Costly Short Selling and Stock Price Adjustment to Earnings Announcements

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ABSTRACT

We study the effect of short sale constraints on the informational efficiency of stock prices using a direct measure of shot sale constraints. Specifically, we test the Diamond and Verrecchia (1987) hypothesis that short sale constraints reduce the speed at which prices adjust to private information. We show that stocks for which short selling is costly have larger price reactions to earnings announcements, especially to bad news. We confirm the Diamond and Verrechia (1987) prediction that the distribution of announcement day returns is more left skewed and returns have larger absolute values when short selling is constrained. We find that trading volume falls and prices become less informative when short selling is constrained. Furthermore, the fraction of long run price reaction realized on the day of the announcement is smaller when short selling is constrained.

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For many years, the effect of short sale constraints has motivated research with important and controversial implications for stock prices. Early papers, such as Miller (1977), argue that short sale constraints prevent pessimistic traders from short selling without restricting optimistic traders from buying, thereby imparting an upward bias to stock prices. In recent years, finance scholars have sought to measure the effects of Miller (1977) and similar models empirically[1]. This article looks at short sale constraints from a different perspective. We characterize the informational efficiency of stock prices in the presence of short sale constraints. Using a timely and accurate measure of short sale constraints, we study the distribution of returns when information is revealed to the public.

Diamond and Verrecchia (1987), DV hereafter, sets up a rational expectations model in which market participants take short sale constraints into consideration when formulating their demand and pricing decisions. In the model, short sale constraints lead to a decrease in trading as informed and uninformed traders are prevented from short selling. Since some relatively informative "sell or short" orders are removed from the market, prices take longer to adjust to private information. Price adjustment is particularly slow in the presence of negative private information because informed investors who do not own shares cannot trade on their information, further reducing the number of informative trades. Since securities subject to short sale constraints are slow to incorporate private information, they have relatively large price reactions when private information is publicized. Furthermore, since price adjustment to negative private

[1]See Asquith, Pathak, and Ritter (2005), Boehme, Danielsen and Sorescu (2006), Chen, Hong and Stein (2001), Danielsen and Sorescu (2001), Diether Malloy and Scherbina (2002), Jones and Lamont (2002), Nagel (2005), Sorescu (2000), among others, for a discussion of the empirical work. Lamont (2004) reviews the evidence.

information is particularly slow, large price reactions are more likely in the presence of bad news, which increases the left skewness of the announcement day return distribution.

Previous empirical work has used the introduction of exchange traded options as a proxy for the reduction in short selling costs (i.e. Jennings and Starks (1986), Skinner (1990)). In this paper, we use rebate rates determined in the equity lending market to test the DV hypothesis. To be sold short, stocks are often borrowed in the equity lending market. The borrowing cost fluctuates with market conditions, making some stocks, or specials, temporarily costly to short sell. Using the borrowing cost as an accurate and timely measure of short selling difficulty, we find evidence that supports the DV hypothesis.

To measure the efficiency of private information in the presence of short sale constraints, quarterly earnings are taken to be private information until firms announce their earnings to the public. Consistent with the DV prediction that announcement day price reactions will be larger when short selling is constrained, results show that the absolute value of announcement day returns is significantly larger when stocks are on special (0.076 vs. 0.058). We also find that the distribution of announcement day returns is more left skewed when short selling is constrained (measured skewness is 0.228 vs. 4.222), which bears out the DV prediction that large announcement day returns are more likely in the presence of negative information. Furthermore, after controlling for stock characteristics, we find that stocks have larger price reactions and larger announcement day volatilities when short selling is costly.

We also find empirical evidence consistent with the mechanism underlying DV. The DV hypothesis hinges on the fact that short sales are removed from the sample of

"sell or short" trades when short selling is constrained. We show that volume decreases by an average of 28,442 shares per day when stocks are on special. Furthermore, following Hasbrouck (1993), we decompose returns into informative and transient components. We find that short sale constraints decrease the informativeness of trades by 30%. Furthermore, in a setting where we control for stock characteristics, we find that specialness significantly decreases market quality.

In addition to stock price reactions to earnings announcements, we look at the relationship between costly short selling and the post earnings announcement drift anomaly. Papers such as Bernard and Thomas (1989) and Abarbanell and Bernard (1992), document that stocks with extreme earnings surprises tend to drift in the direction of their earnings surprise for periods of up to one year. If the costs of short selling reduce the informational efficiency of private information before the announcement, we might also expect efficiency to be reduced after the information becomes public. In particular, the full incorporation of negative earnings surprises will be delayed. Experiments presented in this paper support this hypothesis; stocks that are on special on the day negative earnings are announced have an abnormal return of -12.8% over the next three months, whereas stocks that are not on special have an abnormal return of 1.2% over the same period. To allow for the possibility of different amounts of post earnings announcement drift in the two samples, we present results comparing the percentage of eventual drift realized on the day of the earnings announcement with and without borrowing constraints. We find that stocks realize 32% less of their eventual post earnings announcement drift on the day of the announcement when short selling is costly.

One of the concerns about the effect of costly short selling on stock prices is endogeneity. Since short selling can drive scarcity in the lending market, the short sale constraint measure used in this paper could be problematic private information is driving short selling which, in turn, drives the sort sale constraint. We address this concern in two ways. First, we isolate four corporate events that drive short selling but have nothing to do with private earnings information. These events, mergers, seasoned equity offerings, dividend reinvestment discount programs and initial public offerings, are associated with a sub sample of stock specials for which we can be reasonably certain that the cause of specialness is not related to quarterly earnings. Although the sub sample is small, the distribution of announcement day returns reflects the predictions of the DV hypothesis; the distribution of announcement day returns has a larger average absolute value and more left skewness when short selling is constrained. Second, as a direct test for correlation between private information and specialness, we run a regression of earnings announcement surprises on specialness. We find no relationship, which suggests that stock specials are not associated with private earnings information.

The balance of this paper proceeds as follows. Section 1 describes and interprets the equity lending data. Section 2 describes the relationship between this work and existing literature, and Section 3 characterizes our findings. Section 4 concludes.

1. Data

One of the largest U.S. securities lenders has generously provided a database describing their daily loan portfolio from November 1st, 1998 through October 29th, 1999. The database has prices and quantities for the lender's U.S. equity loans in this period. The rebate rate is a timely measure of short sale constraints. As Table 1 shows, the median

loan duration is 3 days, and the mode of the distribution is 1 day. There are 287,838 observations representing new loans, 1,579,763 observations representing changes to existing loans, and 1,617,773 observations representing loans that were extended but otherwise unchanged. Using averaging over multiple loans in a given stock each day, we have 684,007 unique loan rate observations. The database is more fully described in Geczy, Musto and Reed (2002).

We construct a measure of specialness from the loan database. Equity loans are priced by the interest rate earned on a borrower's cash collateral, or the rebate rate. Specialness is the difference between the general rebate rate and the specific rebate rate on a particular stock loan. As Table 1 shows, the majority of stock loans have specialness near zero and the maximum specialness is 45.47%. Table 2shows that 5.74% of loans have specialness is above 1%, are these "special" loans are not highly concentrated in any market capitalization quintile.

