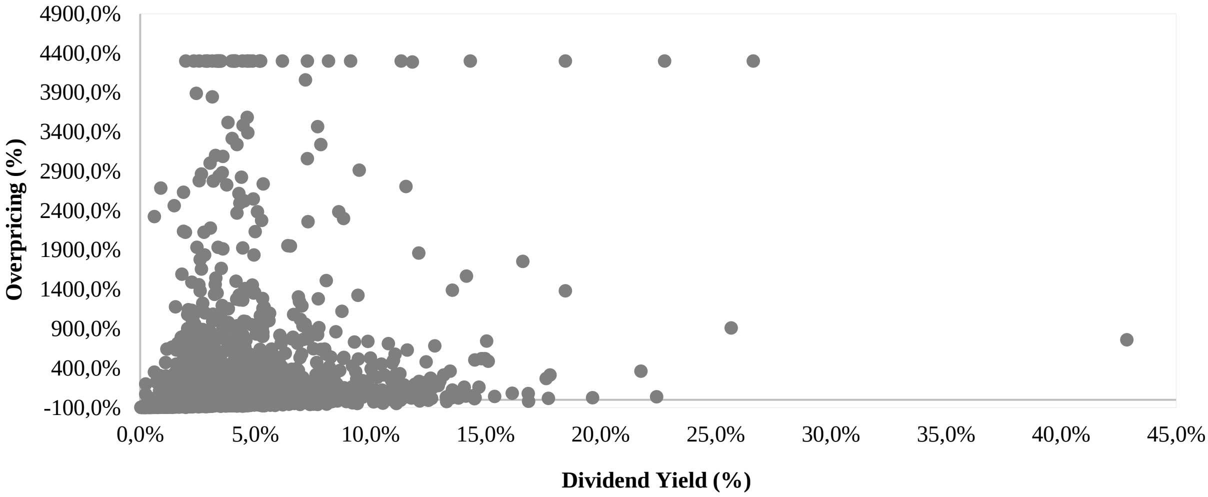


Figure C3.1 presents overpricing total observations across stocks' dividend yield ratios (DPS/P). Overpricing results are mostly concentrated within the [0%, 15%] dividend yield interval.

Figure C3.2
Total overpricing distribution, comprised across different profitability ratios

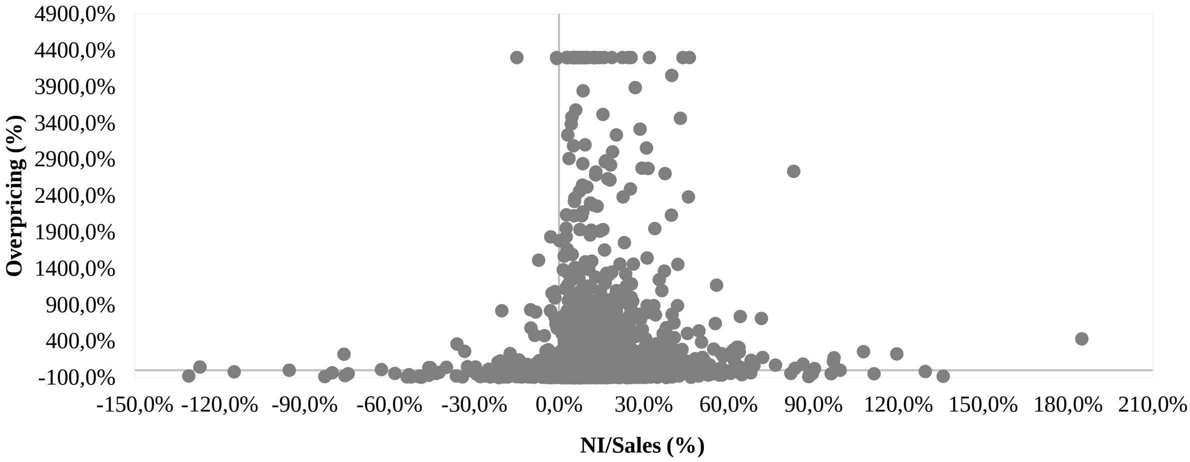


Figure C3.2 presents overpricing total observations across stocks' profitability ratios (NI/Sales). Overpricing results are mostly concentrated within the [0%, 30%] profitability interval.

