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Dividend Clientele Effect in Option Pricing

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Abstract

This paper is the first to document on the dividend clientele effect jointly with the option pricing and is the first to study the relations between stock markets and options markets with respect to the dividend clientele effect. The two main objectives of this research are: first, to calculate and examine the future equity price drop caused by dividend implicitly priced in the option price in order to study the impact of dividend clientele effect on the implicit adjustment for dividend in option pricing prior the ex-dividend day; second, to compare the implied equity price drop priced in the option market with the actual equity price drop on ex-dividend day in order to find out if the option markets use the same set of information than equity markets with respect to the dividend clientele effect.

The results show the implied price drop is found to be statistically significantly different than the actual dividend amount, meaning the dividend clientele effect affects the implicit adjustment for dividend in option pricing prior the ex-dividend day, causing this implicit adjustment to be different than the actual dividend amount. The implied price drop is also found to be statistically significantly different than the actual price drop on the ex-dividend day. It indicates the option markets do not use the same set of information than equity markets with respect to the dividend clientele effect.

It is found later in this paper that the proposed strategy does not generate enough profits, when applied to the whole option sample, to absorb the transaction cost generated by the bid - ask option price difference. It means this strategy is not economically efficient and is impossible to be profitable a priori, without knowing the mean of the differences between the implied price drop and actual price drop. Thus, the proposed strategy cannot be implemented in practice and be applied in trading in the real option markets.

Keywords: dividend, dividend clientele effect, ex-dividend day, implied equity price drop, implicit adjustment for dividend in option pricing

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1. Introduction

When buying stocks of corporations that pay dividends, investors must pay income tax on those dividends and on the capital gains when they sell those shares. Income tax on capital gains is generally different and less than income tax on dividends in most countries. This is the reason why dividend clientele effect suggests that investors attempt to reduce the overall tax burden by sorting themselves into clienteles with low-tax investors and high-tax investors or those who have higher tax-rate on dividends and those who have higher tax-rate on capital gains. Low-tax investors and those who have higher tax-rate on capital gains will collect dividends. High-tax investors and those who have higher tax-rate on dividends will realize capital gains by selling the shares before the ex-dividend dates.

A lot of past and recent papers have documented on the dividend tax clientele effect. Among others, Scholz (1991) provides evidence that investors are sensitive to tax rates when choosing portfolio dividend yields, even after proxy variables are included to control for transactions costs and risk, and thus supports the existence of dividend clientele effect. Dahlquist, Robertsson and Rydqvist (2014) evaluate the dividend tax clientele using a dataset of all domestic stock portfolios in the Swedish market. They examined a few investor categories and found that investment funds that face a higher effective tax rate on dividend income than on capital gains tilt their portfolios away from dividend-paying stocks and consequently earn a dividend yield that is about 35 basis points lower than that of investors who are tax neutral between dividends and capital gains such as pension funds and life insurance companies. More empirical researches on this the dividend clientele effect will be discussed in detail in the literature review section.

With the existence of this dividend tax clientele effect, the equity price drop on the ex-dividend day will not be the same amount as the previously declared dividend since more tax related trading occurs around the ex-dividend dates. Elton and Gruber (1970) first propose to test the existence of dividend clientele by comparing dividends against price declines on ex-dividend dates, calling it the indirect empirical examinations of dividend clientele effect. Remind that the equity price drop happens on the ex-dividend day as a compensation for investors who buy the share thereafter and will not receive the coming dividend. In the absence of dividend clientele effect and profit arbitrage opportunities, the ex-dividend day stock price drop should equal to the amount of dividend paid per share, adjusted for possible risk and transaction costs. The most common explanation of the ex-dividend day stock price drop that is different than the amount of dividend paid per share is based on the marginal long-term investors' higher tax burden on dividend income relative to capital gains, assuming that stockholders wish to maximize their after-tax wealth.

Therefore, Elton and Gruber (1970) and Elton, Gruber, and Rentzler (1984) suggest that a preferential tax treatment of capital gains leads to dividend clientele effect. Specifically, Elton and Gruber (1970) differentiate two components of dividend clientele effect that drive the ex-dividend day stock price drop to be different than the amount of dividend: the fiscal distortion and the actual dividend clientele effect. Fiscal distortion is the effect that dividends and capital gains are taxed at a different rate. If all investors in financial markets have the same tax rate for dividends and for capital gains that are different, the following equation holds and is different than 1:

$$D/d = (1 - td) / (1 - tg)$$

where *D* is the actual ex-dividend day equity price drop, *d* is the actual amount of dividend distributed, *td* is the tax rate on dividends and *tg* is the tax rate on capital gains. Therefore, if *td* and *tg* is the same for all investors in the financial markets, it is possible to perfectly predict *D/d*, thus predict the actual ex-dividend day equity price drop *D*. However, in the real financial markets, *td* and *tg* are not the same for all investors. The marginal investor reflects the supply and demand movements of a company's stock based on the tax preferences for dividends versus capital gains. This effect is the actual dividend clientele effect and it is what brings the unpredictability in the actual ex-dividend day equity price drop that the market anticipates. More past literature on the indirect empirical examinations of dividend clientele effect will be discussed in detail in the next section.

Existing equity holders, on the ex-dividend day, see their shares decline in value, but will collect the dividends to compensate. Option holders, on the other hand, see their options' value affected by the ex-dividend day equity price drop, but will not receive the dividends as equity holders. It is this asymmetry in the division of returns between capital gains and dividends which creates one important difficulty in option pricing. Geske, Roll and Shastri (1983) point out that at that time, the exchange-listed options offer no protection against either stock or cash dividends but, traditionally, options traded in the over-the-counter market have offered cash dividend protection clauses. The typical adjustment, which they call OTC protection, is to reduce the option's exercise price by the amount of the dividend. More papers on this matter will be discussed further in this thesis. Today, where option markets are very liquid and more efficient with respect to information available in the markets, the option market implicitly price this future price drop caused by dividends in the option price in order to avoid any penalties to option holders and arbitrage opportunities on the ex-dividend day.

It has been stated previously that dividend clientele effect affects the amount of equity price drop on the ex-dividend date, causing it to be different than the actual dividend amount. The questions to be answered in this essay are: does the dividend clientele effect exist and how does it impact the equity price drop on the ex-dividend day with respect to the selected data sample? Does the dividend clientele effect affect the implicit adjustment for dividend in option pricing prior the ex-dividend day? If it does, does it affect the implicit adjustment for dividend in option pricing in the same magnitude than it affects the equity price drop on the ex-dividend date? In other words, does the option markets use the same set of information than equity markets with respect to the dividend clientele effect? If it is not the case, is it possible to take advantage of the information in the equity markets with respect to the dividend clientele effect that is ignored in the option market and find a trading strategy to generate arbitrage profits ex-post?

The main goal of this study is to find out if the option markets use the same set of information than equity markets with respect to the dividend clientele effect. That is to study if the future equity price drop implicitly priced in the option price is the same than the actual equity price drop on ex-dividend day. The hypothesis of an efficient option market suggests that there should not be a difference; all information implied in the equity markets with respect to the dividend clientele effect should be taken into account in the option markets. If there is a difference, it means that the option market is «surprised», at least at some level depending on the difference, by the real dividend clientele effect on the ex-dividend day, thus partial information considered in equity markets are ignored in option markets. If it is the case, it is possible to take advantage of the information in the equity markets with respect to the dividend clientele effect that is ignored in the option market and find a trading strategy to generate arbitrage profits ex-post. A simple ex-post trading strategy would be to buy the option on the last cum-dividend day or on the ex-dividend day if the implied price drop makes the option cheaper than the actual price drop on that day and sell it on the other day.

The data sample of this research contains companies that have been in the S&P500 index and the time window for this study is from 2004 to 2014. Specifically, this paper only considered those companies that distribute dividends, have American exercise style options and for which the option prices are available. Only American style options are used here because they are the most common stock options; data on European style stock options, even available, can be less reliable. Due to the large number of firms that have been on S&P500 since its creation and the large amount of daily data available on security and option prices, only firms that have been on S&P500 from 2004 to 2014 will be part of the data sample. Finally, for simplicity and liquidity purpose, only at the money American call options with closest to one month maturity are used.

In order to reach the objectives and to answer the questions above, here is a brief description of the methodology. In the first place, the Elton and Gruber (1970) approach is also used in the present research in order to verify the existence of dividend clientele effect and its impact on equity price drop on the ex-dividend day for the data sample. The hypothesis of this thesis with respect to the existence of dividend clientele effect is in the same direction than documented in the literature. Therefore, the ratio of the actual price drop on the ex-dividend date on the actual amount of dividend in this case is expected to be statistically significantly different than *(1 - td) / (1 - tg)*, the fiscal distortion effect that is predictable by the markets. Afterward, the «implied price drop» of each company's options, *Dimp*, priced by the option market on each last cum-dividend day is obtained from the closing option price (the average of option's closing best bid price and closing best offer price), the closing security price on the last cum-dividend day and the implied volatility of the option on the last cum-dividend date given in the data base given by *OptionMetrics*, and using the dividend adjusted Black and Scholes option evaluation model. Finally, the returns of an ex-post trading strategy are studied. More details will be found in the methodology section.

The main strong hypothesis in the methodology is the use of Black and Scholes option evaluation model to value American style options. However, since only call options are considered in this paper and each option considered has only one known dividend until maturity, it is still appropriate to use this methodology when adjusted for the dividend.

The results of this research show the existence of dividend clientele effect for the final data sample used and it is verified with strong significant test results. Moreover, the adjustment for the future equity price drop caused by dividend implicitly priced in the option price on the last cum-dividend day, the implied price drop, is found to be statistically significantly different than the actual dividend amount, meaning the dividend clientele effect affects the implicit adjustment for dividend in option pricing prior the ex-dividend day, causing this implicit adjustment to be different than the actual dividend amount. The implied price drop is also found to be statistically significantly different than the actual price drop on the ex-dividend day. It indicates the option markets do not use the same set of information than equity markets with respect to the dividend clientele effect.

Finally, the implied price drop (*Dimp)* on the last cum-dividend day is found to be generally smaller than the actual price drop on the ex-dividend day (*D*), with a negative mean of the difference (*Dimp - D)* that is statistically significant, meaning the option markets price a smaller future price drop than what it will actually be in the option price, thus the option price is more expensive than it should be and will be adjusted downward on the ex-dividend day. Therefore, the ex-post trading strategy will be selling short the more expensive option on the last cum-dividend day and buying it back on the next day, the ex-dividend day, when the same option will be cheaper after the price adjustment for the actual real price drop.

However, it is found later in this paper that the proposed strategy does not generate enough profits, when applied to the whole option sample, to absorb the transaction cost generated by the bid - ask option price difference. It means this strategy is not economically efficient and is impossible to be profitable a priori, without knowing the mean of the differences between the implied price drop and actual price drop. Thus, the proposed strategy cannot be implemented in practice and be applied in trading in the real option markets.

No past research has been found in the previous literature documenting on the dividend clientele effect jointly with the option pricing. A lot of past and recent papers study the dividend clientele effect, its impact on security pricing on the ex-dividend day, dividends' impact on option pricing and empirical arbitrage strategies with securities and options around the ex-dividend day. However, no one has thought of calculating the future equity price drop caused by dividend implicitly priced in the option price in order to study the impact of dividend clientele effect on the implicit adjustment for dividend in option pricing prior the ex-dividend day. Furthermore, no previous research has compared the implied equity price drop priced in the option market with the actual equity price drop on the ex-dividend day in order to find out if the option markets use the same set of information than equity markets with respect to the dividend clientele effect. Therefore, this paper is the first to study the relations between stock markets and options markets with respect to the dividend clientele effect.

The proposed research objectives of this thesis are innovative, thus contribute in adding some valuable additional materials in the financial scientific research networks. They also help in finding potential arbitrage opportunities related to the dividend clientele effect hidden in the option markets, hence reveal more information related to dividend clientele effect in option markets and improve the market efficiency.

This research paper proceeds as follow. Section 2 contains a detailed empirical literature review on the existence and the impact of dividend clientele effect on equity price drop on the ex-dividend day and the impact of dividends on option pricing. Some theoretical and empirical trading strategies with securities and options around the ex-dividend day are also briefly discussed. Section 3, titled methodology, describes the hypothesis and the experimental design of the research. Section 4 describes the data extraction and description. Section 5 presents the empirical results and analysis, as well as an ex-post trading strategy given the results. Finally, section 6 concludes this paper and section 7, titled bibliography, lists the references used for the present research.

2. Literature Review

2.1 Dividend Clientele Effect

The Dividend Irrelevance Theory developed by Miller and Modigliani (1961) suggests that dividend payments are irrelevant and a firm's dividend payout ratio does not affect shareholders' wealth since shareholders have the ability to make home-made dividends. The theory defined home-made dividends as the following transaction: selling shares to capture capital gains that would be equivalent to the amount of dividend desired. In order to do so, the following assumptions of a perfect capital market have to be satisfied: there exists a perfect capital market where there are no transaction costs, no floatation costs to companies issuing securities, no taxes and there is symmetric access to credit markets and the future profits of the firm are assumed to be known with certainty.

However, these assumptions cannot be verified in the real world: among others, there are transaction costs in the capital markets and investors are subject to income tax. When companies pay dividends, its shareholders must pay income tax on those dividends. They also pay income tax on capital gains when they sell their shares. With the latter, however, they can choose when to realize capital gains and losses, thus when to pay taxes, as opposed to dividends. Whenever dividends and capital gains are taxed differently, investors would sort themselves into heterogeneous clientele classes by their effective tax brackets and they can realize mutual gains at the expense of the government by trading with one another around the ex-dividend day.

The last day that investors can buy a stock with the rights to receive an earlier declared dividend is defined as the last cum-dividend day. After this day, the stock is considered as trading ex-dividend. Remind that investors who buy the stock on or after ex-dividend day will not have the right to the next dividend payment. Thus, at the opening of trade on the ex-dividend day, the ownership of the stock is separated from the ownership of its declared dividend. Rantapuska (2008) finds, in a study examining the ex-dividend day trading behavior of all investors in the Finnish stock market, that investors who value dividends relative to capital gains hold or buy stocks before ex-dividend day (or on cum-dividend day), and investors who would be disadvantaged to receive dividends would sell the stocks before ex-dividend day or wait until ex-dividend day before buying them. Moreover, in most of the countries, not only dividends and capital gains are taxed at a different rate, different type of investors (individuals, private corporations, tax-exempt institutions, etc.) have different tax rate for both dividends and capital gains. In many cases, dividends are more heavily taxed than capital gains, so highly taxed investors favor firms with lower dividend payout ratios since they are more concerned with minimizing tax liabilities, *ceteris paribus*.

For example, Scholz (1991) mentions that the U.S. Federal tax system imposes dividend taxes more heavily than capital gain taxes for most individuals and allows tax-exemption on dividends for some organizations. It is the case of the Canadian tax system as well, where 100% of dividend income is taxable but only 50% of realized capital gains are taxed. Another reason why capital gains are tax-preferred by most investors is that they are taxed only when they are realized, giving investors the choice of when to pay taxes. Moreover, the capital gains taxes are eliminated when assets are inherited because the basis of bequeathed assets is increased to market value when they are passed on. Thus, dividends are relatively tax disadvantaged in the United-States, therefore it is expected that firms with high dividend payout ratio attract investors with relatively low marginal tax rates. On the other hand, high marginal rate investors are expected to buy the securities of low dividend yield firms, *ceteris paribus*. This expectation, underlying that firms attract different investor clienteles based on the dividend payout ratio or the dividend yield of the firm, is what Scholz (1991) describes as the dividend clientele effect. In other words, the dividend clientele effect assumes investors with the relative lower tax rate on dividends invest more in high dividend paying stocks, while investors with the lower tax rate on capital gains prefer low dividend yield stocks.

After discussing the impact of dividend clientele effect on the demand side, or on the investors' behavior, it is important to mention that the dividend clientele effect also has a significant impact on the supply side, or on the corporations that pay dividends. Allen and Michaely (2002) document that a firm's payout policies, including dividend payouts and share repurchases, are much influenced by the dividend clientele effect as well. Because most investors see capital gains as more fiscally advantageous, share repurchases have become more popular as an alternative payout policy instead of dividend payouts within public and private companies. Moreover, evidence suggests that the rise in the popularity of share repurchases increased firms' overall payout and their financial flexibility. Following the same idea, Miller and Modigliani (1961) states the existence of dividend clienteles is important in determining the possible impact of dividend payouts on security returns. Actually, the existence of clienteles is important to corporate financial managers as the tax characteristics of the firm's investors may influence the firm's optimal financial decisions. Therefore, since taxes influence individual investors' behavior, corporate financial managers are more cautious to change the actual dividend payout ratio of the firm. Indeed, all above studies assume that investors are rational and their primary goal is to maximize their after-tax return.