Our measure of specialness represents scarcity in the equity loan market on a daily basis. When specialness is positive, the stock is said to be on special, and the borrower is earning less than usual on his cash collateral. In this sense, specialness is the opportunity cost of borrowing a particular security as opposed to borrowing at the prevailing rate for stocks. We may also think of this continuous measure of specialness as the probability of a loan being denied; retail brokerages do not generally offer variable rebate rates, but they may deny stock loans if market rebate rates are high. See Geczy, Musto and Reed (2002) or Evans, Geczy, Musto and Reed (2006) for a more complete discussion of the relationship between specialness and loan market structure.

For experiments using earnings announcements, quarterly earnings announcements and forecasts are taken from the I/B/E/S/ database. The date range is November 5th, 1998 to September 16th, 1999. Stock returns are taken from the Center for Research in Security Prices (CRSP). NYSE's Trades and Quotes (TAQ) database is used for intra daily stock prices.

2. Related Literature

One question that has motivated many early studies is whether short interest is a bullish signal because short sellers must eventually buy shares or a bearish signal because of the correlation between short interest and negative private information. Seneca (1967) uses market wide short interest to predict future returns, and he finds that high short interest leads to lower returns for the S&P 500. Similarly, Figlewski (1981) finds that short interest is negatively correlated with future excess returns by sorting stocks into portfolios based on short interest. Further contributing to the evidence that short interest is a bearish signal, Asquith and Meulbroek (1996) form a portfolio of stocks with short interest above 2.5% of available shares, and they find that this portfolio under performs the market. Desai, Thiagarajan, Ramesh, and Balachandran (2000) find similar results for the Nasdaq market and an increase in the probability of delisting for firms with high short interest. Similarly, Senchack and Starks (1993) find short term negative abnormal returns after announcements of higher than expected short interest, and Aitken, Frino, McCorry and Swan (1998) find negative returns when short sales are made.

Miller (1977)'s intuition that short sale constraints, in the presence of divergence of opinion, will lead to overvaluation has been the focus of many recent empirical

investigations. Jones and Lamont (2002) find evidence supporting the Miller (1977) intuition by showing that constrained stocks have high valuations and low future returns. In a study that uses institutional ownership as an indication of short sale constraints, Nagel (2005) finds constrained stocks have low returns. Similarly, Sorescu (2000) and Danielsen and Sorescu (2001) show that the apparent reduction in short sale constraints accompanying option introduction is associated with negative abnormal returns after 1981. In previous samples, Sorescu (2000) and Conrad (1989) both find that option introduction is associated with a price increase. Focusing instead on divergence of opinion, Chen, Hong and Stein (2001) and Diether Malloy and Scherbina (2002) find that stocks with more divergence of opinion have lower future returns. Recognizing that Miller (1977)'s hypothesis applies to stocks where there is divergence of opinion and short sale constraints, Asquith, Pathak, and Ritter (2005) and Boehme, Danielsen and Sorescu (2006) both find support for the Miller (1977) hypothesis for stocks subject to both conditions. Lamont (2004) summarizes evidence in support of the Miller (1977) hypothesis.

Even though Miller (1977) and DV have some contradictory implications, this study is not intended to be a horse race between the two models or a questioning of empirical papers supporting the Miller (1977) hypothesis. This paper uses an accurate daily measure of short sale constraints and focuses on higher moments of return distributions in an effort to shed light on the DV hypothesis. Furthermore, this paper focuses on information events where short run returns are most likely to either support or refute the DV hypothesis. In contrast, empirical work testing Miller (1977) has been

focused on the connection between longer run returns and stock characteristics related to short selling.

By studying the link between short selling and informational efficiency, this study is closely related to several papers which look at how discrete institutional differences in short selling constraints affect informational efficiency. In a finding that supports the DV hypothesis, Jones (2003) shows that the requirement to secure written authorization to lend shares increases bid ask spreads in early U.S. data. Similarly, Ferri, Christophe and Angel (2004) show that there is no abnormal correlation between short selling and price declines in stocks where the Nasdaq National Market bid test does not apply. Even though Lamont and Stein (2004) find evidence suggesting short sellers are not attempting to correct aggregate mispricings, Charoenrook and Daouk (2005) show that allowing short selling improves aggregate market quality in 11 countries.

Two previous papers have directly examined the DV hypothesis about constraints on short selling. These studies use the introduction of exchange traded options as a proxy for the reduction in constraints on short selling. Jennings and Starks (1986) use intra daily trade data to compare the speed of stock price adjustment for firms that have traded options to firms without traded options. They find that stock prices on non option firms take longer to adjust to earnings announcements than prices of option firms. Similarly, Skinner (1990) finds that the information content of firms' earnings announcements is lower after exchange traded options are listed on their stocks. However, the availability of exchange traded options is related to firm size and liquidity, and the information environment in which firms operate is also related to firm size and liquidity. Since firm size and liquidity are related to options availability, it is difficult to infer that the

existence of options causes changes in the price adjustment process. Furthermore, Evans, Geczy, Musto and Reed (2006) and Ofek, Richardson and Whitelaw (2004) show that borrowing costs are transferred to options prices, so the existence of options may not imply a slackening of short sale constraints.

Prices in the equity lending market play an important role in this paper. Duffie, Garleanu and Pedersen (2002) formulate a model of the equity lending market in which investors search for shares and share values are affected by the rebate rate. D'Avolio (2002) uses 18 months of daily data to relate specialness to a variety of stock specific characteristics, and it finds only 16 percent of CRSP stocks, mostly small and illiquid, are potentially unshortable. Using the database used here, Geczy, Musto and Reed (2002) measures the impact of equity loan prices in trading strategies involving short selling. In general, prices in the equity lending market do not preclude short sellers from getting negative exposure to IPOs, dot coms, merger acquirers, large cap, growth or low momentum stocks, but in the case of stock specific merger arbitrage trades, short selling impediments reduce profits substantially. In another paper using the same database, Cristoffersen, Geczy, Musto and Reed (2005 and 2006) find evidence that the equity lending market hosts markets for trading dividends and votes.

3. Results

The discussion of results proceeds as follows. In the first section, we describe the distribution of announcement day returns for stocks with and without short sale constraints. In the second section, we investigate whether microstructure statistics are consistent with the DV idea that trading volume is less for constrained stocks. In the

third section, we look at an alternative measure of informational efficiency based on Hasbrouck (1993) to ask whether short sale constraints reduce efficiency outside of earnings announcements. In the fourth section, we look at the effect of short sale constraints on post earnings announcement drift. In the final section, we ask whether our results are robust to concerns about endogeneity.

3.1 Announcement day return distributions

According to the DV model, short sale constraints impede the incorporation of private information into stock prices, so when private information is made public, stock returns will be larger in absolute value. We use quarterly earnings announcements as information events to test the hypothesis. In the first experiment, Table 3, we use individual stock returns on days when earnings are announced. We split our sample into two groups: returns where short selling is unusually costly that day (specials), and returns where short selling is not unusually costly. In Panel A, we show that when stocks are on special, the average absolute value of announcement day returns is higher; 0.076 versus 0.058 for non specials. The difference is statistically significant at the 1% level. Furthermore, the distribution of announcement day returns is more left skewed when stocks are on special. In other words, large negative returns are more likely when stocks are costly to short sell. This pattern is consistent with slower price adjustment in the presence of bad information demonstrated in the DV model. The skewness of the distribution of returns is 0.228 when stocks are on special and 4.222 when stocks aren't on special. The difference is statistically significant at the 1% level.

