FMC²
Financial Mathematics and Computation Research Cluster

Michael J. Brennan Irish Finance Working Paper Series

We gratefully acknowledge the financial support of Susquehanna International Securities Limited (SIG) for this Working Paper series.

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Dividend capture returns: anomaly or risk premium? Evidence from the equity options markets

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We appreciate helpful comments from: Yakup Eser Arisoy, Utpal Bhattacharya, Douglas Breeden, Michael Brennan, Peter Carr, John Cotter, Darrell Duffie, Paolo Guasoni, Bruce Grundy, and John McConnell. We would also like to thank seminar participants at the OptionMetrics Conference 2016, the Multinational Finance Conference 2017, and the NYU Financial and Risk Engineering 2018 seminar series.

Conall O'Sullivan would like to acknowledge the support of Science Foundation Ireland under grant number 16/SPP/3347.

Abstract

In the run-up to the ex-dividend day a measure based on option implied dividends predicts ex-day abnormal stock returns. These expected ex-dividend day returns increase on stocks where it is less worthwhile to capture the dividend, stocks that are less liquid, stocks with high idiosyncratic risk, and stocks that have experienced a build up in selling pressure. The evidence from the options markets suggests the positive abnormal ex-day returns, net of transactions costs, achieved by institutions skilled in trading are a risk premium for their role in providing liquidity to non-informational stock traders.

I. Introduction

Stock price declines on ex-dividend days are on average less than the dividend paid to the stock holders resulting in positive abnormal ex-day returns. Short term trading by dividend capture arbitrageurs, who purchase the stock on the days proceeding the ex-day, collect the dividend[1], and sell the stock on the ex-day, should drive these ex-day abnormal returns to equilibrium but ex-day abnormal returns persist and have been shown to be robust to transactions costs for institutional dividend capture arbitrageurs skilled in trade execution, see Henry & Koski (2017).

Single stock option market makers are another class of sophisticated traders who are skilled in option trade execution as demonstrated in Muravyev & Pearson (2015). Given these options traders will often delta hedge their positions, it is very likely that they will be skilled traders in the underlying stocks on the options they make markets on. Furthermore, Goncalves-Pinto & Xu (2018) develop a model in which expected stock returns are incorporated into option price quotes in the presence of stock trading costs and empirically demonstrate that option prices embed public information on expected stock returns. Goncalves-Pinto *et al.* (2017) show that excess price pressure in stocks that causes short term stock return reversals may form a large component of option implied stock return predictions. We focus on options in the run-up to the ex-day, after the dividend has been de-

[1]To be precise we define dividend capture returns based on the purchase of the stock on the cum-day, collecting the discounted dividend, and selling the stock on the ex-date. The dividend will not be paid till some days after the ex-date on a date known as the dividend payment date so the discounted dividend is discounted from the payment date to the ex-date.

clared. Expected ex-day stock returns should be incorporated into option price quotes and option implied dividends. Indeed, we show that a measure based on cum-day option implied dividends does predict ex-day stock returns with the top performing quintile group earning a median daily ex-day return of 0.24%. These median ex-day returns are comparable to the returns skilled traders generate with dividend capture in Henry & Koski (2017). However, option implied dividends predict these high abnormal ex-day returns only on stocks where it is less worthwhile, more costly or riskier to capture the dividend, thus these expected ex-day returns embed public information consistent with Goncalves-Pinto & Xu (2018). Option implied dividend ex-day stock return predictions are also high on stocks that have experienced excess selling pressure in the run-up to the ex-day, consistent with the results in Goncalves-Pinto *et al.* (2017). Thus, evidence from the options markets suggests that the high abnormal ex-day realized returns, earned by sophisticated dividend capture arbitrageurs, are a risk premium for providing liquidity to non-informational traders averse to dividends, in the set of stocks that are most difficult or least worthwhile to execute dividend capture on. Liquidity provision in these select ex-day stocks should earn a risk premium that is increasing in the difficulty of dividend capture execution and decreasing in the potential gains to be achieved as measured by the dividend. This is a specific case of the general model presented in Campbell *et al.* (1993) where a risk premium is earned by risk averse market makers on regular (non-ex-dividend) trading days who provide liquidity to non-informational traders. Moreover, our results are consistent with the fact that the risk premium earned by these liquidity providing market makers increases with stock illiquidity as shown in Avramov *et al.* (2006).

Options are not protected from dividend payments, as described in Merton

(1973), hence in the run up to the ex-dividend date, but after the dividend declaration date, option prices should reflect the expected stock price decline as a result of the stock going ex-dividend as opposed to reflecting the declared discounted dividend. Kaplanis (1986) finds that the expected stock price decline implied from options is significantly less than the declared dividend whereas Barone-Adesi & Whaley (1986) find there is no significant difference. We infer the expected stock price decline from option prices before the stock goes ex-dividend to determine whether the options market contains information on ex-day stock returns and to determine the source of this information. First, we find the expected stock price decline implied from option prices is significantly larger than the declared dividend, contrary to the previous studies, most likely due to the implied dividend incorporating stock loan costs. Second, we find that cum-dividend day option implied dividends contain statistically and economically significant information on ex-day stock (abnormal) returns. Third, we show that cum-day option implied dividend stock (abnormal) return predictions embed public information, consistent with the results of Goncalves-Pinto & Xu (2018), and embed temporary stock price pressure, consistent with results of Goncalves-Pinto *et al.* (2017). Fourth, we find that a measure based on option implied dividends predicts high ex-day stock (abnormal) returns on stocks that have high systematic risk, high idiosyncratic risk, low liquidity, small to medium dividends, and have experienced excess selling pressure on the cum-day. These stocks are less likely to be targets of dividend capture. The high expected ex-day returns on these stocks is consistent with the view that high ex-day returns are a simply a risk premium that reward dividend capture arbitrageurs for the provision of liquidity to dividend averse non-informational traders on these "hard-to-capture" stocks.

The rest of this paper is organized as follows. Section II provides a brief review of ex-dividend abnormal returns. Section III reviews the literature on option price implied information and option trading information predicting stock returns. Section IV outlines the data. Section V provides summary statistics and the method behind the extraction of implied dividends. Section VI confirms the presence of the ex-day effect in the stock return data. Section VII performs non-parametric sorts to demonstrates that option implied dividends predict ex-day returns. Section VIII examines this cross-market predictability in the context of regression models to find the most plausible hypothesis for this cross-market predictability. Section IX looks at the economic significance of this cross-market predictability and section X concludes.

II. Ex-Dividend Day Returns

There is a vast literature, from Campbell & Beranek (1955) to Rantapuska (2008) and more recently Henry & Koski (2017), documenting the ex-dividend day effect that stock price declines on the ex-dividend date are on average less than the discounted dividend, resulting in positive abnormal ex-dividend day stock returns. Although the causes of this so-called ex-dividend anomaly are still controversial, the most widely held theory is that originally proposed by Miller & Modigliani (1961) of dividend clienteles where investor heterogeneity, particularly with respect to taxation, leads to investors valuing dividends and capital gains differently[2]. Although Frank & Jagannathan (1998) show that abnormal ex-dividend

[2] Well known papers on the ex-dividend day effect include Campbell & Beranek (1955), Elton & Gruber (1970), Frank & Jagannathan (1998) and Michaely (1991). The dividend clientele

day returns exist in jurisdictions without dividend or capital gains taxes. The catering theory of dividends put forth by Baker & Wurgler (2004) hypothesises that firm's adjust their dividends tp cater to investors who have a time-varying demand for dividends, for psychological or institutional reasons, generally preferring to purchase stocks before they go ex-dividend and preferring to sell stocks after the ex-dividend date. Hartzmark & Solomon (2013) demonstrate that a portfolio consisting of stocks that are expected to pay a dividend in a given month outperforms a portfolio of stocks that are not expected to pay a dividend in that month. Stock price pressure resulting from investor's preferences for dividends seems to be the main driver of this out-performance.

Short term trading around the ex-day involves arbitrageurs, who are indifferent to the tax treatment of dividends, purchasing the stock on the cum-dividend date, collecting the discounted dividend and selling the stock on the ex-dividend date. Given stock prices on average decline by less than the discounted dividend paid, this strategy, referred to as dividend capture, results in positive abnormal returns provided transactions costs are small enough, see Kalay (1982). Indeed, trading volume around the ex-dividend day of a stock is abnormally high (e.g., see Lakonishok & Vermaelen, 1986). Michaely & Vila (1995) provide empirical evidence suggesting that abnormal ex-day trading activity occurs because of the existence of tax clienteles and note that dividend capture strategies are risky and "because of the risk involved, no trader will take an unlimited position, regardless of the price movement." Thus, they argue that ex-dividend day abnormal returns

theory was introduced by Miller & Modigliani (1961) to explain ex-dividend day stock price behaviour and extended to take into account risk and transactions costs in dynamic dividend clientele theories, see Kalay (1982), Michaely & Vila (1995) and Michaely *et al.* (1996)

do not necessarily imply that arbitrageurs are not at work; instead, they may have taken the largest possible positions that their risk tolerance will allow. Rantapuska (2008) examines the ex-dividend day trading behavior of investors in the Finnish market and finds that stocks targeted for dividend capture have low idiosyncratic risk, high dividend yields and are more liquid. We now turn our attention to the options market and option implied dividends.

III. Option Implied Information and Stock Returns

The evidence is mixed on informed trading in the options market during typical trading environments where there is not necessarily strong informational asymmetries between informed and uninformed traders. On typical trading days there is evidence of informed trading in options markets (e.g., Pan & Poteshman, 2006; Bali & Hovakimian, 2009; Cremers & Weinbaum, 2010; Xing *et al.*, 2010; Conrad *et al.*, 2013; and An *et al.*, 2014), whereas Chan *et al.* (2002) and Muravyev *et al.* (2013) find no evidence of price discovery in the options market[3]. Goncalves-Pinto *et al.* (2017) and Goncalves-Pinto & Xu (2018) suggest that prior evidence

[3]There is a distinction in literature between the type of option market information used to predict subsequent stock returns. Bali & Hovakimian (2009), Cremers & Weinbaum (2010), Xing *et al.* (2010), Conrad *et al.* (2013) and An *et al.* (2014) use information inferred from option prices such as implied volatility spread or implied volatility skew, whereas Pan & Poteshman (2006) uses information on option volume. More recent papers that document the ability of information on option volume and stock volume to predict stock returns include Roll *et al.* (2010) and Johnson & So (2012).

on option prices containing information on subsequent stock returns is not necessarily as a result of informed trading on private information taking place in the options market. This cross-market predictability can also be attributed to either options prices reflecting public information on expected stock returns (Goncalves-Pinto *et al.*, 2017), or option prices anticipating stock price reversals on stocks experiencing temporary buying or selling pressure (Goncalves-Pinto & Xu, 2018).

There is strong evidence of informed trading in options markets in the run-up to atypical trading environments in which there are large price effects, such as unexpected merger and acquisition announcements (e.g., Cao *et al.*, 2005; Chan *et al.*, 2015; and Augustin *et al.*, 2015) and around earnings announcement dates (Diavatopoulos *et al.*, 2012 and Driessen *et al.*, 2012)[4].

The ex-dividend date is not a typical trading day for a stock as, although the dividend has already been declared, the stock price decline and the trading activity in the stock around the ex-day may reveal important information regarding the tax preferences of investors in the stock. However, ex-day abnormal stock returns are usually reasonably small with an average mean abnormal return of 5 basis point per day in our data sample as we show later. Thus, there is less of an incentive for options traders to take positions on the anticipation of ex-day gains relative to, for example, unanticipated merger and acquisition announcements where there are potentially large stock price changes. Despite the reasonably small average

[4]These results can also be categorised on the type of option implied information used. Cao *et al.* (2005) use option volume, whereas Chan *et al.* (2015), Diavatopoulos *et al.* (2012) and Driessen *et al.* (2012) use information implied from option prices in the form of option implied spread, option implied skew or option implied moments. Augustin *et al.* (2015) use both soures of information.

gains to be had on short-term ex-day stock trading, Henry & Koski (2017) show that institutional firms, skilled in trading, are frequent users of targeted dividend capture and that this strategy contributes 15% to their overall abnormal returns from all their trading activities thus dividend capture is a substantial revenue generator for these firms.

Focusing on options over ex-dividend events allows us to extract option implied ex-day stock return predictions and to assess whether the options implied return predictions vary with risk factors and characteristics related to dividend capture. We find that option implied dividends, as calculated using the contemporaneous closing prices for options and stocks on the cum-dividend day, are higher on average than that of the declared dividend[5]. However, the difference between the declared and implied dividend, scaled by the cum-day stock price, which we call the Implied Dividend Yield Spread (IDYS), displays a large dispersion and differentiates between stocks that earn higher (lower) abnormal ex-day returns.

Using non-parametric sorting methods and parametric regressions we find that IDYS contains significant information on subsequent ex-day stock returns and abnormal returns. IDYS is robust to option characteristics such as option bid-ask spread, option moneyness, and option time-to-maturity[6], (e.g., Ofek *et al.*, 2004 and Cremers & Weinbaum, 2010). IDYS is also robust to factors that have been shown to be significant in predicting ex-dividend abnormal returns including sys-

[5]The mean and median of option implied dividends are statistically significantly higher than the declared dividend.

[6]We restrict our options data sample by moneyness and time-to-maturity to ensure implied dividends are measured as reliably as possible. More detail on the data filtering can be found in Section IV.

tematic risk as measured by market beta, idiosyncratic risk, liquidity and dividend yield. Consistent with the public information hypothesis of Goncalves-Pinto & Xu (2018), we find that implied dividends are closer to the declared dividend for stocks that are likely targets of dividend capture. These stocks are more likely to have their abnormal ex-day returns crowded out by dividend capture arbitrageurs and option implied dividends reflect this fact. We also find evidence of stock price pressure (Goncalves-Pinto *et al.*, 2017) being a major source of option implied dividend predictability. Stocks that are less likely to be the targets of dividend capture experience larger selling (buying) pressure on the cum-dividend day resulting in larger cum-day negative (positive) returns that are followed by the ex-day return reversals. Our findings suggest that informed trading on private information (Easley *et al.*, 1998 and An *et al.*, 2014) is a minor contributor to the cross-market ex-day return predictability which is not unexpected given the dividend has been announced previous to the ex-day.

In summary, we find the continued presence of the ex-dividend day effect in the stock market, that a measure based on option implied dividends predicts stock (abnormal) ex-day returns, and that the source of this information is most likely due to two factors: price pressure in the underling stock market that is not fully reflected into the option price quotes, and publicly available information on expected ex-day stock returns that is incorporated into option prices quotes. Our findings are consistent with ex-dividend day returns being a risk premium earned by dividend capture arbitrageurs with the risk premium increasing on stocks for which it is harder or less worthwhile to capture the dividend.

IV. Data

The data in this work is extracted from OptionMetrics which contains price data on US listed equity options as well as information on the underlying instruments. The focus is on single stock options so all securities which do not represent an individual ordinary stock such as indices, ETFs, ADRs etc. are discarded.

For each of these stocks we used the daily opening and closing stock prices as well as the daily volume of stocks traded as provided by OptionMetrics. In terms of dividend events, we are only interested in those cases where there was a single ordinary non-zero dividend payment and there were no adjustments to the stock price or dividend amount, due to splits etc. For each dividend satisfying these criteria we record the declaration date, ex-dividend date, payment date and dividend amount. We also use the daily risk-free interest rates provided which are zero coupon interest rates for a number of maturities derived from historical Eurodollar futures and LIBOR rates.

OptionMetrics provides historical closing prices of all options on each business day as well as a mid implied volatility which is derived using a binomial tree from the mid closing price. A tree is used as all the options are American style and no closed form solution is available. In addition a selection of 'Greeks' such as delta, vega and gamma are also given. We extracted data from January 1996 to August 2015 and we discard option data where the option payoff was adjusted.

A. Dataset for Calculating Implied Dividends

Firstly we found those options which contain precisely one ex-dividend date during their remaining life and for which we have closing prices on both the cum-dividend date and the ex-dividend date of a given dividend event. As we are making use of put-call parity results we then further reduced the data into call-put pairs where the call and put are on the same security, have the same trade date, the same strike price and the same expiry date.

Next we ensured the quality and reliability of the dataset by removing all put-call pairs where either the call or the put did not trade on the cum-dividend date as indicated by zero volume, removing those put-call pairs where the bid price for either the call or the put is zero on the cum-dividend date and excluding put-call pairs where, on the cum-dividend date, either the call bid-ask spread $> 20\%$ or the put bid-ask spread $> 20\%$ of the bid price.

All of the options are American-style, as is the norm for single stock options in the US, and thus they may be exercised early. This possibility of early exercise is an issue when deriving values for implied dividends as the put-call parity relationship holds strictly for European-style options only. Any difference in value between the American and European version of an option is due to an early exercise premium, the size of which is a function of a number of variables the most important of which is the moneyness of the option with options which are further in-the-money having higher early exercise premium. Merton (1973) showed that in the case of American-style options on a dividend paying stock it is only ever optimal to exercise call options on the day before the ex-dividend date of the underlying stock. On the other hand it may be optimal to exercise deep-in-the-money put options at any time but this is rarely optimal immediately prior to an ex-dividend date (e.g., see Roll, 1977 and Diz & Finucane, 1993).

Hence, in advance of an ex-dividend event, in-the-money call options will have the largest early exercise premium. Using an option's delta as a measure of its moneyness, we therefore removed all put-call pairs where the call option has delta $> 50\%$ on the cum-dividend date. The remaining dataset consists of put-call pairs where the call option is out-of-the-money and the put option is in-the-money. From these put-call pairs we then calculated the price of the corresponding synthetic forwards as the mid-price of the call option minus the mid-price of the put option for each observation. These synthetic forwards are approximations to equivalent forward contracts constructed from European options that ignore early exercise premia.

The filtered options dataset contains options on cum-dividend dates, meeting certain restrictions, which can be used to value synthetic forwards on their underlying stock with expiry equal to the expiry date of the options and strike price equal to the strike price of the options. It also contains the prices of these same options one day later on the corresponding ex-dividend dates.