In fact, the first formal analysis of tax clienteles is the Capital Asset Pricing Model of Miller and Modigliani (1961) that includes taxes born by investors, the after-tax CAPM. When an investor faces a higher effective tax rate on dividends than on capital gains, the after-tax CAPM predicts a positive relation between the before-tax rate of return of a stock and its dividend yield. The second prediction of this model is that investors hold a combination of the market portfolio, a portfolio that derives from tax efficiency and the risk-free asset. Therefore, investors with a relative tax preference for dividends invest more in high dividend paying stocks, while investors who have the lower tax rate on capital gains prefer low dividend yield stocks. Since the after-tax CAPM also implies a negative relationship between stock price and dividend yield, investors with a tax preference for dividends hold portfolios with a higher dividend yield than other investors do and investors with a tax preference for capital gains hold lower dividend yield portfolios in order to capture more price appreciation. In the same study realized in 1961, Miller and Modigliani also described an equilibrium model of capital structure in presence of taxes where investors can reduce the overall tax bill by sorting themselves into clienteles in which low-tax, low-income investors collect dividends and high-tax, high-income investors realize capital gains following the reasoning that high-tax investors can decide when to pay their taxes by choosing the moment to capture stock price appreciation.

The previous literature on portfolio choice suggests that there are three main factors: transactions costs, taxes and portfolio risk, that may potentially influence the dividend yield of an investor’s portfolio. Many direct and indirect empirical tests of the dividend clientele effect have been done in attempting to infer the tax characteristics of a corporation’s marginal investor. Direct examinations basically use direct observations of transaction data on individual portfolios around ex-dividend dates and those when dividend policy changes and information on the investors who trade to examine the relationships between tax rate and dividend receipts in investors’ portfolios. If investors in higher (lower) tax brackets hold fewer (more) stocks with high dividend payout ratios or if heavily (lightly) taxed investors selling (buying) after a firm increases its payout ratio, the existence of dividend clientele would be proved.

Among the direct examinations of dividend clientele effect, Scholz (1991) provides evidence that investors are sensitive to tax rates when choosing portfolio dividend yields, even controlling for transactions costs and risk, thus support the existence of dividend clientele effect. In another direct examination of dividend clientele effect, Dahlquist, Robertsson and Rydqvist (2014) evaluate the dividend tax clientele using all domestic stock portfolios in the Swedish market. They examined a few investor categories and found that investment funds that face a higher effective tax rate on dividend income than on capital gains tilt their portfolios away from dividend-paying stocks. Consequently, these portfolios earn a dividend yield that is about 35 basis points lower than those of investors who are tax neutral between dividends and capital gains such as pension funds and life insurance companies. They also found evidence that foundations earn higher dividend yields on their stock portfolios than most other investors in the Swedish stock market, which is consistent with the common view that foundations are constrained by charter provisions to make distributions from the income and not from the principal. Finally, Lee, Liu, Roll and Subrahmanyam (2005) study the interaction of dividends and taxes by exploiting the stock market of Taiwan, where the capital gains tax is zero. They find strong evidence of dividend clientele effect where investors subject to high rates of taxation on dividends tend to hold stocks with lower dividends and sell (buy) stocks that raise (lower) dividends, while investors in lower tax brackets behave in the opposite manner. They also document that after the legalization of share repurchases in Taiwan in 2000, firms with higher concentrations of more heavily taxed shareholders were able to begin repurchase programs, which allow shareholders to capture capital gains more easily.

2.2 Dividend Clientele Effect Impact on the Ex-dividend Day Stock Price Decline and Indirect Examinations of Dividend Clientele Effect

The indirect empirical examinations of dividend clientele effect attempt to verify the existence of dividend clientele effect by studying the ex-dividend day stock price behavior and infer the tax characteristics of a firm's marginal investor from movements in ex-dividend day security prices. Elton and Gruber (1970) first propose to test the existence of dividend clientele by comparing dividends against price declines on ex-dividend dates. The stock value declines on the ex-dividend day to eliminate arbitrage opportunities. Since investors who buy the stock on or after ex-dividend day will not have the right to the next dividend payment, they have to pay the share cheaper to compensate. In the absence of dividend clientele effect and profit arbitrage opportunities, the ex-dividend day stock price drop should equal to the amount of dividend paid per share, adjusted for possible risk and transaction costs. The most common explanation of the ex-dividend day stock price drop that is different than the amount of dividend paid per share is based on the marginal long-term investors' higher tax burden on dividend income relative to capital gains, assuming that stockholders wish to maximize their after-tax wealth.

Elton and Gruber (1970) and Elton, Gruber, and Rentzler (1984) suggest that a preferential tax treatment of capital gains leads to dividend clientele effect. Specifically, Elton and Gruber (1970) differentiate two components of dividend clientele effect that drive the ex-dividend day stock price drop to be different than the amount of dividend:

the fiscal distortion and the actual dividend clientele effect. Fiscal distortion is the effect that dividends and capital gains are taxed at different rate. If all investors in financial markets have the same tax rate for dividends and for capital gains that are different, the following equation holds and is different than 1:

$$D/d = (1 - td) / (1 - tg)$$

where *D* is the actual ex-dividend day equity price drop, *d* is the actual amount of dividend distributed, *td* is the tax rate on dividends and *tg* is the tax rate on capital gains. Therefore, if *td* and *tg* is the same for all investors in the financial markets, it is possible to perfectly predict *D/d*, thus predict the actual ex-dividend day equity price drop *D*. However, in the real financial markets, *td* and *tg* is not the same for all investors. The marginal investor reflects the supply and demand movements of a company's stock based on the tax preferences for dividends versus capital gains. This effect is the actual dividend clientele effect and it is what brings the unpredictability in the actual ex-dividend day equity price drop that the market anticipates.

Elton and Gruber (1970) also explain that, in a rational market, the fall in price on the ex-dividend day should reflect the value of dividends relative to capital gains to the marginal stockholders. Since dividends and capital gains are taxed at different rates, the relative tax rate on these two types of income affects the decision. For an investor to hold a stock over the ex-dividend date, the ex-dividend price decline must be less than the dividend by an amount that depends on the relative difference between the marginal effective dividend and capital gains tax rates. Again, let *d* be the dividend amount, *D* be the ex-dividend day price decline, *td* be the marginal effective dividend tax rate and *tg* be the marginal effective capital gains tax rate. Following Elton and Gruber's theory, investors would hold the stock over the ex-dividend date if *D < d*(td - tg)*.

Thus, it is possible to infer marginal stockholder tax brackets from observing the ex-dividend behavior of common stocks' price. Elton and Gruber also find empirical evidence of an inverse relationship between investor's tax bracket and investor's portfolio dividend yield; in other words, investors in higher tax brackets own low dividend yield stocks and show a preference for capital gains over dividend income relative to those in lower tax brackets who own high dividend yield stocks. This observation is a very good illustration of one form of market rationality.

In the same paper realized in 1970, Elton and Gruber find that dividends are generally larger than ex-dividend day price declines. They also document that in order to achieve long-term investors' indifference to dividend income and capital gains on an after-tax return basis, the ex-dividend day price drop on the lower dividend yield stocks specifically is smaller than the dividend amount. Booth and Johnston (1984) study the ex-day effect in Canada, and find the ex-dividend day price drop is generally smaller than the dividend level, indicating a market preference for capital gains. Litzenberger and Ramaswamy (1980) find a positive relationship between the dividend yield and the magnitude of the price drop on the ex-dividend day. Specifically, they document a nearly dollar for dollar security price decrease on the ex-dividend day for firms with higher dividend payouts, while firms with lower dividend payouts have ex-dividend day prices that fall by less than dollar for dollar of dividend payout. The documented lower effective tax rates on dividend income than on capital gains for private corporations under the U.S. tax laws might explain why the ex-dividend day price drop on the high dividend yield stocks is generally higher than the dividend amount. This is interpreted as evidence supporting the dividend clientele hypothesis.

Nonetheless, Elton and Gruber's indirect test of dividend clientele effect has been challenged by many different authors. Brooks and Edwards (1980), Kalay (1982), Lakonishok and Vermaelen (1986) and Karpoff and Walkling (1988) argue that the indirect explanation of dividend tax clienteles holds only if long-term investors, for whom only the timing of their sales or purchase matters, are the equilibrium price determining investors. Specifically, Kalay (1982) shows that, in contrast to prior works, without additional information, the investors' marginal tax rates cannot be inferred from movements in ex-dividend day security prices, which is, therefore, not necessarily the result of a tax induced clientele effect. Despite adjustments for potential biases in earlier work, however, the correlation between the ex-dividend relative price drop and the dividend yield is still positive, which is consistent with a tax effect and a tax-induced clientele effect. His main argument is that short-term traders do not receive a preferential tax status between capital gains and dividend income. Therefore, these traders will capture any arbitrage opportunities resulting in the differences between dividends and security price changes after their marginal transaction costs. Rantapuska (2008) document that traders who engage in overnight arbitrage earn on average a 2% overnight return on their invested capital in the Finnish stock market. Furthermore, transaction costs and dividend yield jointly determine the volume of short-term trading activity around ex-dividend dates.

Brooks and Edwards (1980) also document that traders who take advantage of the arbitrage opportunity would drive the ex-dividend day security price-change-to-dividend ratio toward the value of one with the difference deviating from one as a result of the required coverage of transaction costs. Moreover, many stock exchanges have put transaction costs cap for traders and market makers in order to encourage them to eliminate this arbitrage opportunity. Professional traders will have to pay transactions costs up to a certain amount of which they don’t have to pay transaction costs anymore, allowing them to eliminate the possibilities of arbitrage from the market as much as possible. Consequently, decreases in transaction costs make short-term trading profitable in a greater number of stocks. Therefore, Brooks and Edwards (1980) suggest that traders will capture the arbitrage opportunity for any price-change-to-dividend ratios sufficiently larger or smaller than one, as long as it covers their transactions costs. In fact, this trade is only justified when transactions costs are less than the spread between the dividend and the ex-dividend day security price change, thus allow traders to make profits out of the trade. Therefore, this arbitrage phenomenon is more likely to occur with high dividend yield stocks where larger dividends and ex-dividend day price changes occur. These short-term arbitrage traders drive the ex-dividend day security price-change-to-dividend ratio toward the value of one even if long-term investors who are affected by the dividend clientele effect have a generally lower, or higher if they have a preference for dividend income, equilibrium price-change-to-dividend ratio.

Long-term investors take advantage of the short-term traders' actions of equilibrating the security price-change-to-dividend ratio closer to one; long-term investors who prefer dividend income can sell their ex-dividend shares more expensive while those who don't like dividend can buy the ex-dividend shares cheaper.

Finally, Bhardwaj and Brooks (1999) conclude the following four combinations of dividend tax clienteles and arbitrage conditions to predict the ex-dividend day security price behavior from the empirical results.

1. If only the long-term trader dividend tax clientele effect holds, the security price-change-to-dividend ratio is less than one for preferential treatment of capital gains and greater than one for preferential treatment of dividend income.
2. If only the short-term trader arbitrage phenomenon holds, the security price-change-to-dividend ratio is bounded above or below the value of one by the requirement to cover transaction costs. In the absence of transactions costs, the security price-change-to-dividend ratio has a value of one. Market imperfections, such as the bid-ask spread, unless controlled for, induce noise to this process. With a positive drift in stock prices caused by reinvestment of earnings, the expected the security price-change-to-dividend ratio will be greater than or equal to one.
3. With the combined holding of both the dividend tax clientele and transaction costs phenomenon, the security price-change-to-dividend ratio is bounded by the requirement of transaction costs recovery with a value less than one caused by the dividend tax clientele effect when preferential capital gains treatments hold.

The security price-change-to-dividend ratio is bounded by the requirement of transaction costs recovery with a value greater than one caused by the dividend tax clientele effect when preferential dividend income treatments hold. In the presence of dividend tax clientele effect and short-term trader arbitrage phenomenon, the likelihood of finding a statistically significant variation of the security price-change-to-dividend ratio from one decreases.

4. If neither an arbitrage phenomenon or dividend tax clientele effect holds, the security price-change-to-dividend ratio has an expected value equal to one where deviations from one will not be bounded by transaction costs.

In spite of the challenges of above authors, Elton and Gruber (1970) provide evidence that, despite the existence of short-term traders who challenge the proves of the existence of dividend tax clientele effect by observing the ex-dividend day security price behavior, the indirect test of dividend clientele effect still proves its existence, after adjusting their data by the movement of the market index.

2.3 Theory and Empirical Evidence on the Impact of Ex-dividend Day Security Price Decline and Dividend Clientele Effect on the Stock Option Pricing

Dividends impact option pricing in several ways. Option values are derived from the underlying asset values, which are stocks in the case of this paper. Most stock underwriting options pay cash dividends. The stock value declines on the ex-dividend day to eliminate arbitrage opportunities as stated previously. Since stockholders who buy the stock on or after ex-dividend day will not have the right to the next dividend payment, they have to pay the share cheaper to compensate. Elton and Gruber (1970) demonstrates that the magnitude of this price decline depends mainly on the dividend tax clienteles, with some influences of trading by sort-term arbitrageurs. Therefore, the dividend tax clienteles of a public corporation affect its stock options value.

However, the main difference between stockholders and option holders is that with the latter, they are not entitled to dividend payments at any time, they only have a claim against the capital gains portion of the total stock return. It is this asymmetry in the returns between capital gains and dividends in options and equities that creates the difficulty in option pricing. This asymmetry is one of the important reasons why American style call options can be more valuable than European style call options, which will be explained in detail later. Once the security goes ex-dividend and its price declines, investors who already have the stock on the ex-dividend day see their share become less valuable, but they have collected the dividend to compensate for that loss. Moreover, when the stock goes ex-dividend and its value drops, its call option value declines as well since it is derived from the stock price. The option holders, on the other hand, do not get this compensation (i.e. dividend payment), but still see their options value decline.

Merton (1973) first points out the alteration of the process that stock prices follow because of the presence of dividends, but it has been ignored by subsequent authors of option pricing models, for example, Roll (1977), Geske (1979) and Whaley (1981) who have simply assumed some particular form for the stock price process and ignored any explicit dividend effects on the process. To sum up, the payment of a cash dividend of the underlying stock impacts the option's value in two important ways: the form of the process that stock prices follow is altered by dividend payments and the incentive to exercise the option early is altered for American options.

Equity call options holders are not entitled to receive the cash dividend paid to owners of the underlying stock, unless they exercise the calls prior to the ex-dividend day and purchase the stock at the determined strike price instead of cash settlement in order to have the right to the next dividend. Therefore, American call options provide some partial protection against the stock price decline on the ex-dividend day since American call options holders have the right to exercise their options before maturity. American call options holders have the possibility to capture a greater difference between the underlying stock price and the option strike price before the stock price decline on the ex-dividend day or convert the option to stock in time to receive the dividend.

However, the natural protection provided by the American call option is imperfect as compared to a perfectly protected European call option. The standard European options, on the other hand, don't give the right to exercise before maturity. The European call options holders will see the value of their options decline on the underlying stocks' ex-dividend day without the possibility of capturing the dividend. The dividend payout protected option can compensate for this disadvantage of European options in case of a dividend paying underlying asset and give European options a complete instead of partial protection.

Geske, Roll and Shastri (1983) point out that at that time, the exchange-listed options offer no protection against either stock or cash dividends but, traditionally, options traded in the over-the-counter market have offered cash dividend protection clauses. The typical adjustment, which they call OTC protection, is to reduce the option's exercise price by the amount of the dividend. The reasoning behind the OTC protection is as follows: because of the stock price decline on the ex-dividend date, cash dividend payments reduce the value of call options and raise put option values, regardless of whether the option is European or American. In frictionless markets without taxes or transaction costs, the stock price should decline by exactly the amount of the dividend on the ex-dividend date. Knowing this possibility, the over-the-counter market attempts to protect option traders by reducing the option's exercise price by exactly the amount of the dividend on the same date. This protection completely remove the advantage of early exercise of American call options.

Nevertheless, Merton (1973) shows that this OTC protection adjustment is incorrect and OTC protected options have market values which differ systematically from Black-Scholes values for European options on non-dividend paying stocks. Assuming that the stock price drops by the amount of the dividend on the ex-dividend date, both put and call options with OTC protection will have lower market values than otherwise equivalent options on stocks without dividend payments. The pricing difference is related to both the variance of the underlying stock return and to time until expiration of the option, but it is quite small in dollar amount.

