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ESSAYS ON IMPLIED DIVIDENDS

By

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Abstract

This thesis uses option-implied dividends to investigate research questions in three different areas of finance: the ex-dividend day drop and related option pricing errors; insider trading on superior dividend knowledge; and analyst dividend forecast accuracy, incorporation of market information, and market response to analyst revisions.

The first chapter investigates market expectations of the ex-dividend stock price decline implied by American options. Using a much larger set of option transactions than previous studies, I find the ex-dividend drop-o implied by option prices is significantly less than the cash dividend. The second focus of this study analyses factors that affect option pricing errors such as thin trading, non-synchronous trading, and lower dividend yields. I also find an increase in option pricing errors for deep in-the-money, deep out-of-the-money, and put-call pairs that cross the bid-ask spread.

The second chapter investigates, using a measure of dividends surprise calculated by put-call parity, whether analysts update their forecasts in response to new market information, and likewise, whether the market updates dividend expectations in response to analyst forecast revisions. I find that only superior analysts respond to changes in market information and that the market does not respond to changes in either non-superior or superior analyst forecast revisions. I also compare the accuracy of forecasts and determine the order of increasing forecast precision as non-superior individual analysts, superior individual analysts, option-implied, and consensus analyst forecasts.

The final chapter investigates whether insiders trade on their superior knowledge of future changes in dividend policy. I use the difference between the dividend implied by option transaction prices before and after the announcement as a proxy for dividend surprise. I find that CEOs are more likely to accumulate stock preceding an announcement for an expected increase in the cash dividend. Whereas, Non-director executives and Other Officers and block-holders are more likely to accumulate stock for

an unexpected increase. Directors were less likely to accumulate stock for an unexpected increase and I attribute this to their presence on the firm board. I also find that Directors are more likely to exercise their call options to acquire stock preceding an announcement for an expected increase in the cash dividend. However, Directors and Other Officers and block-holders are less likely to exercise their options for an unexpected increase in the cash dividend. The results are consistent with the information hierarchy hypothesis.

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0.1 Publications during candidature

- No publications.

0.2 Publications included in this thesis

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0.3 Contributions by others to the thesis

No contribution by others.

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Introduction

1.1 Introduction

Given perfect capital markets and symmetric information, Miller and Modigliani (1961) show that corporate payout policy is irrelevant. But in the presence of taxes, transaction costs, and asymmetric information, manager choice matters and dividends have both direct cash flow and signalling effects for firms and investors (Bhattacharya, 1979; Miller and Rock, 1985; John and Williams, 1985). Dividends are also important for stock valuation. Analysts forecast, and report to investors, future dividends that are used by the analyst to forecast earnings, value the stock, and develop more profitable buy-sell recommendations Barker (1999); Loh and Mian (2006).

In this thesis, I use option-implied dividends to investigate research questions in three different areas of finance: the ex-dividend day drop and related option pricing errors; insider trading on superior dividend knowledge; and analyst dividend forecast accuracy, incorporation of market information, and market response to analyst revisions.

Past studies have also used the expected dividends implied by option prices to investigate market phenomena. Barone-Adesi and Whaley (1986) calculate the maximum likelihood estimates for dividend and volatility using an option pricing model. Using another method, Bae-Yosef and Sarig (1992) calculate expected dividends using put-call parity. Due to the current availability of a large set of intraday option and stock transaction prices, I use the methodology from the later paper. The advantage of providing an ex-ante estimate of the dividend is that it is not confounded by economy-wide and firm-specific information releases that may affect the stock price returns surrounding the ex-day. This allows a calculation of the market expectation of the dividend using an empirical instrument that more closely measures the theoretical concept of the dividend surprise.

This chapter provides an introduction and overview to the following three chapters of my doctoral thesis. The first chapter investigates the relative ex-dividend day decline implied by the prices of American options. The second chapter examines whether insiders trade when they have superior knowledge of changes in dividend policy that are not priced by the market. And the third chapter studies the accuracy of analyst dividend forecasts and the effect of forecast revisions on the change in dividends implied by options and vice-versa.

1.2 Chapter I overview

In this chapter, I investigate the ex-dividend stock price decline implied by option transaction prices. Determining the extent of the ex-day price decline is important for security pricing and understanding the portfolio decisions of investors. Previous studies estimate the price decline by observing the change in price from the day before the ex-day to either the opening or closing price on the ex-day. I modify an approach, developed by Bae-Yosef and Sarig (1992), that uses put-call parity to estimate the expected dividend amount. The method I use in this chapter has the advantage of providing an ex-ante estimate of the relative price decline. The only other study that has investigated the ex-day price drop using options is Barone-Adesi and Whaley (1986). They do not find an ex-day price decline that is significantly different from the amount of the dividend. I am able to re-examine this research question using a substantially larger sample of option transaction data. The results are consistent with an ex-dividend drop-off implied by option prices that is significantly less than the cash dividend.

The second purpose of this chapter is to investigate factors that contribute to option mispricing.

Understanding factors that influence option pricing errors can help researchers and practitioners develop sample filters that improve the accuracy of option prices used in implied volatility and risk neutral probability models. I find an increase in pricing errors of the implied dividend with thin trading, non-synchronous trading, and lower dividend yields. I also find an increase in pricing errors for deep in-the-money and deep out-of-the-money options and put-call pairs that are traded at opposing bid and ask combinations.

1.3 Chapter II overview

The first chapter establishes a methodology for implying dividend expectations from option prices. Changes in these expectations over time proxy for changes in the information available to the market about the firm dividend policy. This chapter investigates the relationship between analyst dividend forecasts and market expectations of dividends implied by option prices. My primary research question is whether analysts update their forecasts in response to new market information, and likewise, whether the market updates dividend expectations in response to analyst forecast revisions. Users of analyst forecasts, such as investors, are interested in whether analysts, or a superior subset of analysts, update their forecasts in response to new information. Market participants, such as option traders, would also find it useful to know whether analyst dividend forecasts contain new information that may affect market prices when announced. I answer this question by comparing individual analyst dividend forecasts with implied dividends from option prices as per the methodology in Guerrero (2017), which is an extension of Bae-Yosef and Sarig (1992).

The second focus of this chapter investigates whether option-implied, superior analysts, non-superior, or consensus analysts provide more precise forecasts of firm dividends. Researchers can better test dividend signalling theories, and value-relevancy of accounting measures, by calculating a dividend surprise measure using a more precise forecast of market expectations of the dividend. Analysts, investors, and industry can also calculate stock prices that are closer to fundamental value when they use more precise dividend forecasts as inputs in their models.

The results show that dividends implied by option prices provide a more precise forecast of future dividends than individual analyst and superior analyst forecasts but are not more accurate than the mean consensus dividend forecast. Extending a concept in Baginski and Hassell (1990), that analysts play a role in interpreting the quality of information produced by management revisions and other sources, I find evidence that superior analysts are more likely to update their dividend forecasts in response to changes in the market information about the expected dividend. Non-superior analysts are less likely to increase their forecasts in response to increases in the market expectations of the dividend. The results indicate that analysts could use option-implied dividends to inform their own dividend forecasts, increasing the accuracy of the dividend yield used as an input in their stock valuation models. However, unlike previous studies[1] that find a market response to earnings revisions, I find no evidence for a option market response to analyst dividend forecast revisions.

1.4 Chapter III overview

This chapter applies the option-implied dividend methodology from the first chapter, to the question of whether insiders trade stock or options using their superior knowledge, or control, of changes in the amount of their firm's dividend payments.

Past studies, such as Oppenheimer and Dielman (1988), investigate insider trading prior to dividend cessation or resumption and find that insiders trade and earn abnormal returns based on their superior knowledge of dividend changes. I extend the naive model, that assumes any change in dividend is a surprise to the market, by using the market expectations of dividends implied by option and stock prices. As per the methodology in the previous chapter, I use the dividends implied by American options prices as a proxy for market expectations of dividends. I then use these expectations to calculate a dividend surprise and investigate whether there is abnormal insider trading preceding these dividend surprises. I also test for evidence of the information hierarchy[2] or the alternative, the scrutiny hypothesis[3].

There are two advantages to my approach. First, past studies have included only firms that cease or resume dividends[4], however these firms are a very small subset of all dividend paying firms. Using option-implied dividend changes I can include all dividend paying stocks with a liquid option market. Second, we are interested in changes in the dividend amount that are unexpected by the market; changes in the option-implied dividend provide a more accurate measure of dividend surprise than a naive change[5].

[1](Gleason and Lee, 2003; Park and Stice, 2000)
[2]Seyhun (1986)
[3]Fidrmuc, Goergen, and Renneboog (2006)
[4]Oppenheimer and Dielman (1988)
[5]Bae-Yosef and Sarig (1992)

I find that CEOs are more likely to accumulate stock preceding an announcement for an expected increase in the cash dividend. Whereas, Non-board Executives and Other Officers and Block-holders are more likely to accumulate stock for an unexpected increase. Directors were less likely to accumulate stock for an unexpected increase and I attribute this to their presence on the firm board. The results are consistent with the scrutinary hypothesis of past studies such as Fidrmuc et al. (2006).

I also find that CEOs and Other Officers and Block-holders are less likely to dispose of options prior to an expected increase in dividends. Whereas, Directors are more likely to exercise their call options preceding an announcement for an expected increase in the cash dividend. However, Directors and Other Officers and Block-holders are less likely to exercise their options for an unexpected increase in the cash dividend. This result is consistent with the information hierarchy hypothesis put forward by Seyhun (1986).

These findings will help firms develop appropriate corporate governance policies such as increasing dividend policy transparency around announcement timing, as well as deciding when insiders including non-directors are permitted to buy or sell stock in the company preceding a change in dividends.

2

The Expected Ex-Dividend Stock Price Decline Implied by Option and Stock Prices

2.1 Introduction

Since Campbell and Beranek (1955) discovered an ex-dividend stock price decline of less than the amount of the cash dividend, many studies have investigated this phenomenon. Various studies, discussed in detail later, have proposed different explanations for this observation including tax clienteles, arbitrage, price discreteness and microstructure effects. In addition, estimating the ex-day price decline from observed stock price returns is difficult due to confounding information effects, changes in trading volume around the ex-day, and the effect of the bid-ask spread. Determining the extent of the ex-day price decline is important for security pricing, and understanding the portfolio decisions of investors. In addition, understanding factors that influence option pricing errors can help researchers and practitioners develop sample filters that improve the accuracy of option prices used in implied volatility and risk neutral probability models.

I use an approach, developed by Bae-Yosef and Sarig (1992), that uses put-call parity of option and stock transaction prices to estimate market expectations of the ex-dividend stock price decline. Previous studies estimate the price decline by observing the change in price from the day before the ex-day to either the opening or closing price on the ex-day. The method I use in this chapter has the advantage of providing an ex-ante estimate of the relative price decline that is not confounded by economy-wide and firm-specific information releases that may affect the stock price returns surrounding the ex-day. Barone-Adesi and Whaley (1986) is the only previous study to use option transaction prices to estimate the ex-dividend stock price decline. Their results are consistent with some prior studies, and do not find an ex-day price decline that is significantly different from the amount of the dividend. I am able to re-examine this research question using a substantially larger sample, of option transaction data, than was available previously.

The results are consistent with an ex-dividend drop-off implied by option prices that is significantly less than the cash dividend. I also investigate factors that have an effect on option prices and find an increase in pricing errors with thin trading, non-synchronous trading, and lower dividend yields. I also find an increase in pricing errors for deep in-the-money and deep out-of-the-money options and put-call pairs that are traded at opposing bid and ask combinations.

This chapter proceeds as follows. Section 2 contains a discussion of the theoretical and empirical literature on the ex-day relative price decline. The section is divided into the various explanations hypothesised for the decline. Section 3 outlines the method of estimating the relative ex-dividend stock price decline from American option transaction prices, and the various tests used to test its economic significance. Section 4 presents the results, analysis and discussion. Section 5 summarizes the chapter and provides directions for future research.

2.2 Literature review

2.2.1 Estimations of the ex-day price decline

Early studies on the ex-day stock price decline observe prices surrounding the ex-day and provide descriptive statistics on the extent of the decline for different types of stock distributions during different periods. Typically the measure is calculated as:

$$\frac{S_B - S_A}{D} \tag{2.1}$$

where S_B is the stock price at the close of trading the day before the ex-day, and S_A is the stock price at the opening *or* the close on the ex-day, depending on the paper.

The first study to analyse the ex-dividend drop off value is Campbell and Beranek (1955). Using 399 observations from October 1949 and April 1950, and the last three months of 1953, they calculate the arithmetic mean of drop-off percentages and find the average is approximately 90%. They raise the prospect that the ex-dividend stock price decline should differ depending on the income tax rate of the recipient of the dividend.

In contrast to the above study, Barker (1959) uses stock-dividends, which, unlike cash-dividends, are not taxed as ordinary income. He includes observations of stock-dividends of 5% or more, to reduce the effect of one-eighth rounding of share prices imposed by the exchange, and observes 224 issues by NYSE-listed companies during the years 1951 to 1954. He finds the average market price drop-off was 97.4% of the dilution price decline calculated based on the prior-day closing price; the median was 100.0%. This result suggests that the average decline of less than the amount of the dividend, as per Campbell and Beranek (1955), is possibly due to the difference in taxation between cash-dividends and stock-dividends.

Later studies, such as Durand and May (1960), further investigate the ex-day relative price decline using different methodologies that attempt to remove confounding effects on the price movement around the ex-day. Unlike prior studies that use a panel of stocks, they observe a single stock, AT&T, for 45 consecutive dividends between 1948 and 1959. They use a time series analysis to attempt to remove general market trends surrounding the ex-dividend date. Due to the time series nature of the study, the paper measures the stock price decline from closing price the day before to the closing price on the ex-day, as opposed the closing price to opening price measure used in Campbell and Beranek (1955). Despite variation of stock price decline, they find that the drop-off is on average approximately equal to the dividend. These results do not support the decline of less than the dividend amount from the results of Campbell and Beranek (1955) and prompted further research.

2.2.2 Tax clientele effect

The presence of differential taxation between different types of stockholders may induce a tax clientele effect. Miller and Modigliani (1961) suggest that firms tend to attract a clientele of investors who prefer its particular payout ratio. Investors with a lower income tax rate on dividends such as corporations and pension funds may prefer higher yield stocks. Whereas, other investors with higher income tax rates on dividend distributions prefer to own low yield stocks with higher capital growth.

In order to determine whether a tax clientele effect exists, it is necessary to know the tax rates of marginal stockholders. Elton and Gruber (1970) present a method for inferring the marginal stockholder tax rate using observed ex-dividend price changes. They show that, in the absence of transaction costs, the ex-dividend stock price decline should accord with the following equation:

$$\frac{S_B - S_A}{D} = \frac{1 - t_o}{1 - t_g} \tag{2.2}$$

where S_B is the stock price just before the stock goes ex-dividend and S_A is the stock price just after, t_o is the ordinary income tax rate and t_g is the capital gains tax rate. From this equation I can see that when the capital gains rate is less than the ordinary tax rate, the value of the decline should be less than one.

They use the relationship in equation (2.2) to estimate the marginal stockholder for NYSE-listed stocks that paid a dividend between April 1966 and March 1967. They attempt to isolate the ex-day price changes from the broader market by adjusting the price change by the change in the NYSE index. They find that the relative decline is significantly less than the amount of the dividend at the 1% level, and that the average inferred marginal tax rate is 35.1%.

They also construct two variables to test Miller and Modigliani (1961)'s proposed clientele effect: dividend yield and payout ratio. Using deciles of dividend yield, they find a negative relationship between the dividend yield and the marginal tax bracket.[1] They also find that the implied stockholder tax rate declines with an increase in the firm's payout ratio decile.[2] Both these results support the hypothesis that stockholders with higher marginal tax rates prefer lower current dividends and a higher proportion of capital growth via a lower payout ratio.

As I noted earlier, Barker (1959) use a method for revealing differences in the ex-day price decline

[1]Spearman rank correlation of 0.9152 and significant at the 1% level.
[2]Spearman rank correlation of 0.7939 and significant at the 1% level.

due to taxation by observing stocks with different tax treatments on their distributions. Using this approach, Eades, Hess, and Kim (1984) observe the ex-day returns around common stock taxable distributions, preferred stock distributions, and non-taxable distributions. Their sample includes all stock dividends of 5% or more issued on the NYSE from 1951 to 1954. They find the returns on stock with taxable dividends are consistent with the hypothesis that dividend income is taxed at a higher rate than capital gains. In contrast, the high yield preferred stock has a decline that is greater than the amount of the dividend. This can occur when a marginal stockholder has a capital gains tax rate that is greater than their income tax rate on dividends. This result supports the tax clientele hypothesis and indicates that preferred stock are owned by corporations, which receive an 85% reduction on income received as dividends. They also find that non-taxable cash distributions are priced as if investors receive a tax rebate; possibly due to investor preference of non-taxable distributions over realising a capital gain on the sale of the stock.

A recent study that investigates distributions that are subject to different taxation is Elton, Gruber, and Blake (2005). They examine dividends from closed-end funds with taxable and non-taxable distributions. As both funds are subject to capital gains tax, the difference in price drop from distributions is only due to taxation. They find that funds with non-taxable distributions decline by more than the amount of the distribution; this is consistent with the tax hypothesis and does not support the microstructure hypothesis discussed later. However, short selling restrictions on closed-end funds may produce results that are different to common stocks that are subject to tax-induced short term trading and arbitrage.

2.2.3 Tax-induced short term trading and arbitrage

Kalay (1982) shows that due to arbitrage, the ex-dividend relative decline is bounded. If the dividend per share is smaller than the expected price drop then an investor could sell a stock short cum-dividend and buy it back ex-dividend, where the profit on the trade is

$$(1 - \tau_0)[P_B - \bar{P}_A - D - \alpha\bar{P}] > 0 \tag{2.3}$$

where $\alpha\bar{P}$ is the expected transaction costs of a *round trip*. Alternatively, if the dividend per share is greater than the expected price drop then an investor could buy the stock cum-dividend and sell it ex-dividend, where the profit on the trade is

$$(1 - \tau_0)[D - (P_B - \bar{P_A}) - \alpha \bar{P}] > 0. \tag{2.4}$$

Combining the two equations and rearranging, he derives a range for the drop-off ratios:

$$1 - \frac{\alpha \bar{P}}{D} \leq \frac{P_B - \bar{P_A}}{D} \leq 1 + \frac{\alpha \bar{P}}{D} \tag{2.5}$$

Therefore, the range of the ex-dividend relative decline is inversely proportional to the dividend yield. The tax rates of the firm's stockholders can only be inferred if the values imply a value within this range. He also shows that the ex-dividend price drop is biased downward by $\bar{r}P_B/D$, where $\bar{r}$ is the expected daily rate of return of the stock. Later papers augment their models to control for this effect.

Eades et al. (1984) also supports the hypothesis that a reduction in transaction costs decreases the relative ex-day price decline. They were able to find a decline of less than the dividend amount for taxable distributions from 1962 until the introduction of negotiated commissions in 1975. However, they were unable to find a tax premium between 1975 and 1980 when transaction costs were significantly lower.

In contrast to previous studies, that use stock *price* changes around the ex-day, Lakonishok and Vermaelen (1986) investigate *trading volume* changes to determine whether there is a short term trading effect. The tax clientele hypothesis assumes that prices are set by investors who decide to buy or sell around the ex-day for reasons unrelated to the dividend. Investors choose, depending on their tax position, between bringing their trade forward prior to the ex-day or delaying their trade until after the ex-day. The combined volume of trade before and after the ex-day should not increase due to tax clienteles.

