Waiting Costs and Limit Order Book Liquidity: Evidence from the Ex-Dividend Deadline in Australia*

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Abstract

Recently developed theoretical models suggest a link between order aggressiveness, spreads and waiting time. We directly test these models using an experimental setting where waiting time is likely to be important for traders, namely the ex-dividend day. Consistent with theoretical predictions, we show that order placement is more aggressive before stocks begin trading ex-dividend and that spreads decline. Stocks with higher expected costs of delaying execution experience larger declines in order aggressiveness from the cum-day to the ex-day. Waiting costs also impact effective bid-ask spreads, which fall on the cum-day before rising on the ex-day.

Keywords: order aggressiveness, liquidity, bid-ask spread, ex-dividend day.

JEL classification: G14

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Abstract

Recently developed theoretical models suggest a link between order aggressiveness, spreads and waiting time. We directly test these models using an experimental setting where waiting time is likely to be important for traders, namely the ex-dividend day. Consistent with theoretical predictions, we show that order placement is more aggressive before stocks begin trading ex-dividend and that spreads decline. Stocks with higher expected costs of delaying execution experience larger declines in order aggressiveness from the cum-day to the ex-day. Waiting costs also impact effective bid-ask spreads, which fall on the cum-day before rising on the ex-day.

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1. Introduction

We test the theoretical predictions of recent limit order market models by Foucault, Kadan and Kandel (2005), and Roşu (2009) where the cost of waiting to trade is important. Such models are difficult to test empirically because i) they describe settings where only uninformed participants trade and ii) they require detailed intraday data. To overcome these difficulties, we examine how waiting costs impact order choice, order aggressiveness, market depth and bid-ask spreads around ex-dividend days on the Australian Securities Exchange (ASX).[1]

Our setting has several distinct advantages. First, the ex-dividend day represents a corporate event where traders face a deadline, liquidity-motivated traders are active and informed traders are not - consistent with model settings. Second, the theoretical models describe a setting where traders have subjective differences in valuation, which leads to gains from trade. The differential tax treatment of dividends in Australia provides a distinct institutional setting that drives differences in valuation that are unrelated to private information. Third, theoretical models describe a market where traders differ in patience, with the relative proportion of patient and impatient traders influencing market outcomes. The ex-dividend day provides a setting where the relative proportions of patient and impatient traders are expected to change in a predictable manner, given the existence of dividend clienteles (see for example, Elton and Gruber (1970), Lakonishok and Vermaelen (1986), Richardson, Sefcik and Thompson (1986), Michaely and Vila (1995), and Rantapuska (2008)). With approximately two-thirds of Australian equities held by domestic investors, coupled with an imputation tax system, we anticipate that clienteles will be prevalent in the Australian market and that their trading behavior will change

[1] Theoretical studies of order choice include Parlour (1998), Foucault (1999), Goettler, Parlour and Rajan (2005), and Goettler, Parlour and Rajan (2009). Empirical studies include Biais, Hillion and Spatt (1995), Ranaldo (2004), Bloomfield, O'Hara and Saar (2005), Anand, Chakravarty and Martell (2005), Ellul, Holden, Jain and Jennings (2007), and Cao, Hansch and Wang (2008).

around the ex-day.[2] Our analysis of trading and order choice around the ex-dividend day, together with the detailed ASX data for over nearly two decades, thus provides a unique setting to test theories where liquidity traders face execution risk.

We hypothesize that waiting costs should be higher on the cum-dividend day relative to other days, in light of the impending ex-dividend deadline to trade and the after-tax return that is potentially forgone. For example, Rantapuska (2008) shows that market participants in Finland earn an average overnight return of 2% from the cum-day to the ex-day. Larger waiting costs will induce more competition in the order book from limit order traders, leading to more aggressively priced orders and a narrowing of the bid-ask spread. On the ex-dividend day, waiting costs will be relatively lower in the absence of a trading deadline. With relatively lower waiting costs, the bid-ask spread should be wider as limit orders do not need to be priced as aggressively. We are also able to test our hypotheses in the cross-section of dividend payments, as the level of imputation tax varies across dividend payments from zero to 100%, depending upon the proportion of corporate tax paid on corporation income. If waiting costs are important, we expect the changes in order aggressiveness and spreads between the cum- and ex-days to be more pronounced in stocks whose dividend payments carry a full imputation tax credit. This tax-driven wedge in valuations should encourage liquidity trading and create a higher opportunity cost of not trading for full imputation stocks relative to stocks paying dividends with no imputation. The literature on ex-dividend day valuation and trading also shows that stocks with higher dividend yields and lower transaction costs are likely to attract liquidity traders (Kalay (1982); Boyd and Jagannathan (1994)), and we anticipate order choice and spread changes to vary with these two characteristics.

Our findings provide broad support for the hypothesis that waiting costs are an important determinant of order choice around a trading deadline and that these costs have a material impact on

[2] See Appendix 1 for a description of the data underlying the domestic/foreign holdings breakdown.

the aggressiveness of order submissions. The use of market orders is more prevalent on the cum-dividend day, relative to both the ex-day and a 45-day benchmark period prior to the ex-day. After controlling for known factors that impact order placement, it is evident that traders are more aggressive on the cum-dividend day and less aggressive on the ex-dividend day. For bid orders, the reduction in order aggression between the cum- and ex-day is largest for high yield and full imputation dividend payments, as expected if waiting costs concern traders. We also find that buyers initiate more trades in the cum-dividend period, with the degree of order imbalance positively related to dividend yield and imputation. The depth at the best ask quote increases on the cum-dividend day, while the depth at the best bid quote remains unchanged. However, on the ex-dividend day, the depths decreases significantly at both the best bid and ask quotes. This is consistent with more aggressively priced limit orders on the cum-dividend day and less aggressively priced limit orders on the ex-dividend day. The analysis of order placement, order imbalance and market depth all clearly indicate that traders are more aggressive on the cum-dividend day and less aggressive on the ex-dividend day compared to a 45-day benchmark period prior to the ex-day.

The theoretical limit order book models of Foucault, Kadan and Kandel (2005) and Roşu (2009) also imply that bid-ask spreads will be lower when the cost of waiting to trade is high. We find evidence that effective spreads are lower on the cum-dividend day for high yield and full imputation stocks. The hypothesized reduction in waiting costs also has a substantial impact on ex-day spreads. Our results show that the ex-dividend effective half-spread is 10 basis points, or 27%, higher than the average daily effective half-spread in a benchmark period between *t*-50 to *t*-6, relative to the ex-dividend day. The effective spread peaks on the ex-dividend day and returns nearly immediately to the average spread level in the days following the ex-day. This finding is robust across dividend yields, imputation levels and non-event benchmark spread levels. Both the price impact and realized spread increase on the ex-day. The difference in the effective spread between the cum-day and the benchmark period is positively related to imputation credits after controlling for common determinants of the spread, which suggests that waiting costs differ in the cross-section of dividend payments.

This study contributes to the limit order market literature in several ways. We show that differences in valuation by uninformed traders can actually lead to lower spreads in the presence of a trading deadline.[3] After the trading deadline has passed and the valuation differential has been removed, spreads actually widen. The existence of this result can be attributed to changes in the aggressiveness of order submissions. Consistent with theoretical models, we also find that the duration between trades decline and the time to execution of limit orders are related to our proxy for waiting costs. In their entirety, our results show that both the costs associated with delayed execution and valuation differentials across traders have a material impact on market quality around a liquidity-driven trading deadline. The current study also has broader implications for predictable changes in trading costs in response to liquidity-motivated trading, such as periods around rights issue ex-dates and benchmark index additions and deletions.

The remainder of the paper is organized as follows. Section 2 discusses trading on the ASX and the imputation tax system in Australia. Section 3 outlines the hypotheses based on the literature regarding dynamic models of the limit order book. Section 4 discusses the data used in our analysis. Section 5 presents our results and Section 6 concludes the paper.

2. Institutional Background

The ASX is the major domestic stock exchange in Australia. Prior to October 2, 2006, stocks were traded using the electronic limit order book system called the Stock Exchange Automated Trading System (SEATS). This system commenced operation on October 19, 1987 and fully replaced the

[3] A related study, Handa, Schwartz and Tiwari (2003), shows that differences in valuation lead to wider spreads for French CAC40 stocks. However, their theoretical framework includes informed traders and considers the effect of adverse selection.

trading floor system on September 4, 1990 (Aitken, Brown and Walter (1996)). SEATS operated until October 2, 2006 when it was replaced by an alternative electronic trading system called the Integrated Trading System (ITS). The change from SEATS to ITS did not entail a change in the trading mechanism on the ASX. There are no designated market makers on the ASX, with brokers free to trade as principal or pseudo market makers (Aitken, Garvey and Swan (1995)). The ASX operates distinct market phases. Orders can be submitted or amended between 7:00am and 10:00am in the pre-open phase. The market opens for trading from 10:00am and operates in a continuous open limit order book mode until 4:00pm. The ASX operates an opening call auction at 10am, and in 1997 it introduced a closing call auction (Comerton-Forde (1999)). The closing auction occurs between 4:10pm and 4:12pm, with the entering, amending or cancelling of orders permitted between 4:00pm and 4:10pm. An important feature of the electronic limit order book market on the ASX is that all outstanding orders are cleared from the order book overnight between the cum- and ex-dividend days. This ensures that no stale orders executed on the ex-day reflect cum-dividend stock valuations.

Australia's imputation tax system was introduced on July 1, 1987, replacing the classical tax system. Under the imputation tax system, domestic tax-paying shareholders are eligible to receive an imputation tax credit that is attached to certain dividend payments. Where a dividend carries an imputation credit, the investor is able to offset this credit against personal income tax liabilities to the extent that Australian corporate tax has been paid on the dividend income. The dividend and the imputation credit are then taxed at the investor's marginal tax rate. A company is only able to provide imputation credits on the portion of the dividend paid from corporate profits that have been taxed at the Australian corporate tax rate. In effect, the corporate tax paid by corporations is a pre-collection of personal tax from the shareholder. The level of imputation attached to a dividend can vary between 0% and 100%. The after-tax return to certain investors is considerably higher when they receive a dividend that has full imputation credits, as the corporation has already paid tax on behalf of the investor.

However, not all investors are able to offset imputation credits against their taxable income. Non-resident investors cannot utilize imputation credits. Domestic tax-paying shareholders also need to hold the stock at risk for at least 45-days around the ex-dividend day to be eligible for the imputation credit.[4]

Dividends are generally paid semi-annually by companies listed on the ASX. The financial year for most companies is from July to June in Australia, with the reporting of accounting statements required to occur within two months of the half- or full-year end date. As a result, there is a clustering of ex-dividend dates in our sample in March and September. A number of companies, however, do report based on a different financial year. As a result, ex-dividend dates are recorded in all months of the year. The number of days between the dividend announcement and the ex-dividend day also vary across firms in our sample. On average in our sample, dividends are announced 19 calendar days before the ex-dividend day. The median is slightly lower at 14 days. When the amount of the dividend is announced, companies will also state the level of imputation that is attached to the dividend. As such, this information is publicly available prior to the cum-dividend day.