Merton (1973) proposed that a perfect protection to an option against any dividend payment requires that a call option to be adjusted so that the dividend payment results in a proportionally greater claim on shares of stock for the same exercise price. For example, a stock pays a 1 dollar dividend and the ex-dividend price is 10 dollars. Merton's dividend payout protection adjustment requires that the call option holder now has a claim on ten percent more shares of options that have the same strike price. This perfect dividend payout protection will result in the option’s return being unaffected by dividend payments. Similarly, perfect dividend payout protection on a put option suggests that the put holder has to give up more shares to claim the given exercise price. As in the above example, with a dividend equal to ten percent of the ex-dividend price, a put option holder has to give up ten percent more shares in exchange for the original exercise price. Since the value of a protected put option is less than the value of an unprotected put option on the same stock, because they have to give up some gains by diminishing the claimed shares, and American style options are more valuable than European style options, an unprotected American put is always more valuable than either an unprotected European put option on a dividend paying stock or a dividend payout protected European or American put option on the same stock.

Adams, Wyatt and Walker (1994) proposed a single basic model which can be used to value both American and European options (puts and calls) on dividend paying stocks, which allows for a common dividend adjustment for both European and American puts and calls rather than the separate adjustment process. They also demonstrate that the value of an unprotected American call written on a dividend paying stock is bounded by the value of two European call options: the value of an unprotected European call on the lower side and a protected European call on the upper side. This proposition is very intuitive. Since the unprotected American call offers partial although incomplete protection against payouts, its value cannot be less than the unprotected European call which is the lower bound. Additionally, the unprotected American call is never more valuable than the protected American call. So, the dividend payout protected American call is an upper bound for the unprotected American call. As long as investment and financing policies are fixed, the American or European call option can both be protected against dividend payout which results in the American or European call being valued as if the firm were restricted from making dividend payouts since a perfect dividend payout protected option (put or call) is equivalent to an option on a non-dividend paying stock. The dividend payout protected European and American options will hence have the same value as long as the hypothesized conditions are verified. The dividend payout protected European option, therefore, becomes the upper bound for the unprotected American call. The boundary conditions can then be written as follows: protected European call > unprotected American call > unprotected European call.

While the boundary conditions for the unprotected American call can be tightened to the range between the value of an unprotected European call and a protected European call, the unprotected American put bounds are not so simple. As previously mentioned, the protected American put option and the American put option on the stock of a firm without dividend payouts have the same value. Dividend payout protection reduces the value of a put, because the put holder must give up more shares to obtain the same exercise price. Clearly, under increasing dividend payout, the value of the unprotected put, American or European, increases since the payment of a dividend reduces the capital gains from the stock. The relative value cannot be determined, but clearly, the unprotected American put is more valuable than the dividend payout protected or unprotected European put option. Geske and Shastri (1985) show, however, that due to high dividend payouts, it may still be optimal to hold the unprotected American put to maturity. This results in small early exercise put gains, which is defined as the percentage of the American option price in excess of the corresponding European price, over the unprotected European put.

2.4 Special Considerations in the Valuation of American Call on Dividend-Paying Stocks

The call option pricing model derived by Black and Scholes (1973) includes the 4 following assumptions:

1. All individuals can borrow or lend without restriction at the instantaneous risk-less rate of interest, *r*, and that rate is constant through the life of the option, *T*.
2. Stock price movement through time is described by the stochastic differential equation: $dP/P = pdt + adz$, where *p* is the instantaneous expected rate of return on the stock, *a* is the instantaneous standard deviation of stock return (assumed to be constant over the life of the option), the *dz* is the increment of a standard Brownian motion.
3. The capital market is free of transaction costs (e.g., brokerage fees, transfer taxes, short selling and indivisibility constraints) and tax differentials between dividend and capital gain income.
4. The stock pays no dividends during the option's time to expiration.

The above assumptions are not realistic in the real capital markets. Specifically, the assumed absence of income distributions, or dividends, on the underlying security makes the Black and Scholes formula to overstate the value of an American and European call option on a stock with dividend payments during the option's time to expiration. A dividend paid during the option's life reduces the stock price at the ex-dividend instant, and thereby reduces the probability that the stock price will exceed the exercise price at the option's expiration. Whaley (1981) states that in order to introduce a discrete dividend payment into the option pricing problem it is usually assumed that the stock pays a certain dividend, *D*, at the ex-dividend instant, *t* ($t < T$ which is the maturity of the option), and the stock price simultaneously falls by a known amount, *bD*. The approximation obtained by adding this assumption and substituting the stock price net of the present value of the escrowed dividends into the Black-Scholes model is shown to induce spurious correlation between prediction error and (1) the standard deviation of stock return, (2) the degree to which the option, is in-the-money or out-of-the-money, (3) the probability of early exercise, (4) the time to expiration of the option, and (5) the dividend yield of the stock.

In fact, there are two approximation formulas that are used to estimate an option value and that considered the dividends on the underlying security. The first, the dividend-adjusted Black-Scholes (1973) approximation for European call options, is computed by substituting the current stock price, less the present value of the dividend paid during the option's life, as the stock price parameter. That is:

$$c(S,T,K) = \widehat{S}\mathcal{N}(d_1) - Ke^{-rT}\mathcal{N}(d_2)$$

$$\begin{aligned} d_1 &= \frac{\ln\frac{\widehat{S}}{K} + \left(r + \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}} \\ d_2 &= d_1 - \sigma\sqrt{T} \end{aligned}$$

$$\widehat{S} = S - \sum_{i=1}^{n} d(t_i)\, e^{-rt_i}$$

where *c(S,T,K)* is the option price, *S* is the underlying stock price, *K* is the strike price, *T* is the maturity, *r* is the risk-free rate, *σ* is the volatility, $N(d_1)$ is the cumulative standard normal distribution function of d_1, *n* is the total number of dividends, t_i is the time to the ex-dividend day of *i* dividend and $d(t_i)$ is the dividend amount on t_i.

The second, the Black's approximation (1975) for American call options, is computed by taking the larger of the dividend-adjusted Black-Scholes European option value where the option is assumed to be exercised just prior to the last ex-dividend instant and the standard dividend-adjusted Black-Scholes European option value (Geske and Roll 1984). That is:

$$C(S,T,K) \simeq \max\left(c\left(S-\sum_{i=1}^{n-1} d_i e^{-rt_i}, t_n, K\right), c\left(S-\sum_{i=1}^{n} d_i e^{-rt_i}, T, K\right)\right)$$

where *C(S,T,K)* is the American option price, *c* is the dividend-adjusted Black-Scholes European option price, *S* is the underlying stock price, *K* is the strike price, *T* is the maturity, *r* is the risk-free rate, *n* is the total number of dividends, t_i is the time to the ex-dividend day of *i* dividend, d_i is the *ith* dividend's amount and t_n is the maturity of the last ex-dividend day before maturity.

The intuition behind Black's approximation is that the only case where it is valuable to exercise an American call option on dividend-paying stock prior to its maturity is at the instant just before the last ex-dividend day. Therefore, the Black's approximation calculates the European option value for both scenarios, when the option is exercised just prior to the last ex-dividend instant and when the option is exercised at maturity, then takes the greatest value.

2.5 Stock Trading Strategy Around Ex-dividend Day

The most common stock trading strategy around ex-dividend day is the dividend-capture trading. The practice of dividend-capture trading is defined as the practice of buying a stock shortly before its ex-dividend day and selling it soon after. Dividend-capture practice is particularly widespread within taxable corporations. In dividend capture trading, a tax-paying investor enters into a repurchase agreement with a non-tax-paying entity such as a pension fund or endowments, selling a stock before the ex-dividend date and buying it back afterward.

If this practice has no restriction, it would reduce or even eliminate the Elton and Gruber dividend clientele effect since each clientele class would trade with each other to achieve their goal, therefore making it difficult to detect heterogeneous clientele even when they actually exist. However, there is an inhibition, which is the wash sale rule. The wash sale rule states that the gain made from a sale followed soon by a repurchase of the same asset will be taxed at ordinary rates, not at capital gains rates.

In order to examine the existence and the importance of dividend-capture trading, Karpoff and Walkling (1990) test for cross-sectional relations between ex-dividend day abnormal returns and bid-ask spreads for the stocks traded on NASDAQ. They find that ex-dividend day abnormal returns and bid-ask spreads are positively related; moreover, this relation increases as dividend yield increases and indeed is the strongest in high-yield stocks. Furthermore, this relation does not appear in a return sample of non-ex-dividend days. These findings verify the existence of dividend-capture trading and that the trading strategy affects the ex-day returns of at least some, particularly high-yield, NASDAQ stocks. They provide evidence that dividend-capture trading is an important strategy used by investors.

Evidence of persistent dividend-capture trading is important for several reasons. First, it implies that such trading affects the ex-dividend day returns of at least some stocks. For these stocks, ex-dividend day returns reflect marginal investors' trading costs, not their marginal tax rates, as argued by Elton and Gruber (1970), Litzenberger and Ramaswamy (1980), and others.

Second, Karpoff and Walkling (1990) demonstrate that evidence of dividend-capture trading when ex-dividend day returns are positive implies that ex-dividend day returns are affected by the personal tax treatment of dividend income. This contradicts previous arguments that ex-dividend day returns are invariant to changes in the tax treatment of dividends and capital gains as also suggested by Miller and Scholes (1982).

Third, dividend-capture trading can explain empirical findings by Lakonishok and Vermaelen (1986) that trading volume increases around ex-dividend days, particularly for high-yield stocks, and that ex-dividend day returns for high-yield stocks are larger after a 1984 U.S. tax-law change that increased the cost of dividend capture. Moreover, Blau, Fuller and Van Ness (2011) also find abnormal short selling around ex-dividend date. This may be explained by the return pattern around ex-dividend days documented by Lakonishok and Vermaelen (1986). These authors suggest that demand for a particular stock by dividend capture traders drives stock prices above their fundamental value, thus provide a profitable trading opportunity for short sellers. Consistent with this conjecture, Blau, Fuller and Van Ness (2011) find that both the level of short selling and the return predictability of short selling is significantly higher on and after the ex-dividend day.

A fourth reason to examine dividend-capture trading is that it may explain some ex-dividend day return anomalies. Michaely (1991) finds that the dividends and capital gains tax rates implicit in ex-dividend day returns as suggested by Elton and Gruber indirect test vary even across stocks with similar dividend yields, indicating that ex-dividend day returns are not explained solely by dividend tax clientele effects. He concludes that dividend tax clientele effects do not fully explain changes in ex-dividend day returns after the U.S. Tax Reform Act of 1986. The missing factor, in this case, might be dividend-capture trading. The presence of dividend-capture trading implies a more complicated picture of ex-dividend day returns regarding dividend tax clientele effect.

2.6 Option Trading Strategy Around Ex-dividend Day

As stated above, equity call options holders are not entitled to receive the cash dividend paid to the owners of the underlying stock, unless they exercise the calls prior to the ex-dividend day and purchase the stock at the determined strike price instead of cash settlement in order to have to right on the next dividend. Only American style options allow this early exercise, before maturity. Roll (1977) analyzes American call options on stocks with known discontinuous future dividends. He points out that there is a trade-off between the cost of early exercise of the option, which is the call premium that would be lost if the American call option is exercised, and the expected drop in the value of the underlying asset, against which the option is unprotected. Consequently, the same paper suggests that most owners of American style call options have an incentive to exercise immediately before the stock goes ex-dividend. Essentially, exercise on the last cum-dividend day will be optimal if the value of the dividend exceeds the “time value” remaining in the option after the dividend, representing the remaining call premium. This is most likely to be the case for deep-in-the-money and short-term call options.

However, previous research indicates that option owners do not always follow the optimal exercise strategy. Kalay and Subrahmanyam (1984) and Poteshman and Serbin (2003) document that option holders sometimes exercise when they should not, as well as failing to exercise when they should. If some option owners fail to exercise optimally on the last cum-dividend day, this generates a windfall benefit to those option writers who remain with intact written positions after all exercises have been assigned. In cases where it is not optimal to exercise the option, the assumption of no profit opportunities in the stock market implies that the option price should not be predictable because of the presence of the dividends. In other words, a predictable drop in the price of the option implies profit opportunities to the option writers. Hao, Kalay and Mayhew (2010) estimate that in the exchange-traded equity option market in the United States from 1996 to 2006, more than 40% of the American call options that should have been exercised before maturity remain unexercised.

In the same paper realized in 2010, Hao, Kalay and Mayhew examine the behavior of call options around the underlying stock's ex-dividend date and propose a trading strategy known as a dividend play. In the setup of the dividend play strategy, market makers, traders and other arbitrageurs extract the gains from abnormal returns from unexercised options with windfall benefit, taking these benefits away from the original option writers. The strategy exploits the mechanics of the allocation algorithm employed by the clearinghouse to assign option exercises, and involves two parties executing large offsetting buy and sell call option transactions on the last cum-dividend day.

Hao, Kalay and Mayhew (2010) also demonstrate that the dividend play strategy is more profitable when there is a deep-in-the-money, short-term call option on a stock that pays a high dividend. In these cases, early exercise of American style call options is optimal and the options have a significant unexercised open interest on the last cum-dividend day. Their findings indicate that this strategy is used in the real markets by markets' participants and its existence is verified in the American call options' trading volume observed immediately prior to ex-dividend days on stocks that pay large dividends. In fact, they provide evidence that this trading activity generates substantial trading volume in call options, in some cases large enough to significantly affect statistics such as average daily volume, put-call ratios and exchange market share.

Hao, Kalay and Mayhew (2010) describe the execution of the dividend play strategy as follows. Trader 1 buys a large number of calls from trader 2, who immediately buys an offsetting position back from trader 1. Because the two trades are exactly offsetting and executed at the same price, the initial position has zero risks and requires no capital. The two traders then exercise all their long positions. At the end of the day when the clearinghouse adjusts its accounts to reflect the daily activity, purchases processed before exercises are assigned, but sales that close out open positions are processed after assignment. Thus, when the clearinghouse assigns the daily exercises across all option writers, the resulting assignments will close out a large portion of the two traders' new short position, but will also close out a large portion of the preexisting short positions. The larger the positions taken by the two traders, compared to the preexisting open interest, the higher the proportion of preexisting shorts that will get forced out of their position, and the greater the proportion of the benefit extracted by the traders.

3. Methodology - Hypothesis and Experimental Design

3.1 The Dividend Clientele Effect and the Equity Markets

This paper contributes to find if the option markets use the same set of information than equity markets with respect to the dividend clientele effect. For this matter, the Elton and Gruber (1970) approach is applied to the data sample in the first place to verify the existence of dividend clientele effect and its impact on equity price drop on the ex-dividend day. Recall that the last day that investors can buy a stock with the rights to receive an earlier declared dividend is referred to as the last cum-dividend day. The ex-dividend day stock price behavior is examined by computing the ratio of the actual ex-dividend day equity price drop D (the closing price of the security on the last cum-dividend day $S0$ - the closing price of the security on the ex-dividend day $S1$) on the actual amount of dividend distributed d. That is:

$$D = S0 - S1$$

$$ratio = D/d$$

The ex-dividend day closing security price is adjusted for the movement due to market factors using the return on the S&P 500 index times the beta of the firm so that only the dividend effect is reflected in the ex-dividend day closing price. Empirically, for pragmatism reasons, after the adjustment, if the closing price of the security on the ex-dividend day is still higher than the closing price of the security on the last cum-dividend day, this pair of information will be removed from the data base since it contains too much noise and is not useful in finding results for the objectives of this research.

In order to estimate the different betas used to adjust each ex-dividend day closing security price of each firm, a simple theoretical regression is used. The daily log-returns adjusted for dividends of each firm 249 business days before each ex-dividend day are regressed, including a constant term, *alpha*, on the daily log-returns of the S&P500 total return index of the same days and the slope is the beta estimated for that ex-dividend day of that specific firm. Thereafter, the following adjustment will be applied to the closing security price of each firm on each ex-dividend date: given 0 the closing price of the last cum-dividend day and 1 the closing price of the ex-dividend day; the prices of the S&P500 observed are *I(0)* and *I(1)* and the return is *RI = I(1)/I(0)-1*; in the same way, the prices of the firm observed are *s(0)* and *s(1)* and the return is *RS = s(1)/s(0)-1*; the adjustment hypothesis is *RS = alpha + beta x RI*. Therefore, each ex-dividend day closing security price of each firm is adjusted with the following formulas:

if *s(1)/s(0)-1 = alpha + beta x RI*

then *s(0) = s(1) / (1 + alpha + beta x RI)*

s(0) = S1

where *s(0)* represents the closing security price of the last cum-dividend day after the price drop caused by the dividend and *S1* represents the ex-dividend day closing security price adjusted for the movement due to market factors.