In later tests, we will show that the effect of specialness is increasing in the level of specialness, but in this distributional comparison, the cutoff used to identify a special stock is necessarily arbitrary. So, we present results for several cutoffs. Panels A and B show the results when the sample selection is made based on announcement day specialness. We choose two cutoffs, 25 basis points and 100 basis points. The lower cutoff fits our data provider's explanation of what constitutes a special, and the higher cutoff yields the number of specials expected by industry participants. Panels C and D use average specialness over the five days preceding the earnings announcement. The average captures the overall difficulty of short selling before the public announcement. Finally, since average specialness may hide the presence of short lived borrowing difficulty, in Panels E and F we identify stocks where short selling was constrained at least once in the period before the announcement.

The results in panels B through F generally reflect the pattern seen in Panel A. In particular, we see that the average absolute value of returns is higher when short selling is constrained. The difference is statistically significant at the 1% level for all of the definitions of specialness. Similarly, we find that the announcement day return distribution has a higher standard deviation. The difference is statistically significant at the 10% level for all specialness cutoffs. We also find that there is more left skewness in the return distribution when specialness is constrained, and this difference is statistically significant at the 5% level for all of the definitions of specialness. We find that whether there is a positive or negative difference in the average of the return distribution depends on the specialness cutoff.

Since it has been shown that the distribution of daily stock returns is not normal (see Campbell, Lo, and MacKinlay (1997)), we employ a bootstrap technique to gauge the statistical significance of the difference in sample statistics. Following Efron and Tibshirani (1993), our implementation draws repeated samples (with replacement) from the distribution of returns for non special stocks and builds up a distribution of sample statistics under the null hypothesis that the distribution of returns for the non special sample is the same as the distribution for the special sample. The size of each sample drawn from the non special distribution is the same as the total number of observations in the special distribution under examination. We judge statistical significance by measuring the cumulative probability of the empirical null distribution to the left of our sample statistic.

3.2 Cross sectional characteristics of announcement day returns

Could the distributional differences between stocks be driven by stock characteristics rather than short sale constraints? To get a clean test of the DV hypothesis, we formulate the following regression model:

$$\left|Ex\,\mathrm{Re}\,t\right|_{i,t} = \alpha + \beta * \left|UE\right|_{i,t} + \gamma * Special_{i,t-6\,to\,t-1} + \delta * 1_{Ex\,\mathrm{Re}\,t<-STD\,i,t} * Special_{i,t-6\,to\,t-1} + \sum_{k=1}^{K} \varphi_k * X_{k\,i,t} + \varepsilon_{i,t}$$

The regression is a pooled time series and cross sectional regression where two day announcement returns are regressed on specialness and control variables. $|ExRet|_{i,t}$ is the is excess return of stock *i* over the announcement day and the following day. $Special_{i,t\text{-}6\ \text{to}\ t\text{-}1}$ is the average specialness for the five days preceding the earnings announcement. $1_{\text{ExRet<-STD}}$ is a variable indicating whether the two day return of stock *i* is

more than one standard deviation below its mean, and the X_k are a set of control variables.

Results in Table 4 confirm the DV hypothesis that short sale constraints cause larger announcement day returns in the presence of negative private information. In Model 1, we see that the absolute value of announcement day returns are significantly larger when stocks have higher specialness (estimate 0.0059, p-value <.0001). Unlike the distributional differences presented in the previous sub section, this experiment takes advantage of the continuous measure of equity loan scarcity by including specialness as a continuous variable. The statistically positive result indicates that a one percent increase in specialness increases the absolute value of announcement day returns by 0.5%. Not surprisingly, the absolute value of unexpected earnings is also associated with the size of announcement day returns (estimate 0.0142, p-value 0.0002).

In addition to being a more precise test of the DV hypothesis, the regression in Table 4 allows us to control for stock characteristics. We address five specific concerns where stock characteristics could be responsible for the results. The first concern is that the market capitalization of the announcing firm could be associated with its information environment (e.g. through analyst coverage) which may, in turn, be related to the incorporation of private information. We include market capitalization in the regression, and we find that it has a significant impact on the absolute value of announcement day returns, with small stocks having larger announcement day returns. A second concern is that stocks with higher standard deviations could be leading to distributions of announcement day returns with higher absolute values. After controlling for standard deviation, we find high volatility stocks have larger absolute value announcement day

returns. Third, the availability of exchange traded options provides an alternative trading strategy for those with private information which may be related to differences in the distributions. Specifically, short sale constraints may not be an important impediment to trading if options exist. Surprisingly, we find the availability of traded options increases the absolute value of a stock's announcement day return. However, writers of put options would need to short sell to hedge stock exposure, and Evans Geczy, Musto and Reed (2006) show that purchasing put options does not offer an inexpensive substitute for short selling if a stock is on special. As a further concern, the fact that earnings surprises are systematically larger for value stocks (see LaPorta, Lakonishok, Shleifer, and Vishny (1997)) may be related to distributional differences. We include the price to earnings ratio, and we find that it does not affect the absolute value of announcement day returns. To address a final concern that stocks in widely held indices could be easier for short sellers to borrow regardless of our measure of borrowing difficulty, we include indicator variables for membership in the S&P 500 and Russell 3000. We find both indicator variables are significant predictors of announcement day absolute returns. Even though these control variables are significant, they do not wipe away the importance of specialness as a predictor or return size. Our measure of the cost of borrowing remains an important determinant of large announcement day returns after controlling for size, volatility, options, price to earnings ratios and index inclusion[2].

According to the DV model, short sale constraints will lead to announcement day return distributions with a larger absolute values unconditionally, but large, negative price adjustments are more likely when bad news is released. As a test of this part of the

[2] Results not presented here indicate that the timing of earnings announcement (relative to last year's announcement) is not an important factor in the regression.

DV hypothesis, we choose a market price based proxy of bad earnings new which allows us to avoid assigning news values to earnings announcements where forecasts have been shown to be biased (e.g. Lin and McNichols (1998)). Our variable, $1_{ExRet<-STD}$, is an indication that the market responded to the earnings announcement with a measurably negative response. The results in Model 4 show that after controlling for stock characteristics, the response to bad news is significantly more severe in the presence of short sale constraints. The statistically positive coefficient of 0.01 indicates that the effect of specialness is significantly stronger when bad news is released. Furthermore, the coefficient is relatively large; the effect of specialness is 4.4 times larger in the presence of bad news.

3.3 Market microstructure

In the model put forward by DV, the slow reaction to private information is a result of the reduced number of trades when short selling is constrained. According to the model, when short selling is constrained, short sales are removed from the pool of "sell or short" orders and they are replaced by periods of no trade. We now turn our attention away from the effects of specialness on announcement day return distributions and focus on how specialness affects the trade mechanisms underlying the DV model.

Using intra daily trade and quote data, we confirm the hypothesis that there is significantly less trading when short selling is costly. In this experiment we focus on changes in short sale constraints rather than information events. To identify changes in short sale constraints, we first find days where stocks are on special after a period of non special rebates lasting at least 10 days. We define these days as events and continue in an

event study framework as follows. We measure market statistics such as volume and spread over a control period before each events. We then measure the same statistics in the event period, and we measure changes associated with the incidence of specialness.