However, there are other reasons that investors might trade around the ex-day. Investors with a high income tax rate may sell the stock before and buy the stock back after the ex-day, paying tax on a capital gain rather than dividend income. In addition, other investors with lower taxes on dividends such as corporations may be induced to purchase the stock immediately before the ex-day and sell after, capturing the dividend. Investors trading for these purposes will cause an abnormal increase in trading volume around the ex-day; and this is evident in the empirical results of Lakonishok and Vermaelen (1986). They find that taxable distributions of cash dividends induces a significant increase in trading volume around the ex-day. The increase is more pronounced for high yield stocks and low transaction cost stocks. These results are consistent with arbitrage trading. They find that non-taxable distributions such as stock splits and stock dividends have a negative abnormal volume around the ex-day.

As opposed to previous studies that segmented the sample into pre and post negotiated commissions, Karpoff and Walkling (1990) observe a more direct proxy for transaction costs. They use a one-factor market model to adjust ex-day price declines and the average bid-ask spread over a 30-day period to proxy transaction costs. They find a positive relationship between transaction costs and ex-day returns, which support the hypothesis that a reduction in transaction costs increases tax-induced trading and arbitrage.

Additional support for tax-induced trading and arbitrage comes from Koski and Scruggs (1998). They use NYSE audit file data to determine whether the abnormal trading volume observed by Lakonishok and Vermaelen (1986) is due to security dealers or corporations. They find significant abnormal trading volume by securities dealers that is positively related to dividend yield and negatively related to transaction costs. In addition, they find some evidence of dividend capture by taxable corporations and insufficient evidence to support the tax-clientele hypothesis.

2.2.4 Equilibrium pricing tests

Another approach for determining whether the taxation of dividends increases the return required by investors is to use an equilibrium pricing model. Black and Scholes (1974) test whether the expected returns on high yield stocks are higher than the expected returns on low yield stocks due to differential taxation of dividend verses capital gain. They find that a dividend factor in an augmented CAPM model is insignificant, and conclude that investors do not expect a higher return due to taxation.

A similar method is used by Miller and Scholes (1982) to test for the presence of a difference in expected returns based on dividend yield. In contrast to previous studies, they attempt to adjust their sample selection based on the information available to investors ex-ante. They only include observations of the ex-month for stocks that announced dividends prior to, rather than during, the ex-month. They find a smaller coefficient for stocks prior to the ex-month than during the ex-month and attribute this to a dividend announcement information effect.

However, as subsequently pointed out by Litzenberger and Ramaswamy (1982), the average number of days from the beginning of an ex-month to the ex-date is greater for stocks that announce within the ex-month than for stocks that announce prior to the ex-month. If the information effect occurs over a period of weeks,[3] then this will change the relative returns for the two different pools of stocks. Litzenberger and Ramaswamy (1982) investigate the expected return of portfolios based on yield, using information investors have ex-ante. They find a non-linear relationship between dividend yield and and common stock returns but caution that this relationship may be due to omitted variables.

Michaely and Vila (1995) use an equilibrium model to explain trading volume and stock price behaviour around ex-dividend days. They show that the ex-day price decline relative to the dividend is a function of two variables: the average relative tax rate of dividend and capital gains across traders, weighted by their risk tolerance; and the risk due to uncertainty about the ex-day price returns and the risk-premium demanded by traders. This premium may obscure inferences of the marginal tax rate of any trading group and can result in the ex-day price decline of less than the dividend amount even in the absence of transaction costs. They find empirical support for two predictions of their model. First, that increased stock variance decreases the trading volume around the ex-day. Second, after the 1986 tax reform, which increased tax homogeneity among investor groups, trading volume around ex-days decreased.

2.2.5 Microstructure effects

Price discreteness is another proposed explanation for ex-day price declines of less than the amount of the dividend. Bali and Hite (1998) argue that because ex-day stock prices can only be adjusted down in multiples of the tick size, if the dividend amount is not a multiple of the tick size then the ex-day price will be rounded to the nearest tick. During the period from their sample, the minimum tick size was 12.5¢ and the median cash dividend was 20¢. Using these values as an example produces in a ex-day price decline of 62.5% of the dividend amount. Their empirical results support the discreteness hypothesis just as well as the tax clientele model. However, evidence of the ex-day price decline of greater than the amount of the dividend for non-taxable cash distributions cannot be explained by discreteness and therefore supports the existence of the tax clientele effect.[4]

Another way to determine whether the ex-day decline of less than one is due to microstructure effects or taxes is to examine a market where there are no taxes. Frank and Jagannathan (1998) study ex-day price declines in the Hong Kong market from 1980 to 1993 during which there was no tax on

[3]Black and Scholes (1974) find abnormal returns for several days surrounding the ex-dividend date
[4]Eades et al. (1984); Elton et al. (2005)

dividends or capital gains. They find an ex-day price drop of less than the price of the dividend and propose a microstructure explanation. However, they don't consider the effect of taxation on foreign sourced income. Foreign investors own a large proportion of Hong Kong companies and pay income tax on the repatriated income. The foreign tax effect combined with short selling restrictions for the Hong Kong Market during the sample period, which limit the ability to arbitrage, may explain the relative price drop of less than one.

2.2.6 Motivation

Barone-Adesi and Whaley (1986) use American call option transaction prices to estimate the ex-day relative price decline. Their method has the advantage of providing an ex-ante estimate of the relative price decline that is not confounded by economy-wide and firm-specific information releases that may affect the stock price returns surrounding the ex-day. Consistent with some prior studies, their results do not support an ex-day price decline that is significantly different from the amount of the dividend.

An alternative explanation for their result is that their sample selection increased the variance of the estimate of the relative ex-dividend stock price decline and possibly upwardly biased their estimate. Option traders have a variance for their estimate of the dividend before the announcement. After the announcement, the dividend is known but the relative ex-day stock price decline is still uncertain. Therefore, the variation of the ex-day price decline implied in option transaction prices will be greater before the announcement than after. In addition, if option traders are risk-averse, they will require a risk-premium for the additional uncertainty of pricing the ex-day price decline, as an input in their option prices, before the dividend is certain. This risk-premium is modelled with stock prices by Michaely and Vila (1995), and should be incorporated in option prices. The premium will upwardly bias an estimate of the relative price decline to a greater extent if pre-announcement option transactions are included in an estimation compared with post-announcement. Barone-Adesi and Whaley (1986) include option transactions prior to announcement. Option transactions with less than 4 weeks to expiration account for approximately 4.65% of the observations in their study. However, given the sample period, restricting their sample to option transactions after dividend announcements would provide insufficient power given their sample size. Since their paper was published, option markets have become more liquid and the number of transactions available to use in a study has substantially increased. This provides us with the opportunity to re-examine the issue and ask two questions. First, are dividends implied by option prices accurate forecasts for the cash dividend? And second, following a dividend announcement, do option traders price an ex-day stock decline of less than the amount of the cash dividend?

2.2.7 Summary of the literature

Studies that observe the price change around the ex-day find a relative price decline of less than the dividend amount.[5] A tax clientele effect has been proposed as the primary determinant of the decline, and many papers find evidence to support this effect.[6] Although early papers proposed that the tax rates of the marginal investor could be inferred from the ex-day decline, more recent papers propose tax-induced short term trading and arbitrage as additional effects. There is theoretical and empirical support for both these effects.[7] However, many studies find no support for an ex-day decline greater than the dividend.[8] And some studies propose that microstructure and discreteness effects are partially or wholly responsible for the observed price changes.[9] Importantly, there is no evidence that the ex-day decline of less than the dividend amount is factored into the option prices on dividend paying stock.[10] The question of whether the ex-day relative decline is priced by option traders is the primary goal of this chapter.

2.3 Methodology

2.3.1 Estimation of the implied dividends from option prices

I follow a similar methodology to (Bae-Yosef and Sarig, 1992), who use option put-call parity to estimate changes in dividend expectations as a proxy for dividend surprise. The following equation holds for European options:

$$PV(DIV) = S - (c - p + KB_t) \tag{2.6}$$

where $PV(DIV)$ is the current value of expected interim dividends; S, c, and p are the prices of the underlying stock, the European call, and the European put, respectively; K is the common exercise

[5](Campbell and Beranek, 1955; Elton and Gruber, 1970)

[6](Barker, 1959; Elton and Gruber, 1970; Eades et al., 1984; Elton et al., 2005; Litzenberger and Ramaswamy, 1982).

[7](Kalay, 1982; Eades et al., 1984; Lakonishok and Vermaelen, 1986; Karpoff and Walkling, 1990; Koski and Scruggs, 1998; Michaely and Vila, 1995).

[8]Durand and May (1960); Black and Scholes (1974); Miller and Scholes (1982).

[9](Bali and Hite, 1998; Frank and Jagannathan, 1998)

[10](Barone-Adesi and Whaley, 1986)

price; and B_t is the time-t price of a pure discount bond maturing on the options' common expiration day.

Equation 4.1 is based on European option prices. Since I can only observe American options, I need to take into account the premium due to the right of early exercise. I define the American over European option premium, for calls and puts, by:

$$\Delta c \equiv C - c \geq 0 \tag{2.7}$$

$$\Delta p \equiv P - p \geq 0 \tag{2.8}$$

where C and P are American call and put prices, respectively. Equation 4.1 can now be written as

$$PV(DIV) = S - (c + \Delta c - (p + \Delta p) + KB_t) \tag{2.9}$$

American options will not be exercised early, and therefore have an equivalent price to European options, whenever:

$$D \leq K(1 - e^{-R(T-t)}) \tag{2.10}$$

where D is the dividend, R is the forward rate between the dividend payout time, t, and the expiration date, T, as observed at time t, and K is the exercise price of the option.

The estimation procedure matches the two closest observations, based on time, where a put and call with the same exercise price and expiration date occur on the same day. Transactions are only matched to a single pair but there may exist many pairs on any given day. I find 80,898 put-call trade pairs, approximately 8.37% of the final sample, meet the condition in equation 4.5 and I use a modified equation 4.1 to calculate the future value of the dividend, for these transactions:

$$IDIV = \Big(S - C + P - K\exp\big(-R(T_M - t)\big)\Big)\exp\big(R(T_X - t)\big) \tag{2.11}$$

where $IDIV$ is the future value, at the ex-dividend day T_X, of the cash dividend, C, P, K are the call, put, and strike prices, S is the mean of stock trade prices that occur between the put-call pair, T_M is the time of maturity, and R is the forward rate.

American call options that do not meet the condition in equation 4.5 will be exercised the day before the ex-dividend date due to the expected stock price decline. Whereas, American put options that do not meet the the condition in 4.5 will be exercised on or after the ex-dividend date depending on moneyness. If the interest on the proceeds from early exercise exceed the time value of money then early exercise is optimal:

$$(K - S)(1 - e^{-R(T-t)}) > T.V. \tag{2.12}$$

where $T.V.$ is the time value of the option, and the remaining notation is the same as equation 4.5. Based on the expected price decline due to the dividend, I anticipate an insignificant marginal difference in the European vs American put option premium.[11][12] Therefore, for the main study, the remaining option pairs that do not satisfy equation 4.5 are estimated using equation 4.6 with the maturity date T_M set to the ex-dividend date T_X due to early exercise.

2.3.2 Data

The data in the study are compiled from two sources: OptionMetrics and ThomsonReuters Tick History. I analyse data from years 2009 to 2015. The option tick data provided by ThomsonReuters does not exist prior to 2009, so I am unable to analyse the effect of bear markets and the Global Financial Crisis on the option market expectations of the dividend. However, this is unlikely to have a significant effect given that the options price dividends that are typically less than a financial quarter before the ex-dividend date. Using end-of-day data and dividend event data from OptionMetrics, I compile a list of firm-years that match the following filter: at least a single daily traded volume of 30 for an option instrument with a single ex-dividend date between the trade date and option maturity. Using these firm-years, I collect all option and underlying stock tick data from ThomsonReuters Tick History from 2009-2015. The final sample consists of 9,334 firm-years from 1,908 firms.

I exclude dividend events where the stock price moves more than 10% from the close the day before the ex-dividend date to the opening on the ex-dividend date. I exclude, due to the unavailability of future dividend event information, option maturities with expiration past the dividend event sample period of 31st December 2015. I exclude estimated dividend yields greater than 10%. This reduces the sample approximately 0.01% from 4,818,361 to 4,817,818 individual estimates.

I truncate at the 2nd and 98th percentiles for the individual dividend estimates, implied alpha ,

[11] Gray (1989) finds in favour of put-call parity holding when taking into account the potential rational early exercise of an option and the possibility that dividends and capitalisation changes will differ from expectations.

[12] Whaley (1982) finds only a half-percent difference in pricing between European and American options.

and overnight realized alpha. This reduces the final sample by approximately 10.6% to 4,303,528 individual estimates. I then calculate the mean of the individual estimates for each dividend event and use these values in the following analysis.

[Descriptive statistics table 1 about here]

2.3.3 Estimation of the implied and realized ex-dividend stock price decline

The observed stock returns surrounding the ex-dividend date are noisy due to confounding factors such as idiosyncratic and systematic price effects. I investigate three different measures of the ex-dividend stock price decline to determine the best measure to compare the relationship between $\alpha_{realized}$ and the $\alpha_{implied}$ by the option implied dividend estimates. The first measure I use is the Overnight Stock Price Drop:

$$DROP_{overnight} = S_B - S_O \tag{2.13}$$

where S_B is the stock price at the close of trading the day before the ex-day, and S_O is the stock price at the opening on the ex-day. The second measure I use is the Daily Stock Price Drop:

$$DROP_{daily} = S_B - S_A \tag{2.14}$$

where S_B is the stock price at the close of trading the day before the ex-day, and S_A is the stock price at the close on the ex-day. The third measure I use is the Daily Stock Price Drop adjusted for market movements. I adjust the ex-dividend day stock price return using the *market model*:

$$E(r_i|r_{mt}) = \alpha_i + \beta_i r_{mt} \tag{2.15}$$

where r_m is the S&P 1500 Stock index, α_i and β_i are estimated from sample return data prior to the ex-dividend date. Subtracting $E(r_i)$ from 2.14 gives a market adjusted measure of the ex-dividend day drop:

$$DROP_{adjusted} = S_{i,B}(E(r_i) - r_{i,realized}) \tag{2.16}$$

where $S_{i,B}$ is the close price the day before ex-dividend day, for stock i, $r_i, realized$ is the close to close daily stock return for stock i.

[Results table 2 about here]

The overnight drop model has significantly more explanatory power for explaining the effect of the cash dividend around the ex-dividend date. Therefore, I define the realized ex-dividend stock price decline as:

$$\alpha_{realized} = \frac{S_B - S_O}{D} \tag{2.17}$$

where $\alpha_{realized}$ is the relative ex-dividend stock price decline, S_B is the closing stock price the day before the ex-dividend date, S_O is the opening stock price on the ex-dividend date, and D is the realized cash dividend amount. Likewise, I define a measure of expected stock price decline implied by option prices as:

$$\alpha_{implied} = \frac{IDIV}{D} \tag{2.18}$$

where $\alpha_{implied}$ is the option implied relative ex-dividend stock price decline, $IDIV$ is the dividend amount implied by option prices from 4.6, and D is the realized cash dividend amount.

2.3.4 Pricing error factors

I calculate the expected ex-dividend drop using put-call parity from options and stock prices after the dividend announcement. Because the cash dividend is known, the only variation in the implied drop must come from either heterogeneous expectations among the option traders or empirical effects such as the bid-ask spread. In this section, I test five factors that have an effect on the error in the implied ex-dividend drop. First, I calculate the relative difference between the implied ex-dividend drop and the cash dividend for each individual put-call pair as,

$$\delta_j = \frac{IDIV_{ji} - D_i}{D_i} \tag{2.19}$$

where $IDIV_j$ is the individual implied ex-dividend drop for put-call pair j for dividend event i calculated using equation 4.1. I then calculate the standard deviation of δ_j for each dividend event to measure the amount of variation between the individual ex-dividend drop estimates for each dividend event. I define pricing Errors as,

$$s_i = \sqrt{\frac{1}{N}\sum_{j=1}^{N}(\delta_j - \bar{\delta_j})^2} \tag{2.20}$$

where N is the number of implied dividend estimates for dividend event i.

In the following analysis, dividend events are sorted into factor-based deciles. The mean, median, and standard deviation for each decile is calculated from the pricing errors. The difference between the means of each decile reveals whether the pricing error changes with the factor. Whereas, the difference between the standard deviation of each decile indicates a change in the amount of variation in the error between dividend events based on changes in the pricing factor. Later in the analysis, I use filters to create a subsample with a reduced pricing error. It is important to use the factors that decrease the mean error of the sample but also reduce the variation across dividend events in order improve the estimation of the implied ex-dividend drop.

I test for the equality of means of the pricing error across deciles using the GLM F-statistic developed by (Nelder and Wedderburn, 1972).

If equality is rejected then I use the Jonckheere-Terpstra trend in group medians test developed by Jonckheere (1954); Terpstra (1952). I test the following hypothesis,

$$H_0 : \theta_1 = \theta_2 = ... = \theta_{10} \tag{2.21}$$

$$H_A : \theta_1 \leq \theta_2 \leq ... \leq \theta_{10}, \quad \text{with at least one strict inequality.} \tag{2.22}$$

where θ_i is the median value of the pricing error of the ith decile. The test z-statistic is calculated using the method described in Jonckheere (1954),

$$p_{ia_ija_j} = \begin{cases} 1, & \text{if } X_{ia_i} < X_{ja_j}. \\ 0, & \text{otherwise.} \end{cases} \tag{2.23}$$

where X_{ia_i} is the ath value in the ith sample drawn from k samples of size m, $i = 1, \ldots, k-1; j = 1+i; a_i = 1, \ldots, m_i; a_j = 1, \ldots, m_j$.

$$p_{ij} = \sum_{a_i=1}^{m_i} \sum_{a_j=1}^{m_j} p_{ia_ija_j} \tag{2.24}$$

$$S = 2\sum_{t=1}^{k-1} \sum_{j=1+i}^{k} p_ij - \sum_{t=1}^{k-1} \sum_{j=1+i}^{k} m_i m_j \tag{2.25}$$

$$VAR(S) = \frac{2(n^3 - \sum t_i^3) + 3(n^2 - \sum t_i^2)}{18} \tag{2.26}$$

where n is the total number of scores, and t_i is the number of scores in the ith sample.

$$z = \frac{S_c}{\sqrt{VAR(S)}} \tag{2.27}$$

where S_c is a continuity correction $S_c = |S| - 1$.

Likewise, I test for a trend in the variances of the deciles to determine whether the factor increases or decreases the variability of the error between dividend events. Levene et al. (1960) derives a test for the homogeneity of variance of group observations. This was adapted by Brown and Forsythe (1974) who demonstrated that using medians rather than the means, when calculating the spread between the groups, is more robust to non-normal data whilst retaining good statistical power. Gastwirth, Gel, and Miao (2009) extended these tests to include rank linear trends in the group variances. I test the null hypothesis that the standard deviations of the pricing error are all equal,

$$H_0 : \sigma_1 = \sigma_2 = \ldots = \sigma_{10} \tag{2.28}$$

$$H_A : \sigma_1 < \sigma_2 < \ldots < \sigma_{10} \tag{2.29}$$

with the alternative hypothesis that the standard deviations of the deciles are strictly ordered. I calculate the Modified Brown-Forsythe Levene-type test statistic as,

$$\hat{\beta} = \frac{\sum_{i=1}^{k} n_i (w_i - \tilde{w})(\tilde{z}_{i.} - \tilde{z}_{..})}{\sum_{i=1}^{k} n_i (w_i - \tilde{w})^2} \tag{2.30}$$

$$\bar{w} = \sum_{i=1}^{k} \frac{n_i w_i}{N_i} \tag{2.31}$$

where $\tilde{z}_{i.}$, $i = 1, \ldots, k$, are the group medians of z_{ij} and $\tilde{z}_{..}$ is the grand median over $\bar{z}_{..}$,$i = 1, \ldots, k$. The following results are robust to substituting the means $\bar{z}$ where the medians $\tilde{z}$ are used in equation 2.30; as per the original Levene test.