Recall that Elton and Gruber (1970) differentiate two components of dividend clientele effect that drive the ex-dividend day stock price drop to be different than the amount of dividend: the fiscal distortion and the actual dividend clientele effect. Fiscal distortion is the effect that dividends and capital gains are taxed at a different rate. If all investors in financial markets have the same tax rate for dividends and for capital gains that are different, the following equation holds and is different than 1:

$$D/d = (1 - td) / (1 - tg)$$

where D is the actual ex-dividend day equity price drop, d is the actual amount of dividend distributed, td is the tax rate on dividends and tg is the tax rate on capital gains. Therefore, if td and tg is the same for all investors in the financial markets, it is possible to perfectly predict D/d, thus predict the actual ex-dividend day equity price drop D. However, in the real financial markets, td and tg are not the same for all investors. The marginal investor reflects the supply and demand movements of a company's stock based on the tax preferences for dividends versus capital gains. This effect is the actual dividend clientele effect and it is what brings the unpredictability in the actual ex-dividend day equity price drop that the market anticipates.

Therefore, assuming a market without arbitrage opportunities, without the dividend clientele effect and net of the fiscal distortion, the security price drop on the ex-dividend date due to dividend should be exactly the amount of dividend. Otherwise, the ratio of the actual price drop on the ex-dividend date on the actual amount of dividend is significantly different than 1.

However, it is known that the fiscal distortion exists given that dividends and capital gains are taxed at a different rate in the real fiscal world. Therefore, if the existence of dividend tax clientele effect is verified, the ratio *D/d* should also be statistically significantly different than *(1 - td) / (1 - tg)*, the actual effect of fiscal distortion that is predictable by the markets if all investors in the financial markets have the same tax rate on dividends and capital gains. In this research, the marginal nominal tax rate on dividends and capital gains used for the calculation of the ratio *(1 - td) / (1 - tg)* will be the marginal rates for individuals with the highest bracket's income, assuming low-income equity holders are the minorities among the shareholders and their trading affects minimally the share price.

In the United-Stated, where the firms of my data sample are based, the marginal tax rate on dividends for individuals with the highest bracket's income is 35% from 2005 to 2012 and 39.6% from 2013 to 2014; and the marginal tax rate on capital gains for individuals with the highest bracket's income is 15% from 2005 to 2012 and 20% from 2013 to 2014.

Here is the table representing the marginal tax rate on dividends and capital gains for individuals with the highest bracket's income from 2005 to 2014, as well as the ratio *(1 - td) / (1 - tg)* calculated from these rates for the same calendar years.

Table 1

Marginal tax rate on dividends and capital gains for individuals with the highest bracket's income from 2005 to 2014

Year	td	tg	*(1 - td) / (1 - tg)*
2005	0.35	0.15	0.7647
2006	0.35	0.15	0.7647
2007	0.35	0.15	0.7647
2008	0.35	0.15	0.7647
2009	0.35	0.15	0.7647
2010	0.35	0.15	0.7647
2011	0.35	0.15	0.7647
2012	0.35	0.15	0.7647
2013	0.396	0.2	0.7550
2014	0.396	0.2	0.7550

The ratio of the actual price drop on the ex-dividend date on the actual amount of dividend is calculated for each security on each of its last cum-dividend date and ex-dividend date pairs of its dividend calendar and compared with *(1 - td) / (1 - tg)* in order to verify the existence of dividend clientele effect for the data sample used in this research.

A lot of past and recent researches document on the existence of dividend clientele effect and its impact on equity price drop on the ex-dividend day as mentioned in the literature review section of this paper. Most of them indicate that the dividend clientele effect does exist. Thus, the ratio of actual price drop on the ex-dividend date on the actual amount of dividend is proven to be different than *(1 - td) / (1 - tg)* in the literature. The hypothesis of this thesis with respect to the existence of dividend clientele effect is in the same direction than documented in the literature. Therefore, the ratio of the actual price drop on the ex-dividend date on the actual amount of dividend, in this case, is expected to be significantly different than the ratio of *(1 - td) / (1 - tg),* the fiscal distortion effect that is predictable by the markets.

3.2 The Dividend Clientele Effect and the Option Markets

As stated in the previous section, on the ex-dividend day, both option holders and stockholders of one same company see the equity shares decline in value. However, as opposed to equity holders, options holders don't have the right to the dividend issued to compensate for the stock price drop that potentially affects the value of their holdings. Therefore, the option market implicitly price this future price drop caused by dividend in the option price in order to avoid any penalties to option holders and arbitrage opportunities on the ex-dividend day.

The information implied in the option markets are obtained using the dividend adjusted Black and Scholes option evaluation model. From the closing option price *c0* (the average of option's closing best bid price and closing best offer price) on the last cum-dividend day, the closing security price *S0* on the last cum-dividend day and the implied volatility σ of the option on the last cum-dividend day given in the data base of *OptionMetrics*, and using the dividend adjusted Black and Scholes option evaluation model (since there will be no dividend left until maturity) below:

$$c_0\,(S,T,K) = S_0{*}N\,(d_1) - Ke^{-rT}\,N\,(d_2)$$

$$d_1 = \frac{ln\,\frac{S_0^*}{K} + \left(r + \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}}$$

$$d_2 = d_1 - \sigma\sqrt{T}$$

$$S_0^* = S_0 - D_{imp}e^{-r*\frac{1}{365}}$$

(where *K* is the option's strike price, *r* is the continuously compounded annualized risk-free rate on the last cum-dividend day and *T* is the number of days to maturity of the option) the «implied price drop» of the option, *Dimp*, priced by the option market on the last cum-dividend day is obtained with a solver.

The annualized daily risk-free rate for each date are found by matching the daily U.S. Treasury bills yield curve from 2005 to 2014, using the publication of St-Louis Federal Reserve, with the maturity of the option on that specific date. When the maturity of an option does not match any point on the curve, an interpolation is used by taking the weighted average of two points of the curve where the maturity is found in between. Moreover, the interest rates given by St-Louis Federal Reserve for U.S. T-bills are simple discrete interest rates whereas the risk-free interest rate used in the Black and Scholes option valuation formula is continuously compounded. Therefore, all matching interest rates are transformed into continuously compounded interest rates using the following formulas:

$$1/(1 + X^*T) = exp(-Y^*T)$$

$$Y = (1/T)\ ln(1 + X^*T)$$

where *X* is the simple discrete interest rate, *Y* is the continuously compounded interest rate and *T* is the maturity of the interest rate.

One gap, and also a strong hypothesis, of this method is that the Black and Scholes option evaluation model is used to value American style options. However, since only call options are considered in this paper and each option considered has only one known dividend until maturity, it is still appropriate to use this methodology when adjusted for the dividend.

The implied equity price drop priced in the option market, *Dimp,* is compared with 0 in the first place to see if the option market indeed implicitly price the future price drop caused by dividend in the option price in order to avoid any penalties to option holders. If it does, which is the expected case, the implied price drop priced in the option market is expected to be significantly different than 0.

The implied equity price drop priced in the option market is also compared with the actual dividend amount *d* to see if the dividend clientele effect affects the implicit adjustment for dividend in option pricing prior the ex-dividend day. If it does, which is the expected case, the implied price drop priced in the option market is expected to be significantly different than the actual dividend amount.

Moreover, the implied equity price drop priced in the option market, *Dimp,* is finally compared with the actual ex-dividend day equity price drop *D* found in the first step of this methodology to determine if the option markets use the same set of information than equity markets with respect to the dividend clientele effect.

Here a significance test for a normal distribution (t-test) is used for the three comparisons above. Since the significance tests are based on a strong hypothesis of normal distributions, the robustness of the results will be verified with a non-parametric statistic test: the Wilcoxon signed-ranks test for large samples.

The hypothesis of an efficient option market suggests that there should not be a significant difference between the implied price drop priced in the option market and the actual ex-dividend day price drop; all information implied in the equity markets with respect to the dividend clientele effect should be taken into account in the option markets. If there is a significant difference between the implied price drop priced in the option market and the actual ex-dividend day price drop, it means that the option market is «surprised», at least at some level depending on the difference, by the real dividend clientele effect that has on the actual price drop on the ex-dividend day, thus partial information considered in equity markets are ignored in option markets. This difference is examined for options of each company in the data sample on each date of its last cum-dividend dates of its dividend calendar.

If there is a significant difference, the options examined are then sorted into two categories: companies with options that have generally a greater difference between the implied price drop and actual price drop for each date of its last cum-dividend dates of its dividend calendar; and those with options that have generally a smaller difference between the implied price drop and actual price drop for each date of its last cum-dividend dates of its dividend calendar. The thresholds for the separation will be determined according to the mean of the differences between the implied price drop and actual price drop.

The ex-post trading strategy will be based on either the implied price drop is smaller or bigger than the actual price drop, thus is the difference between the implied price drop and actual price drop is positive or negative when calculating *Dimp - D*. If the implied price drop on the last cum-dividend day is found to be smaller (*Dimp - D* negative) than the actual price drop on the ex-dividend day, it means the option markets price a smaller future price drop than what it will actually be in the option price, thus the call option price is more expensive than it should be and will be adjusted downward on the ex-dividend day. On the other hand, if the implied price drop on the last cum-dividend day is found to be bigger (*Dimp - D* positive) than the actual price drop on the ex-dividend day, it means the option markets price a greater future price drop than what it will actually be in the option price, thus the option price is cheaper than it should be and will be adjusted upward on the ex-dividend day.

For example, if the implied price drop on the last cum-dividend day is found to be bigger than the actual price drop on the ex-dividend day, for each option of each category, the one day return is calculated by taking the difference between the closing option price (closing best bid price *cbb*) on the ex-dividend day *EDD* and the closing option price (closing best offer price *cbo*) on the last cum-dividend day *LCDD* divided by the closing option price (closing best offer price *cbo*) on the last cum-dividend day. That is:

(EDD cbb - LCDD cbo) / LCDD cbo

The idea behind this calculation is to find what would be the profit of an ex-post trading strategy: if one investor buy the «cheaper» option on the last cum-dividend day and sell it on the ex-dividend day. Note that this trading strategy might not be implementable in practice once the transaction costs are considered. More details will be explained further.

Subsequently, the mean return of the option category with a greater difference between the implied price drop and actual price drop, as well as the one for the whole option sample, are calculated and compared. Comparing the results, the fact that this category generates more profit ex-post can be concluded. Calculating and comparing the mean return of the category with a greater difference between the implied price drop and actual price drop demonstrates the return will be bigger if the market is more surprised by the real dividend clientele effect that affects the actual price drop on the ex-dividend day, meaning if the difference between the implied price drop and actual price drop is bigger. It is expected that higher the difference between the implied price drop and actual price drop on the ex-dividend day, the greater would be the return using the ex-post trading strategy proposed in the above paragraph. Therefore, there is a better opportunity to make profits by setting an option trading strategy with this option category.

Furthermore, calculating the mean return for the whole option sample, no matter the difference between the implied price drop and actual price drop, verifies if the proposed strategy is also effective for the whole sample. In other words, ex-ante, without knowing the mean of the differences between the implied price drop and actual price drop, is it still possible to generate profits for the whole option sample with the same trading strategy. If it is still possible, it means the strategy can be generalized and there is a possibility that it can be applied in trading in the real option markets.

4. Data Extraction and Description

4.1 Data Extraction

The data sample of this research contains companies that have been in the S&P500 index and the time window for this study is from 2004 to 2014. Specifically, this paper only considered those companies that distribute dividends, have American exercise style options and for which the option prices are available. Only American style options are used here because they are the most common stock options; data on European style stock options, even available, can be less reliable. Due to the large number of firms that have been on S&P500 since its creation and the large amount of daily data available on security and option prices, only firms that have been on S&P500 from 2004 to 2014 will be part of the data sample.

From *Wharton Research Data Services (WRDS)*, the dividend calendar of the ordinary stocks from 2005 to 2014 of the retained firms was extracted. It was then merged with the daily security and option prices of those firms on the last cum-dividend dates and the ex-dividend dates as indicated in the next paragraph. For this paper, the last cum-dividend day is defined as the business day before the ex-dividend day. The historical daily closing security prices of the retained firms from 2004 to 2014 along with the historical daily closing prices of the S&P500 index from the same time window will also be extracted for the beta estimation regression discussed in the previous section. The historical daily closing security and S&P500 index prices of the extra year of 2004 will serve to estimate the beta of the firms on their ex-dividend dates of the year of 2005.

From *OptionMetrics*, the historical daily security prices non-adjusted for dividends and the historical daily option prices from 2005 to 2014 of those companies were extracted. The non-adjusted security prices were taken in order to reflect the dividend impact on the ex-dividend day equity price drop. In addition, for simplicity and liquidity purpose, only at the money American call options with 1 month maturity are used. At the money options are chosen because they are more liquid and the effect of dividends in their pricing is better reflected. Therefore, all information on put options is filtered out from the sample. Moreover, only options with available implied volatility on the last cum-dividend dates and the ex-dividend dates will be retained in the sample; those are options with standard settlement (meaning options with 100 shares of the underlying security to be delivered at exercise per tick and with strike price and premium multipliers of $100 per tick). Finally, options with a bid of 0 are also eliminated from the sample because these options are too illiquid and it doesn't give an indicative market price when taken the average of options' closing best bid price and closing best offer price.

From the options retained so far, in order to keep only one at the money option with more and less 1 month maturity on each ex-dividend date and last-cum dividend date pair for each firm, only the price of the option with strike price that is the closest to the closing security prices and with days to maturity that is the closest to 30 days at each last cum-dividend date is considered in the sample. It is really important to not choose an option with a maturity longer than 3 months because there are chances that there is another dividend before maturity considered in the option price. In order to make sure that no additional dividend is considered before the option's maturity, the next ex-dividend date is also compared with the expiration date of the selected option for each ex-dividend date of each firm considered. The option's days to maturity should be shorter than the number of days until the next ex-dividend date. When it is not the case, the option is eliminated. This operation allows to verify that the selected option expires before the next ex-dividend date where another dividend is considered. The price of the same option retained in the previous step at each ex-dividend date is also considered in the sample.

Once all these filters are applied to the data extracted from *OptionMetrics* and *Wharton Research Data Services (WRDS)*, the final data base for this research is constructed. Moreover, the annualized daily implied volatility of each retained options, the annualized daily risk-free rate for each last-cum dividend date and ex-dividend date of each firm in the sample, the dividend amount of each retained firm on each ex-dividend day and the SIC code of each of those firms are also available in this data base and is useful in the methodology of this research as described in the previous section. The annualized daily risk free rate for each date are found by matching the daily U.S. treasury bill yield curve from 2005 to 2014, using the publication of St-Louis Federal Reserve, with the maturity of the option on that specific date. There are some dates (105 days over 9 years) from 2005 to 2014 where the interest rates of the daily U.S. Treasury bill curve are missing from the St-Louis Federal Reserve data base.

When it happens, the daily U.S. Treasury bill curve of the day before is used, considering that it is a fair approximation and the interest rate is a parameter that has a very small influence on the results.

In a few cases, there are two different dividend amount for the same firm on the same ex-dividend date. In those cases, the firm has distributed an extraordinary dividend along with the usual, quarterly for example, dividend. Thus, when it happens, the 2 amounts are added together for this firm on this specific ex-dividend day.

The final data base contains closing security prices for each company on each date of its last cum-dividend dates and ex-dividend dates. As for options (American at the money call options with more and less 1 month maturity) prices, it is presented in the form of closing best bid prices and closing best offer prices for options of each company in the data sample on each date of its last cum-dividend dates and ex-dividend dates. An additional column is added to the data base by taking the average of each option's closing best bid price and closing best offer price. Those different option prices have different uses further in the calculations as described in the methodology section.

Finally, from the data base described, the ex-dividend day closing security price is also adjusted for the movement due to market factors using the return on the S&P 500 index times the beta of the firm as detailed in the previous section and presented in a separate column. After this adjustment, if the closing price of the security on the ex-dividend day is higher than the closing price of the security on the last cum-dividend day, all information on the security and the option of that firm for this pair of last cum-dividend day and ex-dividend day will be removed from the data base.

4.2 Data Description

From all the firms that have been on S&P500 from 2004 to 2014, after eliminating those that did not distribute any dividend and those that did not have American exercise style options, 574 firms remain in the final data sample of this research. Considering each ex-dividend date and last-cum dividend date pair on each firm's dividend calendar from 2005 to 2014 as a single event studied, the final data base for this paper contains 15,605 events, thus 15,605 options since only one option per event were retained, before eliminating the events for which the closing price of the security on the ex-dividend day is higher than the closing price of the security on the last cum-dividend day. After this elimination, 10,342 events/options remain in the final data base relevant for the rest of the calculations of this thesis. Therefore, approximately 33.3% of the initial events are noisy and irrelevant for the purpose of this paper.