To better understand the impact that the imputation tax system has on the face value of dividends, Table 1 presents information on three dividend payments in our sample that have full, partial, and zero imputation. We show the face value for a selection of investors that are likely to be involved in liquidity trading around the ex-day. The after-tax face value of \$1 of dividends (ν) is given by:

$$\nu = \frac{(1-\tau_d)}{(1-\tau_g)}\left[1 + \frac{uk\tau_c}{(1-\tau_c)}\right], \tag{1}$$

where τ_d is the tax rate on dividend income, τ_g is the capital gains tax rate, τ_c is the corporate tax rate, and k is the level of imputation attached to the dividend. An investor's utilization of imputation credits

[4] The 45-day rule has been in operation since 1997. Investors who receive a small amount of imputation credits – less than \$5000 – are able to avoid the 45-day holding period rule.

is denoted by *u* and is 0% for foreign investors and 100% for domestic investors. We assume that domestic resident investors are taxed at the marginal rate of 47%. Foreign investors are assumed to be taxed on dividends at a rate of 30% and taxed on capital gains at 20%. The three examples for BHP, QBE Insurance and Qantas Airways show that there will be an after-tax valuation difference between domestic and foreign investors equal to 64% of the face value of the dividend for full imputation stocks. This difference declines as the level of imputation decreases. Further, the value of dividends by foreign investors is not impacted by imputation, with only the valuation by domestic investors varying in proportion with imputation. These examples illustrate the valuation differential that is a key factor in the limit order market models that we test.[5]

[INSERT TABLE 1]

3. Testable Implications of Theoretical Limit Order Book Models

Our hypotheses are developed from dynamic models of the limit order book presented by Foucault (1999), Foucault, Kadan and Kandel (2005), and Roşu (2009). These models do not include informed traders, with trading motivated by liquidity needs based upon traders with subjective valuations above and below fundamental value. In the ex-dividend setting, the subjective valuations reflect differences between tax rates on capital gains and dividend income, as well as the imputation credit that is attached to certain dividends.

Foucault (1999) develops a dynamic limit order book model and shows that the spread has a reservation component related to adverse selection and an execution risk component that is related to non-competitive behavior. Moreover, the bid-ask spread will increase when the execution risk of limit orders increase, as limit order traders capture a larger share of the difference in subjective valuations. Foucault also notes that the use of market orders will increase if there is a change in the relative

[5] The marginal personal tax rates and corporate tax rates do change slightly during the sample. However, these small changes do not have substantial implications for the valuation differentials that exist between traders.

number of traders who place a higher subjective value on the stock. In the ex-dividend setting, this equates to an increase in the proportion of traders who place a higher value on the dividend and imputation tax credit.

Foucault, Kadan and Kandel (2005) and Roşu (2009) formally include trader impatience in their models of limit order book dynamics. Impatient traders have a larger waiting cost per unit of time and the expected total waiting cost is determined by the product of the delay between order submission and execution, and the waiting cost per unit of time. They show that changes in waiting costs will alter the relative proportions of patient and impatient traders. In reality, there will be varying degrees of patience that will affect the aggressiveness of traders' order placements. As such, the current study will focus on waiting costs as a continuous measure, rather than a dichotomous classification of traders as being either patient or impatient.

These theoretical models provide us with a number of testable implications that we examine in days surrounding a stock's ex-dividend date. Of particular importance is the trading deadline that exists at the end of the cum-dividend day. For tax-sensitive traders attempting to maximize after-tax returns, this deadline will induce a higher cost per unit of time between order placement and execution. That is, the opportunity cost of not maximizing after-tax returns is potentially quite large. As such, we expect waiting costs to be larger on the cum-dividend day. After a stock commences trading on an ex-dividend basis, the need to maximize after-tax returns no longer exists, thereby reducing the incentive to trade for tax-motivated reasons. We hypothesize that the waiting cost for traders on the ex-dividend day will decline, relative to the cum-dividend day. The benefits of trading to maximize after-tax returns are most likely to be concentrated in those stocks paying dividends with full imputation, at a relatively high yield. Valuation differentials will be greatest for these stocks and liquidity trading will be relatively higher. As a result, waiting costs will exhibit a time series reduction between the cum- and ex-day, as well as varying in the cross-section of dividend payments.

In the presence of higher waiting costs and a trading deadline, we expect order placement to be more aggressive on the cum-day. The proportion of market orders should be lower on the cum-day than on a 'normal' trading day. A rise in aggressiveness could also manifest as an increase in market depth at both the bid and ask quotes on the cum-day. We expect that the most aggressive order submissions will be predominantly in full imputation and high yield dividend-paying stocks on the cum-day. The theoretical models also indicate that the market will be more resilient, with lower bid-ask spreads, in the presence of higher waiting costs. We therefore hypothesize that bid-ask spreads will be lower on the cum-day, and relatively higher on the ex-day, reflecting the reduction in waiting costs. We expect that the decrease in the bid-ask spread on the cum-day and ex-day will be larger in those stocks paying full imputation dividends at a high yield, as this is where differences in subjective valuation are hypothesized to be largest and waiting costs are likely to be most important to the trading decision.

The presence of opening and closing auctions on the ASX will also have an impact on waiting costs. The closing call auction is likely to temper any increases in waiting costs on the cum-dividend day, as traders will have the option to trade at the close of the market, albeit at an uncertain price. Pagano and Schwartz (2003) show that the introduction of a closing call auction reduces spreads in the last 30 minutes of trading on the Paris Bourse. The opening auction could also affect the aggressiveness of orders on the ex-dividend day. If waiting costs are sufficiently large for a group of participants, they will want to reduce their waiting time to zero. Short-term traders engaging in dividend capture are an example of such a group that would want to unwind trades quickly. To eliminate any waiting time, these traders can execute their trades in the opening auction, but will face an uncertain trade price. However, if there are a substantial number of such impatient traders, there will be relatively more patient traders remaining once continuous trading begins. These patient traders are not likely to submit aggressive orders and, therefore, spreads could be higher on the ex-day.

Foucault, Kadan and Kandel (2005) also identify that the time to execution of limit orders and the conditional duration between trades will depend upon waiting costs. If waiting costs increase and trade impatience rises, in line with their model, we anticipate that the time to execution of limit orders will be lower on the cum-day. This effect should be more pronounced for stocks paying fully imputed dividends. The duration between trades should also decrease as waiting costs rise. With increasing trade impatience and waiting costs, the probability of a market order is higher. In turn, this also reduces the time until the next transaction in the Foucault, Kadan and Kandel (2005) model. We also expect the reduction in duration between trades to vary positively with the level of imputation attached to the dividend.

4. Data and Methodology

We obtain intraday trade and quote data from the Securities Industry Research Centre of Asia-Pacific (SIRCA) for the period February 19, 1990 to December 31, 2008. This data captures all order submissions, cancellations, and trades that took place on the ASX electronic trading systems. Each transaction in the dataset consists of the timestamp to the nearest millisecond, stock ticker, price, volume, bid and ask quotes, bid and ask depth, and trade flags indicating whether the trade was buyer- or seller-initiated, an opening or closing auction trade, technical crossing, an off-market trade, or an odd-lot trade. We also source daily closing prices from SIRCA. Dividends, ex-dividend dates, capitalization adjustments, and month-end share market capitalization data are sourced from the SIRCA Share Price and Price Relative database. In order to remove thin trading stocks, we follow Bell and Jenkinson (2002) and limit the sample to the largest 250 stocks by market capitalization at the end of the month prior to which the stock begins trading ex-dividend. Furthermore, we remove dividend events when the cum-dividend day stock price is below $1 and a capitalization adjustment occurs on the ex-dividend date, as well as excluding foreign stocks such as US depositary receipts.

There are 6,279 dividend payments that occur in the sample between 1990 and 2008. The median imputation credit level of 100% indicates that most companies pass on tax credits to investors, although the average is substantially lower at 64%. There are 3,600 dividend events that have 100% imputation credits, 654 that have partial credits, and 2,025 that do not carry any tax benefits for investors. In unreported results, we find that stocks paying full imputation dividends have higher market capitalization and a larger number of equity analysts covering the firm, on average. This indicates that information asymmetry is likely to be lower for full imputation dividend payments and would make it more difficult to identify a significant effect of imputation on bid-ask spreads.

Table 2 reports the descriptive statistics for the sample. The mean dividend is 14 cents and median dividend is substantially smaller at eight cents. The semi-annual dividend yield is calculated as the cash dividend divided by the closing cum-day price, and has a mean of 2.27%. The interaction of the tax credit and the dividend yield indicates that the face value of the tax credit averages 0.34% of the cum-dividend stock price. This reflects the wedge between investors' subjective valuations, conditional upon their ability to utilize imputation credits. As previously noted, there is a clustering of ex-dates in our sample. Of the 6,279 ex-dividend events, 1,087 occur on unique ex-dates, with the remaining 5,192 events falling on 1,189 ex-dates. March and September have the most ex-dividend dates with 1,321 and 1,211 stocks beginning ex-dividend trading, respectively. The fewest number of ex-dates in our sample are in January (58) and July (90). The remaining eight months contain between 215 and 582 ex-dates.

[INSERT TABLE 2]

Following Michaely and Vila (1996), we calculate abnormal market depth by measuring abnormal volume around the ex-dividend days. We also calculate a separate measure of depth for the bid and ask sides of the order book. Daily bid market depth for stock *i* is measured as the time-weighted ratio of daily depth divided by the total shares outstanding ($Depth_i$). The expected time-weighted bid (ask) depth, $E(Depth_i^d)$, for a dividend event is the average daily time-weighted number of shares at the best bid (ask) price between *t*-45 and *t*-6 and *t*+6 to *t*+45:

$$E(Depth_i^d) = \frac{\sum_{t-45}^{t-6} Depth_{it}^d + \sum_{t+6}^{t+45} Depth_{it}^d}{T}, \tag{2}$$

where *T* is the number of days the stock was able to be traded in the 80-day estimation window and *d* indexes bid and ask orders. Abnormal time-weighted bid market depth ($ADepth_i$) is calculated as the daily number of shares at the best bid price as a percent of the number of shares outstanding, divided by the expected time-weighted daily number of shares at the best bid price as a percent of the number of shares outstanding:

$$ADepth_{it} = \frac{Depth_{it}}{E(Depth_i)} - 1. \tag{3}$$

We focus on three measures of bid-ask spreads following Huang and Stoll (1996) and Bessembinder (2003). We scale all measures of bid-ask spread by a stock's value-weighted average price on the cum-dividend day. The proportional effective half-spread at time *t* in stock *i* is measured as the traded price less the midpoint of the bid and ask, divided by stock *i*'s cum-dividend day value-weighted average price (P_i^c):

$$Effective\ half\text{-}spread_{it} = \left[(P_{it} - M_{it})\delta_{it}\right] / P_i^c, \tag{4}$$

where P_{it} is the traded price, M_{it} is the midpoint price immediately prior to the trade occurring and δ_{it} equals +1 if the trade is a market buy order, and equals -1 if the trade is a market sell order. The proportional realized half-spread measures the price movement unrelated to information after a trade is executed. It represents the non-information component of the effective spread and is calculated as:

$$Realized\ half\text{-}spread_{it} = \left[(P_{it} - M_{it+n})\delta_{it}\right] / P_i^c, \tag{5}$$

where M_{it+n} is the midpoint price after 30 minutes have passed. The price impact captures the informativeness of a trade:

$$Price\ impact_{it} = \left[(M_{it+n} - M_{it})\delta_{it}\right] / P_i^c . \qquad (6)$$

The price impact is also defined as the difference between the effective half-spread and the realized half-spread. The benchmark value of each of the three spread measures are calculated as the daily average between *t*-50 and *t*-6, relative to the ex-dividend day.

5. Results

5.1 Order Aggressiveness

To address our first hypothesis that liquidity suppliers are more aggressive on the cum-dividend day and less aggressive on the ex-dividend day, we directly examine order aggressiveness to determine whether changes are consistent with our expectations by comparing both days to the average order aggressiveness in a benchmark period from *t*-50 to *t*-6. Following Biais, Hillion and Spatt (1995), Ranaldo (2004) and Comerton-Forde and Tang (2009), we classify orders into six groups of aggressiveness, from least aggressive (1) to most aggressive (6): cancelled orders, limit orders outside the prevailing quotes, limit orders at the best quote, limit orders at a price better than the best quote, market orders that are fully executed immediately at the prevailing best quote and market orders with volumes greater than those available at the prevailing best quotes. We only include orders that are submitted while the market is open.