2.4 Results

The first few sections of results present the estimates for pricing error factors. As discussed previously,

2.4.1 Volume of option trades

The individual estimates, calculated from each pair of put-call trades, are averaged to produce an aggregate ex-dividend day decline estimate for each dividend event. The number of individual estimates used for each aggregated estimate depends on the volume of both put and call option trades between the dividend announcement and the ex-dividend date. Options on thinly traded stocks are more difficult to arbitrage and therefore, possibly, have option prices that deviate from those expected from put-call parity. I hypothesise that firms with a lower volume of option trades will have a larger mean pricing error and more variation across events than firms with higher volumes of option trades.

[Results table 3 about here]

Results from Table 3 reject the null hypothesis for an equality of means (F-statistic 51.42), medians (Z-statistic -11.5318), and variances ($\hat{\beta}$ 101.33) in favour of the alternatives that there is a decreasing trend in the median and standard deviation of the pricing errors based on decile of option volume.

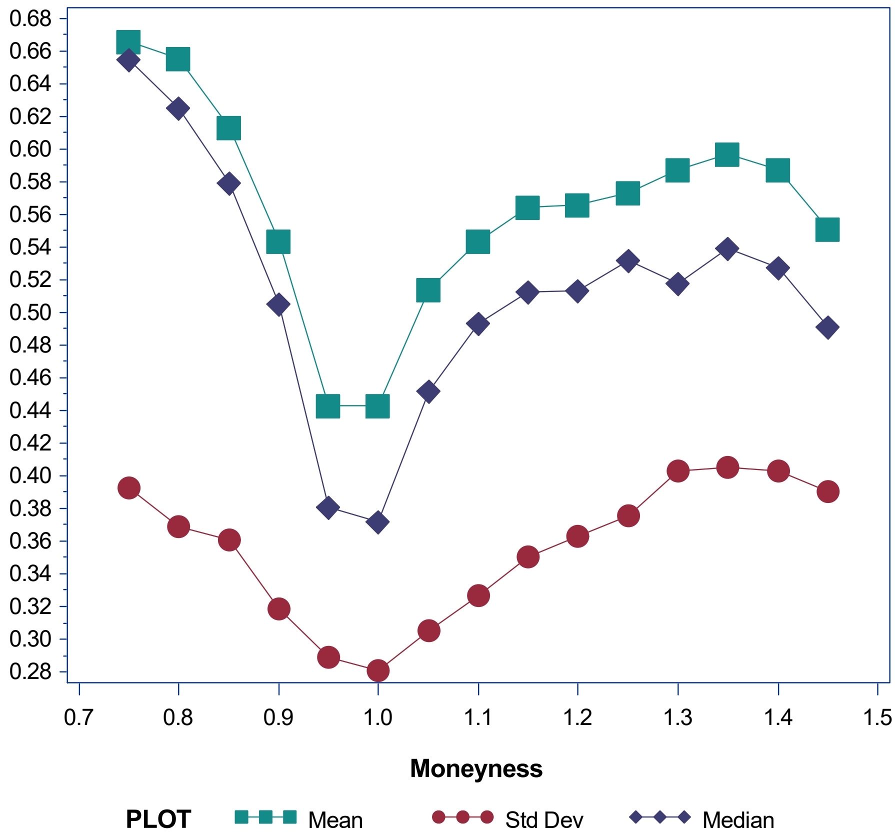
2.4.2 Moneyness of the put-call options

I hypothesize that deep in-the-money options have an larger pricing error because of a divergence in optimal exercise time between calls and puts. Deep in-the-money call options are more likely to be exercised prior to the ex-dividend date, when the stock is expected to fall by the amount of the dividend. Whereas, a put option with the same strike will be deep out-of-the-money and exercise will be delayed until much closer to option expiry.

[Results table 4 about here]

The mean, median, and standard deviation from Table 4 are high at low S/X ratios then low near the money then high again at high S/X ratios. The *upside down umbrella*, Figure 2.1, means that the monotonic trend tests I used previously are not applicable for testing a trend in the moneyness factor. Mack and Wolfe (1981) develop a test for umbrella alternatives with a known peak. However, the lowest mean and median error is unknown and could likely be either $0.95 \leq S/X \leq 1$ or $1 \leq S/X \leq 1.05$. Chen and Wolfe (1990) modify the test to remove the assumption that the underlying populations have the same shape and provide a test statistic for an unknown-peak in the umbrella.

FIGURE 2.1: Pricing error by the degree to which the options are in-the-money.



I test can use the Mack-Wolfe-Chen Test by taking the reciprocal of the pricing error to invert the shape. I then test the following hypothesis,

$$H_0 : \theta_1 = \theta_2 = ... = \theta_k \quad (2.32)$$

$$H_A : \theta_1 \leq \ldots \leq \theta_p \geq \ldots \geq \theta_k, \text{ for some } p\text{, with at least one strict inequality.} \quad (2.33)$$

where θ_k is the median of the reciprocal of the pricing error. The reciprocal is taken to transform the data to fit the umbrella alternative.

Results from Table 4 reject the null hypothesis for an equality of median errors ($A^*_{\hat{p}}$ 39.067) in favour of the alternative that there is an umbrella trend in the median based on the moneyness of the options. The estimated peak group, for lowest median error, is near-the-money between $0.95 \leq S/X \leq 1$.

The distribution of option moneyness from Table 1 shows that deep out-of-the-money and deep in-the-money options have much lower traded volume than near-the-money, at-the-money, and in-the-money options. The results in the previous section, Table 3, show a monotonic trend in pricing error with the volume of individual options per dividend event. In order to rule out option traded volume, as the confounding factor for the above moneyness results, I construct a subsample with a uniform volume across all moneyness group. The sample is constructed by taking the 2nd to the 11th moneyness groups. This is group $0.8 \leq S/X \leq 0.85$ through to $1.3 \leq S/X \leq 1.35$. Additionally, I only use volume deciles 1 to 6 from Table 3. I then select 55 random observations from each moneyness group which results in a total of 3,300 dividend events with a uniform distribution of volume. The results in Table 5 are very similar to the full sample. The Mack-Wolfe-Chen statistic is slightly lower at 11.433 but is still significant at the 0.001 level. The estimated lowest median pricing error has moved from near-the-money, $0.95 \leq S/X \leq 1$, to at-the-money, $1 \leq S/X \leq 1.05$. The results confirm the effect of the inverted umbrella on the option dividend pricing error.

2.4.3 Non-synchronous trading

Put-call parity relies on tradable prices. As the time between the put and call options increase, the price of the underlying stock and the factors that affect the price the option premiums may diverge from the values when the first option was traded. I hypothesize that put-call pairs matched closer in time have a lower pricing error because of reduced non-synchronous trading effects.

[Results table 6 about here]

Results from Table 6 reject the null hypothesis for an equality of means (F-statistic 1186.43), medians (Z-statistic 109.0832), and variances ($\hat{\beta}$ -91.151) in favour of the alternatives that there is an increasing trend in the median and standard deviation of the pricing errors based on decile of time between put-call option pairs.

2.4.4 Put call spread

Suppose a trader were to arbitrage option mispricing using put-call parity. The trader would either buy the stock plus the put and sell the call, otherwise they could sell the stock plus the put and buy the call. Therefore, it is plausible that the combination of put-call bid-ask that would exhibit the largest pricing errors would follow this alternate bid-ask combination. An alternative hypothesis is that traders who arbitrage put-call parity are market makers and do not cross the spread. This would result in same-side bid-bid and ask-ask combinations with the largest pricing errors because they would include an inventory holding premium.

[Results table 7 about here]

Results from Table 7 reject the null hypothesis for an equality of means for the put-call bid-ask combinations as a group (F-statistic 17.94). Tukey's Studentized Range Test shows that two combinations have higher errors than Call-Ask Put-Ask than other combinations at the 0.05 significance level. These two combinations are Call-Ask Put-Bid at 0.023639 higher and Call-Bid Put-Bid which is 0.018259 higher. Call-Bid Put-Bid has a significantly lower error than Call-Ask Put-Bid by 0.017378 and Call-Bid Put-Ask by 0.011998. There is no significant difference between Call-Bid Put-Bid and Call-Ask Put-Ask or between Call-Ask Put-Bid and Call-Bid Put-Ask. These results show that the lowest errors occur when both call and put trades are on the same side either the bid or the ask. If the call and put trade occurs at Bid and the Ask then the error is higher and there is no significant difference whether it is the call or the put on one-side or the other.

2.4.5 Dividend yield

As discussed previously, variation in the relative ex-dividend day decline are possibly due to costs and limits of arbitrage.[13] As such, I hypothesize that the pricing error will be lower for high yield stocks due to transaction costs making up a smaller proportion of the dividend and therefore potential arbitrage profits.

[Results table 8 about here]

Results from Table 8 reject the null hypothesis for an equality of means (F-statistic 845.45), medians (Z-statistic -78.5589), and variances ($\hat{\beta}$ 46.316) in favour of the alternatives that there is a decreasing trend in the median and standard deviation of the pricing errors based on dividend yield.

2.4.6 Comparison of implied alpha and realized alpha

I filter below the median for all factors that were identified, in the previous sections, to increase the error in the implied dividend. I include options that are below the median yield of 0.00621,

[13](Kalay, 1982; Lakonishok and Vermaelen, 1986)

and I include estimates where the time between matched put-call pairs is less than 14 minutes. The moneyness of the filtered sample is limited to $0.9 \geq S/X \leq 1.1$. And the bid-ask of the filtered sample were also limited to Call-Ask Put-Ask or Call-Bid Put-Bid combinations.

This reduces the sample of dividend events from 17,818 to 4,943. I do not filter based on the volume of individual estimates used for each dividend event as this factor has a much smaller effect than the other factors and filtering below the median would exclude 78% of the remaining sample leaving only 1,048 dividend events.

[Descriptive statistics table 9 about here]

It is not surprising that the standard deviation for all observations of the Overnight Alpha (1.88124) is much larger than the standard deviation of the Implied Alpha (0.37995). This is likely due to the confounding factors such as overnight information releases that affect the change in the overnight price and add noise to the observed price change. Whereas, the implied alpha is an ex-ante measure implied from option prices made days or weeks earlier that are not affected by information released after the close of trading the day before the ex-dividend date.

The filtering factors that lower the standard error of the Implied Alpha from 0.37995 to 0.31385 also have an effect on the Overnight Alpha reducing the error from 1.88124 to 0.94456. The mean Overnight Alpha increase when filtered from 0.763177 to 0.815024 whereas the Implied Alpha decreases due to the filtering from 0.894496 to 0.842144.

2.4.7 Predictive ability of alpha implied by option prices

I can test whether the estimates of implied α are able to predict the subsequently realized values of relative stock price decline. This gives us an indication of whether the implied α are economically meaningful.

The estimate of the realized value of α for individual firms is computed as $(S_B - S_A)/D$, where S_B is the closing stock price on the day before ex-dividend, S_A is the opening stock price on the day of ex-dividend, and D is the amount of the dividend. I calculate the Mean Absolute Predictive Error as,

$$MAPE = \frac{1}{n} \sum_{j=1}^{n} |A_j - P_j| \tag{2.34}$$

where A_j is the realized stock price decline estimate for the jth stock, P_j is the predicted stock price decline estimate for the jth stock, and n is the number of observations for the year. And I calculate the Mean Squared Predictive Error as,

$$MSPE = \frac{1}{n}\sum_{j=1}^{n}(A_j - P_j)^2. \tag{2.35}$$

[Results table 3.3 about here]

I can test whether option traders can predict firm variation in the ex-dividend drop by regressing the option implied alpha on the realized alpha, that is,

$$\hat{\alpha}_{realized,j} = \gamma_0 + \gamma_1\hat{\alpha}_{implied,j} + \epsilon_j \tag{2.36}$$

If the estimated coefficients $\hat{\gamma}_0$ and $\hat{\gamma}_1$ are indistinguishable from zero and one, respectively, then the $\alpha_{implied}$ is a good predictor of the $\alpha_{realized}$. The slope coefficient should be insignificantly different from zero if most of the predictive power is due to the $\alpha_{implied}$.

[Results table 11 about here]

The above results are consistent with the theory that option prices do not predict the firm-specific ex-dividend day relative price decline. This is likely due to the fact that option traders cannot predict the confounding factors that affect the overnight price around the ex-dividend day, and these factors outweigh the differences in the expected decline caused by costs to arbitrage. Nonetheless, the intercept for the full sample of 0.894496 is highly significant with a t-value of (37.07). A similar value is observed in the regression of the option implied dividend on the cash dividend amount in 11, which showed that option traders under-price the dividend indicating an expected price decline of 87% for the full sample and 85% for the filtered sample.

2.5 Discussion and conclusion

Past work by (Barone-Adesi and Whaley, 1986), on estimating the expected stock price decline implied by American call options, found the decline insignificantly different from the amount of the dividend. However, using a much larger sample size, and a new method for estimating dividends from option prices, developed by (Bae-Yosef and Sarig, 1992), I find that the expected stock price decline implied by American call options is significantly less than the amount of the dividend. This has important implications for the pricing of options. Pricing a call option with an inflated dividend amount produces a call that is too expensive, likewise it produces a put that is under-priced.

In addition, the results indicate several factors that have an effect on option pricing errors that should be taken into account when using historical option prices in implied volatility and risk neutral probability models. I find that option pricing errors are higher due to thin trading, non-synchronous trading, and lower yields. I also find an increase in pricing errors for deep in-the-money, deep out-of-the-money, and put-call pairs that are traded at opposing bids and asks. I propose that some of these empirical effects, such as non-synchronous and thin trading, are the reason for an ex-dividend drop larger than the arbitrage bounds demonstrated by Kalay (1982).

The results show that the ex-dividend stock price decline implied by American option prices is a useful measure of the expected ex-dividend day price decline. The expected ex-dividend day stock price decline has a mean of between 85% and 87% of the cash dividend. The implied stock price change from options can be grossed up to produce an estimate of the market's expectation of the dividend. Dividend estimates are used in valuation models such as the Dividend Discount Model, as well as pricing models for options, futures, and swaps. Investors are also interested in forecasts of dividends because a change in cash dividend provides a credible signal to investors about changes in firm earnings quality. It is because of the aforementioned reasons that management and analysts often both provide dividend forecasts. The ability to use option prices, and the factors that affect its accuracy, as an additional tool to estimate an expected dividend is therefore economically useful.

TABLE 1: Frequency distributions for the number of individual put-call pairs by the degree to which the options are in-the-money (S/X) and by the time to expiration of the options, (T).

Ratio of stock price to exercise price	Number of transactions	Percent	Time to expiration in weeks	Number of transactions	Percent
$S/X < 0.75$	11622	0.27%	$T < 2$	5,346	0.12%
$0.75 \leq S/X < 0.8$	16,446	0.38%	$2 \leq T < 4$	6,276	0.15%
$0.8 \leq S/X < 0.85$	46,845	1.09%	$4 \leq T < 6$	16,446	0.38%
$0.85 \leq S/X < 0.9$	156,919	3.65%	$6 \leq T < 8$	46,845	1.09%
$0.9 \leq S/X < 0.95$	613,447	14.25%	$8 \leq T < 10$	156,919	3.65%
$0.95 \leq S/X < 1$	1,958,836	45.52%	$10 \leq T < 12$	613,447	14.25%
$1 \leq S/X < 1.05$	945,193	21.96%	$12 \leq T < 14$	1,958,836	45.52%
$1.05 \leq S/X < 1.1$	322,644	7.50%	$14 \leq T < 16$	945,193	21.96%
$1.1 \leq S/X < 1.15$	123,455	2.87%	$16 \leq T < 18$	322,644	7.50%
$1.15 \leq S/X < 1.2$	51,799	1.20%	$18 \leq T < 20$	123,455	2.87%
$1.2 \leq S/X < 1.25$	24,950	0.58%	$20 \leq T < 22$	51,799	1.20%
$1.25 \leq S/X < 1.3$	12,691	0.29%	$22 \leq T < 24$	24,950	0.58%
$1.3 \leq S/X < 1.35$	6,886	0.16%	$24 \leq T < 26$	12,691	0.29%
$1.35 \leq S/X < 1.4$	3,837	0.09%	$26 \leq T < 28$	6,886	0.16%
$1.4 \leq S/X < 1.45$	2,539	0.06%	$28 \leq T < 30$	3,837	0.09%
$1.45 \leq S/X < 1.5$	1,472	0.03%	$30 \leq T < 32$	2,539	0.06%
$1.50 \leq S/X$	3,947	0.09%	$32 \leq T$	5,419	0.13%
Total	4,303,528	100%	Total	4,303,528	100%

TABLE 2: Summary of the regression results for the cash dividend on the estimated realized relative ex-dividend stock price decline for individual stocks.

Measure	$\hat{\gamma}_0$	$\hat{\gamma}_1$	Adj. R^2
$DROP_{overnight}$	0.19634	0.45473	0.4137
	(30.70)	(17.15)	
$DROP_{daily}$	0.26937	-0.16306	0.1676
	(80.19)	(-12.03)	
$DROP_{adjusted}$	0.24145	0.23839	0.2547
	(45.23)	(12.59)	

The regression equation is $D = \gamma_0 + \gamma_1 D\hat{R}OP + \epsilon$, where D is the realised dividend. Sample includes 17,818 dividend events.
$DROP_{overnight}$ is measured as the stock price on the close before the ex-dividend day minus the stock price on the opening of the ex-dividend day.
$DROP_{daily}$ is measured as the close before the ex-dividend day minus the close on the ex-dividend day.
$DROP_{adjusted}$ is measured as the $DROP_{daily}$ adjusted by the expected return on the stock $S_{i,B}(E(r_i) - r_{i,realized})$, the expected return $E(r)_i$ is computed using the market model: $E(r_i|r_{mt}) = \alpha_i + \beta_i r_{mt}$.
The values in parentheses are t-ratios based on White Heteroscedastic Consistent Errors.

TABLE 3: Summary of the mean, median, and standard deviation of the pricing error by decile of the number of individual estimates per dividend event.

Decile	Minimum count	Maximum count	No. of events.	Mean	Median	Std Dev
1	2	2	1,185	0.51966	0.37590	0.48964
2	3	5	2,062	0.57058	0.50100	0.35473
3	6	9	1,539	0.57528	0.52185	0.30138
4	10	16	1,578	0.56377	0.51896	0.26267
5	17	28	1,545	0.54193	0.49674	0.24049
6	29	51	1,615	0.52665	0.47661	0.23612
7	52	95	1,573	0.51896	0.47905	0.22173
8	96	187	1,571	0.49614	0.45051	0.20927
9	188	529	1,588	0.46732	0.42429	0.19367
10	530	71175	1,584	0.41726	0.36497	0.17520
Total	2	71175	15,840	0.52108	0.46191	0.28216

		p-value
GLM test for equality of means F-statistic	51.42	<0.001
Jonckheere-Terpstra trend in medians Z-statistic	-11.5318	<0.001
Modified Brown-Forsythe Levene-type test for monotonic trend in variances	101.33	<0.001

Pricing error, s, calculated as the standard deviation of the relative difference between the implied dividend and the realized dividend, $(D_{implied} - D)/D$, for each dividend event.