Here is the descriptive statistics of the complete list of variables that will be discussed in the results and analysis section.

Table 2

Descriptive statistics table 1

	Mean	Median	Mode	Standard Deviation
Dividend Amount *d*	0.2953	0.2500	0.2500	0.2792
Actual Price Drop *D*	0.5755	0.3903	0.2310	0.6995
Ratio *D/d*	3.3926	1.6048	1.5398	7.8124
D/d - (1 - td) / (1 - tg)	2.6298	0.8421	0.7848	7.8121
Implied Price Drop *Dimp*	0.3099	0.2616	0.0577	0.2518
Dimp - d	0.0250	0.0264	0.0327	0.2019
Dimp - D	-0.2620	-0.1139	-0.0882	0.6681

Table 3

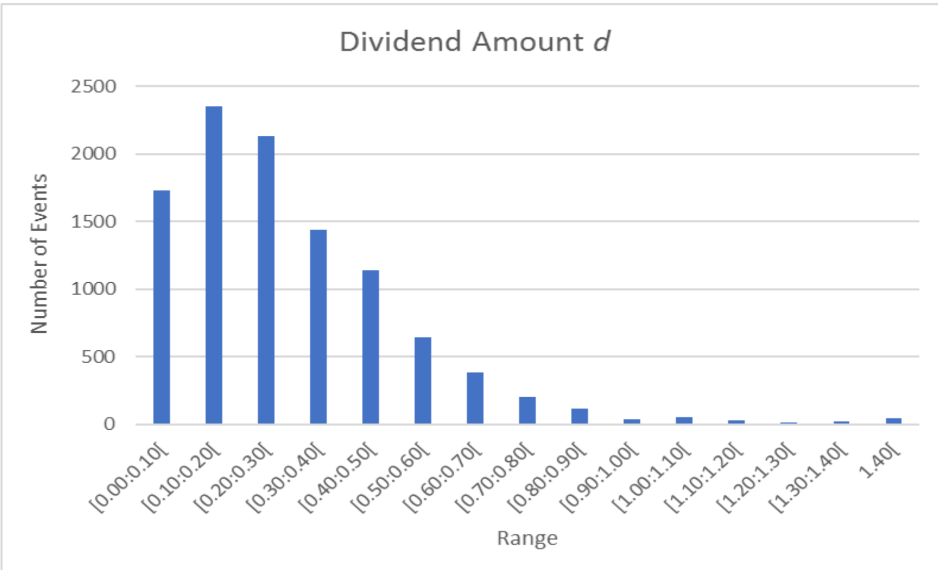
Descriptive statistics table 2

	Standard Error	Min	Max	Count
Dividend Amount *d*	0.0027	0.0045	6.6600	10342
Actual Price Drop *D*	0.0069	0.0000	15.6345	10342
Ratio *D/d*	0.0768	0.0002	256.8369	10342
D/d - (1 - td) / (1 - tg)	0.0768	-0.7645	256.0722	10342
Implied Price Drop *Dimp*	0.0027	0.0009	8.8405	8876
Dimp - d	0.0021	-5.9441	5.8405	8876
Dimp - D	0.0071	-15.4810	6.7467	8876

The following graphics present the plots of distributions of key variables that are listed on the tables above.

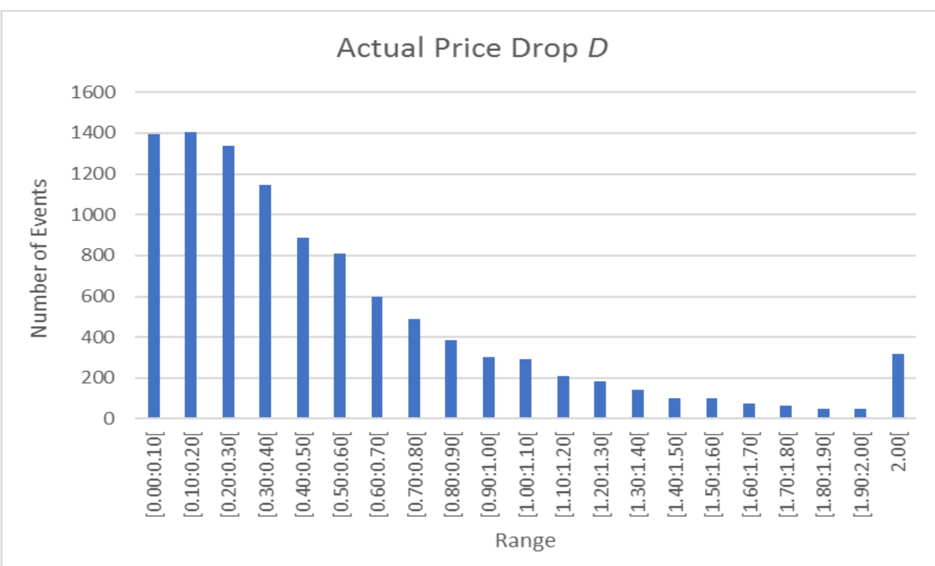
Graphic 1

Distribution plot of dividend amount *d*



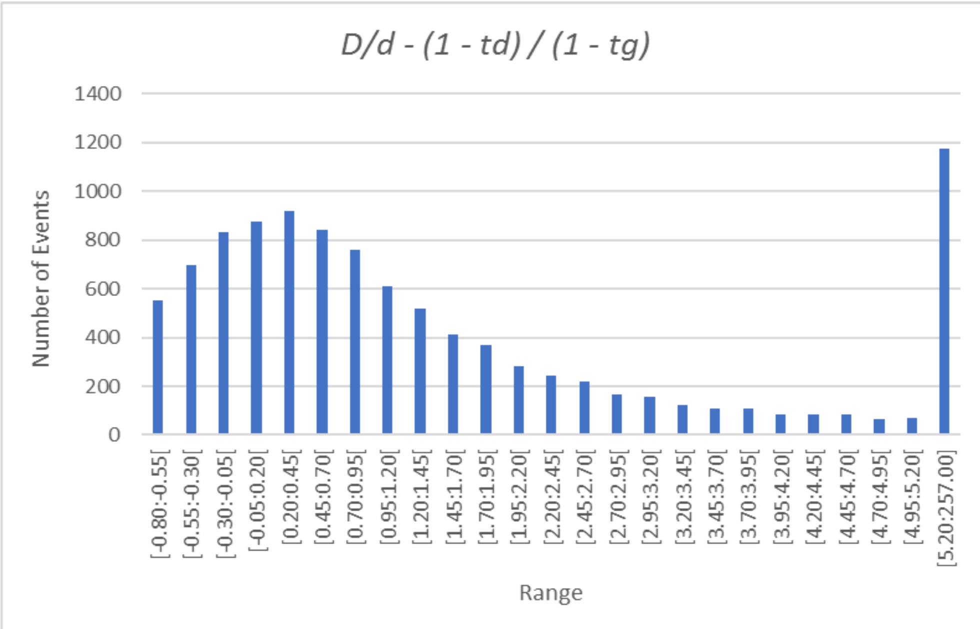
Graphic 2

Distribution plot of actual price drop *D*



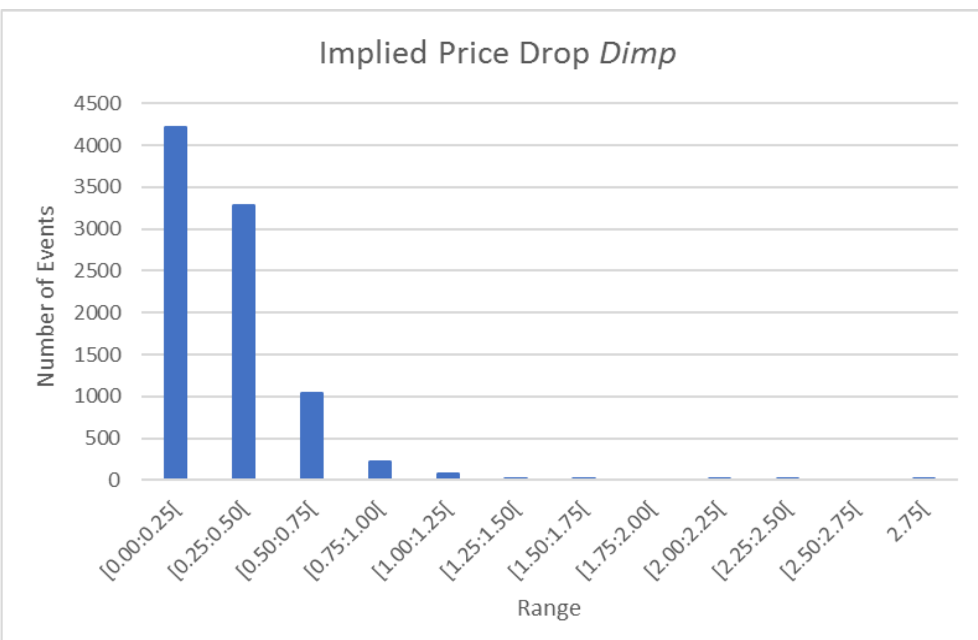
Graphic 3

Distribution plot of *D/d - (1 - td) / (1 - tg)*



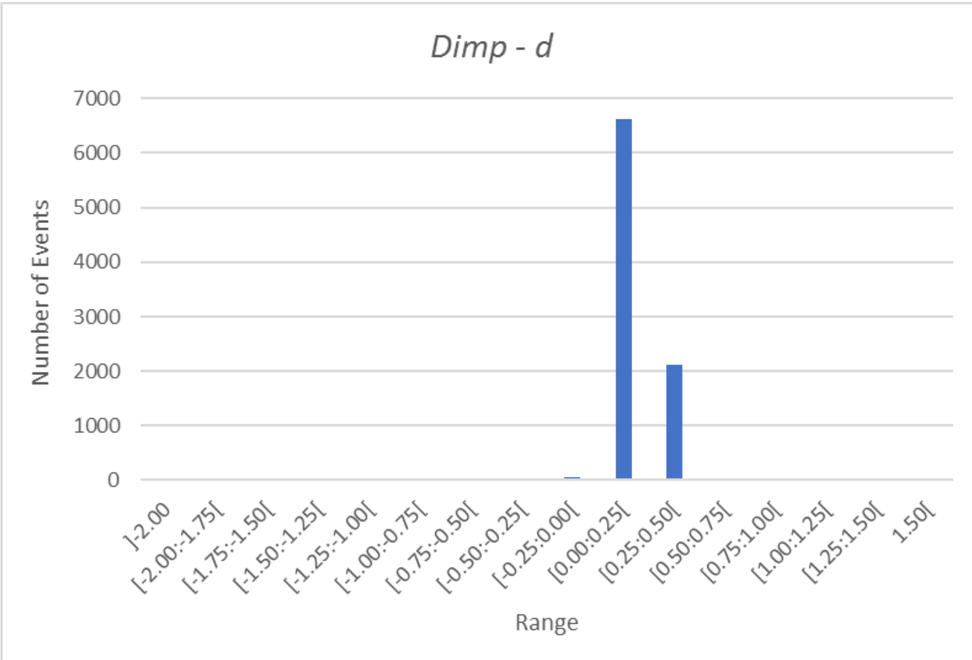
Graphic 4

Distribution plot of implied price drop *Dimp*



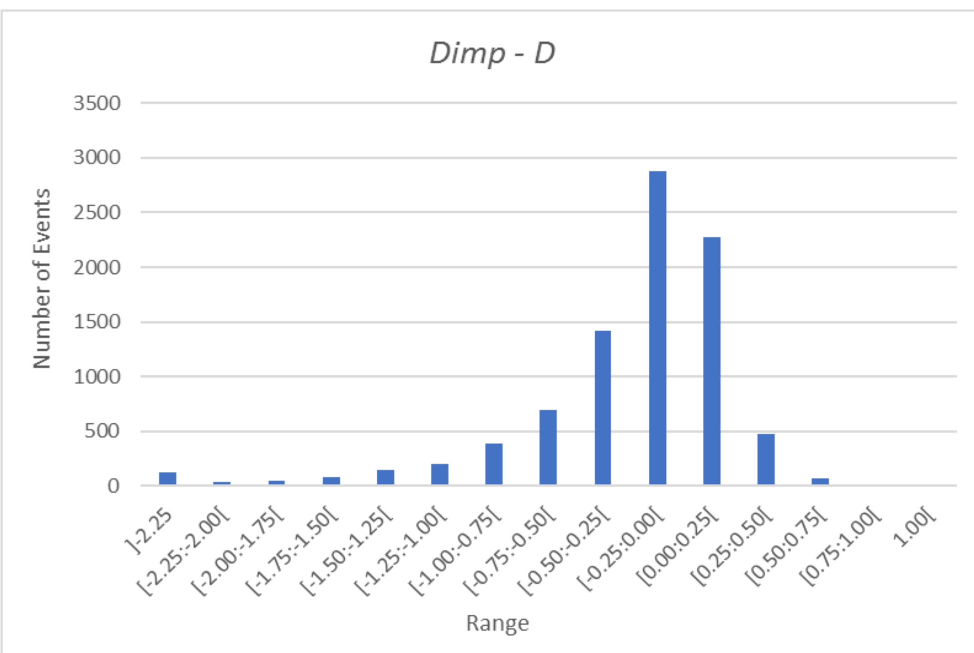
Graphic 5

Distribution plot of *Dimp – d*



Graphic 6

Distribution plot of *Dimp – D*



5. Results and Analysis

The first step before starting any calculations for this research is to adjust the ex-dividend day closing security price for the movement due to market factors using the return on the S&P 500 index times the beta of the firm so that only the dividend effect is reflected in the ex-dividend day closing price as mentioned in the methodology section of this paper. If the closing price of the security on the ex-dividend day is still higher than the closing price of the security on the last cum-dividend day after the adjustment, this pair of information will be removed from the data base since it contains too much noise and is not useful in finding results for the objectives of this research. As stated previously, after this elimination, 10,342 events/options remain in the final data base relevant for the rest of the calculations of this thesis.

5.1 The Dividend Clientele Effect and the Equity Markets

From the 10,342 remaining events, which will be called events studied from now on in this paper, the ratio of the actual ex-dividend day equity price drop *D* (closing price of the security on the last cum-dividend day *S0* - closing price of the security on the ex-dividend day *S1*) on the actual amount of dividend distributed *d* is computed in order to examine the ex-dividend day stock price behavior (*ratio = D/d).*

The ratio *D/d* is then compared with *(1 - td) / (1 - tg)*. As stated in the section 3, assuming a market without arbitrage opportunities, without the dividend clientele effect but considering the fiscal distortion effect, *D/d - (1 - td) / (1 - tg)* should not be significantly different than 0. The following table presents the result of the significance test performed on *D/d - (1 - td) / (1 - tg)* computed from the events studied.

Table 4

Significance test for *D/d - (1 - td) / (1 - tg)*

Significance test for D/d - (1 - td) / (1 - tg)	
mean	2.6298
std	7.8121
t-stat	34.2337

std = standard deviation; t-stat = test statistic

From the table, it is noted that the hypothesis of *D/d - (1 - td) / (1 - tg)* is not significantly different than (or is equal to) 0 is rejected with a level of confidence of 99% and a test statistic value of 34.23, comparing to a critical value of 2.58 for a two-tail test. The robustness of the significance test result is verified with the non-parametric Wilcoxon signed-ranks test with a test statistic value of 79.9, which also rejects the null hypothesis of *D/d - (1 - td) / (1 - tg)* is not significantly different than 0. It is clear that *D/d - (1 - td) / (1 - tg)* computed from the events studied are significantly different than 0, meaning the existence of dividend clientele effect for the final data sample used in this research, even after considering the fiscal distortion effect, is verified.

This result is then broken down into the following subsample periods: 2005 - 2007, before the financial crisis, compared to 2008 - 2014, after the financial crisis;

2005 - 2012, before the change in marginal tax rate on dividends and capital gains for individuals, compared to 2013 - 2014, after the change in the marginal tax rates. The objective of this analysis is to verify if these major events, happened during the time window of this study, have an impact on the results.