We first calculate the proportion of orders that fall into each of the six categories for each dividend event. Table 3 provides the pooled averages of these proportions for the benchmark period, cum-day, ex-day, as well as the differences between the cum-day and benchmark period (*t*-50 to *t*-6), and the differences between the ex-day and the benchmark period.[6] The relative proportions of each

[6] The proportions are similar if we examine the volume of each order rather than the number of orders.

order type are similar across both bid and ask orders. Order cancellations are less prevalent on the cum-day for both bid and ask orders, and market bid orders that are fully filled immediately increase on the cum-day relative to the benchmark period. In terms of ask orders, there are increases in the entry of limit orders that do not improve the best ask quote (categories 2 and 3). This is at the expense of market orders that do not fully consume the bid side of the order book. The increase in aggressiveness of buy orders is consistent with a rise in waiting costs brought about by the ex-dividend deadline. The results are broadly similar for both bid and ask orders when comparing the ex-day to the benchmark. There is a decline in the proportion of market orders (categories 5 and 6). Limit orders priced at the best quotes and cancellations also decrease on the ex-day. The decline in these orders is offset by an increase in orders priced outside the best quotes and orders that improve upon the best quotes.

[INSERT TABLE 3]

The stark difference in the order types on the ex-day has a number of potential explanations. First, the increased use of limit orders shows that trading behavior has changed after the ex-dividend deadline, consistent with the notion that waiting costs affect trading behavior. However, there is no prior reason to expect that the difference would be as large when compared to the benchmark period. The decline in order aggressiveness could also reflect the fact that the limit order book is cleared overnight between the cum- and ex-day. The 45-day holding period rule could also limit the need for traders to trade aggressively after the ex-dividend deadline.

To control for factors that impact upon the choice of order type, we follow Ranaldo (2004) and estimate an ordered probit model for each stock. The model is estimated for all orders from the benchmark period, the cum-day as well as the ex-day. We estimate a different model for bid and ask trades for each dividend event in our sample:

$$OA_t = \gamma_0 + \sum_{j=1}^{k} \gamma_j x_{jt-1} + \nu_t, \tag{7}$$

where *OA* is the order aggressiveness from 1 (least aggressive) to 6 (most aggressive). The independent variables are based upon Ranaldo (2004) and Bessembinder, Panayides and Venkataraman (2009), and include the standard deviation of the lagged 20 mid-quote returns, the depth prevailing on the opposite side of the order book at the best quote, the depth prevailing on the same side of the order book at the best quote, the quoted bid-ask spread immediately prior to the order submission, the average time difference between the last three submitted orders, the number of trades in the last hour, the last trade size, market index volatility over the past hour, industry volatility over the past hour and a dummy variable equal to one for orders submitted in the last hour of trading. The index volatilities are based on one minute returns. We also include a dummy variable that is equal to one for orders submitted on the cum-day, and zero otherwise, as well as an ex-day dummy for orders submitted on the ex-day. We expect that the cum-day dummy variable will be positive and the ex-day dummy variable will be negative – reflecting the submission of more aggressive orders on the cum-day and less aggressive orders on the ex-day, after controlling for the above factors.

For brevity, we report only the median coefficient for the dummy variables in Table 4.[7] The sign and size of the median coefficients for the other independent variables are consistent with expectations and similar across both bid and ask order submissions. The first two columns contain the median dummy variable for bid orders on the cum-day and ex-day, respectively. Our expectation under the waiting cost hypothesis is that this dummy variable should be positive for cum-day orders as traders begin placing more aggressive orders before the deadline. After the deadline has passed orders should become less aggressive and we expect a negative coefficient for the ex-day dummy variable. We see an increase in order aggressiveness on the cum-day for the full sample in Panel A. When partitioning by different dividend and stock characteristics, we observe significant differences in the degree to which orders become more aggressive. Of particular interest is the finding that stocks paying fully imputed

[7] The full set of median coefficients and event-by-event results are available on request from the authors.

dividends experience more aggressive orders, whereas stocks distributing dividends with zero imputation experience an insignificant difference in aggressiveness. The increase in aggressiveness does not vary with dividend yield; instead, the need to execute orders quickly is more important for those stocks with greater valuation differences. Moreover, lower spread stocks have larger increases in aggressiveness on the cum-day, and conditional sorts on imputation yield and spread also show that low spread stocks consistently have a greater increase in aggressiveness.

In contrast to the cum-day, bid orders on the ex-day are generally less aggressive relative to the benchmark period. There is no clear pattern across stock and dividend characteristics. There is only minor evidence of a change in the order aggressiveness for ask orders on the cum-day, with partially imputed dividend-paying stocks and low spread stocks experiencing an increase in order aggressiveness. The median coefficients for the ex-day dummy variables are predominantly negative, which indicates that order aggressiveness declines on the ex-dividend day (Panel A) after controlling for order-level factors. Note that the less aggressive ex-day bid orders are in higher yielding securities and are not in high spread stocks.

In aggregate, the changes in order aggressiveness about the ex-day are consistent with waiting costs being important to traders. In particular, the cum-day increase in the order aggression of bid orders provides clear support for the hypothesis. There are two particular observations that are worthy of discussion. First, there is asymmetry in the changes in order aggressiveness between the two sides of the order book on the cum-day. The increase for bid orders on the cum-day indicates that traders who prefer dividend and imputation credits, and thus place a higher subjective valuation on the dividend, are likely to be in the majority in the Australian market. These dividend capture traders are targeting full imputation, high yield stocks and would be most sensitive to increases in waiting costs. The second observation concerns the ex-day decline in order aggressiveness. We anticipated a decline on the ex-day as traders face a lower waiting cost associated with delaying execution once a stock begins trading ex-dividend. However, the magnitude is considerably larger than the increase for the ex-day. Our expectation was that order aggressiveness would decline from the cum-day to the ex-day in a manner similar to the cum-day increase. The difference suggests that traders become considerably less aggressive once the trading deadline passes, as any traders that needed to transact have done so by the close of the cum-day. Rantapuska (2008) finds the average proportion of overnight trading around the ex-day is less than 5% in Finland. If we consider trading in Australia to be similar to that in Finland, the reduction in order aggressiveness could reflect the fact that not all investors need to trade aggressively to unwind any dividend-induced trading positions. The presence of a 45-day holding period restriction is also likely to moderate the level of order aggressiveness as most investors need to hold the stocks at risk for at least 45 days to receive the imputation credit. Furthermore, the overnight clearing of the limit order book could also lead to less aggressive order submissions.

[INSERT TABLE 4]

5.2 Order Imbalance

Our hypothesis does not indicate whether there will be more buyer-initiated trades or more seller-initiated trades around the ex-dividend day. However, the extent of the order imbalance will provide an indication of whether the waiting costs have a more binding impact on a particular side of the order book. There is also potential for this effect to reverse between the cum- and ex-day given the presence of dividend arbitrageurs. The daily stock-level order imbalance is measured as the difference between buyer-initiated volume and seller-initiated volume as a percent of the sum of buyer- and seller-initiated volume for each stock. Table 5 presents the results for the equally-weighted daily average for the five days centered on the ex-dividend day for the overall sample (Panel A), with partitions on dividend yield (Panel B), imputation level (Panel C), imputation credit yield (Panel D), average effective percentage spread between *t*-50 to *t*-6 days from the ex-day (Panel E) and idiosyncratic volatility (Panel F).[8]

[INSERT TABLE 5]

Over the entire sample, the order imbalance is positive in the cum-dividend period and negative from the ex-dividend day. Buyers use more market orders than sellers in the cum-dividend period, while sellers use more market orders in the ex-dividend period. There is a 4 - 4.7% difference between the volumes of buyer- and seller-initiated trades on the last two cum-dividend days. The proportion of seller-initiated trades is higher once the stock begins trading ex-dividend. Interestingly, the degree of negative order imbalance is considerably less than the proportion of buyer-initiated trading in the cum-dividend period. However, the results based on stocks grouped by dividend yield, imputation level, imputation credit yield and the benchmark effective percentage spread provide additional detail regarding the precise nature of the order imbalance. Indeed, there is an absence of buying pressure in low yield and zero imputation credit stocks prior to the ex-day. In contrast, high yield stocks experience an order imbalance of 8.2% and 9.5% on day *t*-2 and *t*-1, respectively. Partial and fully imputed dividend paying stocks have order imbalance of between 4% and 6.6% prior to the ex-day. When sorting by imputation credit yield, there is clear evidence that significant buying pressure exists, with the order imbalance equal to 8.3% and 10.1% prior to the ex-day. However, there is no discernible difference in the proportion of buyer-initiated trades across the rankings by effective percentage spread, with buyer-initiated volume significantly higher across all terciles. Order imbalance is also related to idiosyncratic risk, with lower risk firms having higher order imbalance.

After the stock begins trading ex-dividend, we do not find evidence of substantial selling pressure that could be created by short-term dividend arbitrageurs. The -1.8% order imbalance is more

[8] We follow Rantapuska (2008) and use the standard deviation of the residuals from a regression of an individual stock's weekly returns against the market return (using the All Ordinaries accumulation index) over its past three years.

than half the magnitude of the cum-day order imbalance, which indicates that cum-dividend buying pressure is not followed by commensurate amounts of selling pressure. The order imbalance is negative for full imputation stocks, but the magnitude is less than that on the cum-dividend day. The higher proportion of seller-initiated volume is actually taking place in stocks that have a low yield, zero imputation, high benchmark effective percentage spread or high firm-specific risk. This asymmetric behavior of order imbalance shows that waiting costs are more important for traders attempting to purchase securities before the ex-day. The existence of positive buying pressure is consistent with the notion that a majority of traders in Australia are able to utilize imputation credits, and hence face a higher opportunity cost of not purchasing before the ex-day. The resulting order imbalance is thus consistent with higher waiting costs impacting the trade initiation of dividend-preferring investors.

5.3 Market Depth

This section considers whether changes in waiting costs around the ex-dividend deadline also impact the available volume at the best quotes. If waiting costs increase, limit order traders are likely to improve upon the best quotes to ensure fast execution. Thus, we anticipate more aggressively priced limit orders in the cum-dividend period. For stocks already trading at the minimum spread, this may lead to an increase in depth at the best bid and ask quotes during the cum-dividend period. On the ex-dividend day, a decline in waiting costs will reduce the aggressiveness of orders and a decline in depth is expected, given the reduced need for traders to ensure fast execution. For robustness, we present results on depth at the best bid and ask quotes as well as the top ten levels of each side of the order book. If order placement has become less aggressive, there is potential for the depth to have shifted away from the best bid and ask quotes.

The results in Table 6 show that there is significant increases in the volume available at the best ask quotes on the cum-dividend day. The ask depth is 10% higher than expected for the entire sample, 26.5% larger for high dividend yield stocks, 11.7% higher for full imputation dividends, 19% for high imputation credit yield stocks, and 6.9% greater for low spread stocks. These groups of stocks are those where the gains from trade are greatest and where we hypothesize that waiting costs would have more of an impact. The greater depth only occurring on the ask side for of the order book for these stocks also implies that sellers respond to the higher waiting costs for buyers by queuing.

[INSERT TABLE 6]

After the trading deadline to receive dividends and any associated imputation credits has passed, the ex-day abnormal bid and ask depth are both negative and statistically significant for the entire sample, with the depth 11.5% lower than expected at the bid and just over 9.5% lower at the ask (Panel A). The abnormal depths are also negative and statistically significant at either the bid or ask across dividend yields (Panel B), imputation levels (Panel C), imputation credit yield (Panel D) and the benchmark effective percentage spread (Panel E) and idiosyncratic volatility (Panel F). Although the lower depth is not consistent across the different sorts on stock characteristics, the results show that liquidity supply decreases on both sides of the order book on the ex-day, consistent with our preceding analysis.