TABLE 4: Results for the standard deviation of the pricing by the degree to which the options are in-the-money.

Ratio of stock price to exercise price	Mean pricing error	Median pricing error	Standard deviation	No. of events	Percent
$0.75 \leq S/X < 0.8$	0.665515	0.654436	0.392236	1430	1.65%
$0.8 \leq S/X < 0.85$	0.655417	0.625206	0.368740	2774	3.21%
$0.85 \leq S/X < 0.9$	0.613488	0.579458	0.360673	5282	6.10%
$0.9 \leq S/X < 0.95$	0.543469	0.505313	0.318858	9788	11.31%
$0.95 \leq S/X < 1$	0.443068	0.380557	0.288769	14255	16.47%
$1 \leq S/X < 1.05$	0.443238	0.371688	0.280799	14602	16.87%
$1.05 \leq S/X < 1.1$	0.513776	0.452150	0.304945	11756	13.58%
$1.1 \leq S/X < 1.15$	0.543937	0.493168	0.326709	8606	9.94%
$1.15 \leq S/X < 1.2$	0.564086	0.512656	0.350467	5973	6.90%
$1.2 \leq S/X < 1.25$	0.566088	0.513062	0.363074	4126	4.77%
$1.25 \leq S/X < 1.3$	0.573306	0.531491	0.375342	2890	3.34%
$1.3 \leq S/X < 1.35$	0.587608	0.517491	0.402739	1984	2.29%
$1.35 \leq S/X < 1.4$	0.597200	0.539364	0.404804	1370	1.58%
$1.4 \leq S/X < 1.45$	0.587043	0.527096	0.403103	1024	1.18%
$1.45 \leq S/X < 1.5$	0.551152	0.491197	0.389973	685	0.79%
Total	0.512894	0.450851	0.324217	86545	100.00%

Mack-Wolfe-Chen Peak Unknown $A^*_{\hat{p}}$ Statistic	39.067
Estimated peak group $\hat{p}$	$0.95 \leq S/X < 1$
Monte Carlo (10,000 iterations) p-value	< 0.001

The reciprocal of the standard deviation of the pricing was used in order to transform the umbrella to fit the Mack-Wolfe test.
Estimated peak group represents the valley (lowest median pricing error).
Pricing error, s, calculated as the standard deviation of the relative difference between the implied dividend and the realized dividend, $(D_{implied} - D)/D$, for each dividend event.

TABLE 5: Results of the volume robustness test for the pricing error by the degree to which options are in-the-money.

Ratio of stock price to exercise price	Mean pricing error	Median pricing error	Standard deviation	Mean volume per event
$0.8 \leq S/X < 0.85$	0.677668	0.666745	0.303589	15.12727
$0.85 \leq S/X < 0.9$	0.645549	0.632600	0.349265	14.17576
$0.9 \leq S/X < 0.95$	0.566909	0.518968	0.324421	14.50152
$0.95 \leq S/X < 1$	0.471505	0.416603	0.319019	14.31212
$1 \leq S/X < 1.05$	0.461638	0.393389	0.302974	14.54545
$1.05 \leq S/X < 1.1$	0.540417	0.473049	0.311026	14.55000
$1.1 \leq S/X < 1.15$	0.552477	0.500461	0.331331	14.25455
$1.15 \leq S/X < 1.2$	0.577878	0.542366	0.333708	14.11212
$1.2 \leq S/X < 1.25$	0.614725	0.586449	0.349198	14.03485
$1.25 \leq S/X < 1.3$	0.612558	0.581061	0.357829	14.08636
Total	0.571245	0.525767	0.335240	14.36364

Mack-Wolfe-Chen Peak Unknown $A^*_{\hat{p}}$ Statistic	11.433
Estimated peak group $\hat{p}$	$1 \leq S/X < 1.05$
Monte Carlo (10,000 iterations) p-value	< 0.001

The reciprocal of the standard deviation of the pricing was used in order to transform the umbrella to fit the Mack-Wolfe test.
Estimated peak group represents the valley (lowest median pricing error).
Pricing error, s, calculated as the standard deviation of the relative difference between the implied dividend and the realized dividend, $(D_{implied} - D)/D$, for each dividend event.

TABLE 6: Results for the standard deviation of the pricing by decile of time, in minutes, between the matched call and put option pairs.

Time between paired put and call in minutes	Mean pricing error	Median pricing error	Standard deviation	No. of events	Percent
$T < 1$	0.326948	0.262589	0.249246	9,331	8.30%
$1 \leq T < 2$	0.31983	0.251283	0.247097	9,275	8.25%
$2 \leq T < 3$	0.320643	0.255371	0.242132	8,404	7.47%
$3 \leq T < 4$	0.343054	0.276788	0.245432	9,528	8.47%
$5 \leq T < 8$	0.374485	0.303039	0.257452	10,506	9.34%
$9 \leq T < 14$	0.402382	0.331764	0.266831	10,971	9.76%
$15 \leq T < 25$	0.438898	0.365691	0.278349	11,717	10.42%
$26 \leq T < 47$	0.473461	0.400944	0.289368	12,845	11.42%
$48 \leq T < 101$	0.52153	0.458988	0.294712	13,955	12.41%
$102 \leq T < 522$	0.597621	0.551951	0.314775	15,908	14.15%
Total	0.43383	0.359401	0.291414	112,440	100.00%

		p-value
GLM test for equality of means F-statistic	1186.43	<0.001
Jonckheere-Terpstra trend in medians Z-statistic	109.0832	<0.001
Modified Brown-Forsythe Levene-type test for monotonic trend in variances	-91.151	<0.001

TABLE 7: Results for the pricing error based on combinations of put-call bid-ask.

		Mean	Standard deviation	Median	No. of observations
C: Ask	P: Ask	0.471371967	0.282135441	0.410257775	12212
C: Ask	P: Bid	0.495010901	0.278108499	0.433918755	14955
C: Bid	P: Ask	0.489630957	0.279118392	0.425400793	26162
C: Bid	P: Bid	0.477633053	0.286919106	0.414576771	14166

Tukey's Studentized Range (HSD) Test for difference in means.

		C: Ask P: Ask	C: Ask P: Bid	C: Bid P: Ask
C: Ask	P: Bid	-0.023639***		
C: Bid	P: Ask	-0.018259***	0.005380	
C: Bid	P: Bid	-0.006261	0.017378***	0.011998***

GLM equality of means F-statistic 17.94 p-value <0.001

Pricing error, s, calculated as the standard deviation of the relative difference between the implied dividend and the realized dividend, $(D_{implied} - D)/D$, for each dividend event. Four standard deviations are calculated for each dividend event using four combinations of matched put and call depending on whether the trades occurred at the bid or the ask. Calls and puts are represented as C and P, respectively.
Tukey's Studentized Range (HSD) Test controls the Type I experimentwise error rate.
Comparisons significant at the 0.05 level are indicated by ***.

TABLE 8: Summary of the mean, median, and standard deviation of the standard deviation of pricing by decile of dividend yield.

Decile	Minimum yield	Maximum yield	Mean	Median	Std Dev
1	0.00014	0.00229	0.85458	0.85136	0.28369
2	0.002294	0.00332	0.72038	0.69895	0.27218
3	0.00332	0.00422	0.62189	0.58967	0.25169
4	0.004219	0.00515	0.54997	0.51379	0.23403
5	0.005154	0.00621	0.49849	0.44575	0.24047
6	0.00621	0.00747	0.44780	0.39036	0.22597
7	0.007476	0.00916	0.41813	0.36034	0.21627
8	0.009157	0.01173	0.39952	0.34738	0.20571
9	0.011728	0.01733	0.36983	0.32775	0.19305
10	0.01734	0.13557	0.31265	0.29768	0.16804
Total	0.00014	0.13557	0.52108	0.28216	0.46191

		p-value
GLM test for equality of means F-statistic	845.45	$<$0.001
Jonckheere-Terpstra trend in medians Z-statistic	-78.5589	$<$0.001
Modified Brown-Forsythe Levene-type test for monotonic trend in variances	46.316	$<$0.001

Pricing error, s, calculated as the standard deviation of the relative difference between the implied dividend and the realized dividend, $(D_{implied} - D)/D$, for each dividend event.

TABLE 9: Descriptive statistics for the relative ex-dividend stock price decline implied by option prices and realized ex-dividend stock price decline from overnight stock price changes.

		Overnight alpha				Implied alpha			
Sample	No. of obs.	Mean	t-statistic	Median	Std. Dev.	Mean	t-statistic	Median	Std. Dev.
All observations	17818	0.763177	16.8	0.827658	1.88124	0.894496	37.07	0.871584	0.37995
Filtered sample	4943	0.815024	13.77	0.860465	0.94456	0.842144	35.36	0.850048	0.31385

Overnight Alpha is the relative ex-dividend stock price decline, $\alpha_{realized} = \frac{S_B - S_O}{D}$, where S_B is the closing stock price the day before the ex-dividend date, S_O is the opening stock price on the ex-dividend date, and D is the realized cash dividend amount.
Implied Alpha is the option implied relative ex-dividend stock price decline, $\alpha_{implied} = \frac{IDIV}{D}$, where $IDIV$ is the dividend amount implied by option prices from 4.6, and D is the realized cash dividend amount.
t-statistic tests the null $H_0 : \mu = 1$ with alternative $H_A : \mu < 1$

TABLE 10: Mean prediction errors of implied and historical estimates of the relative ex-dividend stock price decline from the estimated relative ex-dividend stock price decline for individual stocks.

Sample	No. of obs.	Predictor	$MAPE$	$MSPE$
All observations	17818	Implied	1.198090	3.682731
		Historical	2.524656	171.7672
Filtered observations	4943	Implied	0.659592	1.008796
		Historical	1.160633	5.372345

The estimated realised relative ex-dividend stock price decline is equal to $(S_B - S_A)/D$ for each ex-dividend event. Where S_B is the closing price of the stock the day before the ex-dividend date and S_A is the opening price on the ex-dividend date.
$MAPE$ is the mean absolute prediction error, that is, $MAPE = \frac{1}{n}\sum_j^n |A_j - P_j|$, where A_j is the realised stock price decline estimate (see footnote a) for the jth stock, P_j is the predicted stock price decline estimate for the jth stock, and n is the number of dividend estimates.
$MSPE$ is the mean squared prediction error, that is $MAPE = \frac{1}{n}\sum_j^n (A_j - P_j)^2$.
The implied relative ex-dividend stock price decline is equal to $IDIV/D$ where $IDIV$ is the average of the daily company-specific dividend estimates, and D is the cash dividend amount.

TABLE 11: Results for the regression of the option implied relative ex-dividend stock price decline on the realized relative ex-dividend stock price decline.

Sample	No. of events	$\hat{\gamma}_0$	$\hat{\gamma}_1$	Adj R^2
All observations	17818	0.70821	0.06145	0.0001
		(18.93)	(1.47)	
Filtered sample	4943	0.89011	-0.08916	0.0007
		(22.08)	(-1.83)	

The regression equation is $\hat{\alpha}_{realized} = \gamma_0 + \gamma_1 \hat{\alpha}_{implied} + \epsilon$
The estimated realised relative ex-dividend stock price decline is equal to $(S_B - S_A)/D$ for each ex-dividend event. Where S_B is the closing price of the stock the day before the ex-dividend date and S_A is the opening price on the ex-dividend date.
The values in parentheses are t-ratios based on White Heteroscedastic Consistent Errors.

3

Analyst Dividend Forecast Accuracy and Option-Implied Dividend Forecasts

3.1 Introduction

Dividends have direct cash flow and signalling effects for firms and investors. This is the rationale for why dividend forecasts are used to proxy for market dividend expectations, and a change in forecast is used as a measure of dividend surprise. Finance and accounting researchers use surprise measures to empirically test signalling theories about the relationship between dividend changes and future earnings or cash flows (Bhattacharya, 1979; Miller and Rock, 1985; John and Williams, 1985).

Dividend forecast accuracy is also important because analysts use assumptions of future dividends to forecast earnings and develop buy-sell recommendations. Barker (1999) investigates, using participant observation; questionnaires; and semi-structured interviews, the role of dividends in valuation models used by UK fund managers and analysts. He finds that analysts primarily use Price-Earnings and Dividend Yield in their valuation models. He finds that value-relevance of information varies with the reliability of forecasts. Denis, Denis, and Sarin (1994) also find support for the link between dividends and earnings forecasts. They find that analysts significantly revise their earnings forecasts following a change in dividends. In addition, Loh and Mian (2006) find that analysts with superior earnings forecast accuracy produce recommendations that are more profitable than other analysts. This implies that superior analysts use more accurate dividend forecasts to forecast earnings and generate more profitable recommendations. These studies imply that the better analysts are at forecasting dividends, the more they will rely on this information to forecast earnings, and the more profitable their recommendations to investors.

This chapter investigates the relationship between analyst dividend forecasts and market expectations of dividends implied by option prices. The primary research question is whether analysts update their dividend forecasts in response to new market information, and likewise, whether the market updates dividend expectations in response to analyst forecast revisions. Users of analyst forecasts, such as investors, are interested in whether analysts, or a superior subset of analysts, update their forecasts in response to new information. Market participants, such as option traders, would also find it useful to know whether analyst dividend forecasts contain new information that may affect market prices. I answer this question by comparing individual analyst dividend forecasts with implied dividends from option prices as per the methodology in the first chapter.

Extending a concept in Baginski and Hassell (1990), that analysts play a role in interpreting the quality of information produced by management revisions and other sources, I find evidence that superior analysts are more likely to update their dividend forecasts in response to changes in the market information about the expected dividend. I do not find a similar result for non-superior analysts, as they are less likely to increase their forecasts in response to increases in the market expectations of the dividend. My results indicate that analysts could use option-implied dividends to inform their own dividend forecasts, increasing the accuracy of the dividend yield used as an input in their stock valuation models. However, unlike previous studies[1] that found a market response to earnings revisions, I found no evidence for a option market response to analyst dividend forecast revisions. This finding is important because it contradicts the idea that the market finds analyst dividend forecasts informative.

The second focus of this chapter investigates whether dividend forecasts implied by options, superior analysts, non-superior, or consensus analysts provide more precise forecasts of firm dividends.

[1](Gleason and Lee, 2003; Park and Stice, 2000)

Researchers can better test dividend signalling theories, and value-relevancy of accounting measures, by calculating a dividend surprise measure using a more precise forecast of market expectations of the dividend. Analysts, investors, and industry can also calculate stock prices that are closer to fundamental value when they use more precise dividend forecasts as inputs in their models. My results show that dividends implied by option prices provide a more precise forecast of future dividends than individual analyst and superior analyst forecasts but are not more accurate than the mean consensus dividend forecast. The result is also important because it explains how non-superior analysts

This paper proceeds as follows. Section 1 contains a discussion of the literature on the analyst forecasts and dividends implied by option prices. Section 2 outlines my method of estimating the dividend implied from American option transaction prices, and the various tests used to test my research questions. Section 3 presents the results, analysis and discussion. Section 4 summarizes my paper and provides directions for future research.

3.1.1 Analyst forecasts

Analysts have a trade-off between timeliness and accuracy when developing forecasts based on new information from management revisions to earnings or other sources. Baginski and Hassell (1990) show that analysts either use the information in stock price changes following management revisions or obtain similar information from other sources in order to inform their own earning forecast revisions. Only part of analyst revisions are explained by either management revisions or the stock price reaction to the revision. This implies that analysts may play a role in interpreting the quality of the information provided by management revisions. Therefore, I expect analysts to change their dividend forecasts based on either a change in the dividend implied by option prices, information from their own sources, or management revisions.

The aforementioned study establishes a relationship between price reactions from management announcements and earnings revisions by all analysts as a group. Park and Stice (2000) study the price effect of forecast announcements by analysts with past superior forecasting accuracy. They find that earnings forecast announcements by analysts with superior past forecasts for a specific firm have a greater impact on security prices than the announcements of previously less accurate analysts. They find the price effects from analyst announcements were confined to firms with past superior forecasting and not to all firms by those analysts. The failure to find a spillover effect suggests that the market keeps track of the firm-specific forecasting performance by specific analysts. They also investigate the potential source of the information used by analysts and valued by the market by considering price impact before and after management announcements. They find that superior analysts have a greater impact on price in the 30 days preceding an earnings announcement by management compared with the 30 days following. This suggests that analysts with superior forecasting ability have inside information as opposed to a superior ability to interpret and integrate information revealed in an earnings announcement. Therefore, I expect the option implied dividend changes to have a stronger response to dividend forecast revisions by analysts with superior firm-specific past forecast accuracy.

Another aspect of the price reaction to analyst revisions is the magnitude and time it takes for the market to incorporate the new information into the price. Gleason and Lee (2003) study factors that help explain the post-revision price drift following analyst forecast revisions. They find that the market treats *high innovation* revisions, that provide the market with new information, the same as *low innovation* revisions that move an analyst's forecast toward the consensus. They also find that the price adjusts faster and incorporates more of the information from *Institutional All-Star* analysts than other less well known but highly accurate analysts. They find that firms with low analyst coverage have decreased price discovery efficiency compared with firms with high analyst coverage. Unfortunately, due to a change in policy by Thomson Reuters, analyst names have been anonymized for our sample period and I am unable to use Institutional All-Star dummies in this study. However, I am able to examine superior analysts using past analyst accuracy compared with the consensus analyst forecast.

Many earlier studies, documented by Brown (1993), find that analyst earnings forecasts are optimistically biased. A similar investigation into the accuracy of dividends by Brown, Clarke, How, and Lim (2002) find that analysts' dividend forecasts are also optimistically biased but less biased and more accurate than their earnings forecasts. They find that forecast accuracy is positively correlated with proxies for the amount of information available about the firm, and negatively correlated with proxies for the level of uncertainty about the firm's future operating performance. However, option traders do not operate under the same incentives as sell-side financial analysts, such as favourable forecasts for management access or to promote brokerage volume. Therefore, I expect option-implied dividend forecasts to be more accurate than analyst forecasts.

Many previous studies into dividend surprises use a naive dividend change model that assumes the most recent dividend amount is the next expected dividend amount. This measure does not capture the surprise when the market is expecting a change in dividend based on other sources of information. Dhillon, Raman, and Ramirez (2003) use Value Line Forecasts to proxy for market expectations of dividends in order to calculate a measure of dividend surprise. They find that stock price reactions and earnings changes in response to dividend surprises are more consistent with dividend signaling models. They also show that previous event studies that exclude firms with no dividend change incorrectly exclude observations when analysts are expecting a change. They conclude that future empirical research should incorporate dividend forecasts. I extend their work by comparing analyst forecasts with a measure of dividend surprise based on dividends implied by option prices.

3.1.2 Dividend expectations implied by option prices

Bae-Yosef and Sarig (1992) develop a method to measure dividend surprise that is based on the expected dividend implied from American option transaction prices. They find that the measure is highly correlated with the market price reaction to announcements and outperforms the naive model, a Box-Jenkins time-series measure, and Value-Line Investor Survey. The measure is also shown to be insensitive to the extent to which the options are in or out of the money. I expand on their methodology in the following section.

3.2 Methodology and data

First, I estimate the market expectations of the ex-dividend day drop from the option and stock data. Second, I develop a measure of dividend surprise by calculating the change in option-implied dividend expectations. Third, I calculate a measure of analyst forecast surprise using analyst dividend forecast revisions. Additionally, I identify superior analysts based on their past performance relative to the consensus forecast accuracy. Finally, I regress the models of option-implied dividend surprise and analyst forecast surprise and present the results.