Table 5

Significance test for *D/d - (1 - td) / (1 - tg)* for the period of 2005 - 2007

Significance test for D/d - (1 - td) / (1 - tg)	
mean	2.8991
std	9.4857
t-stat	17.1015

Table 6

Significance test for *D/d - (1 - td) / (1 - tg)* for the period of 2008 - 2014

Significance test for D/d - (1 - td) / (1 - tg)	
mean	2.5129
std	6.9589
t-stat	30.6640

From the table, it is noted that the hypothesis of *D/d - (1 - td) / (1 - tg)* is not significantly different than (or is equal to) 0 is rejected with a level of confidence of 99% and a test statistic value of 17.10 for the period before the financial crisis and a test statistic value of 30.66 for the period after the financial crisis. The robustness of the significance test results is verified with the non-parametric Wilcoxon signed-ranks test with a test statistic value of 44.07 for the period of 2005 – 2007 and a test statistic value of 66.65 for the period of 2008 – 2014, which also reject the null hypothesis of *D/d - (1 - td) / (1 - tg)* is not significantly different than 0 for both periods. These results conclude that the financial crisis of 2008 does not affect the existence of dividend clientele effect even after considering the fiscal distortion effect.

Table 7

Significance test for *D/d - (1 - td) / (1 - tg)* for the period of 2005 - 2012

Significance test for D/d - (1 - td) / (1 - tg)	
mean	2.8831
std	8.4421
t-stat	31.1771

Table 8

Significance test for *D/d - (1 - td) / (1 - tg)* for the period of 2013 - 2014

Significance test for D/d - (1 - td) / (1 - tg)	
mean	1.5784
std	4.1439
t-stat	17.0685

From the table, it is noted that the hypothesis of *D/d - (1 - td) / (1 - tg)* is not significantly different than (or is equal to) 0 is rejected with a level of confidence of 99% and a test statistic value of 31.18 for the period before the change in marginal tax rate on dividends and capital gains for individuals and a test statistic value of 17.06 for the period after the change in the marginal tax rates. The robustness of the significance test results is verified with the non-parametric Wilcoxon signed-ranks test with a test statistic value of 72.34 for the period of 2005 – 2012 and a test statistic value of 33.82 for the period of 2013 – 2014, which also reject the null hypothesis of *D/d - (1 - td) / (1 - tg)* is not significantly different than 0 for both periods. These results conclude that the change in the marginal tax rates of 2013 does not affect the existence of dividend clientele effect even after considering the fiscal distortion effect.

5.2 The Dividend Clientele Effect and the Option Markets

Once the existence of dividend clientele effect within the events studied is verified, the adjustment for the future equity price drop caused by dividend implicitly priced in the option price on the last cum-dividend day, implied price drop (*Dimp)*, is calculated with a solver for each event studied. Remind the following dividend adjusted Black and Scholes option evaluation model is used for this calculation.

$$c_0\ (S,T,K) = S_0{*}N\ (d_1) - Ke^{-rT}\ N\ (d_2)$$

$$d_1 = \frac{ln\frac{S_0^*}{K} + \left(r + \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}}$$

$$d_2 = \ d_1 - \sigma\sqrt{T}$$

$$S_0^* = S_0\ - D_{imp}e^{-r*\frac{1}{365}}$$

where *c0* is the average of option's closing best bid price and closing best offer price on the last cum-dividend day, *S0* is the closing security price on the last cum-dividend day, *K* is the option's strike price, *σ* is the option's implied volatility on the last cum-dividend day given in the data base of *OptionMetrics*, *r* is the continuously compounded annualized risk-free rate on the last cum-dividend day and *T* is the number of days to maturity of the option.

Out of 10,342 total events considered, there are 1,466 cases where the solver is not able to optimize a *Dimp*, leaving the value at 0. These cases are removed from the events studied because they are not exploitable in finding results for the objectives of this research.

Once the exploitable implied price drop of all the studied events are obtained, which is 8,876 events out of 10,342 that form the new events studied, these implied equity price drop priced in the option market, *Dimp,* is compared with 0 in the first place to see if the option market indeed implicitly price the future price drop caused by dividend in the option price in order to avoid any penalties to option holders. If it does, which is the expected case, the implied price drop priced in the option market is expected to be significantly different than 0. The following table presents the result of the significance test performed on *Dimp* computed from the option retained of the events studied.

Table 9

Significance test for *Dimp*

Significance test for implied price drop (Dimp)	
mean	0.3099
std	0.2518
t-stat	115.9581

From the table, it is noted that the hypothesis of *Dimp* is not significantly different than (or is equal to) 0 is rejected with a level of confidence of 99% and a test statistic value of 115.96, comparing to a critical value of 2.58 for a two-tail test. The robustness of the significance test result is verified with the non-parametric Wilcoxon signed-ranks test with a test statistic value of 81.59, which also rejects the null hypothesis of *Dimp* is not significantly different than 0. It is clear that *Dimp* computed from the events studied are significantly different than 0, meaning the option market indeed implicitly price the future price drop caused by dividend in the option price in order to avoid any penalties to option holders.

This result is then broken down into the following subsample periods: 2005 - 2007, before the financial crisis, compared to 2008 - 2014, after the financial crisis; 2005 - 2012, before the change in marginal tax rate on dividends and capital gains for individuals, compared to 2013 - 2014, after the change in the marginal tax rates. The objective of this analysis is to verify if these major events, happened during the time window of this study, have an impact on the results.

Table 10

Significance test for *Dimp* for the period of 2005 - 2007

Significance test for implied price drop (Dimp)	
mean	0.2801
std	0.1914
t-stat	81.7562

Table 11

Significance test for *Dimp* for the period of 2008 - 2014

Significance test for implied price drop (Dimp)	
mean	0.3261
std	0.2778
t-stat	89.0487

From the table, it is noted that the hypothesis of *Dimp* is not significantly different than (or is equal to) 0 is rejected with a level of confidence of 99% and a test statistic value of 81.76 for the period before the financial crisis and a test statistic value of 89.05 for the period after the financial crisis. The robustness of the significance test results is verified with the non-parametric Wilcoxon signed-ranks test with a test statistic value of 48.38 for the period of 2005 – 2007 and a test statistic value of 65.71 for the period of 2008 – 2014, which also reject the null hypothesis of *Dimp* is not significantly different than 0 for both periods. These results conclude that the financial crisis of 2008 does not affect the fact that the option market implicitly price the future price drop caused by dividend in the option price in order to avoid any penalties to option holders.

Table 12

Significance test for *Dimp* for the period of 2005 - 2012

Significance test for implied price drop (Dimp)	
mean	0.3046
std	0.2179
t-stat	127.5028

Table 13

Significance test for *Dimp* for the period of 2013 - 2014

Significance test for implied price drop (Dimp)	
mean	0.3898
std	0.5438
t-stat	16.8876

From the table, it is noted that the hypothesis of *Dimp* is not significantly different than (or is equal to) 0 is rejected with a level of confidence of 99% and a test statistic value of 127.50 for the period before the change in marginal tax rate on dividends and capital gains for individuals and a test statistic value of 16.89 for the period after the change in the marginal tax rates. The robustness of the significance test results is verified with the non-parametric Wilcoxon signed-ranks test with a test statistic value of 79 for the period of 2005 – 2012 and a test statistic value of 20.41 for the period of 2013 – 2014, which also reject the null hypothesis of *Dimp* is not significantly different than 0 for both periods. These results conclude that the change in the marginal tax rates of 2013 does not affect the fact that the option market implicitly price the future price drop caused by dividend in the option price in order to avoid any penalties to option holders.

Furthermore, these implied equity price drop priced in the option market is also compared with the actual dividend amount *d* to see if the dividend clientele effect affects the implicit adjustment for dividend in option pricing prior the ex-dividend day. If it does, which is the expected case, the implied price drop priced in the option market is expected to be significantly different than the actual dividend amount. The following table presents the result of the significance test performed on *Dimp - d* computed from the option retained of the events studied.

Table 14

Significance test for *Dimp - d*

Significance test for Dimp - d	
mean	0.0250
std	0.2019
t-stat	11.6720

From the table, it is noted that the hypothesis of *Dimp - d* is not significantly different than (or is equal to) 0 is rejected with a level of confidence of 99% and a test statistic value of 11.67, comparing to a critical value of 2.58 for a two-tail test. The robustness of the significance test result is verified with the non-parametric Wilcoxon signed-ranks test with a test statistic value of 78.55, which also rejects the null hypothesis of *Dimp - d* is not significantly different than 0. It is clear that *Dimp - d* computed from the events studied are significantly different than 0, meaning the dividend clientele effect affects the implicit adjustment for dividend in option pricing prior the ex-dividend day, causing this implicit adjustment to be different than the actual dividend amount.

This result is then broken down into the following subsample periods: 2005 - 2007, before the financial crisis, compared to 2008 - 2014, after the financial crisis; 2005 - 2012, before the change in marginal tax rate on dividends and capital gains for individuals, compared to 2013 - 2014, after the change in the marginal tax rates. The objective of this analysis is to verify if these major events, happened during the time window of this study, have an impact on the results.

Table 15

Significance test for *Dimp – d* for the period of 2005 - 2007

Significance test for Dimp - d	
mean	0.0023
std	0.2569
t-stat	0.4934

Table 16

Significance test for *Dimp – d* for the period of 2008 - 2014

Significance test for Dimp - d	
mean	0.0373
std	0.1633
t-stat	17.3527

From the table, it is noted that the hypothesis of *Dimp – d* is not significantly different than (or is equal to) 0 is rejected with a level of confidence of 99% and a test statistic value of 17.35 for the period after the financial crisis. However, the hypothesis of *Dimp – d* is not significantly different than 0 cannot be rejected with a level of confidence of 99% and a test statistic value of 0.49 for the period before the financial crisis. The robustness of the significance test results is verified with the non-parametric Wilcoxon signed-ranks test with a test statistic value of 43.58 for the period of 2005 – 2007 and a test statistic value of 64.64 for the period of 2008 – 2014. These results conclude that before the financial crisis of 2008, the dividend clientele effect does not affect the implicit adjustment for dividend in option pricing prior the ex-dividend day, causing this implicit adjustment to not be statistically significantly different than the actual dividend amount. However, after the financial crisis, the option market considers the dividend clientele effect in option pricing and adjusts the implicit adjustment for dividend in option pricing prior the ex-dividend day, causing this implicit adjustment to be different than the actual dividend amount.

Table 17

Significance test for *Dimp – d* for the period of 2005 - 2012

Significance test for Dimp - d	
mean	0.0227
std	0.1774
t-stat	11.6829

Table 18

Significance test for *Dimp – d* for the period of 2013 - 2014

Significance test for Dimp - d	
mean	0.0594
std	0.4234
t-stat	3.3076

From the table, it is noted that the hypothesis of *Dimp – d* is not significantly different than (or is equal to) 0 is rejected with a level of confidence of 99% and a test statistic value of 11.68 for the period before the change in marginal tax rate on dividends and capital gains for individuals and a test statistic value of 3.31 for the period after the change in the marginal tax rates. The robustness of the significance test results is verified with the non-parametric Wilcoxon signed-ranks test with a test statistic value of 76.24 for the period of 2005 – 2012 and a test statistic value of 18.71 for the period of 2013 – 2014, which also reject the null hypothesis of *Dimp - d* is not significantly different than 0 for both periods. These results conclude that the change in the marginal tax rates of 2013 does not affect the fact that the dividend clientele effect affects the implicit adjustment for dividend in option pricing prior the ex-dividend day, causing this implicit adjustment to be different than the actual dividend amount.

Moreover, these implied equity price drop priced in the option market, *Dimp,* is finally compared with the actual ex-dividend day equity price drop *D* found in the first step of this methodology to determine if the option markets use the same set of information than equity markets with respect to the dividend clientele effect. The following table presents the result of the significance test performed on *Dimp - D* computed from the option retained of the events studied.

Table 19

Significance test for *Dimp - D*

Significance test for Dimp - D	
mean	-0.2620
std	0.6681
t-stat	36.9407

From the table, it is noted that the hypothesis of *Dimp - D* is not significantly different than (or is equal to) 0 is rejected with a level of confidence of 99% and a test statistic value of 36.94, comparing to a critical value of 2.58 for a two-tail test. The robustness of the significance test result is verified with the non-parametric Wilcoxon signed-ranks test with a test statistic value of 6.52, which also rejects the null hypothesis of *Dimp - D* is not significantly different than 0. It is clear that *Dimp - D* computed from the events studied are significantly different than 0, meaning the adjustment for the future equity price drop caused by dividend implicitly priced in the option price on the last cum-dividend day is statistically significantly different than the actual price drop on the ex-dividend day and the option markets do not use the same set of information than equity markets with respect to the dividend clientele effect. The option markets implicitly price the future price drop that will occur on the ex-dividend day differently than what the actual price drop really is on the ex-dividend day. More specifically, the mean of *Dimp - D* is found to be negative and statistically significant, indicating the implied price drop on the last cum-dividend day is found to be generally smaller than the actual price drop on the ex-dividend day.

This result is then broken down into the following subsample periods: 2005 - 2007, before the financial crisis, compared to 2008 - 2014, after the financial crisis; 2005 - 2012, before the change in marginal tax rate on dividends and capital gains for individuals, compared to 2013 - 2014, after the change in the marginal tax rates. The objective of this analysis is to verify if these major events, happened during the time window of this study, have an impact on the results.

Table 20

Significance test for *Dimp – D* for the period of 2005 - 2007

Significance test for Dimp - D	
mean	-0.2827
std	0.6615
t-stat	23.8666

Table 21

Significance test for *Dimp – D* for the period of 2008 - 2014

Significance test for Dimp - D	
mean	-0.2508
std	0.6715
t-stat	28.3331

From the table, it is noted that the hypothesis of *Dimp – D* is not significantly different than (or is equal to) 0 is rejected with a level of confidence of 99% and a test statistic value of 23.87 for the period before the financial crisis and a test statistic value of 28.33 for the period after the financial crisis. The robustness of the significance test results is verified with the non-parametric Wilcoxon signed-ranks test with a test statistic value of 2.17 for the period of 2005 – 2007 and a test statistic value of 6.48 for the period of 2008 – 2014, which also reject the null hypothesis of *Dimp - D* is not significantly different than 0 for both periods. These results conclude that the financial crisis of 2008 does not affect the fact that adjustment for the future equity price drop caused by dividend implicitly priced in the option price on the last cum-dividend day is statistically significantly different than the actual price drop on the ex-dividend day and the option markets do not use the same set of information than equity markets with respect to the dividend clientele effect. Moreover, the mean of *Dimp - D* is found to be negative and statistically significant for both periods, indicating the implied price drop on the last cum-dividend day is found to be generally smaller than the actual price drop on the ex-dividend day for both periods.

Table 22

Significance test for *Dimp – D* for the period of 2005 - 2012

Significance test for Dimp - D	
mean	-0.2709
std	0.6717
t-stat	36.7897

Table 23

Significance test for *Dimp – D* for the period of 2013 - 2014

Significance test for Dimp - D	
mean	-0.1283
std	0.5974
t-stat	5.0587

From the table, it is noted that the hypothesis of *Dimp – D* is not significantly different than (or is equal to) 0 is rejected with a level of confidence of 99% and a test statistic value of 36.79 for the period before the change in marginal tax rate on dividends and capital gains for individuals and a test statistic value of 5.06 for the period after the change in the marginal tax rates. The robustness of the significance test results is verified with the non-parametric Wilcoxon signed-ranks test with a test statistic value of 5.79 for the period of 2005 – 2012 and a test statistic value of 3.6 for the period of 2013 – 2014, which also reject the null hypothesis of *Dimp - D* is not significantly different than 0 for both periods. These results conclude that the change in the marginal tax rates of 2013 does not affect the fact that adjustment for the future equity price drop caused by dividend implicitly priced in the option price on the last cum-dividend day is statistically significantly different than the actual price drop on the ex-dividend day and the option markets do not use the same set of information than equity markets with respect to the dividend clientele effect. Moreover, the mean of *Dimp - D* is found to be negative and statistically significant for both periods, indicating the implied price drop on the last cum-dividend day is found to be generally smaller than the actual price drop on the ex-dividend day for both periods.

5.3 Ex-post Trading Strategy

In section 5.2, the implied price drop on the last cum-dividend day is found to be generally smaller than the actual price drop on the ex-dividend day, with a negative mean of *Dimp - D* that is statistically significant, meaning the option markets price a smaller future price drop than what it will actually be in the option price, thus the option price is more expensive than it should be and will be adjusted downward on the ex-dividend day.

Therefore, the ex-post trading strategy will be selling short the more expensive option on the last cum-dividend day and buying it back on the next day, the ex-dividend day, when the same option will be cheaper after the price adjustment for the actual real price drop. For each option, the one day return is calculated by taking the difference between the closing option price (closing best bid price *cbb*) on the last cum-dividend day *LCDD* and the closing option price (closing best offer price *cbo*) on the ex-dividend day *EDD* divided by the closing option price (closing best offer price *cbo*) on the ex-dividend day. That is:

(LCDD cbb - EDD cbo) / EDD cbo

Subsequently, the mean return of the option category with a greater difference between the implied price drop and actual price drop, as well as the one for the whole option sample of the retained events studied, are calculated and compared. The thresholds for the separation will be determined according to the mean of the differences between the implied price drop and actual price drop. Calculating the mean return of the category with a greater difference between the implied price drop and the actual price drop and comparing it with the mean return of the whole sample demonstrates the return will be bigger if the market is more surprised by the real dividend clientele effect that affects the actual price drop on the ex-dividend day. Moreover, calculating the return for the whole option sample, no matter the difference between the implied price drop and actual price drop, verifies if the proposed strategy is also effective for the whole sample.