The results for the top ten bid and ask depth are similar, but they also show an abnormal increase in depth on the cum-day away from the best quotes.[9] Depth for both the bid (12.3%) and ask (14.5%) is higher for high imputation yield stocks on the cum-day. The depth is also greater for low spread stocks. These increases provide support for the waiting cost hypothesis. Although investors are not queuing at the best quotes, there is an increased amount of volume in the order book. On the ex-day, however, it is clear that depth declines significantly at the top ten levels. The decline averages over 20%. The ex-day change in depth may not be entirely consistent with the waiting cost hypothesis. We

[9] The results are qualitatively similar if we use the top five levels rather than the top ten levels.

would expect that the depth would not be different between the ex-day and the benchmark period, unless waiting costs have decreased substantially more than the benchmark period. As noted above during the discussion of order aggressiveness, the clearing of the limit order book could be responsible for the substantial decline in ex-day depth.

5.4 Transaction Costs around the Ex-Dividend Day

Foucault, Kadan and Kandel (2005) predict that the bid-ask spread will be smaller if waiting costs are high as the market will be more resilient. We expect that higher waiting costs cum-dividend should lead to lower cum-day spreads. Lower waiting costs after the stock begins trading ex-dividend will cause the spread to widen on the ex-day. Table 7 reports the effective percentage half-spread during a benchmark period from *t*-50 to *t*-6, the cum-day and the ex-day, as well as the benchmark-relative difference on the cum- and ex-day.

Consistent with our expectations, the effective half-spread is lower on the cum-day and higher on the ex-day (Panel A). The cum-dividend spread drop is 1.6 basis points and is statistically significant at the 1% level. Despite the high statistical significance of the drop, the decline is only 4.5% of the benchmark spread. This could reflect the fact that stocks could already be trading at the minimum tick size and hence are unable to decline further. In contrast, the spread increase is both statistically and economically wider on the ex-dividend day. Over the entire sample (Panel A), the ex-day percentage half-spread of 0.46% is 9.8 basis points higher than the average spread during the benchmark period from *t*-50 to *t*-6. The difference is statistically significant at the 1% level. This represents a 27% increase in the average cost of trading using market orders.[10] To compare the magnitude of the ex-dividend day spread to other days, Figure 1 presents the daily average effective

[10] In unreported results, we also analyze the effective spread over hourly intervals and find the cum-day (ex-day) effective spread is lower (higher) than the benchmark across all hourly intervals.

percentage half-spread between *t*-50 to *t*+50, relative to the ex-day. The spread is at its lowest level two days before the ex-day and at its peak on the ex-day, suggesting that the ex-dividend deadline does affect trading costs in the hypothesized directions.

[INSERT TABLE 7]

[INSERT FIGURE 1]

The results in the 'Cum-Benchmark' column of Table 7 show that the spread decline on the cum-dividend day is greatest for high dividend yield (Panel B), full imputation (Panel C), high imputation credit yield (Panel D), high spread (Panel E) and high idiosyncratic risk stocks (Panel F). The impact of waiting costs will be most pronounced in higher yield and full imputation stocks as valuation differences are greater for these stocks. The high imputation credit yield stocks experience an 11% (3.8 basis points) lower spread on the cum-day. The 'Ex-Benchmark' column shows the effective spread increases across all dividend yield groups (Panel B) by at least 9 basis points, though in percentage terms the average difference between the cum- and ex-dividend days is in excess of 23% for all dividend yield groups. The ex-dividend jump in the spread is similar across imputation levels (Panel C), as it is across imputation yield groups. The increase in the spread for stocks sorted by the benchmark effective spread (Panel E) is monotonically increasing with a 0.1, 6.5 and 22 basis point increase in the spread for low, medium and high spread stocks, respectively, from the cum-dividend to ex-dividend day. High idiosyncratic risk firms also have a higher spread increase.

The results in Table 7 are supportive of our hypotheses regarding the impact of waiting costs on trading behavior around the ex-dividend day. As waiting costs rise on the cum-day, orders become more aggressive and markets become more resilient. We show that effective spreads are lower as a result. Once the ex-dividend trading deadline has passed, waiting costs will decline and orders become less aggressive. The result is a less resilient market. Spreads increase by 27% on average, potentially reflecting the reduced need for traders to lower the time delay between order submission and execution.

However, differences in subjective valuations are not the only cause of the spread increase, as evidenced by the higher spreads for low yield and zero imputation dividend events. As the majority of the spread increases on the ex-day do not differ within each partition by dividend related characteristics, this suggests that some unobservable factor could potentially explain the spread jump. The clearing of the limit order book discussed previously is a possible candidate. To gain a better understanding on the factors that affect the spread around the ex-day, we first analyze the multivariate determinants of the effective spread change, and then decompose the effective spread into a realized spread and a price impact component.

5.5 Determinants of the Effective Spread

It is important to ascertain what observable factors are driving the change in the effective spread as waiting costs are not directly observable. We believe that the level of imputation and dividend yield can serve as proxies for waiting costs and thus include them in a regression of the determinants of changes in the spread, controlling for common factors identified in the literature (Stoll (2000); Comerton-Forde and Tang (2009). We examine how spreads change between the benchmark period, the cum-day and the ex-day. The ordinary least squares regression of the percentage change in the effective spread (ΔES_{it}) is:

$$\Delta ES_{it} = \alpha_0 + \alpha_1 Imputation_{it} + \alpha_2 DY_{it} + \alpha_3 \Delta Volume_{it} + \alpha_4 \Delta\sigma_{it} + \alpha_5 Beta_{it} + \alpha_6 Ivol_{it} + \varepsilon_{it}, \qquad (8)$$

where $Imputation_{it}$ is the percentage to which dividend *t* of stock *i* carries imputation tax credits, DY_{it} is the dividend as a percent of the cum-dividend day closing price, $\Delta Volume_{it}$ is the change in the natural logarithm of daily trading volume, $\Delta\sigma_{it}$ is the change in the risk as proxied by the natural log of the high price divided by the low price for the day, $Beta_{it}$ is the firm's market beta from a regression of weekly stock returns against the market returns over three years, and $Ivol_{it}$ is the standard deviation of the residuals from the same regression. We take averages of the daily values for volume and volatility over the benchmark period to use in the regression. In an alternative specification, we include the imputation credit yield whilst excluding the dividend yield and imputation level. We report *t*-statistics based on standard errors clustered by stock and ex-dividend date.

Table 8 contains the regression results of equation 8, with Column 1 showing the determinants for the spread change from the benchmark to the cum-period. Both the dividend yield and imputation level variables are negative and statistically significant, which indicates that the decline in spread is related to dividend yield and imputation level as expected under a waiting costs interpretation. The higher opportunity cost of not executing one's orders for these stocks lead to more aggressive orders and a smaller cum-dividend spread. The coefficient on the change in volume is negative and the coefficient on the change in volatility is positive, as expected. The coefficient on beta is negative and significant, which indicates that high beta stocks experience a larger spread decline. Column 2 shows the percentage value of the imputation credits instead of the dividend yield and imputation level variables separately, producing the same interpretation: stocks with higher imputation credit yields have a larger drop in spread on the cum-day. Columns 3 and 4 examine the spread increase from the benchmark period to the ex-day. The dividend yield variable is not significant, while the imputation level is significant. Both variables have a positive coefficient, which indicates that the spread increase does vary with dividend-specific attributes and is not solely driven by changes in volume and volatility. The coefficient for the imputation credit yield variable in Column 4 shows that the combination of both the dividend and imputation credit is related to the spread increase.

[INSERT TABLE 8]

These multivariate results show that stocks with the highest tax-induced differences in valuation experience a larger change in effective spread on both the cum- or ex-day, after controlling for the impact of volume, volatility, beta and idiosyncratic risk. This is consistent with predictions from limit order book models, as waiting costs for these stocks are likely to change around the ex-dividend day and, therefore, we observe a spread increase. The results in Table 8 show that although waiting costs cannot be directly linked to effective spread increases, there is substantial evidence consistent with this relationship. Indeed, if imputation tax credits serve as a proxy for liquidity trading in a market with a deadline, we can conclude that waiting costs are an important and significant determinant of changes in market resiliency and increases in the ex-dividend spread. An alternative explanation for higher ex-dividend spread is that the limit order book is cleared overnight. The observed ex-day results could also be consistent with this explanation, but the relationship between dividend characteristics and effective spread suggests that the clearing of the limit order is not the only factor to be considered. However, we can better ascertain the exact nature of the spread change by examining the realized spread and price impact.

5.6 Realized Spread and Price Impact

The increase in effective spread shows that the cost of transacting changes on the cum- and ex-day. To determine whether changes in costs are based on the market's perception of trade informativeness, we decompose the effective spread into realized spread and price impact components. Table 9 reveals that realized spreads do not comprise a statistically significant portion of the effective spread decline on the cum-dividend day. For example, the decline for the full sample (Panel A) is 1.1 basis points and not statistically significant. However, the increase in the realized spread on the ex-day relative to the benchmark is statistically significant for the full sample, increasing by 4.3 basis points or 45% of the benchmark realized spread. There is no clear pattern in the realized spreads when measured across any of the terciles, except for the benchmark spread partitions. Despite the lack of a clear pattern, the results do suggest that compensation paid to liquidity suppliers in the limit order book is greater on the ex-dividend day and that prices are reversing following executed trades moreso than on the cum-dividend day. Therefore, anti-competitive behavior from market makers could potentially be responsible for the increase in the spread. This is consistent with market makers exploiting the trading needs of traders trying to unwind their positions on the ex-dividend day.

[INSERT TABLE 9]

The price impact component of the spread measures the information content of the trade as assessed by the market. On the cum-dividend day, the price impact is generally similar to the benchmark period, with varying levels of statistical significance (Table 10). Price impact falls for stocks that have a high imputation credit yield (Panel D) and a low spread (Panel E). This indicates that the market believes that there is less information in trades in those stocks with greater valuation differentials. The lower adverse selection cost for these stocks is not surprising given that the ex-dividend day is known in advance and that a substantial amount of liquidity trading is also known to be occurring in the cum-dividend period.

However, the market views the information content of ex-dividend day trades as significantly greater than those on the cum-dividend day. In the full sample, the average price impact of a trade rises from 25.6 basis points in the benchmark period to 31.7 basis points on the ex-dividend day (or a 23% increase, statistically significant at the 1% level). The change in price impact varies by stock characteristics, but is significant across all partitions. High dividend yield (Panel B) and high spread stocks (Panel E) experience large and significant increase in price impact of 6.8 basis points (26% increase) and 12 basis points (25% increase), respectively, relative to the cum-day. The price impact for stocks with the highest proportional effective half-spread in the benchmark period is 58.7 basis points on the ex-day, compared to 46.8 basis points in the benchmark period. The fact that the price impact increases for all stocks, irrespective of characteristics, supports the idea that traders view ex-dividend trades as being more informative.[11]

[INSERT TABLE 10]

[11] Appendix 2 contains several robustness checks for the ex-day effective spread, realized spread, and price impact results.

5.7 *Time-to-Execution of Limit Orders*

Foucault, Kadan and Kandel (2005) show that the mix of patient and impatient traders will affect the time to execution of limit orders. We expect that waiting costs, and therefore the proportion of impatient traders, will increase on the cum-day and lead to a reduction in the time to execution of limit orders. This effect should be more pronounced for stocks paying fully imputed dividends. We estimate survival models following Lo, MacKinlay and Zhang (2002) and Bessembinder, Panayides and Venkataraman (2009). The dependent variable is the time to completion of limit orders and is measured as the time between order submission and completion of the order. If the order is unfilled or amended, it is treated as censored. The survival model is estimated on an event-by-event basis across the benchmark period (*t*-50 to *t*-6), the cum-day and the ex-day with a generalized gamma distribution. The dependent variables include the difference between the midpoint of the quote and the last trade price, a dummy variable equaling to one if the last trade was buyer-initiated and zero otherwise, the depth at the best price on the same side of order book, the depth at the best price on the opposite side of the order book, the size of the order submitted, the ratio of the trades in the last 30 minutes to the number of trades in the last 60 minutes, and the log of the number of trades in the last 60 minutes. Of particular interest are two separate indicator variables equal to one for the cum-day or ex-day, and are zero otherwise.