The DV model predicts a reduction in volume when short sellers are removed from the market, and our empirical results bear out this prediction. Panel A of Table 5 shows that trade size decreases by 53.97 shares after the first incidence of specialness. Similarly, the larger sample in Panel B shows a large and statistically significant decrease in daily volume; volume decreases by 28442.43 when a specialness cutoff of 25 basis points is used. This evidence is consistent with the mechanisims put forward by the DV model whereby short sellers are removed from the sample by short sale constraints.

The theories put forward by Miller (1977) and Figlewski (1981) both predict that short sale constraints impart an upward bias in prices as pessimistic short sellers are removed from the market while optimistic buyers are unconstrained. The results in Table 5 show that prices are not biased; prices do not change in any statistically significant way after the first incidence of specialness. The fact that there is no significant price increase in the presence of short sale constraints is consistent with the predictions of the DV model where market participants use the fact that short selling is constrained in forming their demand and pricing decisions.

Table 6 shows the distribution of volatility on the days of the earnings announcement. In contrast to Table 3 where we examine announcement day return volatility, in this experiment we compare increases in announcement day volatility relative to pre announcement volatility. The statistics presented are the differences between sample statistics in the announcement period and the same sample statistics

before earnings are announced. The table shows that the volatility on the day of announcement increases. The increase in standard deviation is 0.5504 when stocks have been on special in any of the five preceding days and 0.4592 when stocks haven't been on special. Using the range as our volatility measure as in Alizadeh, Brandt and Diebold (2002), we find the increase is significantly larger at the 5% cutoff. In other words, volatility increases past a normal level on announcement days, and the increase is larger when the stock has been on special prior to the announcement. The result fits the DV model in the sense that stocks will have larger reactions to private information in the presence of short sale constraints. Like the results in Table 5, the volatility results are largely immune to concerns about stock characteristic driven volatility differences because the results are differences between announcement period measures and control period measures for the same stocks.

3.4 Specialness and Hasbrouck (1993) measures of informational efficiency

The mechanism behind DV's slow adjustment process in the presence of short sale constraints is a lack of trade. After verifying that changes in volume and spreads are consistent with this mechanism, we now turn to measures of market efficiency based on Hasbrouck (1993). Specifically, we examine whether the magnitude of pricing error is associated with specialness.

Hasbrouck (1993) decomposes security returns into two components: one random walk component representing the efficient price and one transitory component representing pricing error. The decomposition is as follows:

$$p_t = m_t + s_t$$

In this model, p_t represents logarithmic transactions prices, and t indexes trades. m_t represents the efficient price, or true price, which is the expectation of the security's value conditional on all public information impounded in the price through trade. s_t represents the pricing error, which is dispersion between true prices and observed prices. The standard deviation of the pricing error, σ_s, is a measure of magnitude of mispricing, and it is generally thought of as an inverse measure of informational efficiency.

Although the Hasbrouck (1991) decomposition of bid ask mid quotes provides a measure of informational asymmetry which could shed light on the DV hypothesis, the Hasbrouck (1993) decomposition of transaction prices is the most appropriate test of the DV model. DV suggests that short sale constraints will prevent short sellers from impounding their beliefs into prices through trade. The idea of short sale constraints acting as a barrier to trade fits Hasbrouck (1993)'s interpretation of σ_s: "Its role as a proxy for market quality rests solely on the premise that as transaction costs and other barriers to trading are reduced, transaction prices should conform more closely to efficient prices"[3].

We estimate the pricing error daily for each stock using the methodology outlined in Hasbrouck (1993) and Boehmer and Kelley (2005). Specifically, we estimate a vector autoregression (VAR) with five lags and four equations representing: (i) differences in logarithmic transaction prices, (ii) a trade sign indicator, (iii) signed trading volume, and (iv) the signed square root of trading volume. The trade sign variable indicates a trade was buyer (seller) initiated if the transaction took place above (below) the bid ask mid point. Using the Beveridge & Nelson (1981) identification restrictions, the pricing error,

[3]Hasbrouck (1993) p. 194.

σ_s, can be estimated using the impulse response coefficients from the return equation in the VAR. We normalize the variance of the pricing error, σ_s, by the standard deviation of log transaction prices, σ_p, by either including σ_p as an independent variable in regressions on σ_s or reporting the ratio σ_s/σ_p in univariate settings.

In our initial results, we find the ratio of pricing errors to trade variances, σ_s/σ_p , to be related to the incidence of specialness. The ratio is 0.2026 for stocks not on special and 0.2630 for stocks that are on special. Using an unequal variances t-test, the difference is statistically significant at the 1% level. In other words, pricing error accounts for a larger fraction of trading variance when stocks are on special. Consistent with DV, we find stocks on special to reflect their true values less than other stocks as short sale constraints prevent traders from impounding their beliefs into prices.

The initial results are consistent with DV, but we can bolster our confidence in the connection between specialness and pricing error by controlling for other factors in the following pooled time series and cross sectional regression:

$$\ln(\sigma_{s\,i,t}) = \alpha + \beta \ln(\sigma_{p\,i,t}) + \delta Special_{i,t} + \sum_{k=1}^{K} \gamma X_{k\,i,t} + \varepsilon_{i,t}$$

where $ln(\sigma_{s\ i,t})$ is the natural log of the standard deviation of pricing error for stock *i* on day *t,* and σ_s is computed using Hasbrouck (1993)'s vector auto regression return decomposition. $Ln(\sigma_{p\ i,t})$ is the natural log of the standard deviation of log transaction prices for stock *i* on day *t*. $Special_{i,t}$ is a measure of specialness for stock *i* on day *t*, and X_k is a set of control variables. The regression further controls for cross sectional differences in characteristics by including fixed effects for each stock.

Table 7 reports the estimation results of the regression. The results are consistent with the DV hypothesis suggesting that short sale constraints decrease informational efficiency. The statistically significant coefficient of 0.1193 on specialness indicates that specialness increases pricing error; which is consistent with the DV idea of informational efficiency being reduced as short sale constraints prevent some traders from impounding their beliefs into prices trough trade. Model 2 shows a similar result. when specialness is included in the regression as an indicator variable. The statistically significant 0.3361 coefficient estimate indicates that stocks have an increase pricing error when they are on special. Furthermore, the result is economically significant; a one standard deviation increase in specialness increases the standard deviation of pricing error by 40.31%. These results reinforce our empirical confirmation of DV by showing that specialness decreases the informational efficiency of stock prices using the Hasbrouck (1993) measure of informational efficiency.

3.5 Post earnings announcement drift and costly short selling

Previous research has shown that share prices of stocks with stronger than expected earnings drift upwards after their earnings announcements, and prices of shares with lower than expected earnings drift downward (e.g. Abarbanell and Bernard (1992) and Bernard and Thomas (1989)). Abarbanell and Bernard (1992) find share prices of stocks in the top quintile of earnings news drift downward by 3.47% over the year after their quarterly earnings announcement and stocks in the bottom quintile drift downward by -4.65%. Table 8 presents measurements of post earnings announcement drift in our sample. We find that share prices of firms in the top quintile of earnings news drift

upward by 8.39% over the 120 days after the good earnings announcement is made. Stocks in the bottom quintile have a return of 0.84% over the 120 days following their bad earnings announcements. Even though stocks with bad earnings announcements do not drift downward, the difference between announcement drift for stocks with good and bad news in our sample is similar to the difference found in previous studies.