While calculating the returns using the above strategy, there are 21 cases where the best offer price on the ex-dividend day is 0, thus unavailable, in the data base, making it impossible to calculate the return since it will have to divide by 0. Therefore, these options will be removed from the option sample of the retained events studied when calculating for the returns. The remaining relevant events/options are computed to be 8,855.

The following table presents the result of the mean return of the options with a *Dimp - D* greater than the mean of *Dimp - D* in absolute value, so smaller than the actual mean of *Dimp - D* since it is a negative value, as well as the descriptive statistics of these returns. The next table presents the result of the significant test for the mean return of this option category.

Table 24

Descriptive statistics of the returns for options with *Dimp – D < mean*

Returns with $Dimp - D < mean$	
Mean	0.1835
Standard Error	0.0100
Median	0.1220
Mode	0
Standard Deviation	0.5561
Minimum	-0.9474
Maximum	18.5000
Count	3067

Table 25

Result and significance test of the mean return for options with *Dimp – D < mean*

Returns with $Dimp - D < mean$	
mean	0.1835
std	0.5561
t-stat	18.2787

From the tables, it is noted that the mean return for options with a greater difference between the implied price drop and the actual price drop is positive, even after including the transaction cost generated by the bid - ask option price difference. Moreover, this positive return is statistically significant with a level of confidence of 99% and a test statistic value of 18.28, comparing to a critical value of 2.58 for a two-tail test. The robustness of the significance test result is verified with the non-parametric Wilcoxon signed-ranks test with a test statistic value of 41.53, which also rejects the null hypothesis of the returns are not significantly different than 0. It shows the return is positive when the market is more surprised by the real dividend clientele effect that affects the actual price drop on the ex-dividend day.

The following table presents the result of the mean return of the whole option sample, as well as the descriptive statistics of these returns. The next table presents the result of the significant test for the mean return of the whole option sample.

Table 26

Descriptive statistics of the returns for all options

Returns with the whole sample	
Mean	-0.0167
Standard Error	0.0043
Median	-0.0465
Mode	0
Standard Deviation	0.4043
Minimum	-0.9667
Maximum	18.5000
Count	8855

Table 27

Result and significance test of the mean return for all options

Returns with all Dimp - D	
mean	-0.0167
std	0.4043
t-stat	3.8917

From the tables, it is noted the mean return for the whole option sample, no matter the value of option's *Dimp - D* calculated, is negative after including the transaction cost generated by the bid - ask option price difference. This negative return is also statistically significant with a level of confidence of 99% and a test statistic value of 3.89, comparing to a critical value of 2.58 for a two-tail test. The robustness of the significance test result is verified with the non-parametric Wilcoxon signed-ranks test with a test statistic value of 32.78, which also rejects the null hypothesis of the returns are not significantly different than 0. This result confirms the proposed strategy is not effective for the whole option sample, when including the cases where the difference between the implied price drop and the actual price drop is smaller.

When comparing the mean return for options with a greater difference between the implied price drop and actual price drop with the mean return of the whole sample, it is clear that the return for the first case is bigger, indeed confirming the previous statement that the return will be bigger if the market is more surprised by the real dividend clientele effect that affects the actual price drop on the ex-dividend day.

Finally, the fact that the proposed strategy does not generate enough profits, when applied to the whole option sample, to absorb the transaction cost generated by the bid - ask option price difference means this strategy is not economically efficient. Even though the option markets do not use the same set of information than equity markets with respect to the dividend clientele effect, and the markets might be already conscious about it, it does not seem to be possible to exploit this difference and make positive returns with the proposed trading strategy ex-ante since this strategy is not efficient enough once the transaction cost is taken into the equation. Therefore, it is not worth it to trade based on this difference. This result is actually a good news for the markets since it proves the markets are somehow efficient given it does not give the possibility to take advantage of the information in the equity markets with respect to the dividend clientele effect that is ignored in the option market and find a trading strategy to generate arbitrage profits.

In conclusion, the proposed trading strategy is impossible to be profitable a priori, without knowing the mean of the differences between the implied price drop and actual price drop. Thus, this strategy cannot be implemented in practice and be applied in trading in the real option markets.

5.4 Results and Analysis of the Aggregate Data Sample without Excluding the 33.3% of Cases where the Price Reaction on the Ex-Dividend Day is Positive

Considering each ex-dividend date and last-cum dividend date pair on each firm's dividend calendar from 2005 to 2014 as a single event studied, the final data base for this paper contains 15,605 events, thus 15,605 options since only one option per event were retained, before eliminating the events for which the closing price of the security on the ex-dividend day is higher than the closing price of the security on the last cum-dividend day. In previous sections, the elimination of those events is proceeded. They represent 33.3% of the initial events and are considered too noisy for the previous analysis. In this section, the results and analysis of the aggregate data sample without excluding the 33.3% of cases where the price reaction on the ex-dividend day is positive are presented for comparison purpose.

Here is the descriptive statistics of the complete list of variables, including the 33.3% of cases where the price reaction on the ex-dividend day is positive, that will be discussed in the results and analysis of this section.

Table 28

Descriptive statistics table 3 – including the 33.3% of cases where the price reaction on the ex-dividend day is positive

	Mean	Median	Mode	Standard Deviation
Dividend Amount *d*	0.2695	0.2200	0.2500	0.2581
Actual Price Drop *D*	0.2448	0.2029	0.2310	0.8906
Ratio *D/d*	0.9090	0.9386	1.5398	9.5814
D/d - (1 - td) / (1 - tg)	0.1461	0.1752	0.7848	9.5814
Implied Price Drop *Dimp*	0.3243	0.2483	0.0577	0.4097
Dimp - d	0.0624	0.0281	0.0327	0.3779
Dimp - D	0.1169	0.0529	-0.0882	0.9941

Table 29

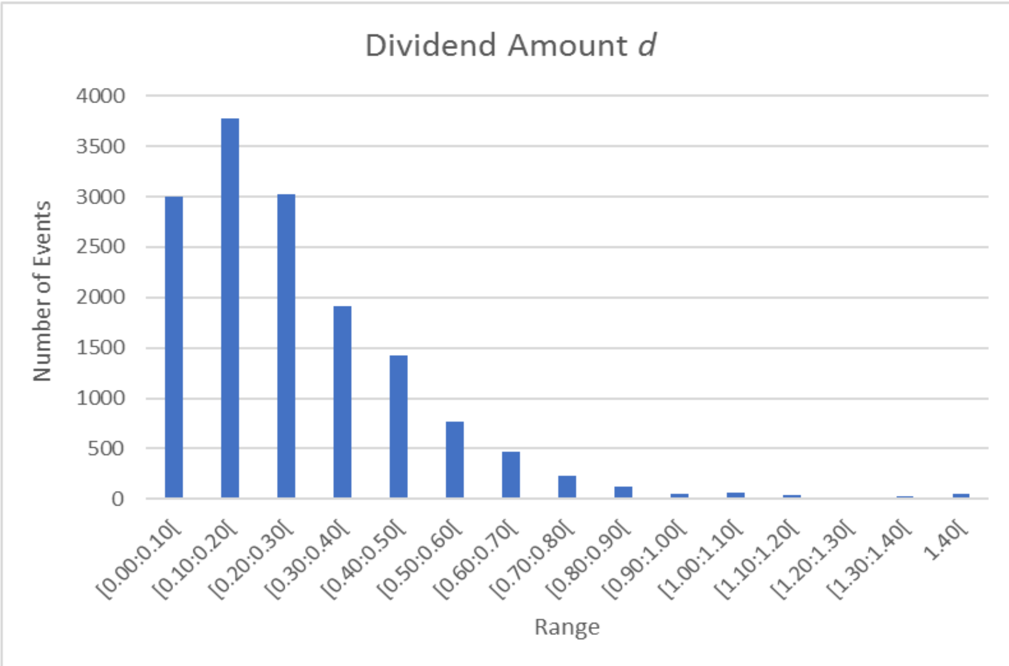
Descriptive statistics table 4 – including the 33.3% of cases where the price reaction on the ex-dividend day is positive

	Standard Error	Min	Max	Count
Dividend Amount *d*	0.0021	0.0045	6.6600	15605
Actual Price Drop *D*	0.0073	-16.8402	15.6345	15605
Ratio *D/d*	0.0783	-276.3804	256.8369	15605
D/d - (1 - td) / (1 - tg)	0.0783	-277.1451	256.0722	15605
Implied Price Drop *Dimp*	0.0035	0.0009	18.9467	13510
Dimp - d	0.0033	-5.9441	18.6667	13510
Dimp - D	0.0086	-15.4810	29.3260	13510

The following graphics present the plots of distributions of key variables, including the 33.3% of cases where the price reaction on the ex-dividend day is positive, that are listed on the tables above.