The results for the survival models are shown in Table 11.[12] The full sample results in Panel A show that the coefficients on the ex-day and cum-day dummy variables are positive and significant for both order types. The magnitudes are also higher for bid limit orders than ask limit orders. This indicates that limit orders take longer to execute on both the ex-day and cum-day than during the

[12] In unreported results, the average time-to-execution of limit orders declines substantially on the cum-day for both bid and ask orders relative to the benchmark period. The difference between the benchmark period and the ex-day is not significantly different for either order type.

benchmark period. However, we need to consider dividend and stock characteristics as we anticipate that these influence the time until execution of limit orders. Higher dividend yield securities also generally have shorter waiting times. The waiting time for ask orders submitted for high yield stocks on the ex-day is not statistically different from the benchmark period. We also do not observe a clear pattern across imputation groups (Panel C). The imputation credit yield partitions show that cum-day ask orders for high imputation yield stocks are faster to completely fill (Panel D). Our results indicate that the bid-ask spread is an important consideration for traders as it restricts profitable dividend trading strategies. There is also clear evidence that lower spread stocks have lower waiting times, across bid and ask orders, and on cum- and ex-days.

[INSERT TABLE 11]

To better understand the impact of stock characteristics on waiting times, we undertake conditional sorts of dividend events into three imputation yield groups, and then further into three spread groups within each imputation yield group. Within each group, the waiting time is positively related to the benchmark effective spread, even after controlling for the spread in the estimation of the hazard model. Focusing our attention on the stocks that will attract the greatest amount of trading given the after-tax net value — high imputation yield, low spread stocks in Panel H – we observe that the time-to-completion of limit orders is not statistically different to the benchmark period for bid orders. In contrast, ask orders experience a lower waiting time on the cum-day. This finding is consistent with our results regarding market depth, and reflects the dominance of domestic investors in the Australian market who are eager to use market orders to guarantee execution before the ex-day. The price will generally move away from bid limit orders and towards ask limit orders on the cum-day. Although the aggregate results do not indicate a shortening of waiting times on the cum-day, the finding for ask orders on the cum-day provides some support for Foucault, Kadan and Kandel (2005). This could reflect the dynamic nature of trading, with the control variables employed in the survival model explaining the nature of the relationship.

5.8 Duration Between Trades

The theoretical model of Foucault, Kadan and Kandel (2005) predicts that the duration between trades should vary with the proportion of patient traders present in the market. With waiting costs increasing and traders becoming more impatient, the probability of a market order is higher. We anticipate a reduction in duration between trades on the cum-day and that this change in duration should vary positively with the level of imputation attached to the dividend. Table 12 contains the results of our analysis of the raw time between consecutive trades.[13]

[INSERT TABLE 12]

The average time between trades falls on both the cum-day and the ex-day relative to the benchmark period. The decline on the cum-day is, on average, twice as large as the decline on the ex-day. Given the increase in waiting costs on the cum-day, we expect to see a reduction in the time elapsed between trades. The cum-day decline in duration is higher for high yield and full imputation dividend payments. Not surprisingly, the decline is also largest for high imputation yield events. Stocks with low benchmark effective spreads have the lowest falls in duration. The decline is statistically significant between the benchmark period and the cum-day, and the changes do not vary with idiosyncratic risk. The results for the ex-day are similar to the cum-day, but the strength of the results, both economically and statistically, are tempered. These results provide further support for the model of Foucault, Kadan and Kandel (2005), in which waiting costs and investor patience are key determinants of order book liquidity in the presence of a deadline.

[13] We also examine the percentage change in the durations and the results are qualitatively similar.

6. Conclusion

Theoretical models of limit order books that are populated by liquidity traders indicate that the anticipated cost of the delay between order placement and order execution can impact on the resiliency of markets and the choice between market and limit orders by traders in a pure order-driven market. The current study tests the theoretical implications of these models in the ex-dividend period for stocks listed on the ASX between 1990 and 2008. We focus on the ex-day as the presence of tax-induced differences in trader valuations and a trading deadline lead to a higher expected waiting cost on the cum-dividend day, given the impact on after-tax returns. Furthermore, the presence of an imputation tax system in Australia creates a larger difference in valuations, as well as providing cross-sectional variability in waiting costs.

We hypothesize that traders will post more aggressive orders in the cum-dividend period, leading to lower spreads. After the ex-dividend deadline has passed, traders will submit less aggressive orders and spreads will be wider. Consistent with these predictions, we find that order placement is more aggressive on the cum-day, relative to a benchmark trading period prior to the ex-day. The change in order aggression is greatest for full imputation and high yield stocks, where waiting costs are expected to be larger. Further support for the hypothesized changes in order aggression is found with an increase in the depth at the best ask quote on the cum-dividend day and significant decrease in both the best bid and ask quote depths on the ex-day. Transaction costs are also affected by changes in waiting costs. The ex-day effective half-spread is around 27% higher than the non-event benchmark period. The effective spread drops on the cum-day and spikes upwards on the ex-day before returning to its average level. This pattern of spread behavior is pervasive across dividend yields, imputation levels, and a non-event benchmark spread. Analysis of the determinants of the spread indicates that the level of imputation tax credits are positively associated with the cum-day spread decline, consistent with tax-induced valuation differentials and higher waiting costs. The decline in duration between trades on the cum-day varies positively with our cross-sectional proxy for waiting costs. Cum-day ask orders are also quicker to execute for stocks with high imputation yields, as expected under our waiting cost hypothesis.

The findings of this study have a number of implications. First, it sheds light on how differences in valuation impact on order placements and transaction costs. Differences in valuation can actually lead to lower spreads in a setting with a trading deadline. Furthermore, the presence of a deadline shows that bid-ask spreads can behave predictably around certain events, in a manner that is unrelated to information. A potential avenue for future research is to assess whether changes in trading behavior and transaction costs exist around other market events that represent a deadline, such as the closing dates of rights issues and benchmark index deletions and additions.

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Appendix 1: Domestic Equity Ownership Proxy

The level of domestic ownership of stocks in our sample is estimated from the daily domestic holdings for stocks prior to the ex-dividend day from the ASX Clearing House Electronic Sub-register System (CHESS). This data is obtained directly from the ASX via SIRCA and is censored so that no individual participant is identifiable. The CHESS domestic share ownership is censored using the following filters as provided by SIRCA. An observation is a CHESS holding at the investor level (e.g. individual or company). We obtain CHESS ownership at the aggregate domestic data category to reduce the censoring by these filters. These filters are: i) "Threshold Test" checks that there are a minimum of ten observations within each point for each data category; ii) "Dominance Test" checks that no single observation accounts for more than 50% of the value for each data point for each data category; that no two observations combined account for more than 75% of the value of each data point for each data category; and that no three observations combined account for more than 90% of the value of each data point for a data category; and iii) "Activity Test" where time series data is provided. The “Activity Test” checks that no single observation accounts for more than 50% of the absolute value of aggregate changes for the data category compared to the previous period, and that no two observations combined account for more than 75% of the absolute value of aggregate changes for the data category compared to the previous period.

As such, about 11.4% of the stock/days we require for analysis are censored, although we note that domestic holdings are stable over time. In order to calculate the daily percentage domestic holdings of a stock, we take the number of domestic shares and divide it by the shares outstanding. We then take the daily average from *t*-30 to *t*-1 (cum-day) of the ex-day and then calculate the cross sectional average. We find an average domestic holding percentage of 66.5%. We also calculate the daily average domestic holding from *t*+0 to *t*+30 and find a similar average holding of 66.9%. Thus, this shows the dominance of domestic investors on the ASX.

Appendix 2: Robustness of Spread Results

The large and statistically significant increase in the ex-dividend effective spread, realized spread and price impact in comparison to the benchmark period warrants special attention. We conduct several robustness checks to better understand the ex-dividend spread increase. For brevity, we do not present the results of these robustness tests, which are available on request from the authors.

First, in an attempt to remove outliers for the daily stock spreads between *t*-50 to the ex-dividend day, we separately truncate the sample at the 5th and 95th percentile and at the 10th and 90th percentile. With the truncation of daily spreads, the full sample ex-dividend spread increase remains statistically significant, though much smaller at 4 and 2.8 basis points for the 5% and 10% truncation of daily spreads, respectively. Alternatively, for each stock on each day, we truncate trades in which the prevailing effective percentage spread is at the 5th and 95th percentile and recalculate the stock's daily effective spread and find similar results. Using this truncation, the ex-div day spread increase is 5 basis points and is statistically significant.

Second, the sample period includes days where market-sensitive company news was announced that could affect the effective spread during our sample period. We use ASX company announcements to identify all market-sensitive announcements on the day, including dividend announcements.[14] We find little change in our results.

Third, we divide dividend events into two groups depending on whether the dividend is a fraction of one cent and the stock is trading with a minimum tick of one cent, or otherwise. We find that the increase in spread is not driven by dividend payments that are not a multiple of the tick size.

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[14] In particular, 5,868 dividend announcement dates for the entire 6,279 ex-dividend event dates were identified and removed from the benchmark window. 4,017 ex-dividend events or 64% of the entire sample had the announcement day in the benchmark window.

Fourth, we examine whether the spread results hold for stocks going ex-dividend listed on the New York Stock Exchange (NYSE). There are notable differences that make our NYSE spread results not directly comparable to the ASX. First, the NYSE is not a pure limit order market as it operates a hybrid market where specialists compete with traders posting limit orders. Second, without imputation credits, subjective valuation of dividends would not be as accentuated – leading to less extreme waiting costs for traders. We use Trade and Quote (TAQ) data to examine 70,334 ex-dividend day events from August 1993 to December 2008. The sample excludes American Depository Receipts (ADRs) and Real Estate Investment Trusts (REITs) and only contains quarterly cash dividends (distribution code 1232). From TAQ, we sign trades and obtain their prevailing bid-ask spreads by applying the Ellis, Michaely and O'Hara (2000) algorithm with a zero-second trade delay following the recommendations in Henker and Wang (2006). We conduct analysis of effective spreads, realized spread and price impact. We present partitions for the effective spread by decimalization era (1/8, 1/16 or decimal ticks), dividend yield and benchmark effective percentage half-spread. The results are reported in Table A.1. We find generally similar results, with the effective half-spread falling on the cum-dividend day (relative to the benchmark period) and increasing on the ex-dividend day. The exception is for the low and medium dividend yield group and the high benchmark spread group, where the ex-dividend spread falls rather than increases. The ex-dividend spread jump in the NYSE sample, however, is not as large and suggests that there could be other factors causing the large increase in Australia.

[INSERT TABLE A.1]

For the realized percentage half-spread, we find inconsistent results that suggest the ex-dividend spread increase is not due to liquidity traders. For price impact, we find that while the results are weaker than in Australia, there is some evidence of a statistically significant increase in price impact on the ex-day. In particular, the ex-day price impact increase occurs for the full sample, medium dividend yield stocks and low benchmark spread stocks. Therefore, the results provide some support that informed trading on the ex-day increases the effective spread.

Table 1
Differences in Valuation in an Imputation Tax System

This table shows the after-tax face value of a $1 dividend payment ($v$) for three stocks in the sample that have different imputation levels:

$$v = \frac{(1-\tau_d)}{(1-\tau_g)}\left[1 + \frac{uk\tau_c}{(1-\tau_c)}\right].$$

τ_d is the tax rate on dividend income, τ_g is the capital gains tax rate, τ_c is the corporate tax rate, and k is the level of imputation. Investors' utilization of imputation credits is denoted by u. We assume that domestic resident investors are taxed at the marginal rate of 47%. Foreign investors are assumed to be taxed on dividends at a rate of 30% and taxed on capital gains at 20%.