Table 1 contains a high level summary of the 42,759 put-call pairs in the dataset. The number of unique companies represented is 1,026 meaning that the data is based on a wide cross-section of the stock market. Also, the total number of ex-dividend dates is 3,268 and is high relative to the total number of business days covered by this study which is approximately 4,900, demonstrating a wide temporal dispersion of ex-day events. The other noteworthy feature of this table is that the open interest for calls is significantly greater than for puts. However, this is exactly what we would expect as the call options are out-of-the-money, whereas the put options are in-the-money and out-of-the-money options are usually more actively traded than their in-the-money counterparts.

Table 1: Summary of Put-Call Pairs Dataset

Number of Put-Call Pairs	42,759			
Number of Companies	1,026			
Number of Ex-Dates	3,268			
	Mean	Median	25th Percentile	75th Percentile
Put-Call Pairs per Company	41.68	8.00	2.00	35.75
Put-Call Pairs per Ex-Date	13.08	6.00	2.00	14.00
Put-Call Pairs Maturity (Days)	44.83	39.00	22.00	57.00
Call Delta	0.33	0.35	0.25	0.43
Put Delta	-0.66	-0.63	-0.74	-0.57
Call Open Interest	8,557.67	2,289.00	729.00	7,168.50
Put Open Interest	2,801.10	750.00	156.00	2,590.00

V. Background and Summary Statistics

There are a number of dividend anomalies discussed in the literature the most persistent and well known of which is the fact that the price of a stock does not fall by the full amount of the discounted dividend on its ex-dividend date. Frank & Jagannathan (1998) and Graham *et al.* (2003) examine the size of the observed drop in stock prices on their ex-dividend day. These papers find that stock prices fall significantly less than the amount of the discounted dividend with $0.5 < \alpha < 0.75$, where α represents the radio of the drop size to the declared discounted dividend, depending on the period studied and the size of the dividend yields. Before we consider option implied dividends, we first examine the ex-dividend day anomaly in the underlying stocks in the dataset.

Table 2 contains descriptive statistics for this ratio calculated from the dividend events in the options dataset with duplicate events excluded. The results are split into two sub-periods to analyse potential reductions in the ex-dividend day anomaly as markets mature. There is a clear pattern evident with the stock price decline closer to the dividend in the second period than in the first. The ex-dividend anomaly is reducing over time but it is still prevalent in the second half

Table 2: Ratio of the change in stock price to the value of the discounted cash dividend i.e. (dSTOCK/DISCOUNTED_DIVIDEND) = $-\alpha$ for ex-dividend dates in the options dataset

Statistic	1996-2006	2007-2015	Full Sample
Mean	-33.61%	-75.19%	-60.93%
Median	-74.19%	-82.76%	-80.00%
Trimmed Mean(5%)	-52.26%	-69.90%	-65.48%
Std Dev	28.29	14.95	20.53
Std Err	0.42	0.16	0.18
Skewness	7.97	-1.60	6.77
Kurtosis	277.46	92.45	360.70
Observations	4,541	8,702	13,243

of the sample period. The median drop for the first period is 74.2% which is very in much in line with the findings of Graham *et al.* (2003) that $\alpha \approx 70\%$. For the more recent period $\alpha \geq 80\%$ which again is in line with findings elsewhere that the anomaly is declining but still present. The median stock price drop of 80.0% for this entire sample is consistent with the findings of others in the literature.

A. Impact of Dividend Yield

It has been noted elsewhere (e.g, see Kalay & Subrahmanyam, 1984 and Graham *et al.*, 2003) that there is a relationship between α and the size of the dividend as measured by dividend yield. It is suggested that this is because it is more "worthwhile" to capture larger dividends as measured by the dividend yield. Thus, for stocks with larger dividend yields a larger stock price drop, as a percentage of the discounted dividend amount, will be observed. We define dividend yield D as

$$\text{DIV\_YIELD} = \frac{D \times 4}{S_c}. \tag{1}$$

Table 3: (dSTOCK/DISCOUNTED_DIVIDEND) split by DIVIDEND_YIELD

DIVIDEND_YIELD	N	Median STOCK_DECLINE/DISCOUNTED_DIVIDEND
0% - 1%	3,553	-66.67%
1% - 2%	3,983	-57.14%
2% - 3%	2,844	-69.23%
3% - 4%	1,401	-90.67%
> 5%	1,462	-104.03%

As ordinary dividends in the US are paid quarterly we chose to approximate the annual dividend amount as 4 times the dividend payment and the denominator, S_c, is the stock price on the cum-dividend date. We divide the results for the options dataset into ranges of dividend yield as shown in Table 3.

The data in Table 3 follow a pattern very similar to that observed elsewhere with the stock price fall as a proportion of the discounted dividend amount increasing as the dividend yield increases. In fact we find that for the highest yielding stocks, yield $> 5\%$, that the fall in the stock price almost exactly matches the size of the discounted dividend. The $0\% - 1\%$ bucket is unreliable as the denominator is the declared dividend amount with some dividends that are close to zero. With appropriate windsorizing this first value would also fall into line close to -60%.

B. Calculating the Implied Dividend

Each of the put-call pairs in the options dataset covers precisely one ex-dividend date hence, we use a version of put-call parity for European options which states that:

$$
\begin{aligned}
C(K,\tau) - P(K,\tau) &= S_c - IDEe^{-r\tau_{div}} - Ke^{-r\tau} + \pi_c^{call} - \pi_c^{put} \\
&= S_c - IDAe^{-r\tau_{div}} - Ke^{-r\tau}, \qquad (2)
\end{aligned}
$$

where $C(K,\tau)$ is the price of an American call option, $P(K,\tau)$ is the price of an American put option, both with strike K and time to expiry τ, S_c is the cum-dividend price of the stock, r is the risk-free interest rate, τ_{div} is the year fraction from the cum-dividend date to the dividend payment date, π_c^{call} and π_c^{put} are the early exercise premia of the American call and put option respectively, IDE is the option implied dividend that can be inferred assuming one has reliable estimates of π_c^{call} and π_c^{put}, and IDA is the option implied dividend extracted from American option prices (erroneously) assuming the European put-call parity equation holds for American options.

The put-call pairs in the dataset have been carefully selected to avoid any possibility of immediate early exercise of the call options on the cum-dividend date thus, the early exercise premia of the American call options in our dataset should be zero. It may be optimal to exercise American put options early on both cum or ex-dividend days although, early exercise premia are expected to be larger on the ex-dividend date than on the cum-dividend date given the stock price decline should push the American put options further into the money. However, changes in other variables that affect early exercise premia, such as volatility or interest rates, may impact the change in American put early exercise premia change over the ex-day.

Rearranging equation (2) gives the implied dividend to be paid on the dividend payment date in τ_{div} years from the cum-dividend date as:

$$IDA = e^{r\tau_{div}} \left(S - Ke^{-r\tau} - C(K,\tau) + P(K,\tau)\right), \tag{3}$$

where the mid of the bid and ask price is used for each call price $C(K,\tau)$ and put price $P(K,\tau)$, following the approach taken in Bar-Yosef & Sarig (1992). It is worth noting that the term in parenthesis in Equation (3) represents the current value of a forward contract on S with strike K in the cash market minus the value of a synthetic approximate forward contract (that ignores early exercise premia) with the same strike and expiry.

We also extracted implied dividends using approximate European prices in case the early exercise potential of the American style options impacts our results. We substitute the implied volatilities (IVs) from OptionMetrics into an escrowed dividend model, similar to the approach taken in Black (1975). The escrowed dividend model simply adjusts the Black-Scholes model by replacing the current stock price with the current stock price minus the present value of the single future dividend payment. The IVs available in OptionMetrics are calculated using a binomial tree that takes the discrete dividend payment into account. Hence, substituting these OptionMetrics IVs into the escrowed dividend model should give a reasonable approximation to the corresponding European option prices. The implied dividend in this case is given by the following equation:

$$\begin{aligned} IDE = e^{r\tau_{div}} \Big(S - Ke^{-r\tau} &- \min\left[c^{BS}\left(S - De^{-r\tau_{div}}, K, r, \tau, IV^c\right), C(K,\tau)\right] \\ &+ \min\left[p^{BS}\left(S - De^{-r\tau_{div}}, K, r, \tau, IV^p\right), P(K,\tau)\right]\Big), \end{aligned} \tag{4}$$

where c^{BS} and p^{BS} denote Black-Scholes call and put option prices, respectively, D is the declared dividend, IV^c and IV^p denote OptionMetrics call and put implied volatilities, respectively, and where the European option prices are capped at their corresponding OptionMetrics American option prices to ensure that the approximated European option prices do not exceed their American option price counterparts. The implied dividends extracted from this equation will have lower early exercise premia bias than those calculated from American option price directly.

C. Comparing the Implied and the Declared Dividend

There are many instances where the options dataset contains more than one put-call option pair on a single cum-dividend stock. To obtain a single implied dividend for each cum-dividend stock we use the combined open interest of the calls and puts to weight multiple implied dividends into a single observation for that stock on that particular cum-dividend date. This approach is in line with that adopted elsewhere in the literature on option implied information (e.g., see Hayunga & Lung, 2014).

For put-call pair i, the combined open interest on the cum-dividend date before ex-dividend event j date is:

$$OI_j^i = OI(Call)_j^i + OI(Put)_j^i$$

Table 4: Summary statistics of declared dividends and implied dividends extracted from American and approximate European option prices

	Dividend Amount (D)	Implied Dividend American (IDA)	Implied Dividend European (IDE)
Mean	0.2672	0.3060	0.2806
Median	0.2000	0.2371	0.2244
Std Dev	0.2608	0.3141	0.3765
Skew	3.7460	1.2523	0.0938
Kurtosis	34.1608	73.3733	50.2816
n	13,243	13,243	13,243

Then for each ex-dividend event j the total cum-dividend date open interest is:

$$OI_j = \sum_i OI_j^i$$

Finally, the weight on the implied dividend extracted from put-call pair i, for ex-dividend event j, is given by:

$$w_j^i = \frac{OI_j^i}{OI_j}$$

Open interest weighted implied dividends, IDA, extracted from American option prices, and IDE, extracted from approximate European option prices are compared to the declared dividends[7] in Table 4.

A t-test (rank-sum test) to evaluate the difference between the mean (median) of the declared dividend and the implied dividend from American options, IDA, rejects the null hypothesis of no difference, in both cases, at the 1% significance level. Similarly, IDE has a statistically significant higher mean (median) than the

[7]On the cum-dividend date the declared dividends have already been announced hence are known with certainty.

Table 5: Ratio of the option dividend implied to the actual dividend paid, where IDA is the implied dividend extracted from American options using put-call parity but ignoring the early exercise premia, and where IDE is the implied dividend extracted using put-call parity but estimating the early exercise premia.

	IDA/D			IDE/D		
Statistic	1996-2006	2007-2015	Full Sample	1996-2006	2007-2015	Full Sample
Mean	153.73%	118.30%	130.45%	119.97%	103.18%	108.94%
Median	125.93%	105.50%	110.59%	122.70%	104.01%	108.04%
Std Dev	3.499	1.176	2.266	5.846	2.496	3.977
Std Error	0.052	0.013	0.020	0.065	0.013	0.035
Skew	12.879	3.545	16.805	-1.399	-20.807	-4.851
Kurtosis	796.740	157.626	1,566.832	395.084	1,102.624	744.812
n	4,541	8,702	13,243	4,541	8,702	13,243

declared dividend at the 1% level.

In Section VII we use the difference between the declared dividend and the weighted implied dividend scaled by the cum-day stock price as a means to predict expected ex-day stock returns. However, in the section we consider the ratio of the implied dividend to the declared dividend to focus our analysis on the comparison between the dividend and implied dividend. Summary statistics for this ratio are given below in Table 5 with columns 2 to 4 depicting results for IDA and columns 5 to 7 depicting results for IDE. The sample is split into two subsamples to investigate how this ratio changes between the first half of the sample and the second half of the sample as the single stock option market matures.

The data in Table 5 is noisy and highly skewed due to a number of small dividend payments leading to a large and unstable mean for the ratios in each period. The medians for both IDA/D and IDE/D are more reliable than their means but both are greater than 100% thus, the implied dividend is on average higher than the declared dividend which is consistent with the results in Table 4.

The median for both ratios is lower in the second half of the data sample indicating that the options market is getting more efficient as the average implied dividend is getting closer to the average declared dividend in the latter half of the sample. This is in agreement with results in Cremers & Weinbaum (2010) who find that put-call parity violations in the US equity options market have decreased over time as the market has become more efficient.

If options prices properly anticipate a lower than average stock price decline over the ex-dividend day we would expect the mean and median of the implied dividends to be smaller than the declared dividend however, we find the opposite result in Tables 4 and 5. We use end-of-day option and stock prices to imply dividends from options prices so this result could be the result of asynchronous trading in the stock and options markets and bid-ask spreads in the options markets. The interest rate used in the calculation of the implied dividend for a given option is the USD Libor rate and may not reflect the true funding cost of an option position. Both these factors may potentially explain why the implied dividend is different to the declared dividend on the cum-dividend date. However, the most likely explanation for the higher average implied dividends is that option prices, and hence implied dividends, embed stock loan fees, as discussed in Kragt (2017) and Muravyev *et al.* (2016). Stock loan fees increase the price of put options, as market makers replicating written put options must borrow the stock to short the stock in their replication strategy. An increase in the price of put options relative to the price of call options at the same strike price and maturity will result in higher implied dividends.

To test the claim that stock loan fees are pushing up implied dividends, we split the sample of the ratio of implied to actual dividends into two sub-samples based on the weighted average maturity of the options used in the implied dividend calculation. As stock loan fees are increasing with maturity, we expect the ratio of implied dividends to actual dividends to be larger when implied dividends are inferred from options with higher weighted average maturity. A t-test (rank-sum test) is used to evaluate the difference between the means (medians) of the ratio between the two maturity sub-samples (we also run this test for both versions of option implied dividends: IDA and IDE). The mean (median) of the ratio for shorter maturity options is 96.63% (105.82%) and for longer maturity options is 118.63% (110.17%), when using the implied dividends adjusted for early exercise, IDE. The mean (median) ratio is statistically significantly larger for the longer maturity sub-sample at the 1% significance level[8]. Thus, the evidence points to option implied dividends embedding stock loan fees. Blau *et al.* (2011) shows that there is drop in demand to short sell stocks in the run up to the cum-dividend day so, although implied dividends may embed stock loan fees, the fee will be unlikely to contain information on ex-day returns.

VI. Ex-Dividend Day Effect in Stock Prices

We examine ex-day stock returns over unique ex-dividend dates by calculating the return earned from buying ex-day stocks on the cum-dividend day, collecting the discounted dividend and selling the stock at the closing price on the ex-dividend date. The dividend collected on the ex-dividend date occurring at time t for stock

[8]The results are qualitatively and quantitatively similar when using implied dividends, IDA, or when sub-dividing the sample into two sub-period samples of 1996 to 2006 and 2007 to 2015 and running the t-test and rank-sum test on both sub-periods separately.

i is the appropriately discounted cash amount:

$$(5) \qquad D^*_{i,t} = D_{i,t_{pay}} e^{-R(t_{pay}-t)}$$

where $D_{i,t_{pay}}$ is the declared dividend, R is the LIBOR rate from the ex-dividend date to the payment date of the dividend and t_{pay} is the time of the dividend payment. The return over the ex-dividend date, $R_{i,x}$, for stock i is given by:

$$(6) \qquad R_{i,x} = \frac{S_{i,x} - S_{i,c} + D^*_{i,x}}{S_{i,c}}$$

where $S_{i,c}$ is the cum-dividend day price and $S_{i,x}$ is the ex-dividend day price. There are 13,243 unique dividend events in our dataset. These occur on 3,268 unique dates as described in Table 1. A histogram of the number of dividend events per date is shown in Figure 1. The mean number of firms that go ex-dividend on a given ex-dividend date is 4 with a maximum of 29 and a minimum of 1. We assume that an investor invests an equal amount of capital on each dividend date so that if there are N firms going ex-dividend on a given day, we split the capital into $1/N$ and diversify equally amongst the N ex-dividend stocks. Summary statistics for this ex-day returns strategy are provided in Table 6 and the cumulative returns of the strategy are depicted in Figure 2.

The first column in Table 6 contains statistics on the raw returns generated by holding ex-dividend stocks over the 3,268 unique ex-dividend dates and shows that holding these stocks appears to be a profitable strategy with a mean (median) return per day of 0.08% (0.09%) and a standard error of 0.04%. Notably, there is a large positive skewness in ex-day returns of 0.366.

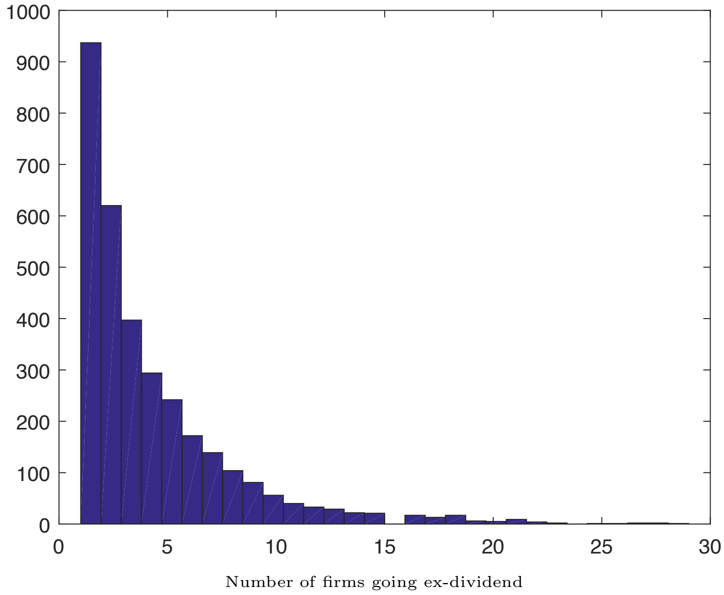


Figure 1: Histogram depicting the number of ex-day events (number of firms going ex-dividend) on the same ex-dividend date.