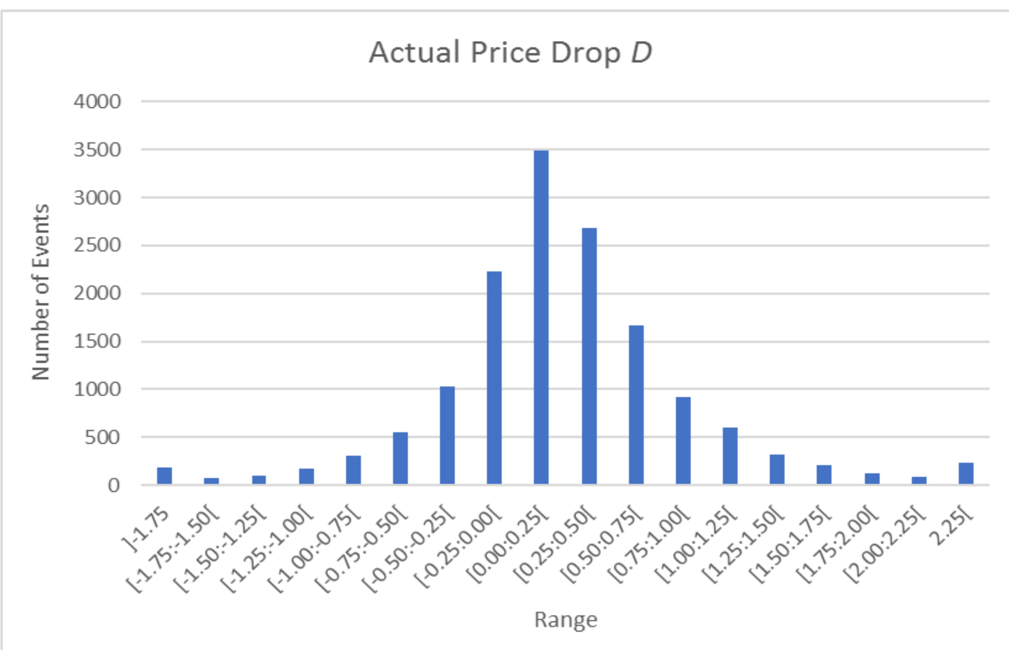
Graphic 7

Distribution plot of dividend amount *d* without exclusions



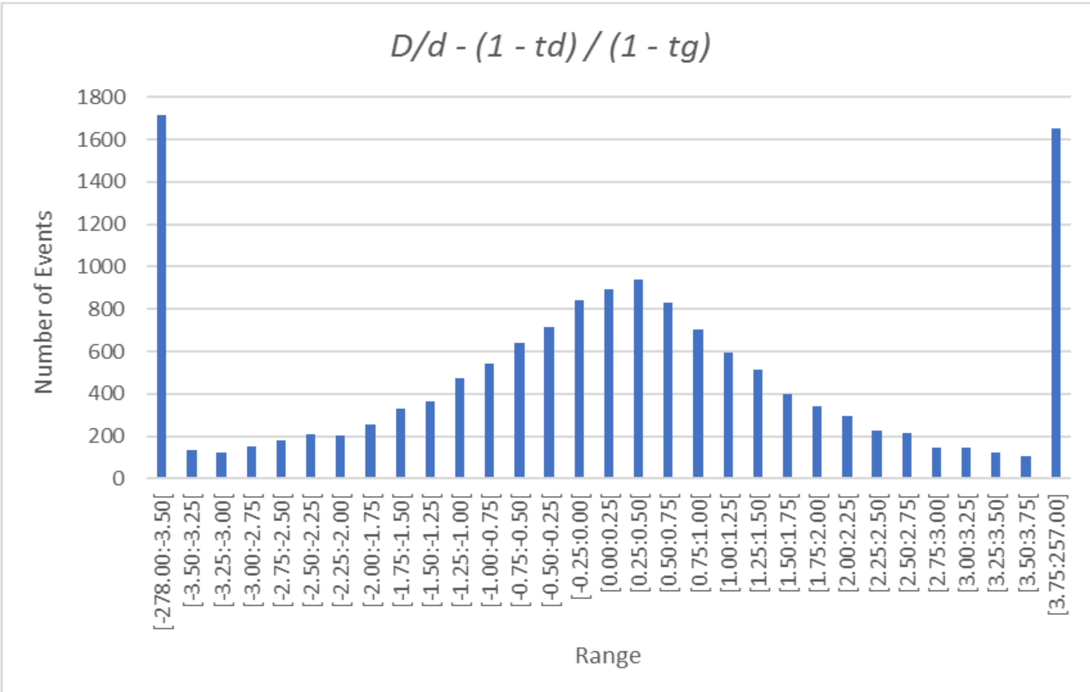
Graphic 8

Distribution plot of actual price drop *D* without exclusions



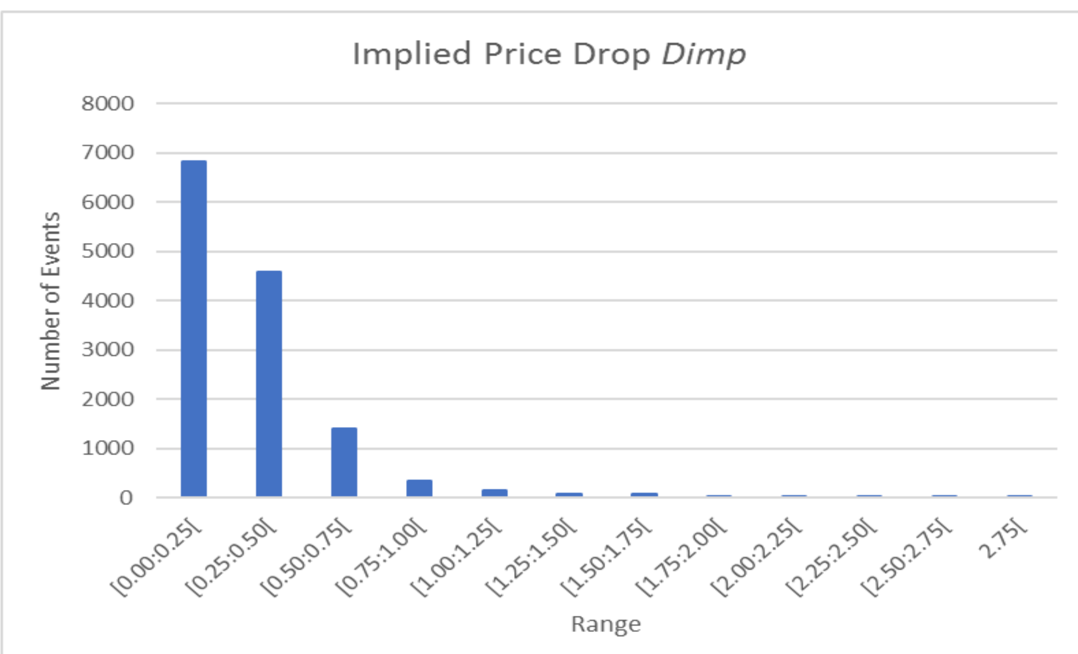
Graphic 9

Distribution plot of *D/d - (1 - td) / (1 - tg)* without exclusions



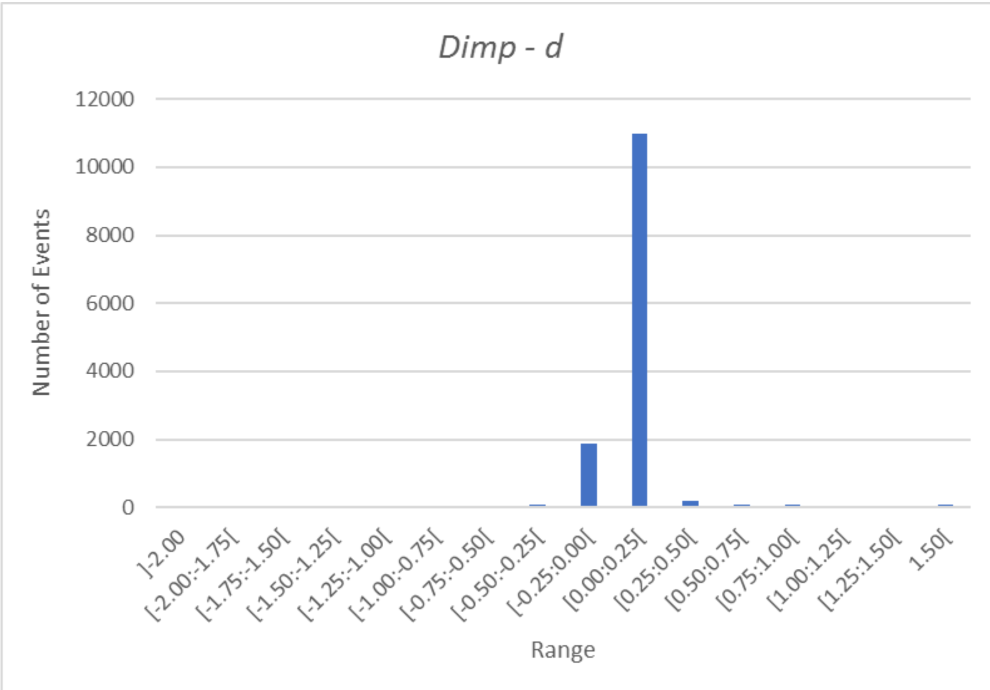
Graphic 11

Distribution plot of implied price drop *Dimp* without exclusions



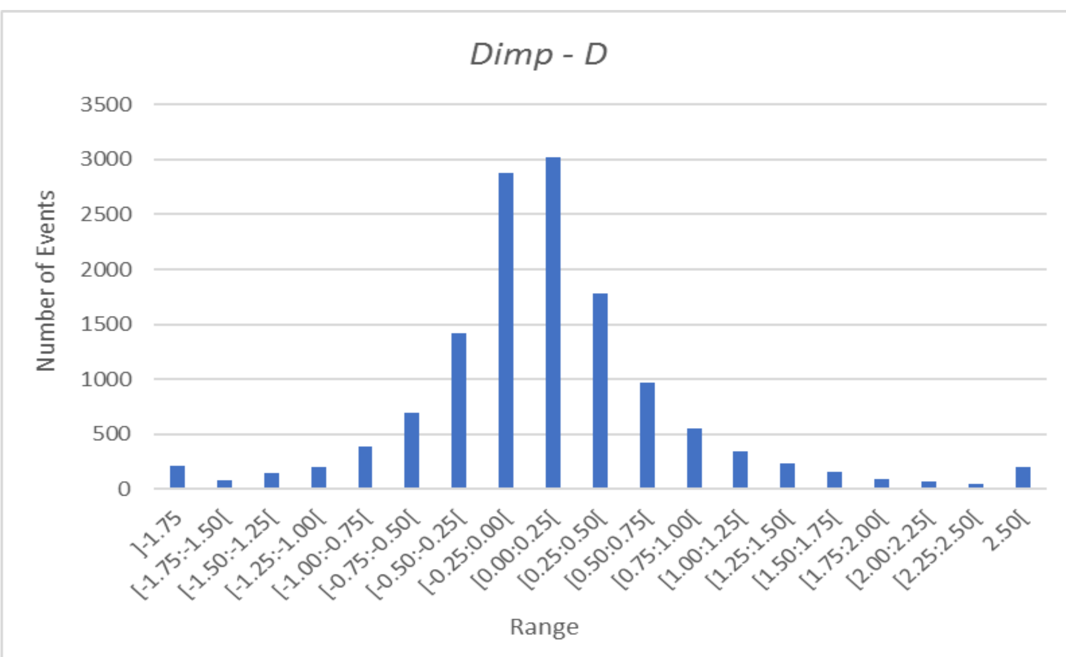
Graphic 10

Distribution plot of *Dimp – d* without exclusions



Graphic 12

Distribution plot of *Dimp – D* without exclusions



5.4.1 The Dividend Clientele Effect and the Equity Markets

From the aggregate 15,605 events, which will be called events studied from now on in this paper, the ratio of the actual ex-dividend day equity price drop *D* (closing price of the security on the last cum-dividend day *S0* - closing price of the security on the ex-dividend day *S1*) on the actual amount of dividend distributed *d* is computed in order to examine the ex-dividend day stock price behavior (*ratio = D/d).*

The ratio *D/d* is then compared with *(1 - td) / (1 - tg)*. As stated in the section 3, assuming a market without arbitrage opportunities, without the dividend clientele effect but considering the fiscal distortion effect, *D/d - (1 - td) / (1 - tg)* should not be significantly different than 0. The following table presents the result of the significance test performed on *D/d - (1 - td) / (1 - tg)* computed from the events studied.

Table 30

Significance test for *D/d - (1 - td) / (1 - tg)* of the aggregate sample

Significance test for D/d - (1 - td) / (1 - tg)	
mean	0.1461
std	9.5814
t-stat	1.8664

std = standard deviation; t-stat = test statistic

From the table, it is noted that the hypothesis of *D/d - (1 - td) / (1 - tg)* is not significantly different than (or is equal to) 0 is rejected with a level of confidence of 90% and a test statistic value of 1.87, comparing to a critical value of 1.64 for a two-tail test. The robustness of the significance test result is verified with the non-parametric

Wilcoxon signed-ranks test with a test statistic value of 61.44, which also rejects the null hypothesis of *D/d - (1 - td) / (1 - tg)* is not significantly different than 0. It is clear that *D/d - (1 - td) / (1 - tg)* computed from the events studied are significantly different than 0, meaning the existence of dividend clientele effect for the final data sample used in this research, even after considering the fiscal distortion effect, is verified.

5.4.2 The Dividend Clientele Effect and the Option Markets

Once the existence of dividend clientele effect within the events studied is verified, the adjustment for the future equity price drop caused by dividend implicitly priced in the option price on the last cum-dividend day, implied price drop (*Dimp)*, is calculated with a solver for each event studied.

Out of 15,605 total events considered, there are 2,095 cases where the solver is not able to optimize a *Dimp*, leaving the value at 0. These cases are removed from the events studied because they are not exploitable in finding results for the objectives of this research.

Once the exploitable implied price drop of all the studied events are obtained, which is 13,510 events out of 15,605 that form the new events studied, these implied equity price drop priced in the option market, *Dimp,* is compared with 0 in the first place to see if the option market indeed implicitly price the future price drop caused by dividend in the option price in order to avoid any penalties to option holders. If it does, which is the expected case, the implied price drop priced in the option market is expected to be significantly different than 0. The following table presents the result of the significance test performed on *Dimp* computed from the option retained of the events studied.

Table 31

Significance test for *Dimp* of the aggregate sample

Significance test for implied price drop (Dimp)	
mean	0.3243
std	0.4097
t-stat	92.0018

From the table, it is noted that the hypothesis of *Dimp* is not significantly different than (or is equal to) 0 is rejected with a level of confidence of 99% and a test statistic value of 92, comparing to a critical value of 2.58 for a two-tail test. The robustness of the significance test result is verified with the non-parametric Wilcoxon signed-ranks test with a test statistic value of 100.66, which also rejects the null hypothesis of *Dimp* is not significantly different than 0. It is clear that *Dimp* computed from the events studied are significantly different than 0, meaning the option market indeed implicitly price the future price drop caused by dividend in the option price in order to avoid any penalties to option holders.

Furthermore, these implied equity price drop priced in the option market is also compared with the actual dividend amount *d* to see if the dividend clientele effect affects the implicit adjustment for dividend in option pricing prior the ex-dividend day. If it does, which is the expected case, the implied price drop priced in the option market is expected to be significantly different than the actual dividend amount. The following table presents the result of the significance test performed on *Dimp - d* computed from the option retained of the events studied.

Table 32

Significance test for *Dimp – d* of the aggregate sample

Significance test for Dimp - d	
mean	0.0624
std	0.3779
t-stat	19.1889

From the table, it is noted that the hypothesis of *Dimp - d* is not significantly different than (or is equal to) 0 is rejected with a level of confidence of 99% and a test statistic value of 19.19, comparing to a critical value of 2.58 for a two-tail test. The robustness of the significance test result is verified with the non-parametric Wilcoxon signed-ranks test with a test statistic value of 96.32, which also rejects the null hypothesis of *Dimp - d* is not significantly different than 0. It is clear that *Dimp - d* computed from the events studied are significantly different than 0, meaning the dividend clientele effect affects the implicit adjustment for dividend in option pricing prior the ex-dividend day, causing this implicit adjustment to be different than the actual dividend amount.

Moreover, these implied equity price drop priced in the option market, *Dimp,* is finally compared with the actual ex-dividend day equity price drop *D* found in the first step of this methodology to determine if the option markets use the same set of information than equity markets with respect to the dividend clientele effect. The following table presents the result of the significance test performed on *Dimp - D* computed from the option retained of the events studied.

Table 33

Significance test for *Dimp – D* of the aggregate sample

Significance test for Dimp - D	
mean	0.1169
std	0.9941
t-stat	13.6681

From the table, it is noted that the hypothesis of *Dimp - D* is not significantly different than (or is equal to) 0 is rejected with a level of confidence of 99% and a test statistic value of 13.67, comparing to a critical value of 2.58 for a two-tail test. The robustness of the significance test result is verified with the non-parametric Wilcoxon signed-ranks test with a test statistic value of 60.68, which also rejects the null hypothesis of *Dimp - D* is not significantly different than 0. It is clear that *Dimp - D* computed from the events studied are significantly different than 0, meaning the adjustment for the future equity price drop caused by dividend implicitly priced in the option price on the last cum-dividend day is statistically significantly different than the actual price drop on the ex-dividend day and the option markets do not use the same set of information than equity markets with respect to the dividend clientele effect. The option markets implicitly price the future price drop that will occur on the ex-dividend day differently than what the actual price drop really is on the ex-dividend day. More specifically, the mean of *Dimp - D* is now found to be positive and statistically significant, indicating the implied price drop on the last cum-dividend day is found to be generally bigger than the actual price drop on the ex-dividend day, once the 33.3% of cases where the price reaction on the ex-dividend day is positive are considered, since price increases are considered to be negative price drops.

5.4.3 Ex-post Trading Strategy

In section 5.4.2, the implied price drop on the last cum-dividend day is found to be generally bigger than the actual price drop on the ex-dividend day, with a positive mean of *Dimp - D* that is statistically significant, once the 33.3% of cases where the price reaction on the ex-dividend day is positive are considered. It means the option markets price a bigger future price drop than what it will actually be in the option price, thus the option price is less expensive than it should be and will be adjusted upward on the ex-dividend day.

Therefore, the ex-post trading strategy will be buying the less expensive option on the last cum-dividend day and selling it on the next day, the ex-dividend day, when the same option will be worth more after the price adjustment for the actual real price drop. For each option, the one day return is calculated by taking the difference between the closing option price (closing best bid price *cbb*) on the ex-dividend day *EDD* and the closing option price (closing best offer price *cbo*) on the last cum-dividend day *LCDD* divided by the closing option price (closing best offer price *cbo*) on the last cum-dividend day. That is:

(EDD cbb - LCDD cbo) / LCDD cbo

Subsequently, the mean returns for the aggregate sample are calculated. It verifies if the proposed strategy is effective for the aggregate sample.

While calculating the returns using the above strategy, there are 147 cases where the best offer price on the last cum-dividend day is 0, thus unavailable, in the data base, making it impossible to calculate the return since it will have to divide by 0. Therefore, these options will be removed from the option sample of the retained events studied when calculating for the returns. The remaining relevant events/options are computed to be 13,363.

The following table presents the result of the mean return of the aggregate option sample, as well as the descriptive statistics of these returns. The next table presents the result of the significant test for the mean return of the whole option sample.

Table 34

Descriptive statistics of the returns for all options of the aggregate sample

Returns of the aggregate sample	
Mean	-0.1173
Standard Error	0.0032
Median	-0.1270
Mode	0
Standard Deviation	0.3685
Minimum	-1
Maximum	21
Count	13363

Table 35

Result and significance test of the mean return for all options of the aggregate sample

Returns of the aggregate sample	
mean	-0.1173
std	0.3685
t-stat	36.7909

From the tables, it is noted the mean return for the whole option sample, no matter the value of option's *Dimp - D* calculated, is negative after including the transaction cost generated by the bid - ask option price difference. This negative return is also statistically significant with a level of confidence of 99% and a test statistic value of 36.79, comparing to a critical value of 2.58 for a two-tail test. The robustness of the significance test result is verified with the non-parametric Wilcoxon signed-ranks test with a test statistic value of 12.83, which also rejects the null hypothesis of the returns are not significantly different than 0. This result confirms the proposed strategy is still not effective for the aggregate option sample, even when the 33.3% of cases where the price reaction on the ex-dividend day is positive are considered.

In conclusion, the proposed trading strategy is still impossible to be profitable a priori, when the 33.3% of cases where the price reaction on the ex-dividend day is positive are considered, without knowing the mean of the differences between the implied price drop and actual price drop. Thus, this strategy cannot be implemented in practice and be applied in trading in the real option markets.

6. Conclusion

This paper is the first to document on the dividend clientele effect jointly with the option pricing and is the first to study the relations between stock markets and options markets with respect to the dividend clientele effect. It investigates the future equity price drop caused by dividend implicitly priced in the option price in order to study the impact of dividend clientele effect on the implicit adjustment for dividend in option pricing prior the ex-dividend day and compare the implied equity price drop priced in the option market with the actual equity price drop on ex-dividend day in order to find out if the option markets use the same set of information than equity markets with respect to the dividend clientele effect.

In the first place, the Elton and Gruber (1970) approach is applied to the data sample to verify the existence of dividend clientele effect and its impact on equity price drop on the ex-dividend day and the existence of dividend clientele effect for the final data sample used in this research is verified with strong significant test results. The adjustment for the future equity price drop caused by dividend implicitly priced in the option price on the last cum-dividend day, the implied price drop (*Dimp)*, is then calculated and found to be statistically significantly different than the actual price drop on the ex-dividend day. It indicates the option markets do not use the same set of information than equity markets with respect to the dividend clientele effect. The implied price drop is also found to be statistically significantly different than the actual dividend amount, meaning the dividend clientele effect affects the implicit adjustment for dividend in option pricing prior the ex-dividend day, causing this implicit adjustment to be different than the actual dividend amount.

Finally, the implied price drop on the last cum-dividend day is found to be generally smaller than the actual price drop on the ex-dividend day, with a negative mean of *Dimp - D* that is statistically significant, meaning the option markets price a smaller future price drop than what it will actually be in the option price, thus the option price is more expensive than it should be and will be adjusted downward on the ex-dividend day. Therefore, the ex-post trading strategy will be selling short the more expensive option on the last cum-dividend day and buying it back on the next day, the ex-dividend day, when the same option will be cheaper after the price adjustment for the actual real price drop. It's been found that, with this trading strategy, the mean return for options with a greater difference between the implied price drop and actual price drop is positive, even after including the transaction cost generated by the bid - ask option price difference whereas the mean return for the whole option sample, no matter the value of option's *Dimp - D* calculated, is negative after including the transaction cost generated by the bid - ask option price difference.

The above results demonstrate the return for the first case is bigger, confirming that the return will be bigger if the market is more surprised by the real dividend clientele effect that affects the actual price drop on the ex-dividend day. Moreover, the fact that the proposed strategy does not generate enough profits, when applied to the whole option sample, to absorb the transaction cost generated by the bid - ask option price difference means this strategy is not economically efficient. Even though the option markets do not use the same set of information than equity markets with respect to the dividend clientele effect, and the markets might be already conscious about it, it does not seem to be possible to exploit this difference and make positive returns with the proposed trading strategy ex-ante since this strategy is not efficient enough once the transaction cost is taken into the equation.

In conclusion, the proposed trading strategy is impossible to be profitable a priori, without knowing the mean of the differences between the implied price drop and actual price drop. Thus, this strategy cannot be implemented in practice and be applied in trading in the real option markets. This result is actually a good news for the markets since it proves the markets are somehow efficient given it does not give the possibility to take advantage of the information in the equity markets with respect to the dividend clientele effect that is ignored in the option market and find a trading strategy to generate arbitrage profits.

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