The DV model suggests that short sale constraints should only affect prices in the presence of private information, and up to this point, we have considered earnings announcements to be events where all private information is released to the public. In this section, we depart from this strict definition to allow for the possibility that relevant private information exists after the public earnings announcement. Our thinking is as follows. Earnings announcements do not necessarily reveal the true value of a firm; firm value may still be private information for investors who are able to interpret an earnings announcement because they are knowledgeable about a firm. If earnings announcements do not fully reveal firm value, we might think of post announcement short sale constraints as we did before the earnings announcement. That is, short sale constraints impede the incorporation of private information into stock prices, which is consistent with the intuition of the DV model.

Table 9 presents evidence suggesting that stocks that have bad earnings news experience more post earnings announcement drift when short selling is costly. In particular, constrained stocks in the bottom quintile of earnings announcement news have cumulative market adjusted returns of -9.45% on average over the 120 days following the earnings announcement. Stocks that are not constrained actually earn a positive 1.36% return over the same period. These results are consistent with the intuition that costly

short selling prevents quick price adjustment to bad earnings announcements, and these results offer a partial explanation for the post earnings announcement drift phenomenon[4].

One of the problems in measuring speed of adjustment in the context of post earnings announcement drift is that there is no obvious finish line; we do not know how far a stock will eventually drift after the earnings announcement. We design an experiment that is immune to potential differences in eventual post earnings announcement drift by measuring how much of the eventual post earnings announcement drift is realized on the day of the earnings announcement. As a measure of drift, we use the return from one earnings announcement date up to, but not including, the date of the second earnings announcement subsequent to the date under study. Using CRSP daily returns through June 30, 2000, we are able to measure two quarter post earnings announcement returns for 24,722 earnings announcements that are made in the period covered by our short loan database, November 1, 1998 through October 29, 1999. In Table 9, we find that specialness reduces the percentage of total drift realized on the first day. For stocks with good news, 67% of the total drift is realized on the first day when short selling is not constrained, whereas only 35% is realized when stocks are on special. For stocks with bad news, the pattern is very similar; 67% of the drift is realized on the first day for general stocks, while only 36% of the subsequent drift is realized when short selling is constrained. When stocks do not have newsworthy earnings announcements, announcement day market adjusted returns are comparable in size to the subsequent two quarter market adjusted returns. Results show that costly short selling reduces the

[4]IS THIS COMMENT JUST LIMITS TO ARB?A similar argument is made in Lamont and Thaler (2001). They argue that relative valuation discrepancies in the case of equity carve outs can not necessarily be eliminated in the presence of short sale constraints.

percentage of two quarter post earnings announcement drift earned on the announcement day by 32%. This reduction is consistent with the general intuition suggested in DV; costly short selling impedes the incorporation of private information into stock prices.

3.6 Tests of endogeneity and robustness

Could private information be driving specialness? Since private information could lead investors to short sell and therefore increase borrowing demand, it is possible that private information causes both specialness and large price reactions on the announcement day.

Furthermore, there is some evidence suggesting short selling is related to earnings announcements. Christophe, Ferri, and Angel (2005) shows that short selling increases in the five days before earnings announcements on NASDAQ traded stocks. Similarly, Daske, Richardson and Tuna (2005) shows that short sales increase around news events. But in a finding allays the concerns of this paper to some degree, the paper also finds that increases are not concentrated before bad news announcements. Even though these papers suggest short selling is related to earnings announcements, they do not indicate how short sale constraints are related to earnings announcements.

In this section, we offer a direct test of whether private information causing short sale constraints. We estimate a logistic regression of specialness over 25 basis points in the 12 days before the quarterly earnings announcement on the ex post percentage error in the earnings forecast:

$Special_{i,\ t-12\ to\ t-1}$	=	-3.0240	+	-0.0329*$Error_{i,\ t}$	
		(< 0.001)		(0.4759)	N(obs)=17875

Each observation in the regression corresponds to one earnings announcement on day *t* for stock *i*. The statistically insignificant coefficient estimate of –0.0329 indicates that the incidence of specialness is not correlated with earnings forecast errors, which we take to be an ex post proxy of ex ante private information. The result shows that there is no statistical relationship between specialness and private information. In other words, the source of specialness is not the earnings announcement.

Even though regression results show that there is no statistical relationship between information and specialness, we can go a step further. In Table 10 we look at the distribution of stock prices in situations where we can identify the cause of specialness. We then look at the distribution of announcement day returns during information events. By identifying the likely cause of specialness, we can be comfortable with the fact that the earnings announcements are not causing the specialness. The first identifiable cause of specialness is merger activity. When two companies plan to merge by exchanging equity, there is almost always a discrepancy between the pre merger equity prices and the proposed exchange rate. In these situations, it is usually profitable to short sell stocks of the acquirer. As seen in Mitchell, Pulvino and Stafford (2002) and Geczy Musto and Reed (2002), merger related short selling increases the borrowing demand for the acquirer's stock, increasing the probability of specialness. We identify periods of merger activity as the time between the announcement of the merger and the date on which the merger is completed or withdrawn.

Similarly, when a company has a seasoned equity offering securities lending demand increases, presumably to profit from the V shaped pattern in prices documented by Kadlec, Loderer, and Sheehan (1997). We identify periods of seasoned equity

offerings as periods between the announcement and the issuance of new shares. Lastly, dividend reinvestment discount programs (DRIPs) often create opportunities to profit from borrowed shares. When the owner of record in a DRIP program reinvests the dividend in new shares, some DRIP programs offer a discount on those shares of up to 10%. To take advantage of the DRIP discount, traders first borrow shares on the dividend record date from owners who prefer to receive dividends in cash. When the dividend is paid, the trader uses the reinvestment discount to purchase shares worth more than the cash dividend. The trader then sells the newly purchased shares and returns the borrowed shares along with the amount of the original cash dividend, and the trader pockets the amount of the dividend discount. Since DRIP discount trading schemes are well known in the equity lending market, securities lenders charge more to borrow DRIP discount stocks. We identify periods of DRIP activity as the twenty trading days surrounding a dividend record date for a stock with a dividend reinvestment discount program. Finally, as shown in Geczy, Muto and Reed (2002), IPOs are almost always on special. (See Geczy, Musto and Reed (2002)) We construct a sample of stocks with 30 or fewer days from their IPO and re run the experiment with this sample where specialness is driven by the lack of availability of shares.

Table 10 shows sample statistics when the cause of specialness is likely to be driven by one of the four corporate events outlined above. Panels A through D measure the statistics for each corporate event. Panel E pools all of the stocks with identified sources of specialness and finds results largely consistent with the DV hypothesis. We find that we cannot reject the hypothesis that the mean is the same for the two samples of announcement day return distributions, although the sample of stocks on special has a

lower mean in a marginal statistical sense. The average absolute value of the special sample is significantly larger (0.062 vs. 0.057). Furthermore, the special sample is significantly more left skewed (-0.041 vs. 0.547). The distribution of announcement day returns under short sale constraints is more left skewed and has a larger average absolute value when the source of specialness is unrelated to the earnings announcement information event.

5. Conclusion

Using a precise daily measure of short sale constraints, we test implications of Diamond and Verrecchia's 1987 model. We use quarterly earnings announcements as information events; earnings are taken to be private information until they are publicly announced. We look at the distribution of returns on the day earnings are announced for two samples. In one sample, short selling is priced normally, and in the other sample, specials in the equity lending market indicate that short selling is unusually costly. We find that when short selling is costly, stock prices are slow to incorporate private information; the strong reaction to information announcements provides evidence of informational inefficiency for constrained stocks. Consistent with the DV hypothesis, we find that the distribution of announcement day returns has a larger average absolute value and exhibits more left skewness when stocks are costly to short sell.