Table 6: Table comparing ex-day stock returns (including the discounted dividends) over unique ex-dividend dates where multiple ex-day event returns occurring on a single ex-date are averaged. Column (2) presents the ex-day stock returns, column (3) depicts the value weighted market returns including re-invested dividends, column (4) depicts ex-day stock returns in excess of the market returns and column (5) depicts CAPM alphas and column (6) depicts Fama-French alphas. In the CAPM and FF-models the betas are estimated for each stock using data from day -45 to -5 where 0 is the ex-day.

	STOCK_RET	MKT_RET	STOCK_RET - MKT_RET	CAPM_ALPHA	FF_ALPHA
Mean	0.08%	0.03%	0.05%	0.06%	0.05%
Median	0.09%	0.07%	0.01%	0.02%	0.03%
Std Dev	2.01%	1.21%	1.51%	1.50%	1.55%
Std Err	0.04%	0.02%	0.03%	0.03%	0.03%
Skewness	0.366	-0.251	0.697	0.820	0.469
Kurtosis	9.652	8.431	12.567	12.064	13.796
Sharpe ratio	3.73%	1.81%			
Observations	3,268	3,268	3,268	3,268	3,268

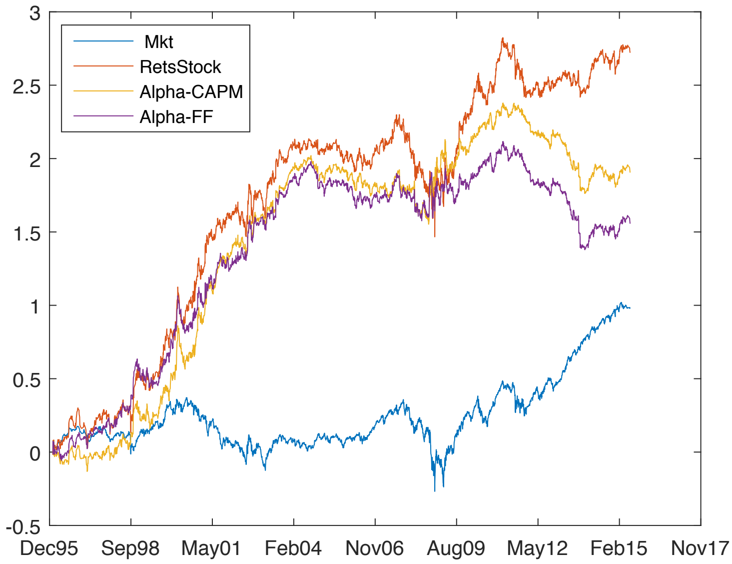


Figure 2: This figure depicts the cumulative returns on holding stocks over unique ex-dividend days (RETS_STOCKS), the cumulative returns of the weighted market index (MKT), the cumulative CAPM-alphas, and cumulative FF-alphas.

The second column of Table 6 contains the same statistics for the broader market total return index[9] across the same unique 3,268 ex-dividend dates. The market also has a positive mean and median return over the period considered at 0.03% and 0.07%, respectively. The standard deviation of the market returns 1.21% and is lower than the ex-day return standard deviation of 2.01%. This is due to the low diversification of ex-day returns, as these returns are often concentrated in a small number of stocks as usually there are only a small number of stocks going ex-dividend on a given date. The skewness of the market is negative with a value of -0.251. Thus, the skewness of the ex-day returns strategy at 0.366 compares very favourably to the market skewness of -0.251.

The excess returns on the stocks are simply calculated as the ex-day returns minus the market returns (where the market return includes dividends). The CAPM alpha is estimated using equation (7):

$$\begin{aligned}(7)\qquad & \text{ALPHA}_{i,t} = \\ & \text{STOCK\_RETURN}_{i,t} - \left(\text{RF}_t + \beta_{i,t}\left(\text{MKT\_RETURN}_t - \text{RF}_t\right)\right),\end{aligned}$$

where t is the ex-dividend date, RF_t is the daily risk-free interest rate[10] at time t is, and $\beta_{i,t}$ is the rolling CAPM beta for stock i calculated using stock return and market return data for the period $t-45$ to $t-5$. The use of a 40-day look-back window from $t-45$ to $t-5$ to estimate betas is consistent with Henry & Koski (2017). The Fama-French betas and alpha is calculated in a similar fashion. The statistics for the excess returns and alphas are summarised in the third, fourth and

[9]The market return we use is the value weighted market index from Kenneth French's website.

[10]The risk-free interest is downloaded from Kenneth French's website.

fifth column of Table 6 and it is clear that, even after controlling for the market return, buying and holding these stocks over their ex-dividend dates results in a mean (median) excess return of 0.05% (0.01%), a mean (median) CAPM alpha of 0.06% (0.02%) and a mean (median) FF-alpha of 0.05% (0.03%). These mean and median excess returns and alphas are statistically significantly different to zero although they may not be economically significant. These results are comparable to those found in Graham *et al.* (2003) where they found mean abnormal ex-dividend date returns of 0.04% during the regime of decimal minimum tick sizes on the NYSE and 0.10% to 0.24% during periods of fractional ticks. The daily Sharpe ratio of the ex-day returns strategy is 3.73% compared with the daily Sharpe ratio of the market of 1.81%. The ex-day returns Sharpe ratio is statistically significantly larger than the market Sharpe ratio at the 10% level. This statistical test does not account for the fact that ex-day returns have a much more favourable skewness value than market returns thus is a conservative estimate of the ex-day out-performance.

One question which arises is that of closing prices rather than intra-day data in our analysis. This is because a stock goes "ex-dividend" overnight and hence any effect of the dividend on the stock price will be incorporated in the opening price of the stock on the ex-dividend day. The results above are generated by comparing the closing stock price on the cum-dividend date with the closing stock price on the ex-dividend date and hence broader market effects are being included in the results that should be controlled for. We investigate this topic in the next section but it is worth noting however, that Graham *et al.* (2003) find that the results on ex-dividend day abnormal returns are similar whether one uses close-to-open data or low frequency end-of-day data, although close-to-close ex-day returns are generally lower than their close-to-open counterparts as dividend capture arbitrageurs unwind their positions throughout the ex-day stock causing excess selling pressure on the stock.

VII. Non-Parametric Sorting by Implied Dividends

To test whether option implied dividends predict ex-day stock returns we sort stock returns into five quintiles based on the value of cum-day IDYS (where IDYS = discounted dividend yield - implied discounted dividend yield[11]). This is similar to the approach taken by Fodor *et al.* (2017) who sort based on the ratio of the implied dividend to the declared dividend to predict dividend omissions. Sorting by IDYS, as opposed to the ratio of the implied to declared dividend, is less sensitive to outliers caused by small dividends as the ratio can be very large for small dividend stocks. We calculate means and medians for the ex-dividend day stock returns, stock returns in excess of market returns, and Fama-French alphas[12] for each of these quintiles. We also split ex-day stock returns and stock returns in excess of market returns into their overnight and open-close components to ensure predictability still holds when there is a gap between measuring IDYS and calculating returns. We report the IDYS quintile median values of the stock beta, idiosyncratic risk, the Amihud illiquidity (Amihud (2002)) of the stock and

[11] We use implied dividends adjusted for the early exercise premia of put options, IDE. Results using implied dividends that ignore early exercise premia, IDA, are similar although not quite as good which is expected given there is more bias in these unadjusted implied dividends.

[12] Results using CAPM alphas are very similar and not reported to save space.

the dividend amount as the latter three variables are significant in determining the amount of dividend capture activity in a stock (e.g., see Rantapuska, 2008 and Henry & Koski, 2017), thus potentially impacting the predictability of IDYS. Finally, we also include the quintile median values of the following option characteristics: put option moneyness (defined as $Ke^{-r\tau}/(S - De^{-r\tau_{div}}) - 1$), option maturity and option bid-ask spread where these option characteristics are weighted according to the open interest of the put-call pairs used in the weighted implied dividend calculations.

Table 7 below contains the details for quintiles grouped by the value of IDYS on the cum-dividend date. The first notable feature in Panel A is that the median value of IDYS is asymmetric about 0 as the lowest qiuntile median IDYS value is -0.24% whereas the highest quintile median IDYS value is 0.13%. This result is due to the implied dividend being larger than the declared dividend on average as reported in Table 4 and Table 5. Column (4) reports the median ex-day (close-to-close) stock returns for each quintile and it is clear that the median returns increase in an almost monotone fashion as IDYS increases. IDYS quintile 1 has a small negative median return of -0.01%, whereas IDYS quintile 5 has a large positive median return of 0.24%. Thus, there is an asymmetry between the higher and lower quintile median returns with small daily losses in the low quintile group and large daily gains on the high quintile group. Furthermore, the difference between the median return of quintile 1 and the median return of quintile 5 is 0.24% and is statistically significant at the 1% level with a z-value of 5.44. The results are similar for the overnight returns in column (5) however, overnight returns are always positive, even for the lowest quintiles. The lowest IDYS quintile 1 median overnight return is 0.09% and the highest IDYS quintile 5 median return is 0.24%.

The difference between quintile 5 and 1 median overnight returns is also significant at the 1% level. The open-close median returns are reported in column (6) and these are also increasing in an almost monotone fashion as IDYS increases. The difference between quintile 5 and 1 median returns is also significant at the 1% level. The notable point about these open-close returns is that they are negative for the low IDYS quintiles (Q1 to Q3) and very small for the higher IDYS quintiles (Q4 and Q5), at 0.00% and 0.02%, respectively. Thus, IDYS predicts stock returns even when overnight returns are omitted leaving a gap between the IDYS measurement and the subsequent stock returns however, on average ex-day open-close stock returns are low. This is to be expected as the overnight returns experience a stock price decline that is on average less than the discounted dividend, whereas the ex-day open-close returns are generally low as dividend arbitraguers sell the stocks on th ex-day that were purchased on the cum-day creating excess ex-day selling pressure in these stocks causing the stock price to fall.

The results for stock returns in excess of market returns[13], reported in columns (7) to (9), also show a pattern of increasing excess returns for higher IDYS values. The difference between the median close-to-close excess returns of the high and low quintiles is 0.16% and significant at the 1% level. The overnight excess returns are positive for all IDYS quintiles however, the difference between the high and low IDYS quintiles is also large at 0.13% and significant at the 1% level. Ex-day open-close excess stock returns are uniformly negative with IDYS no longer successfully differentiating between stocks that have low and high median excess returns.

[13]We use the Fama-French value weighted stock market index to calculate excess close-to-close returns and CAPM-alphas. However, we use the S&P500 index as the market return in overnight and open-close excess return calculations due to data availability.

Column (10) presents results for the cum-to-ex-day close-to-close FF-alphas. We do not report alphas for overnight and open-close intervals as it is not clear what the risk-free rate should be for these intervals however, we expect results will be similar to the excess returns results. The difference between the median alphas of the high and low IDYS quintiles is 0.17% and statistically significantly at the 1% level. Column (11) reports the ex-day close-to-close forward returns[14] as a function of the IDYS quintile and we find no pattern in median forward returns across the IDYS quintiles. IDYS (extracted from cum-day option prices) predicts subsequent ex-day stock (abnormal) returns. As a result, forward returns should not vary with IDYS, which is exactly what we find. This result is consistent with results in Goncalves-Pinto *et al.* (2017) who find that option implied stock returns (where option implied stock returns are constructed from option implied stock values extracted from put-call pairs using a version of put-call parity adjusted for early exercise) are less sensitive than stock returns over intervals where the stocks experience price reversals due to excess buying or selling pressure in the stock over the interval.

[14] Cum-to-ex-day forward returns are defined as follows: FWD_RETs = $[(C_x - P_x) - (C_c - P_c)]/S_c$ where C_x is the ex-day call price, P_x is the ex-day put price, C_c is the cum-day call price, P_c is the cum-day put price, and S_c is the cum-day stock price. As our option price data is from OptionMetrics we only have end-of-day data so cannot evaluate close-to-open or open-to-close forward returns.

Table 7: **Panel A depicts median returns sorted by the cum-dividend date Implied Dividend Yield Spread (IDYS). Column (1) denotes the quintiles of IDYS from low to high values. Column (is) is the number of observations in each quintile. Column (3) is the median IDYS value for each quintile. Columns (4) to (6) depict, respectively, the median ex-day close-to-close stock return (CC RET), cum-day-close to ex-day-open (overnight) stock return (ON RET) and ex-day-open to ex-day-close (open-close) stock return (OC RET). Columns (7) to (9) depict, respectively, the median close-to-close ex-day stock return in excess of the market return (CC RET - MKT), overnight excess stock return (ON RET - MKT) and open-close excess stock return (OC RET-MKT). Columns (10) and (11) depict the close-to-close ex-day Fama-French alphas (CC FF-α) and forward returns (CC FWD RET). Panel B presents median stock risk factors, stock characteristics and option characteristics as a function of the IDYS quintile. The median value of beta (BETA), idiosyncratic risk (IDIO), the Amihud illiquidity measure (ILLIQ), dividend amount (DIV), put option moneyness (MNY), option maturity (MAT) and option bid-ask spread (O_BA) are reported for each quintile. *,** and *** denote significance at the 10%, 5% and 1% level, respectively, where a rank-sum test is used to test differences in medians. Rank-sum z-values are reported in parentheses.**

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Panel A: Medians Returns										
QUINTILE	N	IDYS	CC RETS	ON RETS	OC RETS	CC RETS -MKT	ON RETS -MKT	OC RETS -MKT	CC FF-α	CC FWD RET
Q1=LOW	2,648	-0.24%	-0.01%	0.09%	-0.14%	-0.05%	0.11%	-0.15%	-0.04%	0.11%
Q2	2,648	-0.10%	0.09%	0.13%	-0.04%	-0.00%	0.14%	-0.12%	0.00%	0.12%
Q3	2,648	-0.03%	0.07%	0.14%	-0.09%	-0.02%	0.14%	-0.18%	-0.02%	0.06%
Q4	2,648	0.03%	0.17%	0.17%	0.00%	0.03%	0.17%	-0.10%	0.05%	0.12%
Q5=HIGH	2,648	0.13%	0.24%	0.24%	0.02%	0.11%	0.24%	-0.15%	0.13%	0.06%
HIGH-LOW		0.37%***	0.24%***	0.15%***	0.16%***	0.16%***	0.13%***	-0.00%	0.17%***	-0.05%
z-value		(63.02)	(5.44)	(5.83)	(3.21)	(3.52)	(5.36)	(0.59)	(3.68)	(-0.10)

Panel B: Median Values							
QUINTILE	BETA	IDIO	ILLIQ$\times 10^{8}$	DIV	MNY	MAT	O_BA
Q1=LOW	1.1012	0.0181	0.6927	0.1800	0.0462	0.1178	0.0590
Q2	1.0675	0.0150	0.4970	0.2100	0.0359	0.1082	0.0500
Q3	1.0522	0.0141	0.4475	0.2200	0.0320	0.1069	0.0460
Q4	1.0452	0.0138	0.3867	0.2150	0.0328	0.1049	0.0409
Q5=HIGH	1.0812	0.0153	0.5012	0.1878	0.0412	0.1069	0.0500
HIGH-LOW	-0.0200**	-0.0028***	-0.1915***	0.0078**	-0.0049***	-0.0110***	-0.0090***
z-value	(-2.46)	(-9.68)	(-5.71)	(2.24)	(-4.34)	(-7.81)	(-10.46)

Panel B of Table 7 reports the median quintile values for two stock risk factors: systematic risk (market beta) and idiosyncratic risk, and two stock characteristics: Amihud illiquidity and the declared dividend. Amihud illiquidity, the market beta, and idiosyncratic risk are estimated using daily returns data from day -45 to -5 on each ex-day stock where 0 denotes the ex-day. The market beta is estimated using the Fama-French model and idiosyncratic risk is taken to be the standard deviation of the residuals from the Fama-French model. The following option characteristics are also reported in Panel B of Table 7: put option moneyness, option maturity and option relative bid-ask spread.

The median market beta, idiosyncratic risk, and illiquidity values follow a U-shaped pattern over the IDYS quintiles. The median values of beta, idiosyncratic risk, and illiquidity for quintile 1 are statistically significantly higher than their respective median values for quintile 5 at the 1% significance level. The U-shaped pattern suggests that stocks with higher risk (systematic or idiosyncratic) or higher illiquidity are more likely to have implied dividends that deviate further (higher or lower) from the declared dividend which is as one would expect given these stocks exhibit larger frictions. The fact that the median idiosyncratic risk and illiquidity values are larger for the lowest IDYS quintile (Q1) suggests that stocks with the highest levels of idiosyncratic risk and illiquidity are more likely to have higher implied dividends relative to declared dividends and hence lower IDYS values. Implied dividends increase with the cost of shorting selling thus, this result is in line with our expectations, as stocks with higher idiosyncratic risk and higher illiquidity should be more costly to short sell relative to stocks with lower idiosyncratic risk and higher liquidity.

On the other hand, median declared dividend values are smaller at the extreme

IDYS quintiles relative to the inner quintiles. Higher dividends stocks are more likely to be targets of dividend capture driving down the ex-day abnormal return on these stocks hence, option implied dividends on these higher dividend paying stocks are closer to the declared dividends resulting in IDYS values closer to 0. Furthermore, the median declared dividend value for quintile 1 is statistically significantly lower than the median value for quintile 5 at the 5% level. This suggests that the lowest dividend stocks are predicted by IDYS to have the lowest ex-day returns whilst the second lowest group of dividend stocks are predicted to have the highest ex-day returns. The higher dividend paying stocks are targets of dividend capture that drive down their expected ex-day returns thus IDYS predicts ex-day returns closer to zero for these stocks.

The option characteristic median values also display a non-monotonic U-shape pattern over the IDYS quintiles with higher values at the extreme quintiles and lower values for the inner quintiles. This suggests that more extreme IDYS values tend to be associated with more extreme option characteristics. This is as expected as implied dividends extracted from options with more extreme moneyness, maturity or bid-ask spread values will deviate further from the declared dividend as a result of the larger frictions associated with these options. The low IDYS quintile median values, for moneyness, maturity and option bid-ask spread, are statistically significantly higher, at the 1% level, than their high IDYS quintile median counterparts. Thus, options with the most frictions tend to be associated with the highest implied dividend values and lowest IDYS values.