	Full Imputation	Partial Imputation	Zero Imputation
Company	BHP	QBE Insurance	Qantas Airways
Ex-date	4 June 2001	29 February 2008	26 February 1997
Dividend ($)	0.26	0.65	0.065
Imputation Level	100%	50%	0%
Dividend Yield	1.16%	2.70%	2.69%
Cum-dividend Closing Price ($)	22.38	24.10	2.42
Corporate Tax	34%	30%	36%
After-tax Face Value of $1 Dividend and Imputation Payment			
Domestic Resident	1.52	1.21	1.00
Foreign Investor	0.88	0.88	0.88

Table 2
Descriptive Statistics

This table reports summary statistics for our sample of dividends for companies going ex-dividend on the ASX between February 1990 and December 2008. The cash dividend is the dividend payment in cents. The imputation level is the percentage tax credit attached to the cash dividend. The dividend yield is measured as the cash dividend divided by the closing cum-day price. The imputation credit yield is the dollar value of the imputation credit as a percentage of the cum-dividend closing price.

	Mean	Std. Dev.	Min.	Quartile 1	Median	Quartile 3	Max.
Cash Dividend (¢)	14.05	21.99	0.10	4.50	8.00	15.00	280.00
Imputation Level (%)	64.24	45.53	0.00	0.00	100.00	100.00	100.00
Dividend Yield (%)	2.27	1.66	0.06	1.53	2.08	2.76	79.37
Imputation Credit Yield (%)	0.34	0.34	0.00	0.00	0.33	0.55	8.40

Table 3
Proportion of Orders Ranked by Aggressiveness

This table contains the cross-sectional averages of the proportion of submitted orders ranked by aggressiveness. The least aggressive orders are ranked 1, with 6 representing the most aggressive orders. The order types from least aggressive to most aggressive are: (1) cancelled orders, (2) limit orders outside the prevailing quotes, (3) limit orders at the best quotes, (4) limit orders at a price better than the best quote, (5) market orders that are fully executed immediately at the prevailing best quote and (6) market orders with volumes greater than that available at the prevailing best quotes. The *t*-statistics from a paired *t*-test for differences in means are provided in parentheses. The sample period is from February 1990 to December 2008. **, * denote significance at the 1% and 5% levels, respectively.

Order	Proportion of Orders			Differences	
Aggressiveness	Benchmark	Cum-day	Ex-day	Cum-Benchmark	Ex-Benchmark
Panel A. Bid Orders					
1 (Least)	12.12	11.70	10.40	-0.41**	-1.72**
				(-3.05)	(-13.68)
2	12.50	12.58	17.79	0.09	5.29**
				(0.46)	(26.00)
3	26.19	25.90	24.52	-0.28	-1.67**
				(-1.40)	(-8.52)
4	11.12	10.84	14.84	-0.28	3.72**
				(-1.52)	(16.96)
5	25.63	27.05	22.14	1.42**	-3.48**
				(5.99)	(-16.72)
6 (Most)	10.17	10.33	8.98	0.16	-1.19**
				(1.03)	(-9.03)
Panel B. Ask Orders					
1 (Least)	11.63	11.28	10.82	-0.35**	-0.81**
				(-3.22)	(-8.62)
2	12.04	12.65	17.38	0.61**	5.34**
				(5.41)	(37.62)
3	25.16	26.01	24.11	0.85**	-1.05**
				(5.12)	(-6.95)
4	11.29	11.06	14.10	-0.22	2.82**
				(-1.60)	(17.97)
5	26.58	25.95	22.29	-0.63**	-4.29**
				(-3.22)	(24.96)
6 (Most)	11.08	11.40	10.01	0.31*	-1.07**
				(2.30)	(-9.62)

Table 4
Changes in Order Aggression: Ordered Probit Model

This table presents the median coefficient estimates for each dividend event based on the ordered probit model in Equation 7. The dependent variable is the order aggressiveness of each order on a scale from 1 to 6, with 1 being the least aggressive. The independent variables are the standard deviation of the lagged 20 mid-quote returns, the depth prevailing on the opposite side of the order book at the best quote, the depth prevailing on the same side of the order book at the best quote, the quoted bid-ask spread immediately prior to the order submission, the average time difference between the last three submitted orders, the number of trades in the last hour, the last trade size, the market index volatility over the past hour, industry volatility over the past hour and a dummy variable equaling to one for orders submitted in the last hour of trading. We include a dummy variable equal to one for orders submitted on the cum-day, and zero otherwise, and an ex-day dummy for orders submitted on the ex-day. The statistical significance of the median coefficients is estimated using the Fisher test. The sample period is from February 1990 to December 2008. The Kruskall-Wallis test for differences in medians across groups is reported below the median coefficients. **, * denote significance at the 1% and 5% levels, respectively.

	Bid Orders			Ask Orders		
	Cum-day	Ex-day	N	Cum-day	Ex-day	N
Panel A. Full Sample	0.014**	-0.008**	5709	0.000	-0.010**	5710
Panel B. Dividend Yield						
Low	0.013**	0.000	1916	0.007**	0.000	1917
Medium	0.016**	-0.004**	1909	0.000	-0.010**	1919
High	0.013**	-0.040**	1884	0.000	-0.034**	1874
Kruskall-Wallis	1.475	26.975**		6.554*	24.266**	
Panel C. Imputation Level						
Zero	0.000	-0.003**	1797	0.000	-0.008**	1817
Partial	0.034**	-0.036**	626	0.022**	-0.014*	624
Full	0.025**	-0.005**	3286	0.001**	-0.011**	3269
Kruskall-Wallis	12.298**	3.268		1.854	2.185	
Panel D. Imputation Yield						
Low	0.000	-0.002**	1869	0.000	-0.007**	1889
Medium	0.017**	-0.005**	1920	0.008**	-0.002**	1919
High	0.035**	-0.017**	1920	0.000	-0.022**	1902
Kruskall-Wallis	14.599**	6.280*		3.450	9.302**	
Panel E. Spread						
High	0.000	0.000	1519	0.000	0.000	1517
Medium	0.027**	-0.052**	2101	0.020**	-0.045**	2104
Low	0.051**	-0.022**	2089	0.022**	-0.033**	2089
Kruskall-Wallis	34.584**	26.100**		1.564	16.661**	
Panel F. Low Imputation Yield						
High Spread	0.000	0.000	645	0.000	0.000	661
Medium Spread	0.009***	-0.044***	805	0.013***	-0.072**	809
Low Spread	0.042***	-0.013*	419	0.014	-0.028**	419
Kruskall-Wallis	6.481**	7.040**		0.778	13.592**	
Panel G. Medium Imputation Yield						
High Spread	0.000	0.000	414	0.000	0.000	413
Medium Spread	0.006**	-0.028***	597	0.039***	-0.011	597
Low Spread	0.047***	-0.026***	909	0.034***	-0.032**	909
Kruskall-Wallis	11.807***	1.160		2.326	5.874	
Panel H. High Imputation Yield						
High Spread	0.000*	0.000	460	0.000	0.000	443
Medium Spread	0.046**	-0.085**	699	0.013	-0.046**	698
Low Spread	0.063**	-0.023**	761	0.020**	-0.036**	761
Kruskall-Wallis	13.511**	25.150**		0.873	2.446	

Table 5
Order Imbalance around the Ex-Dividend Day

This table reports the equally weighted average order imbalance around the ex-dividend day. The order imbalance is measured as the difference between buyer-initiated volume and seller-initiated volume as a percent of the sum of buyer- and seller-initiated volume. The sample period is from February 1990 to December 2008. **, * denote significance at the 1% and 5% levels, respectively. We present *t*-statistics with standard errors clustered by the ex-dividend date.

	t-2	t-1	Ex-day	t+1	t+2	N
Panel A. Full Sample	0.040**	0.047**	-0.018**	-0.013*	-0.013*	6279
Panel B. Dividend Yield						
Low	0.010	-0.009	-0.022*	-0.028**	-0.029**	2093
Medium	0.028*	0.056**	-0.019	-0.008	-0.012	2093
High	0.082**	0.095**	-0.013	-0.002	0.002	2093
F-stat	14.13**	28.39**	0.20	1.76	2.32	
Panel C. Imputation Level						
Zero	0.015	0.015	-0.024*	-0.011	0.003	2025
Partial	0.040**	0.044**	-0.012	-0.007	-0.012	654
Full	0.054**	0.066**	-0.016*	-0.015	-0.022**	3600
F-stat	4.61**	8.43**	0.28	0.10	1.82	
Panel D. Imputation Credit Yield						
Low	0.016	0.017	-0.021	-0.010	0.006	2093
Medium	0.022*	0.023*	-0.020*	-0.018	-0.021*	2093
High	0.083**	0.101**	-0.013	-0.011	-0.023*	2093
F-stat	13.85**	22.45**	0.19	0.21	2.45	
Panel E. Benchmark Effective Percentage Half-Spread						
Low	0.041**	0.042**	0.011*	-0.004	-0.009	2093
Medium	0.048**	0.070**	-0.012	0.004	-0.001	2093
High	0.030*	0.030*	-0.054**	-0.040**	-0.030	2093
F-stat	0.84	4.33*	10.42**	5.33**	2.21	
Panel F. Idiosyncratic Volatility						
Low	0.062**	0.083**	0.009	0.014	0.025*	2090
Medium	0.052**	0.045**	-0.018	-0.021*	-0.023*	2090
High	0.006	0.014	-0.046**	-0.031**	-0.040**	2090
F-stat	8.75**	12.19**	7.19**	5.59**	10.73**	

Table 6
Average Abnormal Time-Weighted Bid and Ask Market Depth around the Ex-Dividend Day

This table reports the equally weighted average daily bid and ask market depth, on the cum-day and ex-day for both the best bid and ask and top 10 bid and ask prices. Abnormal time-weighted bid (ask) market depth is calculated as the daily number of shares at the relevant bid (ask) price, divided by the number of shares outstanding over the expected time-weighted daily number of shares at the best bid (ask) price, divided by the number of shares outstanding. The expected time-weighted bid or ask depth for a dividend event is the average daily time-weighted number of shares at the best bid or ask price between *t*-45 and *t*-6, and *t*+6 to *t*+45. The sample period is from February 1990 to December 2008. **, * denote significance at the 1% and 5% levels, respectively. We present *t*-statistics with standard errors clustered by the ex-dividend date.