We provide evidence of a reduction in informational efficiency outside the context of earnings announcements. We find that when short selling is costly, stocks are slow to react to earnings announcement information even after the information is made public. For firms with bad news, the downward drift is strong after 65 days in the

presence of high short sale costs. Results show that when short selling is constrained, stocks realize 32% less of the total post earnings announcement drift on the announcement day. In other words, the slow reaction to public information caused by costly short selling offers a partial explanation for the post earnings announcement drift anomaly. Furthermore, following Hasbrouck (1993), we decompose returns into informative and transient components. We find that short sale constraints decrease the informativeness of trades, indicating short sale constraints reduce informational efficiency of intra daily returns.

To address concerns about endogeneity in our measure of the cost of short selling, we perform two tests. First, we identify four corporate events that drive specialness but are unrelated to earnings announcements. These events, mergers, SEOs, dividend reinvestment discount programs and IPOS are isolated to form a sub sample of data where the cause of specialness is identified. Even though these corporate events only cover a small sample of announcement day returns, we find increased left skewness in the sample of returns for which we can identify an exogenous cause of specialness. Furthermore, we find that there is no significant association between private information, as proxied by realized earnings forecast error, and specialness.

Specials in the equity loan market cause a reduction in informational efficiency, increase the absolute value of returns, and increase the probability of large negative returns. Since specials arise from scarcity in the lending market, increasing the supply of shares available for lending reduces the severity of specials and reduces the cost of short selling. Mutual funds, pension funds and insurance companies are usually the principal lenders in the equity lending market, and they are often hesitant to approve lending for

their shares. Since this work demonstrates that increasing the supply of shares for lending will increase informational efficiency and reduce volatility on announcement days, there is a normative interpretation: increasing equity lending improves market quality. In addition to participating in the income generated from equity lending, mutual funds can increase the informational efficiency and reduce the risk of stocks held in their portfolios by participating in the equity lending market.

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Table 1
Sample statistics

Table 1 presents the distribution of loan size and loan length in the equity loan database. *Loan Size* is the value of the loan on the first day the loan shows up in the database. *Loan Length* is the number of calendar days the loan is outstanding in our database for loans which begin and end between November 1, 1998 and October 29, 1999. *Specialness* is the difference between the weighted average rebate rate on a particular stock's loans and the prevailing rebate rate for stock loans that day.

Statistic	Loan Size (dollars)	Loan Length (calendar days)	Specialness (annual %)
Mean	1,787,535	10.93	0.2478
Standard Deviation	6,979,138	22.94	0.8717
Maximum	1,759MM	344	45.4699
95^{th} Percentile	6,550,500	49	2.2008
75^{th} Percentile	1,603,950	9	0.0004
Median	473,625	3	0
25^{th} Percentile	129,325	1	0
5^{th} Percentile	13,237	1	-0.0541
Minimum	0	0	-1.8823

Table 2
The number of stocks on special

Table 2 presents the number of stocks on special, which is defined here as stocks for which rebate rates below general collateral rates by at least 100 bps (1%). The rebates of several loans in the same stock are combined by taking the weighted average the specialness for each loan where weights are based on the current values of loans. Stocks are assigned size quintiles based on their market capitalization as of the end of the previous month. Size quintiles are based on the entire universe of stocks: NYSE, AMEX and NASDAQ. Panel A shows the frequency distribution of specials for the year long database. Panel B shows the distribution of the number of stocks on special per day.

Panel A. The overall frequency of specials

Stock Size		Specials (Costly to short)	General (Not costly)	Total
1 (Small)	Number of Loans	1281	22373	23654
	% of Database	5.42%	94.58%	100.00%
	% of CRSP	0.31%	0.71%	1.02%
2	Number of Loans	4909	55348	60257
	% of Database	8.15%	91.85%	100.00%
	% of CRSP	1.18%	4.93%	6.11%
3	Number of Loans	11042	104094	115136
	% of Database	9.59%	90.41%	100.00%
	% of CRSP	2.66%	17.92%	20.58%
4	Number of Loans	13958	178726	192684
	% of Database	7.24%	92.76%	100.00%
	% of CRSP	3.36%	40.38%	43.74%
5 (Large)	Number of Loans	8084	284192	292276
	% of Database	2.77%	97.23%	100.00%
	% of CRSP	1.95%	67.28%	69.23%
Total	Number of Loans	39274	644733	684007
	% of Database	5.74%	94.26%	100.00%
	% of CRSP	1.90%	26.29%	28.18%

Panel B. Specials per day

	Minimum	Mean	Median	Max
Number of Stocks	112	156.52	154	271
Percentage of Loans	3.89%	5.74%	5.71%	9.34%

Table 3
Statistics for announcement day returns

Table 3 presents the distribution of two day market adjusted announcement returns. We split our sample of returns into two groups: returns of stocks for which short selling is unusually costly that day, *On Special*, and returns of stocks with the usual borrowing rate, *Not On Special*. A stock is on special if specialness, as described in Table 1, is greater than the cutoff described in each panel. The return of the S&P 500 is subtracted from raw returns to adjust for market movements. Announcement dates are taken from the I/B/E/S/ database, and they range from November 5th 1998 to September 16, 1999. To allow for the possibility of earnings announcements arriving after the market closes, we use returns over the announcement day and the following day. *Average Absolute Value* is the average absolute value of market adjusted returns on the announcement day. The bootstrap implementation used here draws repeated samples (with replacement) from the distribution of returns for non special stocks to compile the distribution of sample statistics under the null hypothesis that the distribution of returns for the non special sample is the same as the distribution of returns for the special sample. The size of each sample drawn from the non special distribution is the same as the total number of observations in the special distribution under examination. P-values measure the cumulative probability to the left of our sample statistic in empirical distribution compiled under the null hypothesis.

Statistic	On special (Costly to short)	Not on special (Not costly)	Difference (1-2)	Empirical CDF (Bootstrap)
Panel A. Announcement day specialness > 25 bps				
N	771	18618		
Mean	-0.00486	0.00361	-0.00847	0
Standard Deviation	0.11605	0.09489	0.02116	0.9998
Skewness	0.59774	4.33975	-3.74201	0.0042
Average Absolute Value	0.07611	0.058	0.0181	0.9998
Panel B. Announcement day specialness > 100 bps				
N	402	18987		
Mean	-0.01263	0.00361	-0.01624	0
Standard Deviation	0.11327	0.0954	0.01786	0.9998
Skewness	0.22807	4.22197	-3.9939	0
Average Absolute Value	0.07812	0.05831	0.01981	0.9998
Panel C. Avearge specialness over days t-6 to t-1 > 25 bps				
N	731	18658		
Mean	-0.00855	0.00374	-0.01229	0
Standard Deviation	0.1064	0.09537	0.01104	0.994
Skewness	0.34058	4.29013	-3.94955	0
Average Absolute Value	0.0733	0.05815	0.01515	0.9998
Panel D. Avearge specialness over days t-6 to t-1 > 100 bps				
N	135	4793		
Mean	0.00218	-0.0002	0.00238	0.9386
Standard Deviation	0.09036	0.10548	-0.01512	0.0192
Skewness	0.35705	6.54332	-6.18627	0.0028
Average Absolute Value	0.06619	0.06144	0.00476	0.9996
Panel E. Specialness > 25 bps at least once in days t-6 to t-1				
N	808	13653		
Mean	-0.00257	0.00429	-0.00686	0
Standard Deviation	0.11156	0.09731	0.01425	0.9938
Skewness	0.92221	5.25356	-4.33135	0.0356
Average Absolute Value	0.07149	0.05883	0.01266	0.9998
Panel F: Specialness > 100 bps at least once in days t-6 to t-1				
N	315	14146		
Mean	-0.00016	0.0049	-0.00506	0
Standard Deviation	0.10413	0.09691	0.00722	0.9202
Skewness	0.15967	5.14208	-4.98241	0
Average Absolute Value	0.07025	0.0585	0.01175	0.9998