Overall, the evidence in Table 7 indicates there is a strong positive relation between the level of IDYS on the cum-day and the (abnormal) return on holding a long position in the underlying stock from the cum to the ex-day[15]. The (abnormal) return from a long stock position held from the close on the cum-dividend date to the close on the ex-dividend date is increasing with IDYS. This is exactly as we would expect as IDYS is higher for lower implied dividends with a lower implied dividend predicting a lower ex-day stock price decline and thus a higher cum-to-ex-day return.

A. Further Sorting

We further investigate the results in Table 7 by splitting the quintiles into subgroups corresponding to high and low levels of the stock risk factor or stock/option characteristic to assess whether cross-market predictability improves or deteriorates as a function of these variables. As in Table 7, the stock risk factors include the idiosyncratic risk of the stock and the stock's beta to the market, and the stock characteristics include the dividend amount and the liquidity of the stock. We choose these factors based on findings (e.g., Rantapuska, 2008 and Henry & Koski, 2017) that these variables (with the exception of beta) are significant in determining the amount of dividend capture activity in a stock. Stocks that are less likely to be the targets of dividend capture potentially leave more money on the table over the ex-day. Hence, dividend capture target stocks should have lower abnormal returns over the ex-day and their returns should be harder to predict.

[15]We also found similar results using mean returns as opposed to median returns. The differences between the extreme quintiles were often larger using mean returns, however, as the daily ex-day return distributions exhibit non-zero (often positive) skewness and excess kurtosis we report medians as opposed to mean values to be more conservative. The results on mean returns are available from the author upon request.

We also choose the weighted average of the option's moneyness, maturity and option bid-ask spread, used in the implied dividend calculations, as second sort variables to assess whether (abnormal) return predictions based on implied dividends (or IDYS to be more precise) improve when certain categories of options data are used. We split the data into high and low groups according to whether the value of the second variable is above or below its median value which has the advantage of splitting the data equally into two groups and then we divide each of these two groups into five quintiles based on IDYS.

Firstly, in Table 8 we sort stocks into low (Panel A) and high (Panel B) groups by the level of systematic market risk (β) of the stock and then sort into quintiles by IDYS separately for the low and high β groups. In Panel A the median market betas are approximately 0.70 for all IDYS quintiles. The high IDYS quintile (Q5) mean stock return is 0.19% and is statistically significantly different at the 10% level to the low IDYS quintile (Q1) mean stock return of 0.04%. Similarly, the Q5 median stock return is 0.19% and the Q1 median stock return is 0.01% which are statistically significantly different at the 1% level. There are no significant differences in Q1 and Q5 mean and median excess returns and mean FF-alphas. The Q5 median FF-alpha is 0.13% and the Q1 median FF-alpha is 0.00% and are statistically significantly different at the 5% level. Thus, there is limited evidence of IDYS predicting ex-day (abnormal) returns for low beta stocks.

In Panel B of Table 8 the median betas display a reverse U-shape patter with higher median betas for the extreme quintiles (Q1 and Q5) and lower median betas for the inner quintiles (Q2, Q3, and Q4). The low IDYS quintile median beta is 1.52 and is statistically significantly greater than the high IDYS quintile median beta value of 1.46. Q5 mean and median stock returns, mean and median excess returns, and median alphas are statistically significantly greater than their Q1 counterpart values as we expect if IDYS contains information on returns. However, the Q1 and Q5 mean alphas are not statistically significantly different from one another. There is a larger difference in the extreme quintile mean and median stock returns and abnormal stock returns (excess stock returns and alphas) in the high beta group in Panel B relative to the low beta group in Panel A. Furthermore, the predictive power of IDYS is generally higher for the high beta group than the low beta group, in particular for abnormal returns. These results are consistent with a limits to arbitrage argument in dividend capture (e.g., Michaely & Vila, 1995) where higher risk stocks are less likely to be targeted for dividend capture, leading to potentially larger ex-day returns on these stocks.

Table 8: Median and mean stock returns, excess returns and CAPM alphas over the ex-dividend dates sorted first into low beta (Panel A) and high beta (Panel B) stocks and then sorted by the cum-dividend date Implied Dividend Yield Spread (IDYS). The first column denotes the quintiles of IDYS from low to high values. The second column records the number of observations in each quintile. The third column presents the median IDYS value for each quintile and the fourth column presents the median beta for each quintile. Column (5) and (6) depict the mean and median cum-day to ex-day stock returns (RET), columns (7) and (8) depict the mean and median stock returns in excess of the market return (RET-MKT) whilst columns (9) and (10) depict the mean and median Fama-French alphas. *,** and *** denote significance at the 10%, 5% and 1% level, respectively, where a t-test is used to test differences in means and a rank-sum test is used to test differences in medians. t-statistics are reported in square parentheses and rank-sum z-values are reported in round parentheses.

QUINTILE	N	Median IDYS	Median BETA	Mean RET	Median RET	Mean RET-MKT	Median RET-MKT	Mean FF-α	Median FF-α
Panel A: Low β									
Q1=LOW	1,324	-0.23%	0.6712	0.04%	0.01%	0.04%	-0.04%	0.02%	0.00%
Q2	1,324	-0.09%	0.7181	0.01%	0.08%	-0.04%	-0.02%	-0.04%	-0.03%
Q3	1,324	-0.03%	0.7069	0.11%	0.06%	-0.02%	-0.03%	0.00%	-0.01%
Q4	1,324	0.03%	0.7052	0.17%	0.13%	0.01%	0.00%	0.07%	0.06%
Q5=HIGH	1,324	0.13%	0.6917	0.19%	0.18%	0.09%	0.05%	0.15%	0.13%
HIGH-LOW		0.36%***	0.0205	0.15%*	0.16%***	0.05%	0.09%	0.13%	0.13%**
t/z-statistics		(44.56)	(0.73)	[1.66]	(2.82)	[0.57]	(1.36)	[1.58]	(2.36)
Panel B: High β									
Q1=LOW	1,324	-0.25%	1.5209	-0.08%	-0.09%	0.01%	-0.10%	0.00%	-0.06%
Q2	1,324	-0.10%	1.4268	0.10%	0.10%	0.08%	0.03%	0.07%	0.01%
Q3	1,324	-0.04%	1.3984	0.10%	0.09%	0.01%	0.01%	-0.02%	-0.03%
Q4	1,324	0.03%	1.3926	0.26%	0.24%	0.12%	0.11%	0.09%	0.05%
Q5=HIGH	1,324	0.14%	1.4614	0.35%	0.33%	0.19%	0.15%	0.15%	0.11%
HIGH-LOW		0.39%***	-0.0595***	0.44%***	0.42%***	0.18%*	0.25%***	0.15%	0.17%**
t/z-statistics		(44.56)	(-3.51)	[3.49]	(4.58)	[1.76]	(3.35)	[1.45]	(2.54)

Table 9: Median and mean stock returns, excess returns and FF-alphas over the ex-dividend dates sorted into a low idiosyncratic risk group (Panel A) and a high idiosyncratic risk group (Panel B) and then sorted by the cum-dividend date Implied Dividend Yield Spread (IDYS). The first column denotes the quintiles of IDYS from low to high values. The second column records the number of observations in each quintile. The third column presents the median IDYS value for each quintile and the fourth column presents the median idiosyncratic risk value for each quintile. Column (5) and (6) depict the mean and median cum-day to ex-day stock returns (RET), columns (7) and (8) depict the mean and median stock returns in excess of the market (RET-MKT) returns whilst columns (9) and (10) depict the mean and median Fama-French alphas. *, and *** denote significance at the 10%, 5% and 1% level, respectively, where a t-test is used to test differences in means and a rank-sum test is used to test differences in medians. t-statistics are reported in square parentheses and rank-sum z-values are reported in round parentheses.**

QUINTILE	N	Median IDYS	Median IDIO	Mean RET	Median RET	Mean RET-MKT	Median RET-MKT	Mean FF-α	Median FF-α
Panel A: Low IDIO_RISK									
Q1=LOW	1,324	-0.17%	0.0106	-0.01%	0.02%	-0.01%	-0.02%	0.01%	0.00%
Q2	1,324	-0.08%	0.0099	0.09%	0.09%	0.00%	-0.04%	0.01%	-0.02%
Q3	1,324	-0.02%	0.0097	0.07%	0.06%	-0.02%	0.01%	0.01%	-0.01%
Q4	1,324	0.03%	0.0098	0.19%	0.17%	0.04%	0.01%	0.07%	0.06%
Q5=HIGH	1,324	0.11%	0.0100	0.22%	0.24%	0.06%	0.06%	0.07%	0.08%
HIGH-LOW		0.28%***	-0.0006***	0.22%***	0.21%***	0.08%	0.08%**	0.05%	0.07%*
t/z-statistics		(44.56)	(-5.29)	[3.24]	(4.29)	[1.36]	(2.24)	[0.95]	(1.80)
Panel B: High IDIO_RISK									
Q1=LOW	1,324	-0.32%	0.0234	0.02%	0.00%	0.07%	-0.08%	0.01%	-0.09%
Q2	1,324	-0.13%	0.0200	-0.03%	0.00%	-0.01%	0.02%	-0.01%	-0.01%
Q3	1,324	-0.05%	0.0194	0.11%	0.10%	0.05%	0.04%	0.01%	0.01%
Q4	1,324	0.03%	0.0194	0.24%	0.17%	0.08%	0.02%	0.08%	0.01%
Q5=HIGH	1,324	0.17%	0.0214	0.34%	0.27%	0.22%	0.18%	0.24%	0.21%
HIGH-LOW		0.48%***	-0.0020***	0.32%**	0.27%***	0.15%	0.26%***	0.24%**	0.30%***
t/z-statistics		(44.56)	(-5.42)	[2.44]	(3.40)	[1.31]	(2.58)	[2.10]	(3.42)

In Table 9 we repeat the high/low sorting using the idiosyncratic risk (IDIO_RISK) of the stock from the Fama-French model to split the data into two groups: a high and low IDIO_RISK stock group. We then sort each of these separate groups by their cum-day IDYS value and evaluate subsequent ex-day stock (abnormal) returns. IDYS statistically significantly predicts mean and median stock returns for both low and high levels of IDIO_RISK. The performance of IDYS in predicting excess returns and FF-alphas is poor on the low IDIO_RISK group whereas, IDYS performs well in the prediction of median excess returns and mean and median FF-alphas in the high IDIO_RISK group. The differences between the extreme quintile returns are larger for the high IDIO_RISK than the differences in the low IDIO_RISK group. Thus, cum-day IDYS is a better predictor of (abnormal) returns for high IDIO_RISK stocks with larger differences in extreme quintile (abnormal) returns. This is consistent with the results in Table 8, as stocks with high IDIO_RISK are also less likely to be the targets of dividend capture strategies thus their ex-day (abnormal) returns are less likely to be eliminated.

Table 10 reports high/low sort results using the Amihud illiquidity measure (ILLIQ) to split the data into high and low ILLIQ groups. We then sort each of these groups by cum-day IDYS. Cum-day IDYS predicts ex-day stock returns and abnormal stock returns for both the low and high ILLIQ groups with no notable difference in performance between the two groups. From the limits to arbitrage argument we expect that less liquid stocks are less likely to be targets of dividend capture resulting in higher (abnormal) returns over the ex-day and stronger predictions for the high ILLIQ group but IDYS performs equally well on both high and low ILLIQ groups.

Table 10: Median and mean stock returns, excess returns and CAPM alphas over the ex-dividend dates sorted into a low illiquidity group (Panel A) and a high illiquidity group (Panel B) stocks and then sorted by the cum-dividend date Implied Dividend Yield Spread (IDYS). The first column denotes the quintiles of IDYS from low to high values. The second column records the number of observations in each quintile. The third colum presents the median IDYS value for each quintile and the fourth column presents the median stock illiquidity value (Amihud measure $\times 10^8$) for each quintile. Column (5) and (6) depict the mean and median cum-day to ex-day stock returns (RET), columns (7) and (8) depict the mean and median stock returns in excess of the market returns (RET-MKT) whilst columns (9) and (10) depict the mean and median Fama-French alphas. *,** and *** denote significance at the 10%, 5% and 1% level, respectively, where a t-test is used to test differences in means and a rank-sum test is used to test differences in medians. t-statistics are reported in square parentheses and rank-sum z-values are reported in round parentheses.

QUINTILE	N	Median IDYS	Median ILLIQ	Mean RET	Median RET	Mean RET-MKT	Median RET-MKT	Mean FF-α	Median FF-α
				Panel A: Low ILLIQ					
Q1=LOW	1,318	-0.21%	0.2096	-0.16%	-0.12%	-0.07%	-0.13%	-0.04%	-0.07%
Q2	1,318	-0.08%	0.1894	0.09%	0.08%	0.02%	-0.03%	0.00%	0.00%
Q3	1,318	-0.03%	0.1765	0.16%	0.11%	0.04%	0.05%	0.03%	0.02%
Q4	1,318	0.03%	0.1761	0.18%	0.17%	0.04%	0.05%	0.03%	0.06%
Q5=HIGH	1,318	0.13%	0.1911	0.19%	0.19%	0.10%	0.07%	0.12%	0.13%
HIGH-LOW		0.34%***	-0.0185**	0.34%***	0.31%***	0.17%**	0.21%***	0.16%*	0.20%***
t/z-statistics		(44.46)	(-2.38)	[3.30]	(4.44)	[1.96]	(3.65)	[1.91]	(3.37)
				Panel B: High ILLIQ					
Q1=LOW	1,318	-0.27%	1.5960	0.06%	0.06%	0.07%	-0.01%	0.00%	-0.04%
Q2	1,318	-0.11%	1.4104	0.07%	0.07%	0.05%	0.01%	0.05%	0.00%
Q3	1,318	-0.04%	1.3282	0.02%	0.06%	-0.05%	0.01%	-0.03%	-0.02%
Q4	1,318	0.02%	1.3426	0.24%	0.18%	0.09%	0.01%	0.14%	0.05%
Q5=HIGH	1,324	0.14%	1.5415	0.38%	0.32%	0.20%	0.13%	0.20%	0.13%
HIGH-LOW		0.41%***	-0.0545	0.31%***	0.26%***	0.13%	0.15%**	0.20%**	0.17%***
t/z-statistics		(44.46)	(-0.94)	[2.77]	(3.79)	[1.36]	(2.15)	[2.02]	(2.68)

Table 11 reports high/low sort results where the declared dividend (DIV) of the stock is used to split the data into high and low DIV groups and then each of these groups is sorted by cum-day IDYS. Cum-day IDYS statistically significantly predicts ex-day mean and median stock returns, excess returns and alphas for the low DIV group and significantly predicts ex-day mean and median stock returns, median excess returns and median alphas for the high DIV group. Thus, the predictability results are slightly weaker for the high DIV group. The differences in extreme quintile mean and median stock returns, excess returns and alphas tend to be larger for the low DIV group relative to the high DIV group. These results are consistent with the fact that lower dividend stocks are less likely to be targets of dividend capture, most likely due to the fact that dividend arbitrageurs expect less worthwhile ex-day gains on lower DIV stocks.

Table 11: Median and mean stock returns, excess returns and CAPM alphas over the ex-dividend dates sorted into a low dividend group (Panel A) and a high dividend group (Panel B) and then sorted by the cum-dividend date Implied Dividend Yield Spread (IDYS). The first column denotes the quintiles of IDYS from low to high values. The second column records the number of observations in each quintile. The third colum presents the median IDYS value for each quintile and the fourth column presents the median declared dividend for each quintile. Column (5) and (6) depict the mean and median cum-day to ex-day stock returns (RET), columns (7) and (8) depict the mean and median stock returns in excess of the market returns (RET-MKT) whilst columns (9) and (10) depict the mean and median Fama-French alphas. *,** and *** denote significance at the 10%, 5% and 1% level, respectively, where a t-test is used to test differences in means and a rank-sum test is used to test differences in medians. t-statistics are reported in square parentheses and rank-sum z-values are reported in round parentheses.

QUINTILE	N	Median IDYS	Median DIV	Mean RET	Median RET	Mean RET-MKT	Median RET-MKT	Mean FF-α	Median FF-α
Panel A: Low DIV									
Q1=LOW	1,324	-0.25%	0.0900	0.00%	0.03%	0.05%	-0.05%	0.00%	-0.06%
Q2	1,324	-0.11%	0.1000	0.10%	0.16%	0.08%	0.06%	0.03%	0.03%
Q3	1,324	-0.04%	0.1100	0.12%	0.09%	0.02%	0.02%	0.02%	0.02%
Q4	1,324	0.03%	0.1000	0.25%	0.19%	0.12%	0.10%	0.14%	0.07%
Q5=HIGH	1,324	0.14%	0.1000	0.37%	0.35%	0.24%	0.15%	0.24%	0.14%
HIGH-LOW		0.40%***	0.0100*	0.37%***	0.32%***	0.19%*	0.19%***	0.24%**	0.20%***
t/z-statistics		(44.56)	(1.84)	[3.10]	(3.61)	[1.87]	(2.58)	[2.26]	(2.78)
Panel B: High DIV									
Q1=LOW	1,324	-0.23%	0.3500	-0.06%	-0.09%	-0.02%	-0.07%	0.01%	-0.02%
Q2	1,324	-0.09%	0.3550	0.01%	0.05%	-0.04%	-0.03%	0.01%	-0.03%
Q3	1,324	-0.03%	0.3500	0.08%	0.06%	-0.01%	-0.02%	-0.02%	-0.02%
Q4	1,324	0.02%	0.3600	0.19%	0.17%	0.01%	0.00%	0.02%	0.03%
Q5=HIGH	1,324	0.12%	0.3625	0.16%	0.19%	0.03%	0.05%	0.06%	0.10%
HIGH-LOW		0.35%***	0.0125**	0.22%**	0.27%***	0.05%	0.12%**	0.05%	0.11%**
t/z-statistics		(44.56)	(2.36)	[2.26]	(4.01)	[0.61]	(2.29)	[0.70]	(2.26)

Table 12 reports high/low sort results where the weighted average maturity of the options (MAT) used in the implied dividend calculations is used to split the data into high and low MAT groups and then each of these groups is sorted by IDYS. Cum-day IDYS statistically significantly predicts ex-day stock returns and abnormal stock returns whether we use low maturity options, with a median maturity of approximately 4 weeks, or high maturity options, with a median maturity of approximately 8 weeks.