	Cum-Day		Ex-Day		Cum-Day		Ex-Day		N
	Best Bid	Best Ask	Best Bid	Best Ask	Top 10 Bid	Top 10 Ask	Top 10 Bid	Top 10 Ask	
Panel A. Full Sample	0.008	0.104**	-0.115**	-0.095**	0.055**	0.070**	-0.233**	-0.211**	6279
Panel B. Dividend Yield									
Low	0.009	-0.004	-0.115**	-0.126**	0.007	0.028	-0.177**	-0.188**	2093
Medium	0.028	0.051	-0.124**	-0.062	0.067**	0.059**	-0.237**	-0.244**	2093
High	-0.012	0.265**	-0.108	-0.097	0.093**	0.123**	-0.284**	-0.202**	2093
F-stat	0.14	4.58*	0.03	0.31	7.25**	6.74**	15.94**	4.77**	
Panel C. Imputation Level									
Zero	-0.006	0.081	-0.160**	-0.055	0.007	0.005	-0.287**	-0.255**	2025
Partial	-0.003	0.103	0.005	-0.148**	0.092**	0.113**	-0.178**	-0.162**	654
Full	0.018	0.117*	-0.112**	-0.108**	0.076**	0.099**	-0.212**	-0.196**	3600
F-stat	0.07	0.09	1.56	0.40	6.36**	8.70**	12.56**	8.47**	
Panel D. Imputation Credit Yield									
Low	-0.005	0.077	-0.159**	-0.060	0.008	0.005	-0.286**	-0.252**	2093
Medium	0.026	0.045	-0.096*	-0.122**	0.035*	0.059**	-0.173**	-0.199**	2093
High	0.004	0.190*	-0.091*	-0.103	0.123**	0.145**	-0.239**	-0.182**	2093
F-stat	0.09	1.32	0.69	0.30	13.52**	14.32**	17.83**	7.48**	
Panel E. Benchmark Effective Percentage Half-Spread									
Low	0.018	0.069**	-0.048	-0.067**	0.091**	0.119**	-0.080**	-0.116**	2093
Medium	0.066	0.152*	-0.158**	-0.169**	0.053**	0.071**	-0.289**	-0.258**	2093
High	-0.060	0.091	-0.140**	-0.049	0.023	0.020	-0.329**	-0.260**	2093
F-stat	1.44	0.42	1.66	1.26	4.30*	6.88**	102.08**	38.60**	
Panel F. Idiosyncratic Volatility									
Low	0.017	0.066	-0.143**	-0.142**	0.039*	0.049**	-0.260**	-0.214**	2090
Medium	0.048	0.154*	-0.090	-0.107**	0.076**	0.092**	-0.204**	-0.200**	2089
High	-0.040	0.093	-0.112**	-0.035	0.050**	0.068**	-0.235**	-0.219**	2087
F-stat	0.70	0.47	0.34	0.89	1.35	1.36	4.36*	0.57	

Table 7
Effective Percentage Half-Spreads around the Ex-Dividend Day

This table reports the equally weighted average effective percentage half-spread measures across dividend events. The effective percentage half-spread is measured as the absolute value of the traded price less the midpoint of the bid and ask immediately prior to the trade occurring, divided by the trade-weighted cum-dividend price. The benchmark spread is the average effective percentage half-spread from *t*-50 to *t*-6 days prior to an ex-dividend date for a given stock. The sample period is from February 1990 to December 2008. *t*-statistics with ex-dividend date clustered standard errors are reported in parentheses. **, * denote significance at the 1% and 5% levels, respectively.

	Benchmark	Cum-day	Ex-day	Cum-Benchmark	*t*-stat	Ex-Benchmark	*t*-stat	N
Panel A. Full Sample								
	0.358	0.342	0.456	-0.016**	(-3.61)	0.098**	(14.24)	6279
Panel B. Dividend Yield								
Low	0.346	0.336	0.451	0.010	(-1.01)	0.105**	(7.05)	2093
Medium	0.351	0.336	0.449	-0.015*	(-2.39)	0.098**	(10.72)	2093
High	0.378	0.353	0.468	-0.025**	(-3.36)	0.090**	(9.24)	2093
F-stat				0.90		0.42		
Panel C. Imputation Level								
Zero	0.412	0.407	0.514	-0.005	(0.51)	0.103**	(7.72)	2025
Partial	0.238	0.239	0.301	0.001	(0.13)	0.063**	(5.00)	654
Full	0.350	0.324	0.451	-0.026**	(-4.40)	0.101**	(11.34)	3600
F-stat				3.15*		1.56		
Panel D. Imputation Credit Yield								
Low	0.405	0.401	0.505	-0.005	(-0.53)	0.099**	(7.72)	2093
Medium	0.325	0.319	0.432	-0.007	(-0.78)	0.107**	(8.37)	2093
High	0.344	0.306	0.431	-0.038**	(-6.12)	0.087**	(9.44)	2093
F-stat				5.51**		0.72		
Panel E. Benchmark Effective Percentage Half-Spread								
Low	0.106	0.104	0.114	-0.001	(-1.69)	0.008**	(7.68)	2093
Medium	0.267	0.260	0.333	-0.007**	(-3.06)	0.065**	(12.57)	2093
High	0.701	0.661	0.921	-0.041**	(-3.06)	0.220**	(11.55)	2093
F-stat				7.19**		93.03**		
Panel F. Idiosyncratic Volatility								
Low	0.292	0.288	0.377	-0.003	(-0.65)	0.085**	(10.43)	2090
Medium	0.320	0.305	0.401	-0.015*	(-2.18)	0.081**	(7.70)	2090
High	0.464	0.433	0.591	-0.031**	(-2.83)	0.128**	(8.23)	2090
F-stat				3.05*		5.01**		

Table 8
Determinants of Percent Change in Effective Half-Spreads

This table reports results from the estimation of the determinants of percentage changes in the effective spread from Equation 8 between February 1990 and December 2008. The dependent variable is Columns 1 and 2 present results for the change from the benchmark period (*t*-50 to *t*-6) to the cum-day, Columns 3 and 4 presents results for the change from the benchmark period to the ex-day. Imputation is the percentage to which the dividend carries tax credits, Dividend Yield is the dividend as a percent of the cum-dividend day closing price, Imputation Yield represents the dollar value of the imputation credit as a percent of the cum-dividend closing price, ΔVolume is the change in the natural logarithm between the two relevant periods, ΔVolatility is the change in the stock return standard deviation as measured by the log difference between the high price and low price for the day, Beta and Idiosyncratic Volatility are from a 3-year rolling market model using weekly data. The *t*-statistics based on standard errors are clustered by stock and ex-dividend dates and are shown in parentheses. **, * denote significance at the 1% and 5% levels, respectively.

	Cum-Benchmark		Ex-Benchmark	
	(1)	(2)	(3)	(4)
Intercept	0.087**	0.063**	0.277**	0.316**
	(4.59)	(3.88)	(5.66)	(7.67)
Imputation	-0.029*		0.071**	
	(-2.03)		(2.63)	
Dividend Yield	-1.044**		1.374	
	(-3.18)		(1.54)	
Imputation Yield		-6.739**		11.047**
		(-4.23)		(2.70)
ΔVolume	-0.091**	-0.091**	-0.211**	-0.211**
	(-9.07)	(-9.03)	(-11.63)	(-11.56)
ΔVolatility	0.987**	0.979**	0.941**	0.936**
	(6.20)	(6.22)	(5.58)	(5.59)
Beta	-0.036*	-0.033*	-0.227**	-0.226**
	(-2.26)	(-2.11)	(-6.90)	(-7.13)
Ivol	-0.558	-0.502	1.434	1.402
	(-1.48)	(-1.32)	(1.35)	(1.33)
N	6,270	6,270	6,270	6,270
Adj. R^2	0.041	0.042	0.072	0.072

Table 9
Realized Percentage Half-Spreads around the Ex-Dividend Day

This table reports the equally weighted realized percentage spreads across dividend events. The realized half-spread is measured as the difference between the trade price and the midpoint price after 30 minutes divided by the trade-weighted cum-dividend day price. The benchmark realized percentage spread is calculated as the average realized percentage spread between *t*-50 and *t*-6 days from the ex-dividend day. The sample period is from February 1990 to December 2008. The *t*-statistics with ex-dividend date clustered standard errors are reported in parentheses. **, * denote significance at the 1% and 5% levels, respectively.

	Benchmark	Cum-day	Ex-day	Cum-Benchmark	*t*-stat	Ex-Benchmark	*t*-stat	N
Panel A. Full Sample								
	0.096	0.086	0.139	-0.011	(-1.73)	0.043**	(5.01)	6279
Panel B. Dividend Yield								
Low	0.078	0.065	0.139	-0.013	(-1.10)	0.061**	(3.60)	2093
Medium	0.107	0.091	0.144	-0.015	(-1.43)	0.037**	(2.77)	2093
High	0.104	0.101	0.134	-0.004	(-0.40)	0.030*	(2.35)	2093
F-stat				0.33		1.27		
Panel C. Imputation Level								
Zero	0.133	0.129	0.182	-0.004	(-0.37)	0.049**	(3.01)	2025
Partial	0.041	0.066	0.058	0.025*	(2.20)	0.017	(0.88)	654
Full	0.086	0.065	0.129	-0.021*	(-2.40)	0.044**	(3.90)	3600
F-stat				2.74		0.60		
Panel D. Imputation Credit Yield								
Low	0.130	0.125	0.177	-0.005	(-0.46)	0.047**	(2.98)	2093
Medium	0.071	0.057	0.120	-0.015	(-1.24)	0.049**	(3.17)	2093
High	0.088	0.075	0.120	-0.013	(-1.25)	0.032*	(2.52)	2093
F-stat				0.23		0.42		
Panel E. Benchmark Effective Percentage Half-Spread								
Low	0.009	0.015	0.011	0.006**	(3.00)	0.002	(0.87)	2093
Medium	0.062	0.064	0.073	0.001	(0.33)	0.011	(1.49)	2093
High	0.218	0.179	0.333	-0.040*	(-2.21)	0.115**	(4.87)	2093
F-stat				5.63**		19.49**		
Panel F. Idiosyncratic Volatility								
Low	0.102	0.097	0.125	-0.004	(-0.58)	0.024*	(2.24)	2090
Medium	0.078	0.069	0.094	-0.009	(-0.95)	0.016	(1.31)	2090
High	0.110	0.091	0.199	-0.019	(-1.33)	0.088**	(4.58)	2090
F-stat				0.50		7.84**		

Table 10
Price Impact around the Ex-Dividend Day

This table presents the adverse selection component of the spread calculated as the effective percentage spread less the realized percentage spread. It is also measured as the difference between the midpoint price prior to the trade and the midpoint price 30 minutes after the trade, divided by the trade-weighted cum-dividend price. The benchmark is measured as the average price impact between *t*-50 and *t*-6 days from the ex-dividend day. The sample period is from February 1990 to December 2008. The *t*-statistics with ex-dividend date clustered standard errors are reported in parentheses. **, * denote significance at the 1% and 5% levels, respectively.

	Benchmark	Cum-day	Ex-day	Cum-Benchmark	*t*-stat	Ex-Benchmark	*t*-stat	N
Panel A. Full Sample								
	0.258	0.256	0.317	-0.003	(-0.41)	0.059**	(7.37)	6279
Panel B. Dividend Yield								
Low	0.266	0.270	0.312	0.004	(0.34)	0.045**	(3.05)	2093
Medium	0.242	0.245	0.305	0.002	(0.20)	0.063**	(4.60)	2093
High	0.266	0.252	0.334	-0.014	(-1.37)	0.068**	(5.42)	2093
F-stat				0.80		0.76		
Panel C. Imputation Level								
Zero	0.277	0.278	0.332	-0.001	(-0.07)	0.055**	(3.79)	2025
Partial	0.198	0.173	0.243	0.026*	(2.46)	0.044*	(2.33)	654
Full	0.258	0.258	0.322	0.000	(0.02)	0.063**	(5.78)	3600
F-stat				0.82		0.31		
Panel D. Imputation Credit Yield								
Low	0.273	0.275	0.327	0.002	(0.15)	0.053**	(3.80)	2093
Medium	0.252	0.262	0.312	0.010	(0.89)	0.060**	(4.17)	2093
High	0.249	0.230	0.311	-0.019*	(-2.11)	0.062**	(4.53)	2093
F-stat				1.93		0.11		
Panel E. Benchmark Effective Percentage Half-Spread								
Low	0.098	0.090	0.103	-0.008**	(-4.09)	0.005	(1.84)	2093
Medium	0.209	0.197	0.260	-0.012*	(-2.46)	0.051**	(6.56)	2093
High	0.468	0.480	0.587	0.013	(0.72)	0.120**	(5.45)	2093
F-stat				1.54		18.28**		
Panel F. Idiosyncratic Volatility								
Low	0.190	0.191	0.252	0.001	(0.14)	0.062**	(-0.70)	2090
Medium	0.238	0.235	0.307	-0.003	(-0.38)	0.069**	(6.47)	2090
High	0.346	0.341	0.392	-0.005	(-0.36)	0.046*	(5.46)	2090
F-stat				0.09		0.78		

Table 11
Survival Analysis of Time to Execution of Limit Orders

This table analyzes the time to completion of limit orders across the benchmark period (*t*-50 to *t*-6), cum-dividend day and the ex-dividend day. The survival model is estimated on an event-by-event basis with a generalized gamma distribution following Lo, MacKinlay and Zhang (2002) and Bessembinder, Panayides and Venkataraman (2009). The median coefficients for a cum-day dummy and an ex-day dummy variable are contained in the table. The other explanatory variables (unreported) are the difference between the midpoint of the quote and the last trade price, a dummy if the last trade was buyer-initiated, the depth at the best price on the same side of order book, the depth at the best price on the opposite side of the order book, the size of the order submitted, the ratio of the trades in the last 30 minutes to the number of trades in the last 60 minutes, and the log of the number of trades in the last 60 minutes. The statistical significance of the median coefficients are estimated using the Fisher test. The Kruskall-Wallis test for differences in medians across groups is reported below the median coefficients. **, * denote significance at the 1% and 5% levels, respectively.