C.4 Overpricing distribution per significant GIC Sectors

Figure C4.1
Information technology stocks – overpricing distribution

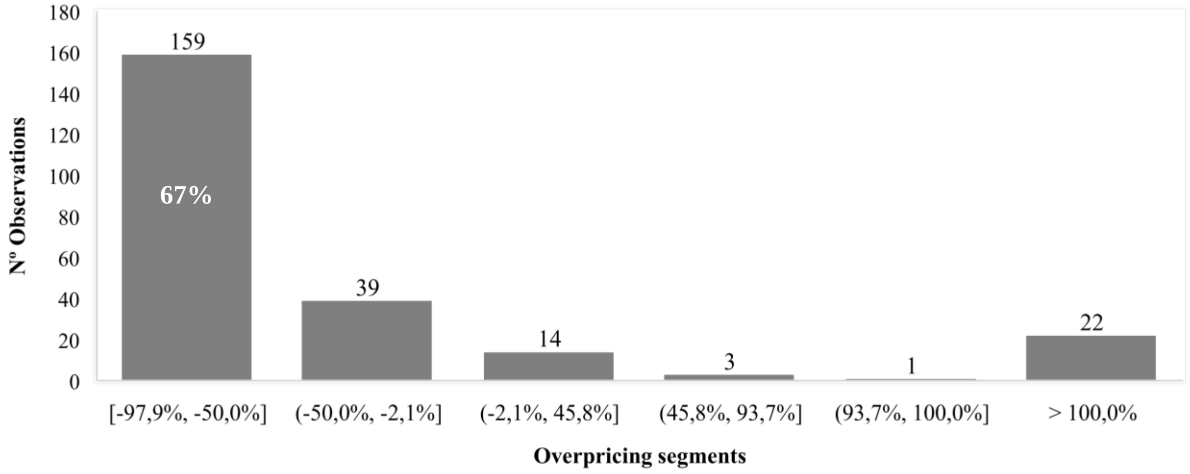


Figure C4.2
Consumer discretionary stocks – overpricing distribution

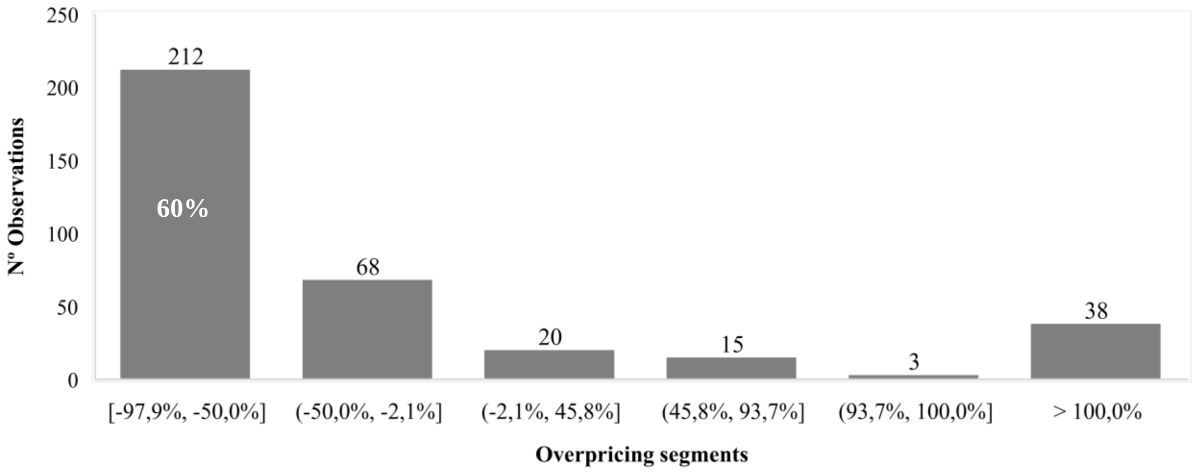
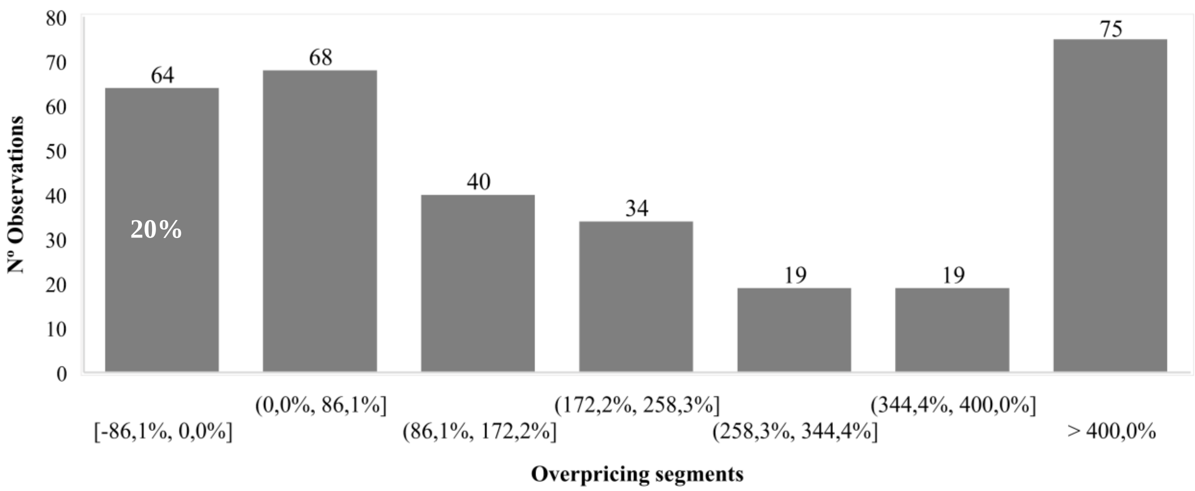


Figure C4.3
Utility stocks – overpricing distribution



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