Table 4
The effect of specialness on returns

Table 4 presents estimates from a regression model of two day announcement returns on specialness and control variables. The dependent variable, $|ExRet|_{i,t}$, is the absolute value of two day returns (net of the S&P 500) for stock *i* on the day of the announcement and the following day. $|UE|_{i,t}$ is the absolute value of unexpected earnings for stock *i*, and it is defined as $|(EPS_{i,t=0}\text{-}Forecast_{i,t=0})/P_{i,t=-2}|$ following Skinner (1990). $Special_{i,t=-6to-1}$ is the average specialness of stock *i* over the five days preceding the earnings announcement. $1_{ExRet<-STD}$ is an indicator variable which takes the value one if the two day return of stock *i* is more than one standard deviation below its mean. $ln(MktCap)_{i,month-1}$ is the natural log of market capitalization for stock *i* at the end of the month preceding day *t*. $Stddev_{i,t-1}$ is the square root of the sample second moment based on the distribution of trades from NYSE's TAQ database on the trading day before the day of the earnings announcement for stock *i*. $Options_i$ is a dummy variable indicating whether options are traded on stock *i*. $(P/E)_{i,t}$ is the price to earnings ratio for stock *i* at the end of the fiscal year preceding day *t*. *S&P 500* is an indicator variable that takes the value one if a given stock is in the S&P 500 and zero otherwise. *Russell 3000* is an indicator variable that takes the value one if a given stock is in the Russell 3000 and zero otherwise. T-statistics are below the reported parameter estimates in italics. *** indicates significance at the 1% level, ** indicates signifigance at the 5% level, and * indicates significant at the 10% level.

Explanatory variable	Model			
	(1)	(2)	(3)	(4)
Intercept	0.0408***	0.0408***	0.0976***	0.0976***
	108.88	*108.88*	*23.24*	*23.24*
|UE|	0.0059***	0.0059***	0.0113***	0.0096**
	6.7900	*6.7600*	*3.0500*	*2.5600*
Special	0.0061***	0.006***	0.0036***	0.0029**
	8.5800	*8.4200*	*3.1800*	*2.4800*
$1_{Ret<-STD}$ * *Special*		0.0057		0.01**
		0.9200		*2.4800*
ln(MktCap)			-0.0055***	-0.0055***
			-16.1800	*-16.1700*
Standard Deviation			0.0377***	0.0377***
			23.0900	*23.1300*
Options			0.0042***	0.0042***
			4.8600	*4.8600*
P/E			0.0000	0.0000
			-0.1900	*-0.1800*
S&P 500			0.003**	0.003**
			2.5700	*2.5600*
Russell 3000			-0.0024**	-0.0025**
			-2.3300	*-2.3700*
R^2	0.0070	0.0070	0.0960	0.0970
N	17856	17856	6614	6614

Table 5
Market statistics when stocks become costly to sell short

Table 5 presents the difference in market statistics after a stock goes on special. We present the difference between the average measure during a pre event period and the average during a post event period. The *Mean* column presents the average difference across all events. *Median* is the median change and *Median %* is the median of percentage changes. Events are defined as the first time a stock goes on special after a period of non specialness lasting at least 10 trading days. The pre event period includes the tenth through second days before the event, and the event period is the second through tenth days after the event. *Trade Size* is the average number of shares traded. *Number of Trades* is the average number of trades in a day. *Daily Volume* is the total number of shares traded in a day. *Spread* is the average difference between offer and bid prices. *Percentage Spread* is the difference between offer and bid prices divided by the average of bid and offer prices (in percent). *Bid Price* and *Offer Price* are the specialist's quoted bid and offer prices where the quoted depth at each is given by *Depth at Bid* and *Depth at Offer*, respectively. Data is taken from the New York Stock Exchange's Trade and Quote (TAQ) database, and the sample extends from November 1st, 1998 through October 29th, 1999. There are 436 observations in Panel A and 2652 observations in Panel B. Only NYSE stocks are used.

Measure		Mean	Median	Median %	T-statistic	P-value
Panel A. Specialness > 25 bps						
Volume	Trade Size	-53.97	-13.20	-1.10%	-2.11	0.0349
	Number of Trades	-0.1078	-0.8125	-2.38%	-0.09	0.9301
	Daily Volume	-4137.78	-1750.00	-4.47%	-0.65	0.5143
Spread	Spread	-0.0055	0.0001	0.04%	-1.78	0.0759
	Percentage Spread	0.0000	0.0000	-0.24%	-0.38	0.7053
Price	Bid Price	-0.1231	-0.0123	-0.07%	-1.06	0.2900
	Offer Price	-0.13	-0.0180	-0.09%	-1.10	0.2722
Depth	Depth at the Bid	0.7386	0.1475	0.61%	0.88	0.3798
	Depth at the Offer	0.8704	-0.1145	-0.33%	1.11	0.2690
Panel B. Specialness > 100 bps						
Volume	Trade Size	-91.36	-14.20	-0.71%	-1.23	0.2208
	Number of Trades	-1.0395	-0.4028	-1.35%	-0.39	0.6980
	Daily Volume	-28442.43	-718.06	-2.93%	-1.92	0.0555
Spread	Spread	-0.5116	0.0004	0.37%	-1.00	0.3157
	Percentage Spread	0.0001	0.0000	0.08%	0.80	0.4228
Price	Bid Price	-0.1783	-0.1434	-1.10%	-0.40	0.6911
	Offer Price	-0.6899	-0.1498	-1.05%	-0.76	0.4468
Depth	Depth at the Bid	-1.1696	0.2102	1.16%	-0.42	0.6778
	Depth at the Offer	0.6036	-0.3422	-1.27%	0.24	0.8141

Table 6
Announcement day return volatility

Table 6 presents differences in volatility measures during and after earnings announcements. The estimation period is the five day period ending one day before the earnings announcement, and the event period is the earnings announcement day. Volatility differences are the average of percentage differences between the estimation period and the event period volatilities for each stock. Daily price volatility is measured in the TAQ intra daily database for stocks with at least 30 trades in a day. As in Table 3, stocks are identified as being on special if the specialness exceeds the given cutoff at least once in the estimation period. Reported p-values are for a pooled t-test for a difference in means.