Table 12: Median and mean stock returns, excess returns and CAPM alphas over the ex-dividend dates sorted into a low maturity group (Panel A) and a high maturity group (Panel B) and then sorted by the cum-dividend date Implied Dividend Yield Spread (IDYS). The first column denotes the quintiles of IDYS from low to high values. The second column records the number of observations in each quintile. The third colum presents the median IDYS value for each quintile and the fourth column presents the median option maturity value for each quintile. Column (5) and (6) depict the mean and median cum-day to ex-day stock returns (RET), columns (7) and (8) depict the mean and median stock returns in excess of the market returns (RET-MKT) whilst columns (9) and (10) depict the mean and median Fama-French alphas. *,** and *** denote significance at the 10%, 5% and 1% level, respectively, where a t-test is used to test differences in means and a rank-sum test is used to test differences in medians. t-statistics are reported in square parentheses and rank-sum z-values are reported in round parentheses.

QUINTILE	N	Median IDYS	Median MAT	Mean RET	Median RET	Mean RET-MKT	Median RET-MKT	Mean FF-α	Median FF-α
Panel A: Low MAT									
Low	1,324	-0.21%	0.08	0.01%	-0.09%	0.04%	-0.05%	-0.04%	-0.05%
Q2	1,324	-0.09%	0.08	0.09%	0.14%	0.05%	0.02%	0.05%	0.01%
Q3	1,324	-0.03%	0.08	0.08%	0.07%	0.01%	-0.02%	0.03%	0.00%
Q4	1,324	0.03%	0.07	0.24%	0.21%	0.09%	0.04%	0.13%	0.07%
High	1,324	0.13%	0.07	0.29%	0.25%	0.15%	0.08%	0.19%	0.11%
H-L		0.35%***	-0.01***	0.27%**	0.34%***	0.12%	0.13%**	0.23%**	0.16%***
t/z-statistics		(44.56)	(-4.85)	[2.41]	(3.33)	[1.18]	(2.10)	[2.40]	(2.68)
Panel B: High MAT									
Low	1,324	-0.27%	0.15	-0.06%	0.00%	0.02%	-0.07%	0.05%	-0.04%
Q2	1,324	-0.11%	0.15	0.05%	0.10%	0.00%	-0.01%	0.01%	-0.02%
Q3	1,324	-0.04%	0.14	0.05%	0.02%	-0.06%	-0.01%	-0.06%	-0.01%
Q4	1,324	0.02%	0.14	0.18%	0.14%	0.03%	0.02%	0.00%	-0.01%
High	1,324	0.13%	0.15	0.30%	0.24%	0.16%	0.12%	0.14%	0.15%
H-L		0.40%***	-0.00***	0.36%***	0.24%***	0.15%*	0.19%***	0.09%	0.19%***
t/z-statistics		(44.56)	(-3.71)	[3.39]	(4.62)	[1.67]	(3.19)	[1.02]	(2.61)

Table 13 reports high/low sort results where the weighted average put option moneyness (MNYNESS) used in the implied dividend calculations is used to split the data into high and low MNYNESS groups and then each of these groups is sorted by IDYS. Cum-day IDYS statistically significantly predicts ex-day mean and median: stock returns, excess returns, and alphas when the weighted average moneyness of the put options used in the implied dividend calculations are smaller (i.e. when the put options are closer-to-the-money). However, IDYS only statistically significantly predicts mean and median stock returns, and marginally predicts median excess returns and median alphas when using put options that are deeper-in-the-money in the IDYS calculation. Thus, IDYS is a more successful predictor of stock (abnormal) returns when put options, used in the calculation of IDYS, are closer to-the-money. Implied dividends suffer from more bias when calculated using put options that are further-in-the-money, as discussed in Section V. Furthermore, deep-in-money options tend to be associated with lower open interest thus, these options are potentially less informative than options that are closer-to-the-money. This results in a deterioration of IDYS predictability when using options that are deep-in-the-money.

Table 13: Median and mean stock returns, excess returns and CAPM alphas over the ex-dividend dates sorted into a low moneyness group (Panel A) and a high moneyness group (Panel B) and then sorted by the cum-dividend date Implied Dividend Yield Spread (IDYS). The first column denotes the quintiles of IDYS from low to high values. The second column records the number of observations in each quintile. The third colum presents the median IDYS value for each quintile and the fourth column presents the median option moneyness value for each quintile. Column (5) and (6) depict the mean and median cum-day to ex-day stock returns (RET), columns (7) and (8) depict the mean and median stock returns in excess of the market returns (RET-MKT) whilst columns (9) and (10) depict the mean and median Fama-French alphas. *, and *** denote significance at the 10%, 5% and 1% level, respectively, where a t-test is used to test differences in means and a rank-sum test is used to test differences in medians. t-statistics are reported in square parentheses and rank-sum z-values are reported in round parentheses.**

QUINTILE	N	Median IDYS	Median MNYNESS	Mean RET	Median RET	Mean RET-MKT	Median RET-MKT	Mean FF-α	Median FF-α
				Panel A: Low MNYNESS					
Low	1,324	-0.20%	0.0214	-0.09%	-0.11%	-0.14%	-0.11%	-0.16%	-0.12%
Q2	1,324	-0.08%	0.0202	0.12%	0.15%	0.00%	0.01%	0.01%	0.00%
Q3	1,324	-0.03%	0.0201	0.03%	0.04%	-0.04%	-0.03%	-0.03%	-0.02%
Q4	1,324	0.02%	0.0212	0.17%	0.17%	0.04%	0.02%	0.04%	0.04%
High	1,324	0.11%	0.0205	0.27%	0.25%	0.12%	0.12%	0.16%	0.13%
H-L		0.31%***	-0.0009	0.36%***	0.36%***	0.26%***	0.23%***	0.31%***	0.25%***
t/z-statistics		(44.56)	(-1.44)	[4.45]	(5.40)	[3.69]	(4.67)	[4.39]	(4.83)
				Panel B: High MNYNESS					
Low	1,324	-0.28%	0.0695	0.00%	0.02%	0.10%	-0.07%	0.09%	0.00%
Q2	1,324	-0.12%	0.0579	0.04%	0.02%	0.09%	0.03%	0.08%	0.03%
Q3	1,324	-0.04%	0.0561	0.17%	0.11%	0.07%	0.08%	0.04%	0.01%
Q4	1,324	0.03%	0.0551	0.28%	0.20%	0.10%	0.06%	0.11%	0.06%
High	1,324	0.16%	0.0654	0.27%	0.22%	0.15%	0.08%	0.16%	0.13%
H-L		0.44%***	-0.0040***	0.26%**	0.20%***	0.05%	0.15%*	0.06%	0.12%*
t/z-statistics		(44.56)	(-3.04)	[2.08]	(2.95)	[0.45]	(1.64)	[0.60]	(1.65)

Finally, Table 14 reports high/low sort results where the weighted average option bid-ask spread (OPTIOB_BA) used in the implied dividend calculations is used to split the data into high and low groups and then each of these groups is sorted by IDYS. IDYS statistically significantly predicts mean and median: stock returns, excess returns, and FF-alphas whether we use data with low option bid-ask spreads or data with high option bid-ask spreads in the IDYS calculation. However, it must be noted that we chose the dataset at the outset to contain reasonably liquid options with bid-ask spreads of less than 10%.

Table 14: Median and mean stock returns, excess returns and CAPM alphas over the ex-dividend dates sorted into a low option bid-ask spread group (Panel A) and a high option spread bid-ask group (Panel B) and then sorted by the cum-dividend date Implied Dividend Yield Spread (IDYS). The first column denotes the quintiles of IDYS from low to high values. The second column records the number of observations in each quintile. The third colum presents the median IDYS value for each quintile and the fourth column presents the median option bid-ask spread for each quintile. Column (5) and (6) depict the mean and median cum-day to ex-day stock returns (RET), columns (7) and (8) depict the mean and median stock returns in excess of the market returns (RET-MKT) whilst columns (9) and (10) depict the mean and median Fama-French alphas. *, and *** denote significance at the 10%, 5% and 1% level, respectively, where a t-test is used to test differences in means and a rank-sum test is used to test differences in medians. t-statistics are reported in square parentheses and rank-sum z-values are reported in round parentheses.**

QUINTILE	N	Median IDYS	Median OPTION_BA	Mean RET	Median RET	Mean RET-MKT	Median RET-MKT	Mean FF-α	Median FF-α
Panel A: Low option bid-ask spread									
Low	1,324	-0.19%	3.49%	-0.13%	-0.06%	-0.14%	-0.16%	-0.12%	-0.13%
Q2	1,324	-0.08%	2.73%	-0.04%	0.02%	-0.07%	-0.07%	-0.04%	-0.03%
Q3	1,324	-0.02%	2.50%	0.03%	0.05%	-0.09%	-0.07%	-0.10%	-0.08%
Q4	1,324	0.03%	2.22%	0.17%	0.13%	0.01%	0.01%	0.04%	0.05%
High	1,324	0.12%	2.50%	0.19%	0.21%	0.05%	0.02%	0.07%	0.05%
H-L		0.31%***	-0.99%***	0.32%***	0.26%***	0.19%**	0.18%***	0.19%**	0.18%***
t/z-statistics		(44.51)	(-9.02)	[3.31]	(4.02)	[2.39]	(2.99)	[2.35]	(3.10)
Panel B: High option bid-ask spread									
Low	1,324	-0.30%	7.80%	0.00%	0.00%	0.06%	-0.04%	0.02%	-0.04%
Q2	1,324	-0.12%	6.65%	0.19%	0.15%	0.16%	0.10%	0.13%	0.07%
Q3	1,324	-0.05%	6.85%	0.20%	0.14%	0.12%	0.07%	0.11%	0.07%
Q4	1,324	0.02%	6.79%	0.24%	0.25%	0.15%	0.08%	0.16%	0.10%
High	1,324	0.15%	7.50%	0.38%	0.31%	0.23%	0.21%	0.23%	0.18%
H-L		0.45%***	-0.30%*	0.38%***	0.31%***	0.17%*	0.25%***	0.21%**	0.22%***
t/z-statistics		(44.51)	(-1.74)	[3.17]	(4.44)	[1.65]	(3.19)	[2.05]	(3.34)

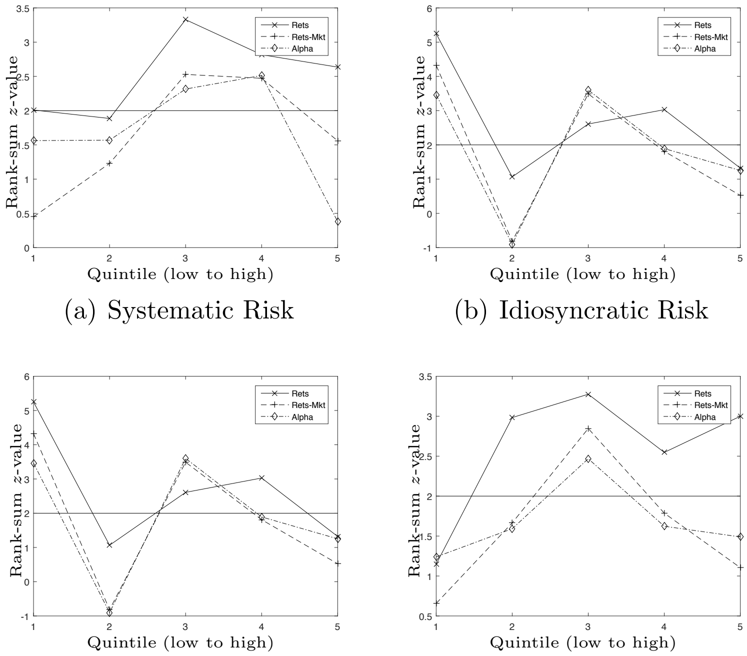
Taken together the sorting results in Tables 8 to 14 provide evidence that cum-day IDYS predicts ex-day stock returns, excess stock returns and alphas. The cross-market predictability is stronger for high levels of systematic risk, idiosyncratic risk, and low dividend amounts. Although, cross-market predictability is similar for both low and high illiquidity groups. With the exception of the liquidity double sort results, these results are consistent with a limits to arbitrage argument in dividend capture (e.g., see Michaely & Vila, 1995), with stronger cross-market predictability and larger (abnormal) returns on stocks where it is riskier or less worthwhile to capture the dividend. These results are also consistent with Goncalves-Pinto & Xu (2018) as option implied dividends embed public information on expected ex-day stock returns. Cross-market predictability is stronger when option implied dividends are estimated using options that are closer-to-the-money, but cross-market predictability is not overly affected by option maturity or bid-ask spread, at least in the reasonably liquid set of options in our dataset that also have a limited range of maturities given the filters applied to the options so that their maturities cover only one ex-day event.

Figures 3 and 4 report rank-sum z-values that evaluate the statistical significance of the difference between high and low IDYS quintile median returns that have been pre-sorted into quintiles based on the previously used stock and option risk factors/characteristics. These double sorting results are a finer grain version of the high-low sorting results presented in Tables 8 to 14. Rather than splitting the data into two separate high and low groups, we split the data into quintiles based on the stock/option risk factor or characteristic and then further breakdown each of these quintiles into quintiles based on cum-day IDYS. Similar results are obtained to those in Tables 8 to 14. There is no discernible pattern in cross-market predictability as a function of systematic or idiosyncratic risk and illiquidity. Cross-market IDYS predictability is low for the lowest quintile dividend amount where ex-dividend-day effects are minimal. IDYS predictability increases for the intermediate dividend quintiles and deteriorates for the highest dividend quintile where dividend capture will be the most prevalent. These results are consistent with the limits to arbitrage argument where option implied dividends reflect the fact that stocks that are more likely to undergo dividend capture are the stocks that are expected to earn smaller abnormal returns over the ex-day. In terms of options characteristics, IDYS predictability is strongest for the lower quintiles of moneyness (where the in-the-money put options used in the calculation of IDYS are closer to-the-money), IDYS predictability is strongest for the intermediate option maturity quintiles, and IDYS predictability is stronger for high and intermediate values of option bid-ask spread.

In the next subsection, we consider the role of temporary stock price pressure in the run-up to the ex-day as a contributor to cross-market predictability from option implied dividends to ex-dividend day stock returns.

B. Stock Price Pressure and Cross-Market Predictability

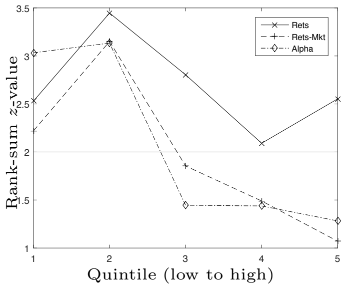
In the run-up to a firm's ex-day there is extra trading activity in the stock that is not necessarily related to the fundamental value of the stock, (e.g., see Lakonishok & Vermaelen, 1986 and 2011, 2011). Investors who want to avail of the dividend will purchase the stock whereas, investors who want to avoid the dividend, for tax reasons or to avoid the nuisance value of reinvesting the dividend, will sell the stock. Dividend capture arbitrageurs will absorb excess selling pressure by



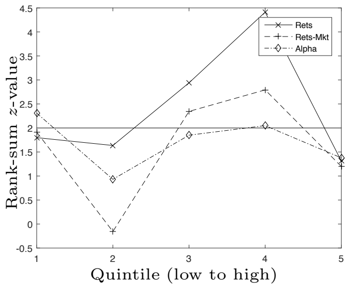
(a) Systematic Risk (b) Idiosyncratic Risk

(c) Illiquidity (d) Dividend Amount

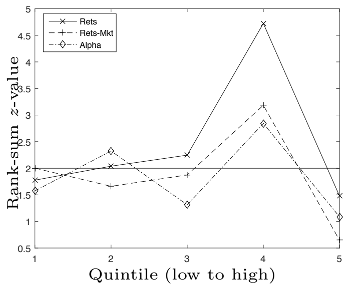
Figure 3: On the cum-dividend date stocks are sorted into quintiles by a stock risk factor or characteristic. Within each of these quintiles stocks are then sorted by the cum-day IDYS. These plots report the rank-sum z-value of the difference between the high and low IDYS quintiles subsequent median stock returns (RETS), returns in excess of the market return (RETS-MKT) and Fama-French alphas. A rounded-off z-critical value of 2 is also plotted to aid interpretation.



(a) Moneyness



(b) Maturity



(c) Option bid-ask

Figure 4: On the cum-dividend date stocks are sorted into quintiles by option characteristics. Within each of these quintiles stocks are then sorted by the cum-day IDYS. These plots report the rank-sum z-value of the difference between the high and low IDYS quintiles subsequent median stock returns (RETS), returns in excess of the market return (RETS-MKT) and Fama-French alphas. A rounded-off z-critical value of 2 is also plotted to aid interpretation.

purchasing stocks on the cum-day or before, collecting the (discounted) dividend and selling the stocks on the ex-day.

Campbell *et al.* (1993) develop a rational equilibrium model in which non-informational traders cause temporary price deviations that, when absorbed by liquidity providers, cause stock prices to revert to their previous values with liquidity providers earning a risk premium for their role. In this model, stock liquidity plays an important role as the demand curves for stocks are not perfectly elastic resulting in larger price reversals for less liquid stocks under non-informational trading events. In the context of dividend capture, stocks where it is riskier or more costly to capture the dividend will experience more extreme price reversals as dividend arbitrageurs are less willing to absorb the excess selling pressure on these stocks thus will demand a greater risk premium to do so. Thus, we examine stock returns from the day before the cum-day to the cum-day itself to assess whether temporary stock price pressure is the reason behind IDYS predictability. Goncalves-Pinto *et al.* (2017) point out that temporary stock price pressure, that is not fully reflected into option price quotes, is the main reason why option implied measures[16] predict stock returns. To test whether stock price pressure is a plausible explanation for the cross-market predictability inherent in IDYS we sort stocks into cum-day IDYS quintiles but also consider the stock return over the cum-day to see whether stock returns reverse from the cum-day to the ex-day and whether this expected reversal is reflected in the cum-day IDYS.

Table 15 reports these results. The number of stocks in each quintile in column

[16] Goncalves-Pinto *et al.* (2017) examine a variety of option implied predictors including the implied volatility spread, but focus their main attention on a measure equal to the difference between the option implied stock price and the stock price.