3.2.1 Estimation of the option-implied dividend forecast

In the first thesis chapter, I expand on a methodology developed by Bae-Yosef and Sarig (1992) to impute dividend expectations from option market prices. I use changes in option-implied dividend as a proxy for the dividend surprise. Expected dividends are calculated using option put-call parity; the following equation holds for European options:

$$PV(DIV) = S - (c - p + KB_t) \tag{3.1}$$

where $PV(DIV)$ is the current value of expected interim dividends; S, c, and p are the prices of the underlying stock, the European call, and the European put, respectively; K is the common exercise price; and B_t is the time-t price of a pure discount bond maturing on the options' common expiration day.

Equation 3.1 is based on European option prices. Since I can only observe American options, I need to take into account the premium due to the right of early exercise. I define the American over European option premium, for calls and puts, by:

$$\Delta c \equiv C - c \geq 0 \tag{3.2}$$

$$\Delta p \equiv P - p \geq 0 \tag{3.3}$$

where C and P are American call and put prices, respectively. Equation 3.1 can now be written as

$$PV(DIV) = S - (c + \Delta c - (p + \Delta p) + KB_t) \tag{3.4}$$

American options will not be exercised early, and therefore have an equivalent price to European options, whenever:

$$D \leq K(1 - e^{-R(T-t)}) \tag{3.5}$$

where D is the dividend, R is the forward rate between the dividend payout time, t, and the expiration date, T, as observed at time t, and K is the exercise price of the option.

My estimation procedure matches the two closest observations, based on time, where a put and call with the same exercise price and expiration date occur on the same day. Transactions are only matched to a single pair but there may exist many pairs on any given day. I find 80,898 put-call trade pairs, approximately 8.37% of my original sample, meet the condition in equation 3.5 and I use a modified equation 3.1 to calculate the future value of the dividend, for these transactions:

$$IDIV = \Big(S - C + P - K\exp\big(-R(T_M - t)\big)\Big)\exp\big(R(T_X - t)\big) \tag{3.6}$$

where $IDIV$ is the future value, at the ex-dividend day T_X, of the cash dividend, C, P, K are the call, put, and strike prices, S is the mean of stock trade prices that occur between the put-call pair, T_M is the time of maturity, and R is the forward rate.

American call options that do not meet the condition in equation 3.5 will be exercised the day before the ex-dividend date due to the expected stock price decline. Whereas, American put options that do not meet the the condition in 3.5 will be exercised on or after the ex-dividend date depending on moneyness. If the interest on the proceeds from early exercise exceed the time value of money then early exercise is optimal:

$$(K - S)(1 - e^{-R(T-t)}) > T.V. \tag{3.7}$$

where $T.V.$ is the time value of the option, and the remaining notation is the same as equation 3.5. Based on the expected price decline due to the dividend, I anticipate an insignificant marginal difference in the European vs American put option premium.[2][3] Therefore, the remaining option pairs that do not satisfy equation 3.5 are estimated using equation 3.6 with the maturity date T_M set to the ex-dividend date T_X due to early exercise.

The ex-dividend stock price decline implied by options is downwardly biased due to short-term tax-induced trading, arbitrage, and tax-clientele effects. I need to adjust upward my option-implied dividend estimates to allow a fair comparison of the forecast accuracy between option-implied dividends and analyst forecasts. I estimate the ex-dividend day relative stock decline, α, and adjust upward my estimates of the dividend expectations as per the first thesis chapter Guerrero (2017). The adjusted option-implied dividends are denoted $IDIVA$.

3.2.2 Consensus analyst forecast

I compare the price-based measure of dividend surprises to the I/B/E/S analyst consensus dividend forecast. The expected quarterly dividend payment is calculated as the difference between annual dividends as forecast just before the dividend announcement and the already-paid dividend amounts divided by the remaining number of dividend payments for that year. These expectations are denoted by $CDIV$.

[2] Gray (1989) finds in favour of put-call parity holding when taking into account the potential rational early exercise of an option and the possibility that dividends and capitalisation changes will differ from expectations.

[3] Whaley (1982) finds only a half-percent difference in pricing between European and American options.

3.2.3 Superior analysts

I use a similar selection criteria from Park and Stice (2000) to designate analysts as superior forecasters of dividends for specific firms. An analyst is classed as superior for a specific firm if 80% or more of the analyst's forecasts for that firm were closer to realised earnings than was the I/B/E/S consensus forecast, $CDIV$, existing at the time the forecasts were given. In order to qualify, as superior, the analyst must have provided at least four forecasts. In addition, the analyst must not be the sole analyst in the consensus forecast. I classify the dividend forecast for superior analysts and denote these forecasts by $SDIV$.

3.2.4 Predictive ability of forecasts

I can test whether the various dividend forecasts are able to predict the subsequently realized cash dividend amounts by comparing two measures of predictive error. I calculate the Mean Absolute Predictive Error as,

$$MAPE = \frac{1}{n}\sum_{j=1}^{n}\frac{|D_{jt} - F_{jt}|}{P_{jx}} \tag{3.8}$$

where D_{jt} is the realized dividend amount for the jth stock at time t, F_j is the dividend forecast, for the jth stock at time t, P_{jx} is the stock price two days before the ex-dividend date at time x, and n is the number of observations for the year. The dividend forecasts, defined previously, are the Adjusted Option-implied $(IDIVA)$, Consensus analyst $(CDIV)$, Individual Analyst $ADIV$, and Superior analyst $(SDIV)$. I also calculate the Mean Squared Predictive Error as,

$$MSPE = \frac{1}{n}\sum_{j=1}^{n}\frac{(D_{jt} - F_{jt})^2}{P_{jx}}. \tag{3.9}$$

Finally, I can test the predictive power of the forecasts by regressing the forecast values on the realized values of the cash dividend, that is,

$$\hat{D}_j = \gamma_0 + \gamma_1 \hat{P}_j + \epsilon_j \tag{3.10}$$

If the estimated coefficients $\hat{\gamma}_0$ and $\hat{\gamma}_1$ are indistinguishable from zero and one, respectively, then the forecaster is a good predictor of the realized cash dividend amount. The slope coefficient should be insignificantly different from zero if most of the predictive power is due to the forecast.

3.2.5 Analyst forecast revision response to new market information

Baginski and Hassell (1990) find that analysts update their earnings forecasts based on new information from management revisions to earnings or other sources. This suggests that analysts are likely to update their dividend forecasts in response to timely market information. Therefore, I formulate the following hypothesis:

Hypothesis 1. *Analysts increase their dividend forecasts when there is an increase in the option-implied dividend.*

In order to answer the above hypothesis, I construct a forecast surprise measure using the same approach as Park and Stice (2000); Stickel (1992); Lys and Sohn (1990). Since Stickel (1991) finds that the best measure of forecast surprise is based on the most recent forecast by the same analyst, I construct my forecast surprise measure as follows:

$$FR_{ijt} = \frac{DPSF_{ijt} - DPSF_{ijr}}{P_{i,t-2}} \tag{3.11}$$

where $DPSF_{ijt}$ is the dividend per share forecast for firm i by analyst j on day t, $DPSF_{ijr}$ is the most recent DPS forecast for firm i by analyst j, and $P_{i,t-2}$ is the price per share for firm i two days before forecast revision at day t.

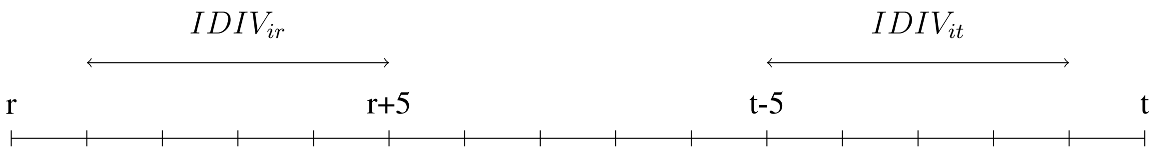
In order to answer the question of whether analysts update their dividend forecasts in response to changes in market information, I need to measure the change in option-implied dividend forecasts. I use the change in the mean option-implied dividend, for the week following the previous ex-dividend date, and the mean option-implied dividend for the week following the analyst forecast revision. I define the option-implied dividend forecast revision as:

$$IDIVFR_{it} = \frac{IDIV_{it} - IDIV_{ir}}{P_{i,t-2}} \tag{3.12}$$

where $IDIV_{it}$ is the mean option-implied dividend per share for firm i for options traded during the week *preceding* analyst revision at day t, $IDIV_{ir}$ is the mean option-implied dividend per share for firm i for options traded during the week *following* the previous ex-dividend day at time r, and $P_{i,t-2}$ is the price per share for firm i two days before the analyst forecast revision at day t.

In the previous thesis chapter, Guerrero (2017), I find that the option-implied dividend is a noisy

FIGURE 3.1: Option-implied forecast revision measure timeline



measure of the expected dividend due to transaction costs, moneyness of the options, thin-trading, non-synchronous trading, and dividend yield. I use a latent variable model and probit regressions as I am primarily interested in the likelihood of a change in either the market prices or the analyst forecasts, and not necessarily in a linear relationship. Consider the latent variable model,

$$y_i^* = x_i'\beta + \epsilon_i \tag{3.13}$$

where y_i^* is an unobservable latent variable that measures the change in analyst dividend forecasts, x_i is a vector of explanatory variables, β is a vector of unknown parameters and ϵ_i is a random disturbance term. I assume that y_i^* is related to the observed variable y_i, in the following way,

$$y = \begin{cases} 1, & \text{if } y_i^* > 0 \\ 0, & \text{otherwise} \end{cases} \tag{3.14}$$

I can use option-implied forecasts as a proxy for new information available to the market about the expected dividend. I can see whether analysts incorporate this information into their forecast revisions using a probit model to regress the option-implied forecast revision on the analyst forecast surprise, that is,

$$\hat{FR}_{ijt} = \gamma_0 + \gamma_1 IDI\hat{V}FR_{it} + \epsilon_j \tag{3.15}$$

Barker (1999) find that the forecast accuracy of analysts is dependent on the value-relevance of the information used in their valuation models. He finds that the primary inputs to analyst forecasts are earnings and dividend yields. Therefore, I expect superior analysts to incorporate more timely market information in their dividend forecasts, and formulate the following hypothesis:

Hypothesis 2. *Superior analysts are more likely to increase their dividend forecasts when there is an increase in the option-implied dividend.*

I can test whether this effect holds for a more direct proxy of the market's expectations of dividends, than stock price, by including a dummy variable for superior analysts in equation 4.14,

$$\hat{FR}_{ijt} = \gamma_0 + \gamma_1 \hat{IDIVFR}_{it} + \gamma_2 \hat{SDIV}_{ijt} \hat{IDIVFR}_{it} + \epsilon_j \tag{3.16}$$

where $\hat{FR}_{ijt}$ and $\hat{IDIVFR}_{it}$ are dummy variables that indicate an analyst revision or option-implied dividend increase, based on definitions from equation 4.6 and 3.12, and $\hat{SDIV}_{ijt}$ is a dummy to indicate analyst j is a superior analyst for firm i at time t.

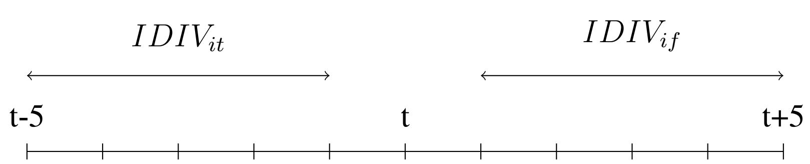
3.2.6 Market response to analyst dividend forecast revisions

Likewise, in order to answer the question of whether the market update their dividend forecasts in response to changes in analyst revisions, I need to measure the change in option implied dividend forecasts as a result of analyst information releases. I use the change in the mean estimate before and after the analyst forecast. Therefore, I define the analyst revision option-implied forecast surprise as:

$$IDIVSP_{it} = \frac{IDIV_{it} - IDIV_{if}}{P_{i,t-2}} \tag{3.17}$$

where $IDIV_{it}$ is the mean option-implied dividend per share for firm i for options traded during the week *preceding* analyst revision at day t, $IDIV_{if}$ is the mean option-implied dividend per share for firm i for options traded during the week *following* the day after the analyst revision at day t, and $P_{i,t-2}$ is the price per share for firm i two days before the analyst forecast revision at day t.

FIGURE 3.2: Option-implied forecast surprise measure timeline



As mentioned previously, Gleason and Lee (2003) find that the market price adopts new information from analyst earnings forecast revisions. Likewise, I expect option market prices to update in response to analyst dividend forecast revisions.

Hypothesis 3. *The market increases the option-implied dividend amount in response to an increase in the dividend forecast by analysts.*

Using a similar probit model to equation 4.14, I can test whether the market responds to released of new analyst forecasts by regressing the analyst forecast revision on the change in the market implied-option prices, that is,

$$ID\hat{IV}SP_{it} = \gamma_0 + \gamma_1 \hat{FR}_{ijt} + \epsilon_j \quad (3.18)$$

As discussed earlier, Gleason and Lee (2003) find that the market treats *high innovation* revisions, that provide the market with new information, the same as *low innovation* revisions that move an analyst's forecast toward the consensus. They also find that the market reacts more strongly for *Institutional All-Star* analysts compared with other superior analysts. I am unable to investigate the market response to All-star analysts due to Thomson Reuter's anonymization of analysts for my sample period. However, I am able to check whether the option market are more likely to respond to superior analysts compared with other analysts. Park and Stice (2000) find that *earnings* forecast announcements by superior analysts have a greater impact on security prices than less accurate analysts. I expect their results to apply to *dividend* announcements, and formulate the following hypothesis:

Hypothesis 4. *The market is more likely to increase the option-implied dividend amount in response to an increase in the dividend forecast by superior analysts compared with non-superior analysts.*

I can test the above hypothesis by incorporating a dummy variable for superior analysts into the probit regression equation 3.18,

$$ID\hat{IV}SP_{it} = \gamma_0 + \gamma_1 \hat{FR}_{ijt} + \gamma_2 S\hat{DIV}_{ijt}\hat{FR}_{ijt} + \epsilon_j \quad (3.19)$$

where $\hat{FR}_{ijt}$ and $ID\hat{IV}SP_{it}$ are dummy variables that indicate an analyst revision or option-implied dividend increase, based on definitions from equation 3.6 and 3.1, and $S\hat{DIV}_{ijt}$ is a dummy to indicate analyst j is a superior analyst for firm i at time t.

3.2.7 Data

The data in my study are compiled from three sources: OptionMetrics, Thomson Reuters I/B/E/S, and Thomson Reuters Tick History.

Analyst forecast data

The sample begins with all sell-side analyst forecasts for U.S. firms from years 2009 to 2015. I exclude 45,892 analyst dividend forecasts because the announcement date of the forecast is after the financial period end date of the dividend. I also exclude 267 semi-annual forecasts. I exclude analyst forecasts where the analyst has issued more than 13 revisions, the 99th percentile, for any dividend event. This results in 618,574 quarterly estimates prior to matching with firms and quarters for which I am able to calculate option-implied dividends.

The above filters result in 132,442 individual forecasts for 1,857 dividend events, by 689 analysts for 453 firms. There are 302 analysts that are superior analysts of at least one firm. The descriptive statistics from Table 3.2 show that during my sample period, 2009-2015, approximately 30.05% of dividends increased from the previous dividend and the remainder, 70.17% decreased or were unchanged from the previous dividend amount.

Option data

I analyse data from years 2009 to 2015. Using end-of-day data and dividend event data from OptionMetrics, I compile a list of firm-years that match the following filter: at least a single daily traded volume of 30 for an option instrument with a single ex-dividend date between the trade date and option maturity. Using these firm-years, I collect all option and underlying stock tick data from ThomsonReuters Tick History from 2009-2015. My final sample consists of 9,334 firm-years from 1,908 firms.

I exclude dividend events where the stock price moves more than 10% from the close the day before the ex-dividend date to the opening on the ex-dividend date. I exclude, due to the unavailability of future dividend event information, option maturities with expiration past the dividend event sample period of 31st December 2015. I exclude estimated dividend yields greater than 10%. This reduces the sample approximately 0.01% from 4,818,361 to 4,817,818 individual estimates.

I truncate at the 2nd and 98th percentiles for the individual dividend estimates, implied alpha, and overnight realized alpha. This reduces the sample by approximately 10.6% to 4,303,528 individual estimates. When the option-implied dividends are matched to the analyst dividend forecasts from $I/B/E/S$ the final sample of individual option dividend estimates reduces to 1,279,588.

The ratio of the stock price to exercise price and the time in weeks to expiration are detailed in

Table 1. 74.13% of the transactions are in the money, that is, the options have a S/X ratio above 1. The largest category of time to maturity is between two and four weeks with 138,884 option pairs. However, the number of transactions doesn't linearly decrease with increasing time to maturity. The second highest category is twenty to twenty-two weeks with 136,372.

3.3 Results

The first two sections of results provide evidence for the earlier hypotheses about analyst and market behaviour and the causality of forecast revisions. The final section of results examines the accuracy of analyst forecasts based on measures developed in section 3.2.4.

3.3.1 Do analysts react to market revisions?

Analysts update their earnings forecasts based on new information from management revisions or other sources (Baginski and Hassell, 1990). Based on this result, I formulated Hypothesis 1, that analysts increase their dividend forecasts when there is an increase in the option-implied dividend. In addition, superior analysts possibly have more accurate forecasts because they update their forecasts in response to changes in publicly available information about upcoming dividends. using this intuition, I proposed Hypothesis 2, that *superior* analysts are more likely to increase their dividend forecasts when there is an increase in the option-implied dividend.

I find strong evidence that, unlike non-superior analysts, superior analysts respond to changes in dividend pricing information available to the market. The results from Table 3.5 show that other analysts are less likely (42.63%) to increase their dividend forecasts upward in response to an increase in the option-implied dividend forecast compared with superior analysts (69.84%). This result provides evidence to support Hypothesis 2 but not Hypothesis 1. Just as Baginski and Hassell (1990) finds that analysts update their *earnings forecasts* based on new information from management revisions to earnings or other sources, this result supports the hypothesis that superior analysts update their *dividend forecasts* in a similar manner. Barker (1999) shows that dividend yields are a primary input to analyst forecast models, and this results contributes to our understanding by showing that analysts update their dividend forecasts based on new market information.

3.3.2 Does the market react to analyst revisions?

Gleason and Lee (2003) find that the market price adopts new information from analyst earnings forecast revisions. I expect market reaction to extend to analyst *dividend* forecast revisions. Earlier, I formulated Hypothesis 3: the market increases the option-implied dividend amount in response to an increase in the dividend forecast by analysts. In addition, Park and Stice (2000) find that *earnings* forecast announcements by superior analysts have a greater impact on security prices than less accurate analysts. Therefore, I defined Hypothesis 4: the market is more likely to increase the option-implied dividend amount in response to an increase in the dividend forecast by superior analysts compared with non-superior analysts.

After finding, in the previous results section, that superior analysts update their forecasts in response to market information, it comes as a surprise that there is no significant market response to analyst revisions. The results from Table 3.4 provide no evidence in support of Hypothesis 3 or 4. The forecast revision dummy variable has a p-value of 0.1373 and the superior analyst forecast revision dummy variable has a p-value of 0.9906. The alternative to hypothesis 3 and 4 is that the market does not react to analyst forecast revisions. These results show no evidence that the earnings revision market response effect, found by Gleason and Lee (2003) and Park and Stice (2000), extends to a market response in the dividend information implied by option prices. In the next section, my analysis of the accuracy of the different forecast measures provides more insight into these results.