	Bid Orders			Ask Orders		
	Cum-day	Ex-day	N	Cum-day	Ex-day	N
Panel A. Full Sample						
	0.064**	0.033**	4055	0.003**	0.018**	3955
Panel B. Dividend Yield						
Low	0.073**	0.041**	1447	0.041**	0.042**	1428
Medium	0.087**	0.051**	1278	0.003**	0.000	1243
High	0.018**	0.023**	1330	-0.019	0.026**	1284
Kruskall-Wallis	5.060	1.648		9.774**	2.336	
Panel C. Imputation Level						
Zero	0.070**	0.039**	1084	0.012**	0.000	1049
Partial	0.059**	0.006	537	0.033**	0.069*	532
Full	0.064**	0.037**	2434	0.000*	0.027**	2374
Kruskall-Wallis	2.664	2.906		4.194	1.267	
Panel D. Imputation Yield						
Low	0.066**	0.032**	1351	0.021**	0.000*	1318
Medium	0.070**	0.028**	1352	0.037**	0.046**	1319
High	0.055**	0.045**	1352	-0.015	0.024**	1318
Kruskall-Wallis	3.046	0.856		13.148*	0.382	
Panel E. Spread						
Low	0.032**	0.024**	2069	-0.009	0.015	2037
Medium	0.089**	0.044**	1628	0.024**	0.000*	1584
High	0.525**	0.149**	358	0.224**	0.401**	334
Kruskall-Wallis	52.397*	26.981*		36.692*	43.421*	
Panel F. Low Imputation Yield						
Low Spread	0.005	0.000	524	-0.020	-0.005	520
Medium Spread	0.086**	0.067**	656	0.021**	0.000	637
High Spread	0.575**	0.195**	171	0.419**	0.366**	161
Kruskall-Wallis	27.766*	12.870**		22.915*	17.637*	
Panel G. Medium Imputation Yield						
Low Spread	0.043*	0.027*	827	0.013	0.034	804
Medium Spread	0.080**	0.004**	441	0.162**	0.035	432
High Spread	1.004**	0.231**	84	0.089**	0.294**	83
Kruskall-Wallis	25.341*	10.495*		10.360**	10.076*	
Panel H. High Imputation Yield						
Low Spread	0.042	0.036*	718	-0.046*	0.018	713
Medium Spread	0.102**	0.056**	531	0.000	0.009	515
High Spread	0.071*	0.079**	103	0.060**	0.570**	90
Kruskall-Wallis	4.431	4.855		6.452*	17.784*	

Table 12
Raw Trade Duration

Trade duration is measured as the seconds that elapse between consecutive trades. This table presents the difference in the trade duration between the benchmark period and the cum-day, as well as the benchmark period and the ex-day. The benchmark is measured as the average trade duration between *t*-50 and *t*-6 days from the ex-dividend day. The sample period is from February 1990 to December 2008. **, * denote significance at the 1% and 5% levels, respectively.

	Benchmark	Cum-day	Ex-day	Cum-Benchmark	*t*-stat	Ex-Benchmark	*t*-stat	N
Panel A. Full Sample								
	1132.92	983.506	1058.99	-149.41**	(8.44)	-73.93**	(-3.72)	5975
Panel B. Dividend Yield								
Low	1032.48	992.23	1013.20	-40.25	(1.20)	-19.28	(-0.57)	1968
Medium	1170.40	1005.81	1097.33	-164.59**	(6.09)	-73.07*	(-2.33)	1998
High	1194.03	952.78	1065.71	-241.25**	(8.30)	-128.32**	(-3.85)	2009
F-stat				12.11**		2.81		
Panel C. Imputation Level								
Zero	1301.97	1208.23	1257.26	-93.74**	(2.76)	-44.71	(-1.08)	1906
Partial	625.08	547.71	588.23	-77.38*	(2.56)	-36.86	(-0.99)	643
Full	1134.18	940.28	1037.04	-193.91**	(8.30)	-97.14**	(-3.96)	3426
F-stat				4.74**		1.04		
Panel D. Imputation Credit Yield								
Low	1274.42	1187.40	1233.29	-87.03**	(2.63)	-41.14	(-1.03)	1974
Medium	991.57	875.64	929.03	-115.93**	(4.11)	-62.55*	(-2.11)	1990
High	1133.89	890.11	1016.51	-243.78**	(8.28)	-117.39**	(-3.56)	2011
F-stat				8.24**		1.47		
Panel E. Benchmark Effective Percentage Half-Spread								
Low	194.89	167.57	159.68	-27.32**	(4.36)	-35.21**	(-8.16)	2087
Medium	755.40	617.05	703.69	-138.35**	(9.25)	-51.71**	(-2.98)	2082
High	2652.11	2348.86	2507.82	-303.25**	(5.65)	-144.29*	(-2.33)	1806
F-stat				22.04**		3.12*		
Panel F. Idiosyncratic Volatility								
Low	1103.33	949.50	1049.06	-153.83**	(6.08)	-54.27	(-1.49)	2022
Medium	1010.79	826.17	906.15	-184.62**	(7.04)	-104.64**	(-4.24)	1991
High	1293.02	1183.35	1229.63	-109.67**	(2.93)	-63.39	(-1.57)	1953
F-stat				1.65		0.68		

Figure 1
Average Daily Effective Percentage Half-Spread around the Ex-Dividend Day

The sample is for dividends paid between February 1990 and December 2008. This figure presents the equally weighted average daily effective percentage half-spreads across dividend events from *t*-50 to *t*+50, relative to the ex-dividend date.

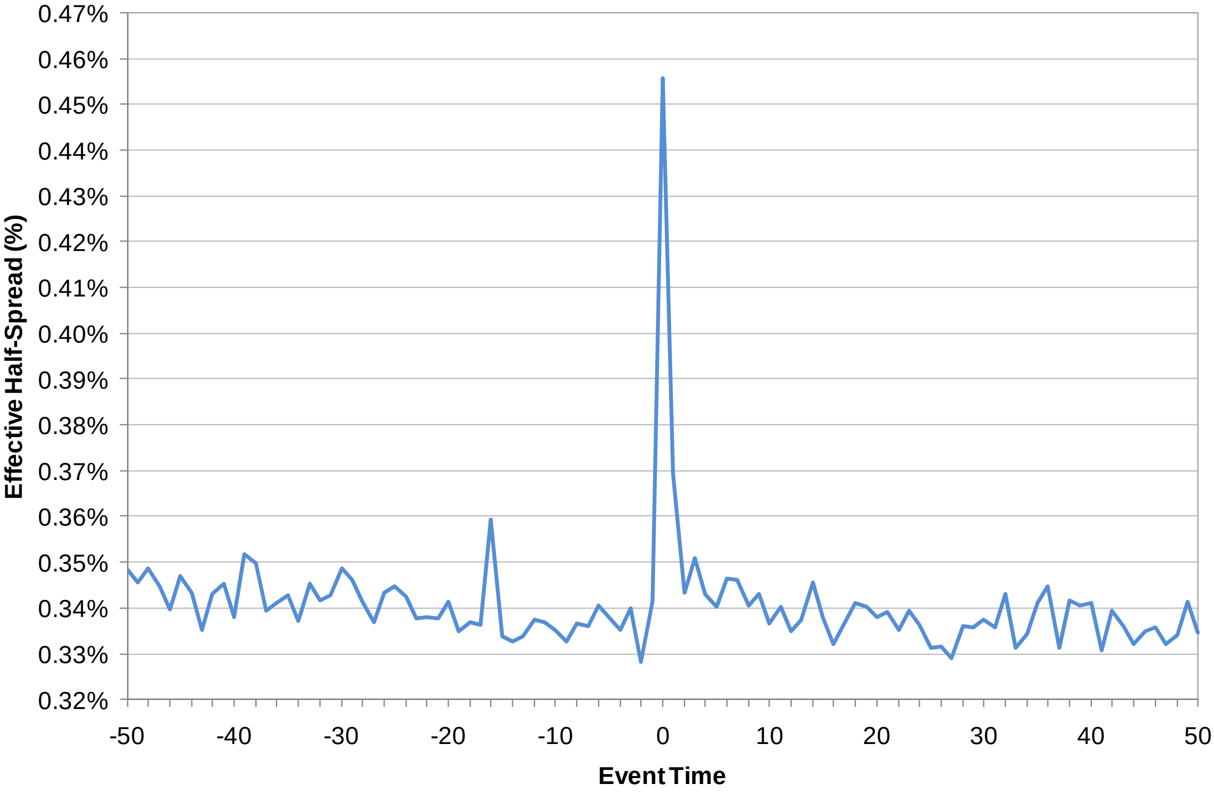

Table A.1
Effective Spreads, Realized Spread and Price Impact around the Ex-Day for NYSE Stocks

This table reports the equally weighted average effective percentage half-spread measures across dividend events for NYSE stocks. The effective percentage half-spread is measured as the absolute value of the traded price less the midpoint of the bid and ask immediately prior to the trade occurring, divided by the trade-weighted cum-dividend price. The benchmark spread is the average effective percentage half-spread from t-50 to t-6 days prior to an ex-dividend date for a given stock. The sample period is from August 1993 to December 2008. *t*-statistics with ex-dividend date clustered standard errors are reported in parentheses. **, * denote significance at the 1 and 5% level.

	Benchmark	Cum-day	Ex-day	Cum-Benchmark	*t*-stat	Ex-Benchmark	*t*-stat	N
Panel A. Effective Spread: Full Sample								
	0.346	0.339	0.353	-0.007**	(-8.05)	0.007**	(8.06)	70334
Panel B. Effective Spread: Decimalization Era								
1/8	0.461	0.458	0.473	-0.003*	(-2.35)	0.012**	(8.99)	19784
1/16	0.434	0.425	0.443	-0.008**	(-4.11)	0.009**	(4.46)	20839
Decimal	0.207	0.199	0.210	-0.009**	(-7.25)	0.003*	(2.09)	29711
F-stat				8.25**		18.35**		
Panel C. Effective Spread: Dividend Yield								
Low	0.296	0.289	0.291	-0.007**	(-7.12)	-0.005**	(-4.99)	23445
Medium	0.344	0.337	0.338	-0.007**	(-5.87)	-0.006**	(-5.30)	23444
High	0.397	0.391	0.431	-0.006**	(-4.31)	0.033**	(19.48)	23445
F-stat				0.28		370.98**		
Panel D. Effective Spread: Benchmark Effective Percentage Half-Spread								
Low	0.102	0.104	0.114	0.002**	(4.72)	0.012**	(18.67)	23444
Medium	0.259	0.259	0.277	0.000	(0.00)	0.019**	(16.23)	23445
High	0.677	0.654	0.668	-0.023**	(-10.95)	-0.009**	(-4.35)	23445
F-stat				173.50**		149.54**		
Panel E. Realized Spread: Full Sample								
	0.123	0.105	0.115	-0.017*	(-2.42)	-0.008	(-1.09)	70334
Panel F. Price Impact: Full Sample								
	0.223	0.234	0.238	0.010	(1.45)	0.015*	(2.09)	70334