(2) of Table 15 is slightly lower than in Table 7, as this data is restricted to ensure that put-call pairs trade both on the day before the cum-day and the cum-day itself, as we use this information in a follow on table. Despite the slightly lower number of stocks in each quintile, the median IDYS quintile values reported in column (3) are very similar to those in Table 7, ranging from the lowest quintile IDYS median value of -0.25% to the highest quintile median IDYS value of 0.13%. Column (4) reports the cum-day stock returns (calculated using close-to-close returns from cum-day-1 to cum-day). Stocks in the highest (lowest) IDYS quintile have experienced the lowest (highest) cum-day returns. Median cum-day returns also decrease almost monotonically as we move to the higher IDYS quintiles. The lowest (highest) IDYS quintile median cum-day return is 0.32% (-0.50%). The difference between the highest and lowest IDYS quintile median cum-day returns is -0.82% and is statistically significant at the 1% level. Column (5) depicts the ex-day returns excluding the discounted dividend. Here, the returns are monotonically increasing in the IDYS quintiles. The difference between the highest and lowest IDYS quintile median ex-day returns excluding dividends is 0.35%, and this difference is statistically significant at the 1% level. Column (6) presents the discounted dividend yield and these median dividend yields are reasonably similar across the quintiles. Column (7) reports the ex-day returns including the discounted dividend yield. As in Table 7, the median ex-day returns are monotonically increasing in the IDYS quintiles, the difference between the highest and lowest IDYS quintile median ex-day returns is 0.24%, and this difference is statistically significant at the 1% level. Columns (8) to (11) report the IDYS quintile median values for betas, idiosyncratic risk, illiquidity, and dividends and results are very similar to those reported in Table 7. Table 15 clearly demonstrates that

stocks in the outer IDYS quintiles, that are less likely to be targets of dividend capture, experience the most extreme return reversals from the cum-day to the ex-day.

Table 15: This table depicts median returns sorted by the cum-dividend date Implied Dividend Yield Spread (IDYS). The first column denotes the quintiles of IDYS from low to high values. The second column records the number of observations in each quintile. The third column presents the median IDYS value for each quintile. Columns (4) to (7) depict, respectively, the median cum-day stock returns (CUM RET), the median ex-day stock returns excluding the discounted dividend (EX RET EXCL. DIV), the median discounted dividend yield (DIV YIELD), and the median ex-day stock returns including the discounted dividend payment (EX RET INCL. DIV). Columns (8) to (11) depict, respectively, the median beta (BETA), idiosyncratic risk (IDIO), Amihud measure (ILLIQ), and dividend amount (DIV) for each quintile. *, and *** denote significance at the 10%, 5% and 1% level, respectively, where a rank-sum test is used to test differences in medians. Rank-sum z-values are reported in parentheses.**

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
		Median Values								
QUINTILE	N	IDYS	CUM RET	EX RET (EXCL. DIV)	DIV YIELD	EX RET (INCL. DIV)	BETA	IDIO	ILLIQ$\times 10^8$	DIV
Q1 = Low	2,592	-0.25%	0.32%	-0.68%	0.42%	-0.01%	1.1496	0.0196	0.8735	0.1800
Q2	2,592	-0.10%	0.16%	-0.45%	0.43%	0.06%	1.0782	0.0144	0.4187	0.2050
Q3	2,592	-0.04%	0.08%	-0.37%	0.43%	0.10%	1.0741	0.0134	0.3600	0.2200
Q4	2,592	0.03%	0.09%	-0.36%	0.44%	0.15%	1.0795	0.0134	0.3369	0.2200
Q5 =High	2,592	0.13%	-0.50%	-0.32%	0.43%	0.23%	1.1075	0.0156	0.4796	0.1800
H-L		0.38%***	-0.82%***	0.35%***	0.01%	0.24%***	-0.0423**	-0.0039***	-0.3940***	0
z-value		(62.348)	(-14.925)	(6.327)	(-1.023)	(5.384)	(-2.39)	(-12.95)	(-11.34)	(-0.0277)

To examine the role of stock price pressure as the source of option implied dividends predictive power, we sort stocks into quintiles based on the cum-day return, and then assess the median IDYS value and subsequent ex-day returns. Results are reported in Table 16. The median quintile values of cum-day returns in column (3) are more extreme than median cum-day returns when sorted by IDYS quintiles. The lowest (highest) quintile median cum-day return is -2.39% (2.38%). Median IDYS values are reported in column (4) and these are all negative. The median IDYS values are negatively related to the median cum-day return values as they are decreasing monotonically from the lowest to the highest quintile. The difference between the lowest and highest IDYS quintile is -0.06% and is statistically significant at the 1% level. As expected if stock price pressure predicts ex-day returns, ex-day returns (with or without dividends) decrease monotonically as cum-day returns increase. The lowest cum-day return quintile is associated with the highest ex-day return (including dividend) of 0.18%, whilst the highest cum-day return quintile is associated with the lowest ex-day return (including dividend) of 0.05%. However, sorting by cum-day returns is not as effective in predicting ex-day returns as sorting by IDYS. The difference in quintile 1 and 5 ex-day returns is 0.13% (significant at 5%) when sorting by cum-day returns whereas, the difference in quintile 5 and 1 ex-day returns is 0.24% (significant at 1%) when sorting by IDYS as reported in Tables 7 and 15. Stock price pressure certainly contributes to the predictability of IDYS but the results in Table 16 confirm that price pressure is not the only reason for this cross-market predictability. To examine this point further, we now consider the performance of IDYS, measured on the day before the cum-day, in predicting ex-day returns.

Table 16: **This table depicts median returns sorted by cum-dividend date stock returns (CUM RET). The first column denotes the quintiles of CUM RET from low to high values. The second column records the number of observations in each quintile. The third column presents the median CUM RET value for each quintile. Columns (4) to (7) depict, respectively, the median implied dividend yield spread (IDYS), the median ex-day stock returns excluding the discounted dividend (EX RET EXCL. DIV), the median discounted dividend yield (DIV YIELD), and the median ex-day stock returns including the discounted dividend payment (EX RET INCL. DIV). Columns (8) to (11) depict, respectively, the median beta (BETA), idiosyncratic risk (IDIO), Amihud measure (ILLIQ), and dividend amount (DIV) for each quintile. *,** and *** denote significance at the 10%, 5% and 1% level, respectively, where a rank-sum test is used to test differences in medians. Rank-sum z-values are reported in parentheses.**

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
		Median Values								
QUINTILE	N	CUM RET	IDYS	EX RET (EXCL. DIV)	DIV YIELD	EX RET (INCL. DIV)	BETA	IDIO	ILLIQ$\times 10^8$	DIV
Q1 = Low	2,592	-2.39%	-0.01%	-0.30%	0.38%	0.18%	1.2018	0.0182	0.6196	0.150
Q2	2,592	-0.82%	-0.02%	-0.41%	0.45%	0.14%	1.0451	0.0136	0.4138	0.220
Q3	2,592	0.00%	-0.03%	-0.48%	0.48%	0.10%	1.0007	0.0123	0.3498	0.240
Q4	2,592	0.85%	-0.04%	-0.48%	0.45%	0.10%	1.0254	0.0133	0.3360	0.228
Q5 =High	2,592	2.38%	-0.07%	-0.48%	0.40%	0.05%	1.1915	0.0182	0.5855	0.170
H-L		4.77%***	-0.06%***	-0.19%**	0.02%	-0.13%**	-0.0102***	0.0000	-0.0340	0.020***
z-value		(62.348)	(-14.401)	(-2.004)	(1.636)	(-1.965)	(-6.210)	(0.077)	(-0.898)	(2.730)

IDYS measured on the day before the cum-day excludes the excess selling or buying pressure in the stock price on the cum-day itself. Table 17 reports median cum-day IDYS values, cum-day returns and ex-day returns along with stock risk factors and characteristics, sorted into quintiles by the value of IDYS as measured on the day before the cum-day[17]. The median quintile values of the sorting variable, cum-day-1 IDYS, presented in column (3) of Table 17, are very similar to the median values when sorting by IDYS measured on the cum-day, presented previously in Tables 7 and 15. Column (4) depicts the median cum-day IDYS value sorted by the previous day's IDYS value. It is clear that there is persistence in IDYS as sorting on the previous day's IDYS value predicts the cum-day IDYS value with a statistical significance of 1%. However, the difference between quintile 1 and 5 median cum-day IDYS drops to 0.12%. Cum-day-1 IDYS also predicts cum-day returns, as expected, however the difference between the first and fifth quintile cum-day median returns is 0.13% as opposed to the larger spread of 0.24% when cum-day IDYS is used to predict ex-day returns, as reported in Tables 7 and 15. The cum-day median returns do not increase monotonically with cum-day-1 IDYS suggesting that cum-day-1 IDYS is a noisier predictor of cum-day returns with less potential for abnormal returns relative to the performance of cum-day IDYS in predicting ex-day returns. The cum-day median returns when sorted by the previous day's IDYS value are ,pre symmetric about zero with quintile 1 median cum-day returns of -0.08% versus quintile 5 median cum-day returns of 0.06% relative to ex-day returns. This demonstrates that there is lower potential for abnormal returns when predicting cum-day returns

[17]If the ex-day occurs on a Monday, the day before the cum-day is taken to be a Friday.

with the previous day's IDYS value versus the prediction of ex-day returns with the cum-day IDYS value. When predicting ex-day returns with cum-day IDYS, quintile 1 has a median ex-day return of -0.01% and quintile 5 had a median ex-day return of 0.23%. Despite stock price pressure on the cum-day not playing a role in the value of IDYS, when IDYS is measured on the day before the cum-day, there remains evidence that cum-day-1 IDYS predicts ex-day returns (both including and excluding discounted dividends). The prediction is weaker when compared to using cum-day IDYS, nevertheless cum-day-1 IDYS predicts ex-day returns. The difference between the high and low quintiles of 0.11% is statistically significant at the 5% level. Ex-day returns also increase monotonically with the value of cum-day-1 IDYS. The lowest (highest) quintile median ex-day return is 0.06% (0.17%) which compares well with the lowest (highest) quintile median cum-day return of -0.08% (0.06%). Again, we see evidence of the ex-day returns getting a lift from the fact that stock prices drop by less than the discounted dividend on the ex-day. When comparing the results of this table to Table 16, we see that the spread between the low and high quintile ex-day stock returns reduces by approximately 50% to 0.11% when price pressure is excluded from the prediction by using IDYS measured on the day before the cum-day. Thus, there is still cross-market predictability from the options market to the stock market even when excluding the cum-day build up in stock price pressure. We will examine the contribution of price pressure, public information and private information to cross-market predictability in more detail with the use of regression models in the following section.

Table 17: **This table depicts median returns sorted by the Implied Dividend Yield Spread as measured on the day before the cum-dividend date (CUM-1 IDYS). The first column denotes the quintiles from low to high values. The second column records the number of observations in each quintile. The third column presents the median CUM-1 IDYS value for each quintile. Columns (4) to (8) depict, respectively, the median CUM IDYS value, the median cum-day stock return (CUM RET), the median ex-day stock return excluding the discounted dividend (EX RET EXCL. DIV), the median discounted dividend yield (DIV YIELD), and the median ex-day stock return including the discounted dividend payment (EX RET INCL. DIV). Columns (9) to (12) depict, respectively, the median beta (BETA), idiosyncratic risk (IDIO), Amihud measure (ILLIQ), and dividend amount (DIV) for each quintile. *,** and *** denote significance at the 10%, 5% and 1% level, respectively, where a rank-sum test is used to test differences in medians. Rank-sum z-values are reported in parentheses.**

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
		Median Values									
QUINTILE	N	CUM-1 IDYS	CUM IDYS	CUM RET	EX RET (EXCL. DIV)	DIV YIELD	EX RET (INCL. DIV)	BETA	IDIO	ILLIQ$\times 10^8$	DIV
Q1=Low	2,592	-0.25%	-0.12%	-0.08%	-0.53%	0.42%	0.06%	1.1695	0.0194	0.7912	0.175
Q2	2,592	-0.10%	-0.05%	0.03%	-0.43%	0.42%	0.07%	1.0842	0.0146	0.4339	0.200
Q3	2,592	-0.04%	-0.03%	-0.04%	-0.43%	0.44%	0.09%	1.0560	0.0133	0.3387	0.225
Q4	2,592	0.03%	-0.02%	0.05%	-0.35%	0.43%	0.17%	1.0774	0.0132	0.3578	0.220
Q5=High	2,592	0.13%	0.01%	0.06%	-0.40%	0.44%	0.17%	1.1059	0.0158	0.4926	0.180
H-L		0.38%***	0.12%***	0.13%***	0.13%**	0.02%	0.11%**	-0.0636***	-0.0037***	-0.2986***	0.005*
z-value		(62.348)	(24.054)	(2.887)	(2.181)	(1.560)	(2.022)	(-6.543)	(-12.297)	(-9.622)	(1.790)

VIII. Hedged and Unhedged Ex-Day Stock Returns

In this section we develop simple linear models for unhedged and hedged ex-dividend day stock returns in order to gain insight into the cross-market predictability from the options market to the stock market over ex-dividend events. Before we move on to consider the sources of cross-market predictability, we first consider a baseline regression model for ex-day hedged and unhedged returns. To construct this baseline model we use an extended version of put-call parity for a set of American call and put option pairs with cum-dividend date prices denoted, respectively, by C_c and P_c, where all put-call pairs have the same strike price and expiry date, and where the maturity of the options only covers one ex-dividend date.

We can write the value of an American synthetic forward[18], F_c^A, on the cum-dividend date as the difference between the price of an American style call and put on that date:

$$\begin{aligned} F_c^A &= C_c - P_c = c_c - p_c + \pi_c^{call} - \pi_c^{put} \\ &= S_c - Ke^{-r\tau} - IDE^* + \pi_c^{call} - \pi_c^{put}, \end{aligned} \tag{8}$$

where c_c and p_c denote, respectively, cum-dividend date European call and put

[18]We refer to the position that is long an American style call and short an American style put as a synthetic forward contract even though this position does not exactly replicate a forward contract as the holder of the synthetic forward position can have the put option exercised early against them.

prices with the same strike price and expiry date, π_c^{call} and π_c^{put} denote, respectively, the cum-dividend date early exercise premia of the call and put options, S_c is the cum-dividend date stock price, K is the strike price for both options, and IDE^* is the implied discounted dividend[19] associated with European call and put option prices. We restrict our dataset to use only at-the-money or out-of-the-money cum-day call options where $\pi_c^{call} \approx 0$. However, it must be noted that we can only estimate IDE^* by approximating the early exercise premia of the call and put options on the cum-dividend day[20], as the options in our data sample are American style.

On the ex-dividend date there is no further dividend by construction so the synthetic forward price can be expressed as:

$$\begin{aligned} F_x^A &= C_x - P_x = c_x - p_x + \pi_x^{call} - \pi_x^{put} \\ &= S_x - Ke^{-r(\tau - \delta t)} + \pi_x^{call} - \pi_x^{put}, \end{aligned} \tag{9}$$

where δt represents the time between the cum-dividend date and the ex-dividend date and where the subscript x denotes the option prices (or early exercise premia) are recorded on the ex-date.

Using Equations (8) and (9), the change in the synthetic forward price from the cum to the ex-dividend day can be written as:

[19]The implied dividend is discounted from the dividend payment date which follows one to two weeks after the ex-dividend day.

[20]We estimate European option prices using equation (4) as detailed in Section (V)

(10) $$\delta F^A = \delta S - rKe^{-r\tau}\delta t + IDE^* + \delta\pi^{call} - \delta\pi^{put}.$$

Adding the actual discounted dividend, D^*, to Equation (10) and re-arranging gives:

$$\delta S + D^* - \delta F^A = rKe^{-r\tau}\delta t + D^* - IDE^* - \delta\pi_x^{call} + \delta\pi_x^{put}.$$

Dividing both sides by the spot price on the cum-dividend date, S_c, gives the cum to ex-dividend day hedged spot returns (HGD_RET):

(11)
$$\left(\delta S + D - \delta F^A\right)/S_c = r\left(Ke^{-r\tau}/S_c\right)\delta t + \left(D^* - IDE^*\right)/S_c + \left(\delta\pi_x^{put} - \delta\pi_x^{call}\right)/S_c.$$

We have filtered our dataset to contain only out-of-the-money call options on the cum-day with a single up-and-coming dividend payment. Thus, on the cum-day, the early exercise premia on the out-of-the-money call options, π_c^{call}, should be zero[21]. Furthermore, on the ex-day the options in our dataset no longer include a dividend payment hence, the early exercise premium on the ex-day call, π_x^{call}, should be zero. Therefore, the change in the early exercise premia of call options

[21] Jensen & Pedersen (2016) show that market frictions, such as short sale costs, transactions costs or funding costs, can induce a non-zero early exercise value, even for American call options on non-dividend paying stocks. Hence, in Equation 11 we are assuming that the early exercise premia due to market frictions for out-of-the-money cum-day and ex-day American call options, π_c^{call} and π_x^{call}, are both zero.

over the ex-day, $\delta\pi_x^{call} = \pi_x^{call} - \pi_c^{call}$, should be zero. On the other hand, American put options that are in-the-money will include an early exercise premium whether the stock is due to pay a dividend or not. Using this information we can simplify Equation (11) to the following:

$$\text{(12)} \qquad \left(\delta S + D^* - \delta F^A\right)/S_c = r\left(Ke^{-r\tau}/S_c\right)\delta t + \left(D^* - IDE^*\right)/S_c + \delta\pi_x^{put}/S_c.$$

We define hedged returns as HGD_RET $= \left(\delta S + D^* - \delta F^A\right)/S_c$; let the risk-free return RF_RET $= r\left(Ke^{-r\tau}/S_c\right)\delta t$ with δt being either 1/360 or 3/360 depending on whether the ex-event occurs over a weekday or over a weekend; define the implied dividend yield spread as IDYS $= \left(D^* - IDE^*\right)/S_c$, which is equal to the spread between the declared discounted dividend and the implied discounted dividend on the cum-dividend day, extracted from European style options, normalised by the cum-dividend day stock price; and let δEEP_PUT $= \delta\pi_x^{put}/S_c$ represent the change in the early exercise premium of the American put option over the ex-dividend day normalised by the cum-dividend day stock price. The size of the early exercise premium on the cum-date and ex-date, for the reasonably short-dated put options in our dataset, is dependent largely on the forward moneyness of the option. Furthermore, we want to restrict the right hand side variables to use information from the cum-dividend day only. Hence, we proxy δEEP_PUT using the expected change in the forward put option moneyness, δPUT_MNY, using only cum-day information as follows:

$$\delta\text{PUT\_MNY} = \text{PUT\_MNY}_x - \text{PUT\_MNY}_c,$$

where cum-day put moneyness is proxied by $\text{PUT\_MNY}_c \approx Ke^{-r\tau}/S_c - 1$ and expected ex-day put moneyness is proxied by $\text{PUT\_MNY}_x \approx Ke^{-r(\tau-\delta t)}/\left(S_c - D^*\right) - 1$. In the proxy for expected ex-day put moneyness we assume the expected stock price decline is equal to the declared discounted dividend. The expected change in put forward moneyness, δEEP_PUT, is always positive as the discounted declared dividend $D^* > 0$. This is because the put option is expected to move further in-the-money on the ex-dividend day as the stock price is expected to decline, even if the expected decline is on average less than the discounted dividend.