3.3.3 Accuracy of analyst forecasts and option-implied dividends

This section examines differences in accuracy between the analyst and option-implied forecast measures. A comparison of accuracy is important for two reasons: firstly, accuracy has direct profitability consequences for market participants who use dividend forecasts to model stock and derivative prices; and, secondly, it helps explain why we find superior analysts updating their forecasts in response to new market information and why the market does not respond to analyst revisions.

In section 3.2.4, I define two measures of forecast accuracy $MAPE$ and $MSPE$. The mean prediction errors of Adjusted Option-Implied Dividends ($IDIVA$), Consensus Analyst Dividend Forecast ($CDIV$), Individual analysts ($ADIV$), and Superior analysts ($SDIV$), are presented in Table 3.3. Ranked from most accurate to least accurate based on $MAPE$ and $MSPE$ are: All Analysts, Superior Analysts, Option-implied, and Consensus analyst forecasts. Although, option-implied forecasts are only marginally more accurate, about 11%, than superior analysts when comparing MAPE, superior analyst $MSPE$ is about 172% larger. The results are similar for all analysts, with a 40% larger $MAPE$, but 244% larger $MSPE$ than option-implied dividend forecast. $MSPE$ is affected by larger individual variations from the accurate forecast compared with the $MAPE$. This indicates that whilst analysts and option-implied forecasts have a similar level of accuracy, analysts tend to have less frequent but larger deviations compared with option-implied forecasts. This effect is not seen in the consensus analyst forecast, which has a $MSPE$ that is comparable to the option-implied forecast. It appears that analysts tend not to herd together, allowing the consensus mean forecast to not shift too far from the actual dividend when a single analyst makes a bold but erroneous forecast.

Whilst the consensus analyst forecast is more accurate than the option-implied dividends, the individual analyst forecasts, even from superior analysts, is not. This is possibly why, in the previous results section, there is no significant evidence of a market reaction to changes for individual analyst forecasts. As individual analyst forecasts are less accurate, option market participants can't improve their forecasts by incorporating analyst revisions and therefore do not react to revisions.

As mentioned in the previous section, non-superior analysts are less likely to revise their forecasts in response to new information about the dividend compared with superior analysts. The failure of non-superior analysts to update their forecasts in response to market information is probably a contributing factor to their higher $MAPE$ and $MSPE$.

Another interesting result, from Table 3.3, is that although the individual analyst estimates are less accurate than option-implied dividends, the consensus analyst is more accurate based on the $MAPE$ and $MSPE$. This is likely due to the role that the consensus forecast plays in aggregating the point-estimates of analyst forecasts into an expectation of analyst beliefs in a similar way to how the market aggregates the dividend beliefs of individual option traders when determining option prices based on supply and demand.

3.4 Conclusion

This study investigates the relationship between analyst dividend forecasts and market expectations of dividends implied by option prices. My primary research question is whether analysts update their forecasts in response to new market information, and likewise, whether the market updates dividend expectations in response to analyst forecast revisions. I answer this question using a more direct proxy of market expectations than previous studies such as Dhillon et al. (2003). My method, using option put-call parity is developed in the first thesis chapter Guerrero (2017), and extended from Bae-Yosef and Sarig (1992). Extending a concept in Baginski and Hassell (1990), that analysts play a role in interpreting the quality of information produced by management revisions and other sources, I find evidence that superior analysts are more likely to update their dividend forecasts in response to changes in the market information about the expected dividend. Non-superior analysts are less likely to increase their forecasts in response to increases in the market expectations of the dividend. However, unlike previous studies[4] that find a market response to earnings revisions, I find no evidence for a option market response to analyst dividend forecast revisions. This result is likely due to the lower accuracy of individual analyst dividend forecasts compared with option-implied dividends. The absence of a market response indicates that option market participants have already incorporated into their prices superior information about the upcoming dividend compared with the information available to individual analysts.

The second focus of this paper investigates whether option-implied, superior analysts, non-superior, or consensus analysts provide more precise forecasts of firm dividends. Researchers can better test dividend signalling theories, and value-relevancy of accounting measures, by calculating a dividend surprise measure using a more precise forecast of market expectations of the dividend. Analysts, investors, and industry can also calculate stock prices that are closer to fundamental value when they use more precise dividend forecasts as inputs in their models. I find that dividends implied by option prices provide a more precise forecast of future dividends than individual analyst and superior analyst forecasts but are not more accurate than the mean consensus dividend forecast. Barker (1999) find that analysts primarily use Price Earnings and Dividend Yield in their valuation models. My results indicate that investors and analysts could use option-implied dividends to inform their own dividend forecasts, increasing the accuracy of the dividend yield used as an input in their stock and derivative valuation models.

My results create the opportunity for future research on the stock price reaction to changes in analyst and option-implied dividend forecasts, the option-implied dividend reaction to management revisions, and the effect of dividend payout policy on analyst forecast accuracy and option prices.

[4](Gleason and Lee, 2003; Park and Stice, 2000)

TABLE 3.1: Frequency distributions for the number of individual put-call pairs by the degree to which the options are in-the-money (S/X) and by the time to expiration of the options, (T).

Ratio of stock price to exercise price	Number of transactions	Percent	Time to expiration in weeks	Number of transactions	Percent
$S/X < 0.75$	4,076	0.32%	$T < 2$	18,518	1.45%
$0.75 \leq S/X < 0.8$	5,352	0.42%	$2 \leq T < 4$	138,884	10.85%
$0.8 \leq S/X < 0.85$	11,719	0.92%	$4 \leq T < 6$	105,863	8.27%
$0.85 \leq S/X < 0.9$	29,254	2.29%	$6 \leq T < 8$	67,904	5.31%
$0.9 \leq S/X < 0.95$	75,390	5.89%	$8 \leq T < 10$	56,635	4.43%
$0.95 \leq S/X < 1$	205,432	16.05%	$10 \leq T < 12$	100,366	7.84%
$1 \leq S/X < 1.05$	441,822	34.53%	$12 \leq T < 14$	199,503	15.59%
$1.05 \leq S/X < 1.1$	254,331	19.88%	$14 \leq T < 16$	127,494	9.96%
$1.1 \leq S/X < 1.15$	123,202	9.63%	$16 \leq T < 18$	135,112	10.56%
$1.15 \leq S/X < 1.2$	58,304	4.56%	$18 \leq T < 20$	80,806	6.32%
$1.2 \leq S/X < 1.25$	29,932	2.34%	$20 \leq T < 22$	136,372	10.66%
$1.25 \leq S/X < 1.3$	15,757	1.23%	$22 \leq T < 24$	89,566	7.00%
$1.3 \leq S/X < 1.35$	9,289	0.73%	$24 \leq T < 26$	16,330	1.28%
$1.35 \leq S/X < 1.4$	5,574	0.44%	$26 \leq T < 28$	2,327	0.18%
$1.4 \leq S/X < 1.45$	3,362	0.26%	$28 \leq T < 30$	1,310	0.10%
$1.45 \leq S/X < 1.5$	1,767	0.14%	$30 \leq T < 32$	1,174	0.09%
$1.50 \leq S/X$	5,025	0.39%	$32 \leq T$	1,424	0.11%
Total	1,279,588	100.00%	Total	1,279,588	100.00%

TABLE 3.2: Descriptive statistics for the Option-implied dividend surprise and analyst forecast revision surprise.

	Mean	Std. dev.
Dividend Yield	1.0835%	0.010409
Yield change	-0.1306%	0.031609
Firms	453	
Analysts	689	
Superior analysts (at least one firm)	302	
Dividend events	1857	
Obs. dividend increased	30.05%	
Obs. dividend unchanged or decreased	70.17%	

All analysts	IDIVSP	FR	IDIVFR	FR
Increased	49.96%	49.18%	50.59%	48.21%
Unchanged or decreased	50.04%	50.82%	49.41%	51.79%
	n=3467		n=2985	

Superior analysts	IDIVSP	FR	IDIVFR	FR
Increased	49.00%	64.70%	51.12%	64.25%
Unchanged or decreased	51.00%	35.30%	48.88%	35.75%
	n=847		n=716	

FR is the Forecast revision specific to either the IDIVFR or IDIVSP regressions.
An analyst is classed as superior for a specific firm if 80% or more of the analyst's forecasts for that firm were closer to realised earnings than was the I/B/E/S consensus forecast existing at the time the forecasts were given. In order to qualify, as superior, the analyst must have provided at least four forecasts. In addition, the analyst must not be the sole analyst in the consensus forecast.
Mean yield change is the mean of the change in dividend yield, that is $D_{t-1} - D_t/P_t$, where D_t is the current dividend at time t, D_{t-1} is the previous dividend at time $t-1$, and P_t is the share price two days prior to the dividend at time t.
The option-implied dividend forecast revision is $IDIVFR_{it} = \frac{IDIV_{it} - IDIV_{ir}}{P_{i,t-2}}$ where $IDIV_{it}$ is the mean option-implied dividend per share for firm i for options traded during the week *preceding* analyst revision at day t, $IDIV_{ir}$ is the mean option-implied dividend per share for firm i for options traded during the week *following* the previous ex-dividend day at time r, and $P_{i,t-2}$ is the price per share for firm i two days before the analyst forecast revision at day t.
The analyst revision option-implied forecast surprise is $IDIVSP_{it} = \frac{IDIV_{it} - IDIV_{if}}{P_{i,t-2}}$ where $IDIV_{it}$ is the mean option-implied dividend per share for firm i for options traded during the week *preceding* analyst revision at day t, $IDIV_{if}$ is the mean option-implied dividend per share for firm i for options traded during the week *following* the day after the analyst revision at day t, and $P_{i,t-2}$ is the price per share for firm i two days before the analyst forecast revision at day t.

TABLE 3.3: Mean prediction errors of Adjusted Option-Implied Dividends ($IDIVA$), Consensus Analyst Dividend Forecast ($CDIV$), Individual analysts ($ADIV$), and Superior analysts ($SDIV$).

No. of obs.	Predictor	$MAPE$	$MSPE$
11,769	Option-implied	0.002021	0.000256
11,769	Consensus analyst	0.001028	0.000225
132,442	All analysts	0.002840	0.000882
35,463	Superior analysts	0.002290	0.000698

$MAPE$ is the mean absolute prediction error, that is, $MAPE = \frac{1}{n}\sum_{j=1}^{n}\frac{|D_{jt}-F_{jt}|}{P_{jx}}$ where D_{jt} is the realized dividend amount for the jth stock at time t, F_j is the dividend forecast, for the jth stock at time t, P_{jx} is the stock price two days before the ex-dividend date at time x, and n is the number of observations for the year.
$MSPE$ is the mean squared prediction error, that is $MSPE = \frac{1}{n}\sum_{j=1}^{n}\frac{(D_{jt}-F_{jt})^2}{P_{jx}}$.

TABLE 3.4: Dependent: Market revision IDIVSP dummy

	Estimate	Probability	Std. Dev.	Wald χ^2	P-value
Intercept	0.0341	51.36%	0.0299	1.3071	0.2529
Forecast revision	-0.0714	48.51%	0.0480	2.2084	0.1373
Forecast revision (Superior analysts)	-0.00075	51.33%	0.0637	0.0001	0.9906

Criterion	Intercept Only	Intercept and Covariates
AIC	4808.280	4809.449
SC	4814.431	4827.902
-2 Log L	4806.280	4803.449

Association of Predicted Probabilities and Observed Responses			
Percent Concordant	31.9	Somers' D	0.029
Percent Discordant	29.1	Gamma	0.047
Percent Tied	39	Tau-a	0.014
Pairs	3005020	c	0.514

Testing Global Null Hypothesis: BETA=0		
Test	χ^2	p-Value
Likelihood Ratio	2.8311	0.2428
Score	2.8307	0.2428
Wald	2.8293	0.243

An analyst is classed as superior for a specific firm if 80% or more of the analyst's forecasts for that firm were closer to realised earnings than was the I/B/E/S consensus forecast existing at the time the forecasts were given. In order to qualify, as superior, the analyst must have provided at least four forecasts. In addition, the analyst must not be the sole analyst in the consensus forecast.

The option-implied dividend forecast revision is $IDIVFR_{it} = \frac{IDIV_{it} - IDIV_{ir}}{P_{i,t-2}}$ where $IDIV_{it}$ is the mean option-implied dividend per share for firm i for options traded during the week *preceding* analyst revision at day t, $IDIV_{ir}$ is the mean option-implied dividend per share for firm i for options traded during the week *following* the previous ex-dividend day at time r, and $P_{i,t-2}$ is the price per share for firm i two days before the analyst forecast revision at day t.

The analyst revision option-implied forecast surprise is $IDIVSP_{it} = \frac{IDIV_{it} - IDIV_{if}}{P_{i,t-2}}$ where $IDIV_{it}$ is the mean option-implied dividend per share for firm i for options traded during the week *preceding* analyst revision at day t, $IDIV_{if}$ is the mean option-implied dividend per share for firm i for options traded during the week *following* the day after the analyst revision at day t, and $P_{i,t-2}$ is the price per share for firm i two days before the analyst forecast revision at day t.

TABLE 3.5: Dependent: Forecast revision dummy

	Estimate	Probability	Std. Dev.	Wald χ^2	P-value
Intercept	-0.0502	48.00%	0.0326	2.3598	0.1245
Market revision	-0.1357	42.63%	0.0499	7.4048	0.0065
Market revision (Superior analysts)	0.5701	69.84%	0.0752	57.4187	$< .0001$

Criterion	Intercept Only	Intercept and Covariates
AIC	4136.252	4081.757
SC	4142.254	4099.761
-2 Log L	4134.252	4075.757

Association of Predicted Probabilities and Observed Responses			
Percent Concordant	36.5	Somers' D	0.128
Percent Discordant	23.7	Gamma	0.212
Percent Tied	39.7	Tau-a	0.064
Pairs	2224694	c	0.564

Testing Global Null Hypothesis: BETA=0		
Test	χ^2	p-Value
Likelihood Ratio	58.4954	$< .0001$
Score	57.9389	$< .0001$
Wald	57.4447	$< .0001$

An analyst is classed as superior for a specific firm if 80% or more of the analyst's forecasts for that firm were closer to realised earnings than was the I/B/E/S consensus forecast existing at the time the forecasts were given. In order to qualify, as superior, the analyst must have provided at least four forecasts. In addition, the analyst must not be the sole analyst in the consensus forecast.

The option-implied dividend forecast revision is $IDIVFR_{it} = \frac{IDIV_{it} - IDIV_{ir}}{P_{i,t-2}}$ where $IDIV_{it}$ is the mean option-implied dividend per share for firm i for options traded during the week *preceding* analyst revision at day t, $IDIV_{ir}$ is the mean option-implied dividend per share for firm i for options traded during the week *following* the previous ex-dividend day at time r, and $P_{i,t-2}$ is the price per share for firm i two days before the analyst forecast revision at day t.

The analyst revision option-implied forecast surprise is $IDIVSP_{it} = \frac{IDIV_{it} - IDIV_{if}}{P_{i,t-2}}$ where $IDIV_{it}$ is the mean option-implied dividend per share for firm i for options traded during the week *preceding* analyst revision at day t, $IDIV_{if}$ is the mean option-implied dividend per share for firm i for options traded during the week *following* the day after the analyst revision at day t, and $P_{i,t-2}$ is the price per share for firm i two days before the analyst forecast revision at day t.

4

Insider Trading and Option-Implied Dividend Surprises

4.1 Introduction

Insider trading relates to board members and executives trading in the securities of their own company. Analysis of insider trades surrounding firm information releases is important because it gives us greater understanding of market efficiency. Studies, such as Jaffe (1974); Seyhun (1986), show that insider trading enhances the informational efficiency of the market. This analysis extends to firm dividend announcements, such as Oppenheimer and Dielman (1988), who investigates insider trading prior to dividend cessation or resumption and finds that insiders trade and earn abnormal returns based on their superior knowledge of dividend changes. In addition, insider trading serves a signaling purpose to corroborate the quality of earnings surrounding dividend announcements. Trading by insiders, prior to announcements of dividend initiations, indicates to the market that management has confidence in future dividends and the sustainability of earnings (John and Lang, 1991).

Past studies, on dividends and insider trading, have used dividend resumptions and initiations or a naive model, that is, using the most recent dividend as the expected future dividend. In this chapter, I investigate whether insiders trade stock or options using their superior knowledge of changes in the amount of their firm's dividend payments. I am able to capture a more complete measure of dividend surprise by using the market expectations of dividends implied by option prices. As per the methodology in the previous chapter, an extension of Bae-Yosef and Sarig (1992), I use the dividends implied by American option prices as a proxy for market expectations of dividends. I then use these expectations to calculate a dividend surprise and investigate whether there is abnormal insider trading preceding these dividend surprises. There are two advantages to my approach. Firstly, past studies have included only firms that cease or resume dividends, however these firms are a very small subset of all dividend paying firms. Using option-implied dividend changes I can include all dividend paying stocks with a liquid options market. Secondly, changes in the option-implied dividend provide a more accurate measure of dividend surprise than a naive change[1]. I also extend past papers by considering the hierarchy of insider classification. By aggregating the sample based on the hierarchy of insiders, I am also able to test for evidence of the information hierarchy hypothesis[2], that more senior insiders are more likely to trade on their superior knowledge, or the alternative, the scrutiny hypothesis[3], that more senior insiders are less likely to trade due to the possibility of shareholder or SEC actions.

Consistent with previous signaling studies[4], I find that CEOs are more likely to accumulate stock preceding an announcement for an *expected* increase in the cash dividend. Whereas, insiders lower in the information hierarchy such as Non-Director Executives and Other Officers and Block-holders are more likely to accumulate stock for an *unexpected* increase in the cash dividend. Directors, who are also lower on the information hierarchy, were less likely to accumulate stock for an unexpected increase in the dividend. I attribute the difference, between Directors versus Non-Director Executives and Other Officers, to board membership acting as an additional burden of scrutiny. These results support the scrutiny hypothesis of Fidrmuc et al. (2006). The findings are important because non-board insiders appear to benefit from insider knowledge about dividend policy but do not provide the signaling effect to markets such as when CEOs trade prior to dividend announcements[5]. It is possible

[1] Bae-Yosef and Sarig (1992)
[2] Seyhun (1986)
[3] Fidrmuc et al. (2006)
[4] John and Lang (1991)
[5] John and Lang (1991)

that firms could better align market dividend expectations with insider knowledge by improving corporate governance policies such as long-term dividend policy transparency or implementing trading windows, between announcement and ex-dividend date, for non-board insiders.

This chapter proceeds as follows. Section 1 contains a discussion of the theoretical and empirical literature on insider trading and dividends implied by options. The section is divided into insider superior earnings knowledge and returns, market responses to insider trades, information hierarchy, block-holders, insider trading and dividends, and option implied dividends. Section 2 outlines my method of estimating the dividend implied from American option transaction prices, and the insider trading data sources and models. Section 3 presents the results, analysis and discussion. Section 4 summarizes the chapter and provides directions for future research.

4.1.1 Insider trading profits

Superior knowledge and returns

Early studies using U.S. data find that insiders earn abnormal returns on their trades (Jaffe, 1974; Finnerty, 1976; Seyhun, 1986). Ikenberry, Lakonishok, and Vermaelen (1995) finds that insiders are better informed about their firm's prospects than outside investors and the market is slow at adjusting to insider signals. However, studies conflict on whether outsiders can profit from trading on insider signals. Some studies, such as Seyhun (1986) and Rozeff and Zaman (1988), show that outsiders do not benefit by imitating insiders. Whereas other studies, such as Bettis, Vickrey, and Vickrey (1997), show that investors can earn abnormal profits by trading on large insider trades by top executives.