		On special (costly to short)	Not on special (not costly)	p-Value for difference
Panel A. Specialness > 25bps				
Standard Deviation Difference	Mean	0.5504	0.4592	0.1694
	Median	0.1715	0.1683	
Range Difference	Mean	0.6402	0.4868	0.0266
	Median	0.2381	0.2124	
Panel B. Specialness > 100 bps				
Standard Deviation Difference	Mean	0.6108	0.4612	0.1966
	Median	0.3323	0.1659	
Range Difference	Mean	0.7366	0.4902	0.0415
	Median	0.3333	0.2116	

Table 7
The effect of specialness on pricing error

Table 7 reports estimates from a regression of the standard deviation of pricing error, σ_s, on specialness and control variables. σ_s is computed using Hasbrouck (1993)'s vector auto regression transaction return decomposition described in the text. *ln(σ_p)* is the natural log of standard deviation of log transaction prices. *Specialness* is defined in Table 1. *Specialness Ind.* is an indicator variable that takes the value one is specialness is above 0.25% and zero otherwise. *ln(MktCap)* is the natural log of market capitalization at the end of the preceding month. *Options* is an indicator variable that takes the value one if exchange traded options are available and zero otherwise. *P/E* is the price to earnings ratio for stock at the end of the preceding fiscal year. *S&P 500* is an indicator variable that takes the value one if a given stock is in the S&P 500 and zero otherwise. *Russell 3000* is an indicator variable that takes the value one if a given stock is in the Russell 3000 and zero otherwise. *Ln(Price)* is the natural log of the daily closing stock price. *ln(Volume)* is the natural log of trading volume. The regression includes fixed effects for each stock. *AIC* is the Akaike Information Criterion. T-statistics are below the reported parameter estimates in italics. *** indicates significance at the 1% level, ** indicates significance at the 5% level, and * indicates significant at the 10% level.

Explanatory variable	Model			
	(1)	(2)	(3)	(4)
Intercept	0.2830***	0.2410***	7.7762***	7.7690***
	39.19	*29.72*	*305.87*	*279*
ln(σ_p)	0.5253***	0.5334***	0.1447***	0.1445***
	338.33	*309.01*	*65.73*	*59.32*
Specialness	0.1193***		0.0198***	
	77.55		*9.2*	
Specialness Ind.		0.3361***		0.0615***
		24.36		*3.95*
ln(Mkt. Cap.)			-0.249***	-0.2596***
			-106.69	*-103*
Options			-0.0305***	-0.0353***
			-8.92	*-9.19*
P/E			0.00001**	0.00002***
			2.27	*4.01*
S&P 500			-0.2590***	-0.2491***
			-56.86	*-49.86*
Russell 3000			0.0643***	0.0527***
			12.72	*10.25*
ln(Price)			-0.3084***	-0.2957***
			-91.45	*-78.44*
ln(Volume)			-0.0887***	-0.0774***
			-45.84	*-36.59*
AIC	862847	675028	73661	60689
N	378492	296497	71891	58737

Table 8
Post earnings announcement cumulative market adjusted returns

Table 8 presents market adjusted returns after the announcement of quarterly earnings. Good earnings announcements are announcements in the highest quintile of unexpected earnings, and bad announcements are in the lowest quintile, where unexpected earnings is the *UE* variable defined in Table 4. The top and bottom quintile correspond to 9.7% above and 11.48% below the consensus estimate, respectively. *N* is the number of stocks that are included in the in the average cumulative market adjusted return calculation.

		Days after announcement		
News	N	10	65	120
Panel A. Overall				
Good	1789	-0.31	3.91	8.39
Bad	1680	-1.7	0.49	0.84
Panel B. Not on special				
Good	1687	-0.17	4.44	8.68
Bad	1599	-1.65	1.17	1.36
Panel C. On special				
Good	102	-2.61	-4.15	3.58
Bad	81	-2.68	-12.18	-9.45

Table 9
Post earnings announcement price adjustment and specialness

Table 9 presents the percentage of two quarter absolute value return realized on the day of an earnings announcement. The two quarter return for a given announcement date is defined as the market adjusted return realized from the day of earnings announcement up to the day of the second earnings announcement after the given announcement, not including the second announcement day return. The ratio presented is the absolute value of announcement day return divided by the absolute value of two quarter return. News definitions are based on sample quartiles of the unexpected earnings variable as defined in Table 4. Good news is *UE* above 0.143%, bad news is *UE* is below -0.141%. T-statistics are based on tests which allow the variances of the two samples to differ; statistics not presented here indicate that this is a necessary allowance. P-values are based on a two sided test of the null hypothesis that the difference in means is zero.

Statistic	General (Not costly)	Specials (Costly to short)	Difference (1-2)
Panel A. Good news			
Mean	0.6719	0.3461	0.3257
p-value			0.0004
N	5954	130	
Panel B. No news			
Mean	0.9599	1.2400	-0.2800
p-value			0.6772
N	12176	278	
Panel C. Bad news			
Mean	0.6720	0.3551	0.3170
p-value			0.0006
N	6026	158	
Panel D. All news			
Mean	0.8171	0.7876	0.0294
p-value			0.9296
N	24156	566	

Table 10
Announcement day returns during corporate events

Table 10 presents statistics for two day market adjusted announcement day returns when identifiable corporate events are isolated. A stock is *On Special* if the average specialness is at least 25 basis over the five days preceding the earnings announcement. To allow for the possibility of earnings announcements arriving after the market closes, we use returns over the announcement day and the following day. Panel A shows sample statistics for stocks that are acquirers in corporate mergers between the merger announcement and completion (or withdraw). Panel B shows stocks with earnings announcements within 20 days of seasoned equity offerings. Panel C shows the distribution of returns for stocks subject to dividend reinvestment discount programs with earnings announcements within 20 days of a dividend payment record date. Panel D shows sample statistics for the combined sample of stock returns with identifiable sources of specialness.

Statistic	On Special (Costly to Short)	Not On Special (Not Costly)	Difference (1-2)	Empirical CDF (Bootstrap)
Panel A. Merger acquirers				
N	64	1175		
Mean	0.0133	0.01033	0.00297	0.802
Standard Deviation	0.10963	0.12233	-0.0127	0.3692
Skewness	0.5296	11.54728	-11.01768	0.0052
Average Absolute Value	0.06807	0.06014	0.00793	0.988
Panel B. Seasoned equity offerings				
N	13	173		
Mean	0.03863	-0.01129	0.04991	0.9998
Standard Deviation	0.1157	0.08045	0.03525	0.9998
Skewness	0.29028	0.00355	0.28672	0.7276
Average Absolute Value	0.07917	0.05685	0.02232	0.9998
Panel C. Drip discounts				
N	1	121		
Mean	-0.00637	-0.00652	0.00015	0.5146
Standard Deviation	n/a	0.09259	-0.09259	0
Skewness	n/a	0.94828	n/a	n/a
Average Absolute Value	0.00637	0.0642	-0.05783	0
Panel D. Initial public offerings				
N	48	39		
Mean	-0.01434	-0.00946	-0.00487	0.4148
Standard Deviation	0.09323	0.1104	-0.01717	0.2772
Skewness	-0.09668	1.52087	-1.61755	0.1156
Average Absolute Value	0.06762	0.07537	-0.00776	0.2818
Panel E. All identified sources				
N	126	1508		
Mean	0.00523	0.00599	-0.00076	0.4286
Standard Deviation	0.10444	0.116	-0.01155	0.383
Skewness	0.38701	10.66436	-10.27736	0.0048
Average Absolute Value	0.06855	0.06048	0.00807	0.9968