This motivates the following linear model for hedged returns over the ex-day:

$$\begin{aligned} \text{HGD\_RET}_i &= \alpha + \beta_{\text{RFR}} \times \text{RF\_RET}_i \\ &+ \beta_{\text{IDYS}} \times \text{IDYS}_i + \beta_{\text{PM}} \times \delta\text{PUT\_MNY}_i + u_i \end{aligned} \tag{13}$$

where i is an index representing each cum to ex-dividend day event, and RF_RET, IDYS and δPUT_MNY are the three independent variables that impact the hedged returns in our model. Comparing Equation (13) to Equation (12), we hypothesize that β_{RFR} and β_{IDYS} are equal to 1, although it must be noted that as we only have end-of-day options data (as opposed to cum-day close to ex-day open data) we expect this to impact the estimate of the β_{IDYS} coefficient. As $\delta\text{PUT\_MNY} > 0$ and the hedged return consists of a position that is long a stock, short an American call option and long an American put option (or a portfolio of these options), the early exercise premium of the put option is expected to increase when the stock goes ex-dividend so we expect the coefficient β_{PM} to be positive.

If option implied dividends contain information on ex-day stock returns, we expect IDYS to be a significant factor in predicting the stock returns, which we denote by STOCK_RETS= $(\delta S + D^*)/S_c$ however, we do not expect IDYS to be a significant factor in the prediction of synthetic forward returns, denoted by FWD_RETS $= \delta F^A/S_c$, as forward returns are expected to incorporate this information on the cum-day. Hence, we split the hedged returns into a stock returns component and a synthetic forward returns component as follows:

$$\text{HGD\_RET}_i = \text{STOCK\_RETS}_i - \text{FWD\_RETS}_i,$$

and estimate the regression in Equation (13) using stock returns and synthetic forward returns as dependent variables in place of hedged returns. Finally, we replace stock returns with Fama-French alphas to determine the significance of IDYS in predicting abnormal stock returns.

A. Regression Tests on the Predictability of Ex-Day Returns with Option Implied Dividends

Previous results presented in Table 13, Section VII (A), demonstrate that cum-day IDYS performs poorly in predicting ex-day returns when implied dividends are extracted from put-call pairs with deep-in-the-money put options. Hence, to ensure our regression results are as informative as possible, we filter out the top quintile of cum-day put-call pairs with the deepest-in-the-money put options. This reduces the number of observations from 13,243 ex-day events to 10,594 events. Following Henry & Koski (2017) we also filter out data with dividends less than \$0.01 and data where the cum-day stock price is less than \$5. This further reduces the data to 10,582 points events. Results are similar but slightly noisier when we discard these filters and use all 13,243 ex-day events. Furthermore, we winsorize the right-hand variables at the 1% and 99% level to avoid outliers driving the results. Our results remain very similar if we winsorize at 5% and 95% or if we do not winsorize the data. We do not winsorize the dependent variables. White heteroscedasticity-consistent standard errors are used to compute all t-statistics and p-values.

Table 18 depicts regression results from the estimation of Equation (13) where the dependent variable, that varies across the columns, is chosen to be either: hedged returns, stock returns, forward returns, or FF-alphas. When there are multiple cum-day put-call pairs available on a firm's single ex-day event, we weight the multiple implied dividends by the average open interest on the put-call pair to obtain a single estimate of the implied dividend as described previously in Section V (C). The other predictor variables in the regression are also weighted by open interest. In this case, hedged returns can be interpreted as a position that is long the stock over the ex-day and short multiple synthetic forward contracts (with weights proportional to their open interest) and forward returns are long positions in a portfolio of synthetic forwards (long the call option and short the put option) scaled by the cum-day stock price.

The first column presents results using hedged returns as the dependent variable. All three independent variables are statistically significant at the 1% level. However, β_{RFR} and β_{IDYS} are also statistically significantly different to 1 at the 1% level, with $\beta_{\text{IDYS}} = 0.749 < 1$ which is less than expected, and $\beta_{\text{RFR}} = 3.451 > 1$ which is considerably more than expected, when we compare these coefficient values to their expected values in Equation (12). The most likely reason that $\beta_{\text{IDYS}} = 0.749 < 1$ is that we use cum-day close to ex-day close data to estimate this regression. Hence, in Equation (12) we ignore stock price pressure that af-

Table 18: Table depicting regression results where hedged returns, spot returns, synthetic forward returns and FF-alphas are regressed on the implied dividend yield spread (IDYS), the risk-free return (RF_RET), and on the expected change in put moneyness (δPUT_MNY). White heteroscedasticity-consistent standard errors are used to compute the t-statistics presented in parenthesis. *,** and *** denote significance at the 10%, 5% and 1% level, respectively.

	DEP. VAR.			
INDEP. VAR.	HGD_RETS	STOCK_RETS	FWD_RETS	FF-α
IDYS	0.749***	0.579***	-0.170	0.467***
	(21.85)	(3.71)	(-1.13)	(3.31)
RF_RET	3.451***	2.052	-1.399	5.265***
	(10.44)	(0.93)	(-0.64)	(2.64)
δPUT_MNY	0.031***	-0.086^{**}	-0.117^{***}	-0.102^{***}
	(3.69)	(-2.05)	(-2.81)	(-3.00)
CONSTANT	0.0001**	0.00153***	0.0014***	0.0007**
	(2.16)	(4.39)	(4.12)	(2.15)
# Observations	10,582	10,582	10,582	10,582
R^2_{adj}	24.46%	0.28%	0.06%	0.36%

fects ex-day stock prices from the ex-day open to the ex-day close. Stock returns from the ex-day open to the ex-day close are usually negative, reversing the previous cum-day positive returns, as was previously shown in column (6) of Table 7. This will push down the spot return component of hedged returns resulting in a coefficient β_{IDYS} that is less than one.

The carry coefficient $\beta_{\text{RFR}} = 3.451$ means hedged returns are approximately 3.5 times more sensitive to the carry term, $rK\delta t/S_c$, than expected. We assume there are 360 days in the year and set $\delta t = 1/360$ when the ex-day occurs on a Tuesday to Friday and $\delta t = 3/360$ when the ex-day occurs on a Monday. When we assume there are only 252 trading days in the year and set $\delta t = 1/360$ for all ex-days, the coefficient β_{RFR} increases to 4.356. If we simplify the carry term to $r\delta t$ by ignoring the weighted moneyness of the options used to calculate IDYS, the coefficient remains very similar at 3.556. Thus, the sensitivity of hedged returns to the carry term stems mainly from their dependence on the interest rate r. We use USD LIBOR interest rates in the carry term. Derivatives traders funding costs are not necessarily linked to LIBOR especially since the 2007-2008 financial crisis (e.g., Hull & White, 2012). To investigate this further, we split the data into two sub-samples, the first from 01/1996 to 12/2006 and the second from 01/2007 to 08/2015. The first sub-sample does not include the financial crisis of 2007-2008 and in this period there was more consensus regarding LIBOR as the appropriate rate to use in derivatives valuation. In the first sub-sample the carry coefficient is 1.938, which is considerably less than 3.447 but is still statistically significantly greater than 1 at the 1% level. Restricting the data to the latter sub-sample, from 2007 onwards, results in a carry coefficient of 2.990 which is also statistically significantly greater than 1 but less than the full sample estimate of 3.451. Thus, we observe that hedged returns become more sensitive to the carry term in the latter half of the sample that includes the financial crisis[22]. However, even when the regression is estimated using the first 10 years of data from 01/1996 to 12/2006, the hedged returns are more sensitive to the carry term than expected. As this issue is beyond the scope of this article we leave this to future research. The put moneyness coefficient β_{PM} is positive as expected. The adjusted-R^2 is 24.46%, so only a quarter of the variation in hedged returns, consisting of a long position in one share of the stock and multiple short positions in synthetic forwards, is explained by the variation in the three right-hand-side variables[23].

The second column presents the stock return regression results. The coefficient $\beta_{\mathrm{IDYS}} = 0.579$ and is significant at the 1% level as expected if cum-day IDYS contains information on a stock's ex-day returns. The risk-free return coefficient β_{RFR} is not significant as expected from theory. The moneyness coefficient β_{PM} is positive and significant at the 5% level. This could be due to the presence of the discounted dividend in the proxy for δPUT_MNY. In fact, when the dividend value is included as an additional explanatory variable in the regression, the coefficients

[22]In unreported results we estimate the regression models in Table 18 for both sub-samples separately, where the first sub-sample uses data from 01/1996 to 12/2006 and the second uses data from 01/2007 to 08/2015. The IDYS coefficient in the hedged return regression $\beta_{\mathrm{IDYS}} = 0.737$ in the first sub-sample and $\beta_{\mathrm{IDYS}} = 0.785$ in the second sub-sample, and both are significant at the 1% level.

[23]We also added a fourth variable, cum-day option implied volatility, to the right-hand-side of the equation as a potential factor that may explain the variation in the early exercise value of American put options in the forward returns. Higher cum-day implied volatilities should reduce the early exercise premia of American put options. We find this coefficient to be negative, as expected, but it is insignificant.

associated with δPUT_MNY and the dividend both become insignificant. The constant in the regression is equal to 15 basis points and is significant at the 1% level as expected given ex-day returns are on average positive. There is a large drop in adjusted-R^2 when we move from the hedged return to the spot return regression. This is also expected as the close-to-close stock returns are affected by many factors over the course of the ex-day whereas, the variation in stock returns are often counterbalanced by equal and opposite variations in synthetic forward returns for hedged returns.

The results in the third column of Table 18 depict the synthetic forward returns. Interestingly, the coefficients on IDYS and RF_RET are insignificant, although δPUT_MNY is negative and significant at the 1% level (again this is likely due to the presence of the dividend value in the proxy for δPUT_MNY as this coefficient becomes insignificant if we proxy the change in early exercise value by the put moneyness itself). The constant is equal to 14 basis points, is significant at the 1% level and is almost identical to the constant in the stock returns regression. These results show that synthetic forward price do not react to the implied dividend factor in the same way as the stock prices suggesting that forward prices (constructed from option prices) incorporate information on the ex-day return.

The results in the fourth column depict the Fama-French alphas as a function of the three predictor variables. Results are broadly similar to the stock returns results with IDYS significant at 1%. The constant is significant at 5% and slightly lower at 6 basis points relative to the constant in the stock return regression. The adjusted-R^2 is 0.36% and is slightly higher than the adjusted-R^2 in the stock return regression of 0.28%.

Overall, the results in Table 18 show that IDYS predicts ex-day hedged returns, stock returns and abnormal stock returns, but not ex-day synthetic forward returns. These results are in agreement with the sorting results presented in Table 7 and are consistent with option price quotes and the resulting IDYS factor embedding information on expected stock (abnormal) returns.

Next we focus our analysis on the regression of abnormal returns, as measured by FF-alphas, on the predictor variable IDYS, ignoring the carry term and forward moneyness term as there is no economic reason why these predictors should predict abnormal stock returns. Table 19 presents results where we standardize the predictor IDYS to aid interpretation. Column (2) depicts the baseline univariate regression results where IDYS is significant at the 1% level. A unit standard deviation increase in IDYS contributes approximately 0.08% to the abnormal return alpha. Column (3) shows that IDYS remains significant at the 1% level, with a similar coefficient to the baseline regression in column (2), when stock fixed effects are included in the regression. Column (4) shows that IDYS also remains significant at the 1% level, with a larger coefficient relative to the baseline regression in column (2), when time fixed effects are included in the regression. Thus IDYS is robust to fixed stock effects and fixed time effects. That is, fixing the stock, IDYS predicts ex-day returns over time for that stock. Similarly, fixing the ex-date, IDYS predicts ex-day returns across different stocks that are going ex-dividend on that date.

Table 20 presents results from a series of bivariate regressions where ex-day abnormal returns, as measured by FF-alpha, are regressed on the predictor variables IDYS and a series of control variables that potentially impact ex-day returns and dividend capture. We standardize all predictors by dividing each predictor by its standard deviation to ease the interpretation of the impact each predictor

Table 19: Table depicting regression results where FF-alphas are regressed on the implied dividend yield spread (IDYS), including stock fixed effects and time fixed effects. White heteroscedasticity-consistent standard errors are used to compute the t-statistics presented in parenthesis. *,** and *** denote significance at the 10%, 5% and 1% level, respectively.

	DEP. VAR.: FF-Alpha		
INDEP. VAR.			
IDYS	0.0768%***	0.0651%***	0.1366%***
	(3.25)	(2.94)	(5.44)
STOCK F.E.	No	Yes	No
TIME F.E.	No	No	Yes
CONSTANT	0.0429%***	0.5798%	$-2.864\%^{*}$
	(2.54)	(22.62)	(-1.80)
# Observations	10,582	10,582	10,582
R^2_{adj}	0.19%	5.31%	12.41%

has on abnormal returns. All predictors have also been winsorized at the 1% and 99% level. The constant in the regression has been omitted from the table to save space. In the baseline regression with no control variable we see that a one standard deviation increase in IDYS results in an increase of 0.08% for the abnormal stock return and this coefficient is significant at the 1% level. In fact, in the bivariate regressions the coefficient on IDYS remains remarkably stable and is always statistically significant at the 1% level. All other controls, with the exception of dividend and dividend yield, are insignificant. The dividend and dividend yield coefficient are significant at the 5% and 1% level, respectively. In both cases, we see that high dividends and high dividend yields result in reductions in expected abnormal returns of approximately 0.04% and 0.06%, respectively. It should be noted that in these two bivariate regressions where the dividend and dividend yield are included as controls, the constant actually increases from the baseline regression constant of 0.04% (t-stat 2.54) to 0.09% (t-stat 3.16) when the dividend is used as a control and 0.11% (t-stat 3.96) when the dividend yield is used a control. Higher dividends (dividend yields) reduce expected abnormal returns however, IDYS remains statisically significant[24]. The CUM_RETS coefficient is not significant and had a positive value which is the opposite to expected from the stock price pressure theory. However, in a univariate regression where abnormal ex-day returns are regressed on CUM_RETS as the single predictor variable, the coefficient is negative, as we would expect if the price pressure theory holds, but remains insignificant. We investigate this issue further in the next section.

The results in this subsection demonstrate that IDYS predicts abnormal stock

[24]The correlation between IDYS and DIV is -2.28% and between IDYS and DIV_YIELD is -7.12% so multicollinearity is not an issue with these results.

Table 20: Table depicting bivariate regression results where the dependent variable abnormal stock returns, measured by FF-alpha, is regressed on the implied dividend yield spread (IDYS) and a control variable. BETA is the market beta of the stock from the FF-model. IDIO_RISK is the stock idiosyncratic risk. ILLIQ is the stock Amihud illiquidity measure. DEC_DIV is the declared dividend amount. DIV_YIELD is the declared dividend annualised yield. CUM_RET is the cum-day return of the stock. All predictors are normalized by their standard deviation to aid interpretation. White heteroscedasticity-consistent standard errors are used to compute the *t*-statistics presented in parenthesis. *, and *** denote significance at the 10%, 5% and 1% level, respectively.**

DEPENDENT VARIABLE: FF-ALPHA						
CONTROL NAME	IDYS	(t-stat)	CONTROL COEFF.	(t-stat)	Obs.	R^2_{adj}
NO CONTROL	0.0768%***	(3.25)	-	-	10,582	0.19%
BETA	0.0765%***	(3.24)	−0.0133%	(-0.64)	10,582	0.19%
IDIO	0.0788%***	(3.35)	0.0171%	(0.70)	10,582	0.20%
ILLIQ	0.0770%***	(3.26)	−0.0171%	(-0.94)	10,582	0.20%
DIV	0.0759%***	(3.22)	−0.0384%**	(-2.49)	10,582	0.24%
DIV_YIELD	0.0728%***	(3.09)	−0.0563%***	(-3.30)	10,582	0.29%
CUM_RET	0.0776%***	(3.24)	0.0052%	(0.22)	10,582	0.19%

returns and is robust to control variables that potentially impact ex-day returns and dividend capture activity. We investigate the potential sources of IDYS predictability in the next subsection.

B. Source of Stock Predictability

The previous regression tests provide evidence that IDYS extracted from option prices on the cum-day, predict ex-day stock abnormal returns. There are a number of potential sources for this predictability. One potential explanation is that this predictability is a result of informed options trading (Easley *et al.*, 1998 and An *et al.*, 2014). A second potential explanation is that public information on ex-day expected stock returns is reflected in option price quotes on the cum-day (Goncalves-Pinto & Xu, 2018) indicating that options market makers are skilled at processing this public information. A third potential explanation is that stock price reversals caused by buying (selling) pressure and limited stock liquidity are anticipated by options market makers and incorporated into their option price quotes (Goncalves-Pinto *et al.*, 2017).