Many studies investigate whether insiders trade on their superior knowledge of future earnings. They find no evidence, between 20 days and 12 months, of a significant change in buying or selling preceding a change in earnings (Elliott, Morse, and Richardson, 1984; Givoly and Palmon, 1985; Noe, 1999). Insiders possibly avoid trading close to earnings announcements due to the risk of prosecution either from the SEC or from civil class actions (Seyhun, 1992). However, other studies such as Noe (1999) have examined insider trades over longer periods such as 12 months to 5 years and find some evidence that insiders trade and profit from changes in long term earnings growth. It's possible that insiders trade on short term dividend surprises due to their control over dividend policy and the reduced attention from regulators compared with insider trades surrounding earnings.

Ke, Huddart, and Petroni (2003) look at insider trades preceding a break in a string of quarterly earnings increases over a window of up to 16 quarters before the break. The share price reaction is larger for a break following many quarters of earnings growth and this provides insiders with a strong motivation to sell prior to this event. Prior studies have shown this effect should be larger for growth stocks than value stocks (Skinner and Sloan, 2002). The results from Ke et al. (2003) show that insiders attempt to avoid negative implications from SEC enforcement and class actions by selling stocks well before the event: 3 to 9 quarters before a break in a string of earnings growth. The study also finds that insider selling increases incrementally if firm-quarters are for growth firms as indicated in Skinner and Sloan (2002). It also increases if the break in earnings growth is longer or if the earnings decline is larger. This implies that insiders trade on their superior knowledge of the quality of future earnings. Ke et al. (2003) contributes to the literature by showing how insiders reveal their knowledge of future earnings breaks by trading further out from the event.

Insiders are more likely to be contrarian (Seyhun, 1992). Because earnings announcements often accompany actual changes in performance, it leaves open the question of whether insiders are trading on investor errors in valuation or because of the insiders superior knowledge about the firms future cash flows. Piotroski and Roulstone (2005) investigates this issue by comparing the relative strength of contrarian trading versus beliefs about future cash flow news and realisations. Results from Piotroski and Roulstone (2005) show strong evidence that insider purchases are positively related to future earnings performance and positively related to BM ratios and inversely related to past returns. However, superior information about future cash-flow changes explain a smaller portion of insider purchase activities than misvaluation. They also shows that insider purchases have stronger correlation with current and future earnings in firms with higher information asymmetry such as small firms that are poorly followed by analysts.

Market response to insider trades

Lakonishok and Lee (2001) examine the information content of insider trades and the best way to interpret insider signals. 55% of firms in their sample have purchasing or selling by insiders and 72% for larger firms. As expected, insider sales as a portion of the firms market capitalisation are larger at 1.3% than purchases of 0.6% possibly because insiders are remunerated in stock options and sell more than they purchase for non-information liquidity motivations such as requiring cash or diversification. During the sample period of 1975-1995 insider purchases had no material increase. The study also finds that the market tends to ignore reported insider activities; abnormal returns around the reporting dates of insider trades are not economically meaningful. However, abnormal returns around the trading dates were relatively large. The main contribution of Lakonishok and Lee (2001) is that whilst insider trades earn abnormal earnings, the markets response to disclosure of these trades is insignificant.

Information hierarchy

Seyhun (1986) studies insider trades from 1975 to 1981 and finds that chairman of the board and directors are more successful predictors of abnormal stock prices than officers and shareholders. Whereas, Fidrmuc et al. (2006) extend tests of the information hierarchy hypothesis by examining trades by different levels of insiders, different types of announcements, and the effect of ownership. They are unable to find evidence that supports the information hierarchy, instead they find that CEO trades have a lower information content than other directors' trades. They suggest this is due to CEOs, having a more important position in the firm than other insiders, trading more cautiously due to greater market scrutiny. They also detail the difference between the US and UK insider trading regulatory environments. They are able to compare UK insider trades with the results from US insider trades presented in Lakonishok and Lee (2001). Fidrmuc et al. (2006) find CAAR to be higher in the UK compared with the US (from Lakonishok and Lee (2001) possibly because of speedier reporting and because UK directors trade less frequently due to trading bans and therefore have higher information content when they do trade. The study also finds that insider purchases likely convey positive information about a firm's prospects whereas insider sales may also be liquidity motivated which would decrease the information value of the trade. They find that director purchases and sales trigger significant immediate market reactions of 3.12% and 0.37%, respectively, over a 2-day window from announcement day.

Insider trading and dividends

Oppenheimer and Dielman (1988) investigate insider trades prior to firms announcing the cessation of dividend payments or the resumption of dividend payments after two years of non-payment. They find that insiders increase their purchases before the resumption of dividend payments. However, they fail to find evidence that insiders earn positive abnormal returns from purchases but find that they earn positive abnormal returns from sales.

Looking at the context of simultaneous information releases, Cheng and Leung (2008) examine insider trading before simultaneous earnings and dividend announcements in Hong Kong. They find significant net-insider-buying activities before announcements of good news ('Earnings-Dividend Increase') and significant net-insider-selling activities before bad news ('Earnings-Dividend Decrease' and 'Earnings Decrease-Dividend Zero'). Extending this work, Cheng, Davidson, and Leung (2011) find greater information asymmetry for simultaneous bad news earnings-dividend announcements with insider sales than good news earnings-dividend announcements with insider purchases. These results strengthen the likelihood of finding insider trading preceding dividend surprises implied by option prices.

Tanimura and Wehrly (2012) provides additional support for the incentives for the scrutiny hypothesis put forward by Fidrmuc et al. (2006), they study the effects of two regimes of insider trading restrictions on insider trades around dividend initiations and omissions between 1935 and 1974. They find that insiders sold less frequently and made less profits under the increased adjudicative approach of the SEC. These studies provide tension with the information hierarchy hypothesis put forward by Seyhun (1986).

4.1.2 Option implied dividends

Past research has investigated whether insider trading activity is abnormal preceding dividend announcements and whether insiders earn abnormal profits following these trades. The change of expectations that these studies have used when a firm resumes paying dividends after a period of non-payment or the cessation of dividends following a period of dividend payments. These *all or nothing* dividend changes may not generalise to the much more common case of a moderate increase or decrease in the amount of dividend paid. Derivatives can be used to extract a market expectation of the implied dividend. Announced changes that differ from the market expectations should cause a change in the pricing of the securities. Insiders may purchase more stock when they expect an upward revision in the market expectation of dividends following an announcement of an increased dividend or when that information becomes available to the market after their trade. In the following section I detail the method used in Bae-Yosef and Sarig (1992) to calculate a measure of dividend surprise using American options.

4.2 Methodology and data

First, I estimate the market expectations of the ex-dividend day drop from the option and stock data. Second, I develop a measure of dividend surprise by calculating the change in option-implied dividend expectations. Third, I calculate measures of different insider trading activities preceding dividend announcements. Finally, I regress the dividend surprise on the insider trading activities and present the results.

4.2.1 Estimation of the option-implied dividend forecasts

In the first thesis chapter, Guerrero (2017), I expand on a methodology developed by Bae-Yosef and Sarig (1992) to estimate option market dividend expectations. I use changes in option-implied dividend as a proxy for dividend surprise. Expected dividends are calculated using option put-call parity; the following equation holds for European options:

$$PV(DIV) = S - (c - p + KB_t) \tag{4.1}$$

where $PV(DIV)$ is the current value of expected interim dividends; S, c, and p are the prices of the underlying stock, the European call, and the European put, respectively; K is the common exercise price; and B_t is the time-t price of a pure discount bond maturing on the options' common expiration day.

Equation 4.1 is based on European option prices. Since I can only observe American options, I need to take into account the premium due to the right of early exercise. I define the American over European option premium, for calls and puts, by:

$$\Delta c \equiv C - c \geq 0 \tag{4.2}$$

$$\Delta p \equiv P - p \geq 0 \tag{4.3}$$

where C and P are American call and put prices, respectively. Equation 4.1 can now be written as

$$PV(DIV) = S - (c + \Delta c - (p + \Delta p) + KB_t) \tag{4.4}$$

American options will not be exercised early, and therefore have an equivalent price to European options, whenever:

$$D \leq K(1 - e^{-R(T-t)}) \tag{4.5}$$

where D is the dividend, R is the forward rate between the dividend payout time, t, and the expiration date, T, as observed at time t, and K is the exercise price of the option.

My estimation procedure matches the two closest observations, based on time, where a put and call with the same exercise price and expiration date occur on the same day. Transactions are only matched to a single pair but there may exist many pairs on any given day. I find 80,898 put-call trade pairs, approximately 8.37% of the original sample, meet the condition in equation 4.5 and I use a modified equation 4.1 to calculate the future value of the dividend, for these transactions:

$$IDIV = \Big(S - C + P - K \exp\big(-R(T_M - t)\big)\Big) \exp\big(R(T_X - t)\big) \tag{4.6}$$

where $IDIV$ is the future value, at the ex-dividend day T_X, of the cash dividend, C, P, K are the call, put, and strike prices, S is the mean of stock trade prices that occur between the put-call pair, T_M is the time of maturity, and R is the forward rate.

American call options that do not meet the condition in equation 4.5 will be exercised the day before the ex-dividend date due to the expected stock price decline. Whereas, American put options that do not meet the the condition in 4.5 will be exercised on or after the ex-dividend date depending on moneyness. If the interest on the proceeds from early exercise exceed the time value of money then early exercise is optimal:

$$(K - S)(1 - e^{-R(T-t)}) > T.V. \tag{4.7}$$

where $T.V.$ is the time value of the option, and the remaining notation is the same as equation 4.5. Based on the expected price decline due to the dividend, I anticipate an insignificant marginal difference in the European vs American put option premium.[6][7] Therefore, for the main study, the remaining option pairs that do not satisfy equation 4.5 are estimated using equation 4.6 with the maturity date T_M set to the ex-dividend date T_X due to early exercise.

[6]Gray (1989) finds in favour of put-call parity holding when taking into account the potential rational early exercise of an option and the possibility that dividends and capitalisation changes will differ from expectations.

[7]Whaley (1982) finds only a half-percent difference in pricing between European and American options.

Mean option-implied dividend forecasts are denoted $IDIV$.

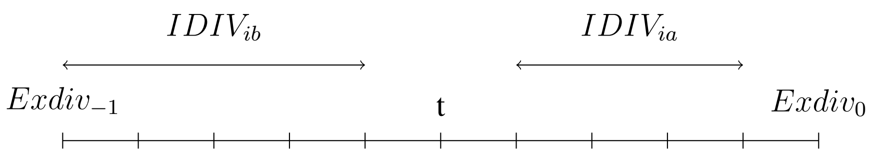
4.2.2 Option-implied dividend surprise

In order to answer the question of whether insiders trade on their superior knowledge of future dividends, I need to measure the change in the market's expectations of the dividend amount due to the information release of the dividend announcement by the firm. The measure I use is the change in the mean estimate from before to after the dividend announcement. Therefore, I define the option-implied dividend surprise as:

$$IDIVSP_{it} = \frac{IDIV_{ia} - IDIV_{ib}}{P_{i,t-2}} \tag{4.8}$$

where $IDIV_{ib}$ is the mean option-implied dividend per share for firm i for options traded prior to the dividend announcement on day t but after the previous ex-dividend day $Exdiv_{-1}$, $IDIV_{ia}$ is the mean option-implied dividend per share for firm i for options traded after the dividend announcement on day t up until the day before the ex-dividend day $Exdiv_0$, and $P_{i,t-2}$ is the price per share for firm i two days before the dividend announcement at day t.

FIGURE 4.1: Option-implied dividend surprise measure timeline



4.2.3 Measures of insider trading activity

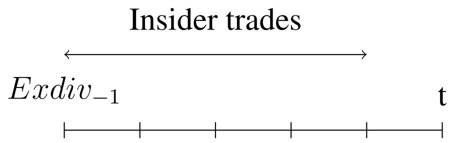
I use the net purchase ratio, as per (Lakonishok and Lee, 2001), as the measure of insider trading activity, that is,

$$NPR_{it} = \frac{PURCHASES_{it}}{PURCHASES_{it} + SALES_{it}} \tag{4.9}$$

where NPR_{it} is the insider net purchase ratio for firm i for insider trades between the previous ex-dividend day and the announcement at day t for the current upcoming dividend, $PURCHASES_{it}$

and $SALES_{it}$ are, respectively, the sum of insider purchases and the sum of insider sales between the previous ex-dividend date and the announcement at day t for firm i.

FIGURE 4.2: Net Purchase Ratio timeline



I use the option exercise ratio, as the measure of option exercise activity by insiders, that is,

$$OER_{it} = \frac{EXERCISEPURCHASES_{it}}{PURCHASES_{it} + SALES_{it}} \tag{4.10}$$

where OER_{it} is the option exercise ratio for firm i for insider trades between the previous ex-dividend day and the announcement at day t for the current upcoming dividend, $EXERCISEPURCHASES_{it}$, $PURCHASES_{it}$ and $SALES_{it}$ are, respectively, the sum of purchases from exercising options, the sum of insider purchases, and the sum of insider sales between the previous ex-dividend date and the announcement at day t for firm i.

4.2.4 Do insiders increase their purchases if there is a dividend surprise?

Earlier work by Oppenheimer and Dielman (1988), find that insiders increase their purchases before the resumption of dividends after two years of non-payment. Likewise, I expect this affect to hold for unexpected changes in the dividend amount.

In addition, Seyhun (1986) find that CEO and chairman have trades that reveal a higher information content than insiders lower in the information hierarchy. Alternatively, Fidrmuc et al. (2006) find that insiders higher in the firm hierarchy shy away from trading on their superior knowledge, possibly due to the higher scrutiny by shareholders and exchange regulators. I can test whether insiders act on their knowledge or trade when they have less scrutiny by formalising the following hypothesis:

Hypothesis 1. *Insiders higher in the information hierarchy are more likely to accumulate stock, than insiders lower in the hierarchy, when there is a positive dividend surprise.*

In the previous thesis chapter, Guerrero (2017), I find that the option-implied dividend is a noisy measure of the expected dividend due to transaction costs, moneyness of the options, thin-trading, non-synchronous trading, and dividend yield. I use a latent variable model and probit regressions as I am primarily interested in the likelihood of a change in either the market prices or the analyst forecasts, and not necessarily in a linear relationship. Consider the latent variable model,

$$y_i^* = x_i'\beta + \epsilon_i \tag{4.11}$$

where y_i^* is an unobservable latent variable that measures the accumulation of stock by insiders, x_i is a vector of explanatory variables, β is a vector of unknown parameters and ϵ_i is a random disturbance term. I assume that y_i^* is related to the observed variable y_i, in the following way,

$$y = \begin{cases} 1, & \text{if } y_i^* > 0 \\ 0, & \text{otherwise} \end{cases} \tag{4.12}$$

I can see whether insiders increase their net purchases of their stock by trading on their superior knowledge of their firm's upcoming dividend change by regressing the option-implied dividend surprise on the measure of insider trading activity. Therefore, I estimate the following probit model,

$$NPR_{it} = \gamma_0 + \gamma_1 NAIVESP_{it} * IDIVSP_{it} * ROLE_{it} + \gamma_2 NAIVESP_{it} * ROLE_{it} + \epsilon_j \tag{4.13}$$

where NPR_{it} has a value of 1 when the insider net purchase ratio defined in equation 4.9 is greater than 0.5 and a value of 0 otherwise, $IDIVSP_{it}$ has a value of 1 when the option-implied dividend surprise defined in equation 4.8 is positive and a value of 0 otherwise, $NAIVESP_{it}$ has a value of 1 when the dividend at time t is greater than the previous dividend and a value of 0 otherwise, and $ROLE_{it}$ is a categorical dummy variable that represents the position within the firm, that is, Chairman, CEO, Directors, Executive Directors, Former Officers, and Other Executives.

4.2.5 Do insiders exercise their options if there is a dividend surprise?

Insiders may not increase their net purchases prior to a change in the dividend announcement due to public scrutiny of their stock purchases. However, exercisement of their existing option holdings may not attract as much attention from shareholders and regulators. The value of the options will be affected to a greater extent by the ex-dividend day decline, than stock, because options do not receive the cash dividend unless exercised early.

Likewise, I can extend the tests of the information hypothesis (Seyhun, 1986) vs. scrutiny hypothesis (Fidrmuc et al., 2006) to option disposition. I formulate the following hypothesis:

Hypothesis 2. *Insiders higher in the information hierarchy are more likely than insiders lower in the hierarchy to dispose of options, when there is a positive dividend surprise.*

We can infer whether insiders exercise their options prior to an unexpected increase in dividends by regressing the option-implied dividend surprise on the measure of insider option exercise. Therefore, I estimate a similar probit model as equation 4.14,

$$OER_{it} = \gamma_0 + \gamma_1 NAIVESP_{it} * IDIVSP_{it} * ROLE_{it} + \gamma_2 NAIVESP_{it} * ROLE_{it} + \epsilon_j \quad (4.14)$$

where OER_{it} has a value of 1 when the insider option exercise ratio defined in equation 4.10 is greater than 0.5, and the other variables are defined, as above, in equation 4.14.

4.2.6 Data

The data in the chapter are compiled from three sources: OptionMetrics, Thomson Reuters Insider Data, and Thomson Reuters Tick History.

Insider transactions

I use insider transaction data from Thomson Reuters for U.S. firms between 2009 and 2015. The data are from Forms 3, 4, and 5. As per Lakonishok and Lee (2001), I exclude transactions with less than 100 shares to focus on the more meaningful events. The number of transactions less than 100 shares is 34,437. I remove trades for which the number of shares traded exceed 20% of the number of shares outstanding. There are 892 dividend-paying firms that are present in both the insider data and the option tick data. The final sample includes 119,019 stock and 95,905 derivative transactions.

The analysis of stock accumulation includes transaction codes A, F, I, J, M, P, S, D. These codes represent: Acquisition of a derivative or non-derivative security, payment of option exercise price or tax liability by delivering or withholding securities incident to exercise of a derivative security, Discretionary transaction in accordance with Rule 16b-3(F) - typically employee benefit plans, Exercise of in-the-money or at-the-money derivative security in accordance with Rule 16b - typically employee benefit plans, Open market purchase, Open market sale, Disposition of a derivative or non-derivative security.

I include the following types of derivative securities: Call option, Non-employee director stock option, Director's stock option, Employee stock option, Options. The option disposition analysis includes transaction codes C, D, I, J, M, O, S, X. These codes represent: Conversion of a derivative security, Disposition of a derivative or non-derivative security, Discretionary transaction in accordance with Rule 16b-3(F) - typically employee benefit plans, Other acquisition or disposition, Exercise of in-the-money or at-the-money derivative security in accordance with Rule 16b - typically employee benefit plans, Exercise of out-of-the-money derivative security, Open market sale, Exercise of in-the-money or at-the-money derivative security.

The insider purchases and sales, by firm and by dividend quarter, for the final sample are summarized in Table 2. The number of net purchases and sales are very similar at 53,032 and 65,275 respectively. CEOs made significantly more purchases (4,882) and sales (8,381) than Chairman with 531 purchases and 661 sales. This could be because I categorize an insider as a CEO if they are both a CEO and a Chairman. The median market capitalization of the trades appear to decrease monotonically, from 0.0334% for CEOs through to 0.0126% for Officers and beneficial holders. The pattern of decreasing market capitalization of trade size with decreasing position within the firm appears to generally hold for sales, with CEOs at 0.0226% through to Officers and beneficial holders at 0.0097%. It could be argued that Non-director executives and Non-executive directors have a similar level within the firm hierarchy but the executives are more likely to receive larger option packages and vested shares than their non-executive director counterparts.