To assess the source of IDYS predictions Table 21 presents regression results from the estimation of the following bivariate regression equation:

$$\begin{aligned} \text{FF-Alpha}_i &= \beta_0 + \beta_{\text{IDYS}} \times \text{IDYS}_i \\ &+ \beta_{\text{INT}} \times \text{IDYS}_i \times \text{INT}_i + u_i \end{aligned} \tag{14}$$

where the following stock risk and characteristic variables are used as the interaction variable INT: systematic market risk BETA; idiosyncratic risk IDIO; Amihud stock illiquidity ILLIQ; dividend amount DIV; dividend yield DIV_YIELD; and cum-day returns CUM_RETS. We also use option based characteristics that impact the calculation of IDYS as candidates for the interaction term including: the weighted average put moneyness MNY; the weighted average maturity MAT; and the weighted average option relative spread O_BA.

Table 21 reports the interaction regression results of Equation (14). The main predictor IDYS remains significant in the presence of the interaction terms with the exception of the regressions involving the interaction of IDYS with BETA and IDYS with IDIO. The only significant interaction coefficient is the interaction of IDYS with ILLIQ. Higher stock illiquidity strengthens the relationship between abnormal ex-day stock returns and cum-day IDYS. This is expected as less liquid stocks undergo less dividend capture resulting in more predictable ex-day returns. The interaction coefficient of IDYS with CUM_RET is negative as expected from the stock price pressure theory as higher cum-day stock returns attenuates the relation between abnormal ex-day stock returns and cum-day IDYS however, this interaction coefficient is not significant. Similarly, higher values of moneyness, maturity, and option relative spread attenuate the relationship between abnormal ex-day stock returns and cum-day IDYS. This is expected as measures extracted from these options with higher frictions are potentially noisier, however these interaction terms are not significant. These regression results are not informative enough to shed light on the sources of IDYS predictability so we examine regression results of IDYS as the dependent variables on cum-day factors to determine the most important contributor to IDYS.

Table 22 reports the regression results where the dependent variable is cum-day IDYS and the predictor variables are cum-day-1 IDYS and contemporaneous cum-day returns. In the univariate regression results reported in the second column

Table 21: Regression results where hedged returns are regressed on the implied dividend yield spread (IDYS) and an interaction term (INT) along with control terms. STOCK_ILLIQ measures stock illiquidity with the Amihud method. OPTION_ILLIQ measures option illiquidity with the option relative bid-ask spread. SO_ILLIQ is the ratio of stock illiquidity to option illiquidity. DEC_DIV is the declared dividend amount. DIV_YIELD is the declared dividend annualised yield. IDIO_RISK is the stock idiosyncratic risk. BETA is the beta of the stock. White heteroscedasticity-consistent standard errors are used to compute the *t*-statistics presented in parenthesis. *, and *** denote significance at the 10%, 5% and 1% level, respectively.**

	DEPENDENT VARIABLE: FF-ALPHA					
INT VARIABLE	IDYS	(t-stat)	IDYS $\times$ INT COEFF.	(t-stat)	Obs.	R^2_{adj}
NO INTERACTION	0.454***	(3.25)	-	-	10,582	0.19%
BETA	0.383	(1.26)	0.066	(0.22)	10,582	0.19%
IDIO	−0.051	(-0.14)	25.743	(1.19)	10,582	0.27%
ILLIQ	0.437***	(3.10)	0.663***	(3.38)	10,529	0.22%
DIV	0.348*	(1.80)	0.323	(0.99)	10,582	0.20%
DIV_YIELD	0.376**	(2.00)	10.114	(0.69)	10,582	0.19%
CUM_RET	0.460***	(3.24)	−3.053	(-0.44)	10,582	0.19%
MNY	0.949***	(2.84)	−14.260	(-1.59)	10,582	0.27%
MAT	0.691**	(2.09)	−1.952	(-0.93)	10,582	0.20%
O_BA	0.578**	(2.36)	−1.453	(-0.48)	10,559	0.20%

Table 22: Table depicting regression results where the dependent variable cum-day IDYS is regressed on the predictor variables cum-day-1 IDYS (CUM_DAY_MINUS_1_IDYS) and cum-day returns (CUM_DAY_RETS). White heteroscedasticity-consistent standard errors are used to compute the t-statistics presented in parenthesis. *,** and *** denote significance at the 10%, 5% and 1% level, respectively.

	DEP. VAR.: CUM_DAY_IDYS		
INDEP. VAR.			
CUM_DAY_MINUS_1_IDYS	0.5353^{***}		0.541^{***}
	(16.28)		(16.57)
CUM_DAY_RETS		-0.0183^{***}	-0.0198^{***}
		(-10.71)	(-11.95)
CONSTANT	-0.0003^{***}	-0.0006^{***}	-0.0003^{*}
	(-14.59)	(24.24)	(-14.60)
# Observations	12,963	12,963	12,963
R^2_{adj}	15.26%	1.89%	17.47%

we see that cum-day IDYS strongly depends on cum-day-1 IDYS with a highly significant coefficient of 0.535 and with an adjusted-R^2 of 15.26%. Thus, IDYS is persistent in that high values on the day before the cum-day are likely to be high on the cum-day. The univariate regression of IDYS on contemporaneous cum-day returns (evaluated from the close on the day before the cum-day to the close on the cum-day) shows a highly significant negative relation as we expect from the price pressure theory, although the adjusted-R^2 of 1.89% shows us that variation in cum-day price pressure only explains a minor proportion of the variation of option implied predictions of expected ex-day stock returns. Finally, when we include both predictors in the regression we see that they both remain highly significant and we also observe an increase in the adjusted-R^2. So although cum-day stock price pressure is certainly an important contributor to option implied predictions of ex-day stock returns, we see that the cum-day-1 IDYS value is a more significant contributor to IDYS. This agrees with the sorting results in Tables 16 and 17 of Section VII (B). In the next section we consider the potential gains achievable from selective dividend capture using option implied information.

IX. Economic Significance

To assess the economic significance of the information embedded in option implied dividends we consider a simple trading strategy that exploits the information embedded in option implied dividends and examine the profitability of this trading strategy. The unconditional or naïve strategy invests in all stocks (in our restricted dataset) that are going ex-dividend. We assume these stocks are purchased on the cum-dividend day market close and sold on the ex-dividend day market close. We also estimate the returns from a conditional strategy where we only invest in ex-dividend stocks if the ratio of the implied dividend to the dividend on the cum-dividend date is less than 0.75. Here, we compare the ratio of the implied dividend to the dividend as a very simple rule of thumb rather than use the more sophiscated IDYS to make decisions[25]. It must be noted that we are ignoring transactions costs and market impact in this analysis. However, we carry out this analysis to compare selective dividend capture to naïve dividend capture where we also do not include transactions costs and market impact in the latter strategy. It also should be pointed out that we consider these returns from holding the position from cum-day close to ex-day close and thus, these strategies include the negative stock price return from the ex-day open to the ex-day close. Finally,

[25]Results are more impressive when we use IDYS for selective dividend capture.

the returns to the selective dividend capture, whilst impressive, are most likely a risk premium for taking positions in stocks that are riskier, less liquid, or have small to medium dividends.

The distributions of naïve dividend capture strategy (purchasing all stocks going ex-dividend over the ex-day) and option implied selective dividend capture strategy are compared in Table 23 below and it is clear that the returns from the strategy using option implied dividend information are superior to those from the naïve strategy. The option implied dividend strategy has a mean (median) daily return of 0.33% (0.24%) relative to 0.13% (0.11%) for the naïve strategy. The volatility (as measured by simple standard deviation) of the option implied dividend strategy is 2.93% which is higher than the volatility of the naïve strategy of 2.42%. However, the option implied dividend strategy has a larger positive skewness value of 0.76 versus 0.35 for the naïve strategy. The t-statistic for the mean return of the option implied dividend strategy is 4.50 which is significant at the 1% level.

Table 23: Stock returns on all ex-dates and select ex-dates

Statistic	Stock returns all ex-dates	Stock returns when ratio < 0.75
Mean	0.13%	0.33%
Median	0.11%	0.24%
Standard deviation	2.42%	2.93%
Standard error	0.02%	0.07%
Skew	34.78%	76.12%
Kurtosis	823.01%	990.70%
N	13,1345	1,604

A. Estimating the Significance of Trading Strategy Profitability

We next consider the abnormal returns from the naïve dividend capture strategy and the selective dividend capture strategy by considering CAPM-alphas[26]. The results in Table 24 show that the market factor is highly significant in both strategies as we would expect for any long-only strategy and both strategies have a beta larger than 1 although the option implied selective dividend capture strategy has higher systematic risk. The CAPM-alpha is significant at the 1% level for both strategies but at 0.05% may not be economically significant for the naïve dividend capture strategy whereas the 0.18% for the option implied dividend strategy is much more likely to generate economic profits. The excess market return explains a similar proportion of variation in each strategy with an adjusted R^2 of 30.44% for the unconditional strategy and an adjusted R^2 of 27.73% for the option implied dividend strategy.

[26]The results for Fama-French alphas are slightly better so to be more conservative we report CAPM alphas

Table 24: Linear models for unhedged trading strategies: White heteroscedastic consistent t-statistics in $(\cdot)$

	UR All Dates	UR Ratio < 0.75
β	1.096***	1.230***
	(47.69)	(17.68)
α	0.0005***	0.0018***
	(2.67)	(2.90)
Observations	13,145	1,603
R^2_{adj}	30.44%	27.73%

Summary statistics on the distribution of the ex-day stock returns are given in Table 25 and show clearly the superior return of the option implied dividend strategy versus the unconditional strategy or the market return (MR) although both the unconditional and option implied strategies are not diversified as seen by their high standard deviations that are approximately twice the level of the market return standard deviations. It is worth noting the large positive skew of the option implied dividend strategy whereas the skewness for the market strategy is negative. Also the Sharpe ratio of the option implied dividend strategy at 11.86% is much better than the 4.26% for the unconditional version.

It is interesting that the market return over those dates when the ratio is < 0.75 is superior to that over all dates. There appears to be some effect on the broader market of dividend capture in the stock(s) which are going ex-dividend but this point is beyond the scope of this article.

Table 25: Comparison of Strategies

Statistic	Market Return All Obs	Stock Return All Obs	Market Return Ratio < 0.75	Stock Return Ratio < 0.75
Mean	0.07%	0.13%	0.13%	0.33%
Standard deviation	1.22%	2.42%	1.29%	2.93%
Skew	-45.46%	34.78%	-51.89%	76.12%
Kurtosis	673%	892%	527%	991%
Sharpe Ratio (Daily)	5.54%	4.94%	9.43%	11.06%

A.1. Comparative Utility

In Table 25 it is clear that the option implied dividend strategy is more profitable than the benchmark but that these extra returns are achieved in part by taking on more volatility which is not surprising as the ex-dividend strategies (both naïve and option implied) are usually invested in a single stock on a given ex-date (unless there is more than one stock going ex-dividend on a particular date) hence these are positions are undiversified. The positive skew of the option implied dividend strategy returns make for very attractive cumulative returns but the daily standard deviation of the strategy is more than twice that of the market index.

One approach to comparing two strategies, that takes into account higher moments, is that adopted by Martin *et al.* (2017) building on Fleming *et al.* (2001) where they solve for the performance fee that when applied to the stock strategy would give the same average utility to a representative investor with a particular level of relative risk aversion as an investment in the appropriate benchmark.

Specifically we solve for Φ such that

$$\bar{U}(R_{Strategy} - \Phi) = \bar{U}(R_{Benchmark}) \tag{15}$$

where $\bar{U}(R_{Strategy})$ and $\bar{U}(R_{Benchmark})$ are the average realised utilities of the strategy and the index benchmark respectively. Using a CRRA utility function, which is increasing (decreasing) in the third (fourth) moment of returns, the average realised utility of any strategy k can be calculated as follows:

$$\bar{U}(R_k) = W_0 \left(\sum_{t=1}^{T} \left(\frac{R_{k,t}^{1-\rho}}{1-\rho} \right) \right) \tag{16}$$

where ρ is the coefficient of relative risk aversion, W_0 is initial wealth and $R_{k,t}$ is the return on strategy k on day t.

In keeping with Martin *et al.* (2017) we calculated the performance fee for three different levels of relative risk aversion with the results in Table 26. The interpretation of these results is that for an individual with low relative risk aversion, $\rho = 1$, there would need to be an daily fee for holding a position in the stock strategy of 0.17% for such an investor to be indifferent between the stock strategy and holding a long position in the market. For an investor with an average level of relative risk aversion, $\rho = 3$, the daily fee would need to be 0.10%. Finally, for an extremely risk averse investor, $\rho = 10$, the market has a higher average realized utility than the selective dividend capture strategy and thus a negative fee of -0.13% would be required on the selective dividend capture for such an investor to be indifferent between the two.

Table 26: Comparison of Utility

Coefficient of Relative Risk Aversion	Daily Performance Fee
$\rho = 1$	0.17%
$\rho = 3$	0.10%
$\rho = 10$	-0.13%

In summary the comparative utility findings in Table 26 show that this stock strategy is extremely compelling, so much so that the average investor with a typical level of risk aversion of 3 would be willing to pay an daily fee of 0.10% to earn the returns from this strategy rather then earn the total return on the market index. Much of the attraction of the stock strategy from an investor perspective is due to the large positive skew of its returns particularly when compared with the negative skew of the returns on the market. It must be noted that stock transactions would lower the performance fees reported and that these returns are a reward for taking long ex-day positions in stocks with higher idiosyncratic risk, lower liquidity and lower to medium dividends.

X. Conclusions

We find the continued presence of the ex-dividend day effect that stock price declines on the ex-dividend date are on average less than the discounted dividend resulting in positive abnormal ex-dividend day stock returns. In line with the previous research on the ex-day effect, we find that stocks with higher dividend yields experience stock price declines that are closer to the discounted dividend resulting in lower ex-day abnormal returns when compared to lower dividend yield stocks, as it is more worthwhile for short term traders to capture the dividends on these high dividend yield stocks.

Although in theory option implied dividends should reflect the fact that the expected stock price decline on the ex-dividend day is lower than the discounted declared dividend, we find that the mean and median option implied dividend is comparable to but larger than the discounted declared dividend. We find evidence to sugguest that this is most likely due to option implied dividends embedding stock loan fees. Despite this, we find that a measure based on the difference between declared dividend yields and option implied dividend yields extracted on the cum-dividend day predicts ex-dividend day stock returns and abnormal stock returns.

Using non-parametric sorting methods we find that stocks with high (low) values of implied dividend yield spread on cum-dividend days are more likely to experience high (low) stock returns and abnormal stock returns over the ex-dividend day. The difference in upper and lower quintile median daily stock returns is 0.24% and for abnormal stock returns is 0.17%, which is both statistically and economically significant.

In parametric regressions we find the implied dividend yield spread, significantly predicts stock returns and abnormal returns from the cum-dividend day to the ex-dividend day and is robust to firm characteristics, firm risk factors and option related factors. Consistent with option market makers incorporating public information into their option price quotes, we find that the strength of IDYS is weaker for higher dividend yield stocks which are known to have lower abnormal returns over the ex-day. Furthermore, the relationship between IDYS and subsequent stock returns is stronger for less liquid stocks, riskier stocks and stocks with lower to medium dividends. Our findings suggest that options market makers are sophisticated investors who incorporate public information on ex-dividend day expected stock returns into their option price quotes resulting in predictability flowing from the options market to the stock market that is not necessarily as a result of informed trading. We also find that stock price pressure forms a component of this cross-market predictability.

Finally, we explore the economic significance of an option implied selective dividend capture strategy that is long stocks over ex-dividend dates when the ratio of the implied dividend to the declared dividend is below a threshold. This option implied strategy is highly profitable with a mean daily return close to three times the contemporaneous market mean daily return alongside a standard deviation that is double the market standard deviation. The skewness of this strategy is strongly positive whereas the skewness of contemporaneous market returns is highly negative. The expected utility performance fee, that takes account of higher moments such as skewness and kurtosis, shows that an investor would pay to give up this strategy in favour of the benchmark for reasonably levels of risk aversion.

XI. Appendix - Asynchronicity between option and stock markets

There is a potential issue with using OptionMetrics data to extract the prices of puts and calls and then using these values in the put-call parity equation. These calculations assume that the option prices and the stock prices are contemporaneous and there is a subset of OptionMetrics data for which is not the case. The issue is raised in Cremers & Weinbaum (2010) and is discussed in more detail in an appendix to Battalio & Schultz (2006) where they explain that there are options in the database whose prices are taken at 4.02 pm Eastern Time despite the market for the underlying stock having closed 2 minutes earlier in New York at 4 pm Eastern Time. This time difference could lead to a foresight bias and spurious predictability in option implied information. As described in Cremers & Weinbaum (2010) "Any evidence that option prices contain information not yet incorporated in the prices of the underlying securities could simply be due to nonsynchronicity".

This issue affects OptionMetrics data prior to 1^{st} February 2006 and it only affected the closing prices of options from the ISE exchange. The ISE exchange has since been acquired by Nasdaq and the OptionMetrics database does not differentiate between the two so that all options which traded on ISE are marked as Nasdaq options. In our dataset only 3,812 are from before 1^{st} February 2006 and of these only 527 or 13% are Nasdaq options so only 4% of the 13,243 observations in the entire dataset could be affected by this issue. In fact even this is very conservative as it assumes that all Nasdaq options are at risk when in fact only a small fraction of these will have been from the ISE exchange. However, adopting the most conservative policy and excluding all 527 observations and re-running the sorting results above we found that the results were unchanged.

We also fitted the univariate model of unhedged returns to a reduced dataset where all observations from before 1^{st} February 2006 with options listed on Nasdaq have been removed. This left a total of 12,633 observations and the results of fitting the model to this set is in Table 27. The coefficient of IDYS is significant at the 1% level.

Table 27: Regressing Unhedged Spot Returns (UR) on IDYS(Reduced Set): Coefficients are scaled to be interpreted as the change in the dependent variable resulting from a one standard-deviation increase in that independent variable. White heteroscedastic consistent t-statistics in $(\cdot)$

	UR
IDYS	0.0010^{***}
	(3.27)
Constant	0.00159^{***}
	(6.86)
Observations	12,633
R^2_{adj}	0.17%

These tests show conclusively that our results are robust to the exclusion of any observation where the option price may have been taken from after the close of the market in the underlying stock and thus our results are not affected by foresight bias.

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