Option data

Using end-of-day data and dividend event data from OptionMetrics, I compile a list of firm-years that match the following filter: at least a single daily traded volume of 30 for an option instrument with a single ex-dividend date between the trade date and option maturity. Using these firm-years, I collect all option and underlying stock tick data from Thomson Reuters Tick History from 2009-2015. The final sample consists of 9,334 firm-years from 1,908 firms.

I exclude dividend events where the stock price moves more than 10% from the close the day before the ex-dividend date to the opening on the ex-dividend date. I exclude, due to the unavailability of future dividend event information, option maturities with expiration past the dividend event sample period of 31st December 2015. I exclude estimated dividend yields greater than 10%. This reduces the sample approximately 0.01% from 4,818,361 to 4,817,818 individual estimates.

I truncate at the 2nd and 98th percentiles for the individual dividend estimates, implied alpha , and overnight realized alpha. This reduces the sample by approximately 10.6% to 4,303,528 individual estimates. After I match the individual estimates with insider trading records, the final sample of individual dividend estimates reduces to 3,009,020. I then calculate the mean of the individual estimates for each dividend event and use these values in the following analysis.

The ratio of the stock price to exercise price and the time in weeks to expiration are detailed in Table 1. 84.92% of the transactions have a S/X ratio within 0.9 to 1.1. Most of these transactions are within-the-money. The largest category of time to maturity is between four and six weeks with 762,226 option pairs. 91.66% of option pairs are less than 14 weeks.

Naive changes in dividends and the option-implied dividend surprises are summarized in Table 3. The pre-announcement and post-announcement means of 0.8398 and 0.8953, respectively, are both very close to the means of expected drop in the first thesis chapter of 0.871584 for all observations and 0.850048 for the filtered sample. The mean naive change in dividend over this time period for the sample is negative at -0.0700%. Likewise, the option-implied dividend surprise also has a negative mean of -0.0381%. The median naive change in dividend is 0% because more than half of the dividend events include no change in the dividend paid. As expected, I see a reduction in the standard deviation of the implied dividend, from 0.3889 pre-announcement to 0.3059 post-announcement, due to the increased certainty of the dividend amount.

4.3 Results

4.3.1 Stock trading

Do insiders acquire or dispose stock prior to a dividend change?

The results from Table 4 show a significant increased probability (0.4151) for CEOs to engage in stock accumulation in the prior inter-dividend period when the increase is known to the market. No other classification of insider has a significant estimate. As CEOs are the most influential insiders for determining dividend payout policy, the accumulation of stock for a known dividend increase signals to the market the CEO's confidence in the sustainability of the dividend and therefore the cash flows of the firm[8].

The results for an *unexpected* increase in dividend, implied by option prices, gives a negative significant estimate (-0.2315) for Directors, indicating they are less likely to accumulate stock. However, Non-board Executives (0.1955) and Other insiders (0.0848) have a positive probability of accumulating stock given an unexpected increase in dividend. Putting aside for the moment the result from Directors, the increased stock accumulation for the later two classifications do not support Hypothesis 1. Instead, this result supports the alternative hypothesis put forward by Fidrmuc et al. (2006) that insiders lower in the hierarchy are less likely to be noticed and prosecuted for trading on private knowledge. One possible explanation for the difference between the Director versus the Non-board Executives and Other insider estimates is that Directors' presence on the board means they have a higher level of scrutiny by shareholders and the SEC than non-board insiders. Various case law such as Grobow v. Perot, 539 A.2d 180 198 (1988), set out duties of directors in a business such as to "act in the best interests of the corporation" and "not involve self-interest". Directors have a *Duty of Care* and *Duty of Loyalty* that do not burden non-directors, and this could be a possible explanation for these results. The insignificance of an estimate for Executive Directors could be due to a lack of power, as the number of observations is much lower at 541 compared with Directors at 2,229, Non-board Executives at 3,971, and Other Block-holders at 2,914 observations. However, the lack of a significant estimate for Executive Directors does not detract from the support for the board-membership explanation given previously. Overall, the result seems to support the scrutiny hypothesis of (Fidrmuc et al., 2006) that insiders higher (lower) in the firm hierarchy are less (more) likely to act on their private information due to higher (lower) scrutiny of their actions by shareholders and regulators.

4.3.2 Option exercise

Do insiders exercise options prior to a dividend change?

Similar to the analysis in the previous section, results for an *expected* change in dividend are presented first. Table 5 reveals a significantly negative estimate for CEO (-0.1930) and Other Block-holders (-0.1137), indicating that they are less likely to exercise their options prior to an expected increase in

[8] John and Lang (1991)

dividends. However, Directors have a significantly positive estimate (0.5448) and are more likely to exercise their options prior to an expected increase in dividends. I expected that insiders would exercise their options prior to the announcement given an expected increase in cash dividend decreases the value of their option. The result from CEO and Other Block-holders is inconsistent with this intuition and I'm unable to explain this result.

The significant estimates for an unexpected increase in dividend indicate that Directors (-0.2352) are less likely to exercise their options. Directors hold a lower position within the firm and I expect that they are less likely to know about the likelihood of an increase in dividends, and the quality of the dividend with regard to future earnings, before a vote by the board of directors. However, Non-board Executives and Other Block-holders are also low within the information hierarchy but have an increased probability (0.1955) and (0.0848), respectively, of exercising their options prior to an unexpected increase in dividends. The result is consistent with the stock accumulation results in the previous section. This provides further evidence that there is a possible difference in market and regulatory scrutiny between the trades of low information hierarchy insiders who are on the board of the firm compared with insiders who are not on the board.

The results for option disposition are inconsistent with Hypothesis 2 and favour the alternative, the Scrutiny Hypothesis put forward by Fidrmuc et al. (2006). Non-board executives and block-holders are too low in the firm's hierarchy to support the information hypothesis put forward by Seyhun (1986). The results, are possibly different to Seyhun (1986) due to the increased regulatory and litigatory environment since the late 1970s sample period used in that study.

4.4 Conclusion

In this chapter, I investigate whether insiders accumulate stock, or exercise their options, based on their superior knowledge of changes in the firm dividend policy. If a category of insider is more likely to trade prior to a dividend surprise then I conclude that the insider is trading on upcoming dividend information that is not yet available to the market. I calculate a measure of dividend surprise, using the option put-call method from the prior chapter which is an extension of Bae-Yosef and Sarig (1992). Estimating dividends from option prices has an advantage over using the naive-change in dividend because the estimates incorporate information that is available to the market prior to the dividend announcement by the firm. The measures of insider trading activity are two binary variables based on whether or not the category of insider has accumulated stock and whether they have exercised options over the last quarter prior to the dividend announcement.

Consistent with past studies such as Fidrmuc et al. (2006), the results indicate that insiders who are low in the information-hierarchy and not on the board of directors are more likely to engage in stock accumulation and option exercise than board directors and senior management. Acknowledgement that low hierarchy insiders are accumulating stock and disposing of options prior to dividend surprises will enable firms to develop appropriate corporate governance policies on dividend policy transparency and insider trading windows.

Future research could consider the sustainability of the dividend increase and the effect of increased cash-flows on insider accumulation and option exercise. Another promising extension is whether there is a difference, on insider accumulation, if the dividend is paid out of firm debt or cash reserves. It's possible that the capital structure of the firm could also have an effect on the level of capital expenditure for new projects and this, in turn, could affect the long term growth of the firm. It's possible that the insider classifications with insignificant estimates may become significant when the above factors are incorporated in a future analysis. A natural extension of this study could also examine the holding period returns of insiders and the economic impact of the trading.

TABLE 1: Frequency distributions for the number of individual put-call pairs by the degree to which the options are in-the-money (S/X) and by the time to expiration of the options, (T).

Ratio of stock price to exercise price	No. of transactions	Percent	Time to expiration in weeks	No. of transactions	Percent
$S/X < 0.75$	2,378	0.08%	$T < 2$	117,924	3.92%
$0.75 \leq S/X < 0.8$	3,733	0.12%	$2 \leq T < 4$	528,319	17.56%
$0.8 \leq S/X < 0.85$	10,233	0.34%	$4 \leq T < 6$	762,226	25.33%
$0.85 \leq S/X < 0.9$	30,338	1.01%	$6 \leq T < 8$	571,257	18.98%
$0.9 \leq S/X < 0.95$	107,400	3.57%	$8 \leq T < 10$	382,694	12.72%
$0.95 \leq S/X < 1$	426,683	14.18%	$10 \leq T < 12$	203,733	6.77%
$1 \leq S/X < 1.05$	1,351,495	44.91%	$12 \leq T < 14$	191,918	6.38%
$1.05 \leq S/X < 1.1$	669,921	22.26%	$14 \leq T < 16$	143,205	4.76%
$1.1 \leq S/X < 1.15$	234,643	7.80%	$16 \leq T < 18$	54,102	1.80%
$1.15 \leq S/X < 1.2$	90,609	3.01%	$18 \leq T < 20$	31,179	1.04%
$1.2 \leq S/X < 1.25$	38,606	1.28%	$20 \leq T < 22$	13,589	0.45%
$1.25 \leq S/X < 1.3$	18,790	0.62%	$22 \leq T < 24$	3,955	0.13%
$1.3 \leq S/X < 1.35$	9,562	0.32%	$24 \leq T < 26$	1,644	0.05%
$1.35 \leq S/X < 1.4$	5,289	0.18%	$26 \leq T < 28$	921	0.03%
$1.4 \leq S/X < 1.45$	3,071	0.10%	$28 \leq T < 30$	854	0.03%
$1.45 \leq S/X < 1.5$	1,933	0.06%	$30 \leq T < 32$	491	0.02%
$1.50 \leq S/X$	4,336	0.14%	$32 \leq T$	1,009	0.03%
Total	3,009,020	100.00%	Total	3,009,020	100.00%

TABLE 2: Stocks transactions, value, and market capitalization broken down by type of trader, Jan 2009 - Dec 2015.

Net purchases (53,032 trades)	Mean	Median	Maximum	Minimum
Trade value ($'000)	6,046,452	1,170,869	7,840,470,000	0
% Market capitalization	0.1592%	0.0306%	51.6004%	0.000008%
% Market capitalization by category of insider				
CEO (4,882 trades)	0.0861%	0.0334%	6.7448%	0.000007%
Chairman (531 trades)	0.0740%	0.0274%	0.9192%	0.000083%
Executive Directors (1,705 trades)	0.0672%	0.0209%	3.3359%	0.000006%
Non-executive Directors (11,582 trades)	0.0774%	0.0065%	29.4507%	0.000001%
Non-director Executives (21,442 trades)	0.0378%	0.0159%	6.6743%	0.000008%
Officers and beneficial holders (12,890 trades)	0.1354%	0.0126%	40.3144%	0.000018%

Net sales (65,275 trades)	Mean	Median	Maximum	Minimum
Trade value ($'000)	1,270,363	125,664	3,643,720,000	614
% Market capitalization	0.2358%	0.0248%	57.7457%	0.000004%
% Market capitalization by category of insider				
CEO (8,381 trades)	0.0674%	0.0226%	4.8988%	0.000022%
Chairman (661 trades)	0.0956%	0.0203%	2.4380%	0.000038%
Executive Directors (2,454 trades)	0.0683%	0.0152%	6.1334%	0.000006%
Non-executive Directors (9,711 trades)	0.1269%	0.0059%	33.0110%	0.000004%
Non-director Executives (27,020 trades)	0.0326%	0.0113%	13.8216%	0.000007%
Officers and beneficial holders (17,760 trades)	0.2740%	0.0097%	40.3144%	0.000023%

The above figures are aggregated transaction values by firm and insider classification for insider stock purchases and sales made between ex-dividend dates.

TABLE 3: Implied dividends as a proportion of actual dividends, Naive dividend surprise, and Option-implied dividend surprise as percentages of dividend yield.

	IDIV standardized by dividend amount		Change in yield	
	Pre-announcement	Post-announcement	Implied surprise	Naive surprise
Mean	0.8398	0.8953	-0.0381%	-0.0700%
Median	0.8100	0.8707	-0.0260%	0.0000%
Std. dev.	0.3889	0.3059	0.002386	0.016092

Implied dividends are calculated as $IDIV = \Big(S - C + P - K\exp\big(-R(T_M - t)\big)\Big)\exp\big(R(T_X - t)\big)$ where $IDIV$ is the future dividend value, at the ex-dividend day T_X, of the cash dividend, C, P, K are the call, put, and strike prices, S is the mean of stock trade prices that occur between the put-call pair, T_M is the time of maturity, and R is the forward rate.

The Implied dividend surprise is calculated as $IDIVSP_{it} = \frac{IDIV_{ia} - IDIV_{ib}}{P_{i,t-2}}$ where $IDIV_{ib}$ is the mean option-implied dividend per share for firm i for options traded prior to the dividend announcement on day t but after the previous ex-dividend day $Exdiv_{-1}$, $IDIV_{ia}$ is the mean option-implied dividend per share for firm i for options traded after the dividend announcement on day t up until the day before the ex-dividend day $Exdiv_0$, and $P_{i,t-2}$ is the price per share for firm i two days before the dividend announcement at day t.

Table 4: Probit estimates of stock accumulation. Independent variable: binary stock accumulation. Dependent variables: binary naive dividend surprise and option-implied dividend surprise.

		Naive dividend surprise				Option-implied dividend surprise			
Position	Obs	Estimate	Standard error	Wald χ^2	p-value	Estimate	Standard error	Wald χ^2	p-value
Chairman	190	-0.1472	0.2336	0.3969	0.5287	0.2637	0.5287	0.2487	0.6180
CEO	2159	0.4151	0.0808	26.4226	$\leq .0001$	-0.0125	0.1238	0.0101	0.9198
Executive Director	541	0.2187	0.1307	2.8013	0.0942	0.2725	0.2475	1.2129	0.2708
Director	2299	-0.0289	0.0802	0.1299	0.7186	-0.2315	0.1164	3.9551	0.0467
Non-board Executive	3971	0.0469	0.0667	0.4940	0.4821	0.1955	0.0930	4.4163	0.0356
Other	2914	-0.0212	0.0476	0.1982	0.6562	0.0848	0.0131	41.6646	$\leq .0001$

Joint Tests		
Effect	Wald χ^2	p-value
Naive Dividend Surprise	33.893	$\leq .0001$
Option-implied Dividend Surprise	9.8431	0.0732

The binary probit is a maximum likelihood estimation. The model includes a dummy variable for each firm position, a dummy variable to indicate whether the firm's dividend is higher than the previous dividend, and a dummy variable to indicate whether the option-implied dividend surprise is positive.

TABLE 5: Probit estimates of option disposition. Independent variable: binary option disposition. Dependent variables: binary naive dividend surprise and option-implied dividend surprise.

		Naive dividend surprise				Option-implied dividend surprise			
Position	Obs	Estimate	Standard error	Wald χ^2	p-value	Estimate	Standard error	Wald χ^2	p-value
Chairman	48 (25%)	-0.1439	0.2656	0.2934	0.5881	0.2757	0.5660	0.2372	0.6262
CEO	411 (19%)	-0.1930	0.0893	4.6764	0.0306	-0.1567	0.1436	1.1908	0.2752
Executive Director	125 (23%)	-0.1639	0.1471	1.2405	0.2654	-0.2573	0.2919	0.7769	0.3781
Director	923 (40%)	0.5448	0.0830	43.134	$\leq .0001$	-0.2353	0.1168	4.0619	0.0439
Non-board Executive	1074 (27%)	0.1199	0.0718	2.789	0.0949	-0.1274	0.0998	1.6304	0.2016
Other	756 (26%)	-0.1137	0.0520	4.7855	0.0287	-0.5841	0.0140	1750.7176	$\leq .0001$

Joint Tests		
Effect	Wald χ^2	p-value
Naive Dividend Surprise	69.5838	$\leq .0001$
Option-implied Dividend Surprise	7.0031	0.2204

The binary probit is a maximum likelihood estimation. includes a dummy variable for each firm position, a dummy variable to indicate whether the firm's dividend is higher than the previous dividend, and a dummy variable to indicate whether the option-implied dividend surprise is positive.

5

Conclusion

This thesis examines research questions in three different areas of finance using a method that calculates market expectations of dividends using put-call parity of American option prices. The research questions cover the ex-dividend day drop and related option pricing errors; insider trading on superior dividend knowledge; and analyst dividend forecast accuracy, incorporation of market information, and market response to analyst revisions.

Ex-ante estimates of the dividend provide a cleaner expectation of the dividend drop because they are not confounded by other pricing effects surrounding the ex-dividend date. This allows us to calculate changes in the market expectation of the dividend and use an empirical instrument that more closely measures the theoretical concept of the dividend surprise.

In the first chapter, I investigate the ex-dividend stock price decline implied by option transaction prices. Contrary to past studies, such as Bae-Yosef and Sarig (1992), that have investigated option prices, I find that the expected ex-dividend drop is significantly less than the cash dividend amount. The second purpose of this chapter investigates factors that contribute to option mispricing. We find an increase in pricing errors of the implied dividend with thin trading, non-synchronous trading, and lower dividend yields. We also find an increase in pricing errors for deep in-the-money and deep out-of-the-money options and put-call pairs that are traded at opposing bid and ask combinations. I demonstrate that option prices can be filtered based on these factors to improve the accuracy of option prices that could potentially be used in implied volatility, risk neutral probability, or discount dividend models.

The second chapter expands on the first by applying the same methodology to study the relationship between analyst dividend forecasts and market expectations of dividends implied by option prices. The primary research question of this chapter is whether analysts update their forecasts in response to new market information, and likewise, whether the market updates dividend expectations in response to analyst forecast revisions. I find no evidence that supports a market reaction to either non-superior or superior analysts. However, superior analysts update their dividend forecasts in response to changes in market dividend forecasts. The second focus of this chapter investigates whether option-implied, superior analysts, non-superior, or consensus analysts provide more precise forecasts of firm dividends. The results show that dividends implied by option prices provide a more precise forecast of future dividends than individual analyst and superior analyst forecasts but are not more accurate than the mean consensus dividend forecast.

In the final chapter, I also apply the methodology from the first chapter to answer the question of whether insiders trade stock or options using their superior knowledge, or control, of changes in the amount of their firm's dividend payments. Past studies, such as Oppenheimer and Dielman (1988), investigate insider trading prior to dividend cessation or resumption and find that insiders trade and earn abnormal returns based on their superior knowledge of dividend changes. I extend the naive model, that assumes any change in dividend is a surprise to the market, by using the market expectations of dividends implied by option and stock prices. Consistent with the scrutiny hypothesis[1], I find evidence that insiders lower in the information hierarchy are more likely to accumulate stock prior to a dividend surprise. There is also a difference between non-executive board directors and other low hierarchy insiders that are not on the board. I attribute this additional scrutiny to director duties and oversight. Whereas, consistent with the information hierarchy hypothesis[2], those same low level insiders are less likely to exercise their options prior to a dividend surprise.

This thesis uses a method for measuring ex-ante dividend expectations that only relies on liquid

[1] Fidrmuc et al. (2006)
[2] Seyhun (1986)

option and stock prices. The three research areas investigated: option pricing, analysts, and insiders; yield valuable results that have applications for applying option prices in asset pricing, the use and interpretation of analyst dividend forecasts, and the transparency of dividend policy by firms. The methodology used in this thesis can be applied to additional extensions in these research areas but also to any other research area that uses dividend expectations or requires a proxy for dividend surprise.

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