Short-Sale Constraints, Return Predictability, and Listing Decisions around Option Introductions

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Abstract:

Research argues that short-sale constraints are mitigated when options are introduced as short-selling activity increases for stocks that list options (Figlewski and Webb, 1993, and Danielsen and Sorescu, 2001). Contrary to previous research, this paper documents that short-sale constraints are not meaningfully relaxed when options are introduced. In fact, constraints do not appear to be binding in the pre-introduction period. Short sellers become less able to predict future negative returns after the introduction of options. However, the reduction in the information contained in short sales is driven by short selling of stocks that are least likely constrained. Further, I document that short-selling activity is an important determinant in the decision of exchanges to list options as short activity is highest in the month before the introduction of the option.

I. Introduction

This paper examines short-selling activity around option introductions. The objective of this study is to determine (i) if short-sale constraints are meaningfully relaxed when options are introduced, (ii) if short-sale constraints are binding before the option is listed, and (iii) if option exchanges use a stock's level of short-selling activity as a determinant in the listing decision. Danielsen and Sorescu (2001) observe short-selling activity around option listings and show that monthly short interest increases after options are introduced. Figlewski and Webb (1993) argue that short-sale constraints are relaxed when options list because the cost of short selling decreases. The presence of options allows investors to create synthetic short positions by buying put options and/or writing call options, which decreases the demand for, and subsequently the cost of short selling. Further, option market makers, who hedge against synthetic short positions by holding a mirror position, may do so by shorting the stock. If market makers and other investors face smaller short-sale costs, then the level of short selling will increase after options are listed.

In a separate stream of literature, D'Avolio (2002) examines the loan market for borrowing stocks and finds that over 90 percent of stocks are shortable and that short-sale costs are reasonably low. Additionally, Boehmer, Jones, and Zhang (2008) and Diether, Lee, and Werner (2007) find that short volume makes up a substantial portion of total trade volume and argue that short-sale constraints are not widespread. The recent literature suggests that short-sale constraints may not be binding.

In order to isolate the economic effect of the option introduction on short-sale constraints, I examine a 61-day window around option listings and find that short-selling activity decreases after the listing, which suggests that short-sale constraints are not

meaningfully relaxed when options are introduced. Asquith, Pathak, and Ritter (2005) and Nagel (2005) argue that stocks with low institutional holdings are most likely constrained because these stocks have the fewest lendable shares. Arnold et al. (2005) suggest that smaller cap stocks are likely to be more constrained than larger cap stocks. Empirically, D'Avolio (2002) finds that costs of short selling are negatively related to a stock's institutional ownership and market capitalization. Following Asquith, Pathak, and Ritter and Arnold et al., I sort stocks that list options into institutional ownership and market capitalization portfolios. The results show that stocks with lower levels of institutional holdings and market capitalization have significantly more short-selling activity prior to option listings than stocks with higher levels of institutional holdings and market capitalization. The findings suggest that short-sale constraints are not binding in the pre-introduction period and are consistent with, what I term the *unconstrained hypothesis*.

The notion that short-sale constraints are relaxed when options are listed is partly based on the decrease in the demand for short sales at the option introduction because pessimistic traders can use options to create synthetic short positions. The *substitute hypothesis* suggests that informed, pessimistic traders will prefer options to short-sales. Figlewski and Webb (1993) argue that introducing options reduces the level of information in short-sale constraints by allowing investors with unfavorable information to synthetically short stocks, which suggests that the substitutability between options and short sales is caused by severe short-sale constraints prior to option listings. However, the authors find that information contained in short sales is similar for both samples of stocks with options and stocks without options.

Figlewski and Webb (1993) recognize that the use of monthly short-interest data presents limitations in their study and argue that using finer short-sale data is more ideal. In this paper, I test the ability of short sellers to predict future negative returns around the introduction of options using data at the daily level. First, I show that short sellers are able to predict negative next day returns before options are introduced, which is consistent with Diamond and Verrecchia (1987), Senchack and Starks (1993), Aitken et al. (1998), Boehmer, Jones, and Zhang (2008), and Diether, Lee, and Werner (2007). Second, the introduction of options decreases the ability of short sellers to predict future negative returns. The reduced informational effect of short sales suggests that informed, pessimistic investors prefer using options to using short sales, which is consistent with the substitute hypothesis.

Since Figlewski and Webb (1993) argue that option introductions reduce the informational content in short-sale constraints, I also examine the return predictability of short-selling activity for stocks that are most likely constrained. Tests reveal that short sellers of stocks with low institutional ownership and market cap become better at predicting negative returns after options are introduced, suggesting that option introductions do not reduce the information content of short-sale constraints, which do not appear to be binding prior to the listing. While options provide pessimistic investors a substitute for short sales, the results of this paper suggest that the substitutability between short sales and options is not driven by stocks that are most likely constrained.

Beyond examining whether short-sale constraints are binding in the pre-option introduction period, I also test whether short-sale activity is a possible determinant in the option listing decision. Mayhew and Mihov (2004) argue that if the main objective for an

exchange is to maximize profits for its members, then exchanges will choose to list options that will generate the highest post-listing trading volume. Consistent with this argument, Mayhew and Mihov find that volume, volatility, and firm size are important determinants in the listing decision by exchanges.

In this paper, I also test the *listing hypothesis*, which suggests that stocks with high short-selling activity make good candidates for option listing because of the substitutability between short sales and options. The results show that short-sale volume is highest in the month prior to an option listing. When comparing stocks that list options to stocks that are eligible but do not list options, there is a significant difference in the level of short activity between the two samples in the 30 days prior to the option listing. Danielsen, Van Ness, and Warr (2007) note that option exchange personnel admit to making listing decisions in the month prior to introducing an option. After controlling for other determinants of the listing decision, such as volume, volatility, and the size of the stock (Mayhew and Mihov, 2004), I document that short-selling activity significantly increases the likelihood of stocks introducing options.

The implications of this study suggest first, that the empirical finding of increased short interest after option introductions is not due to immediately relaxed short-sale constraints. Instead, I document that short-selling activity declines in the 30 days after options are introduced. Second and perhaps more important, short-sale constraints do not appear to be binding in the pre-introduction period. Contrary to the findings of Figlewski and Webb (1993), the level of information contained in short sales decreases after options are introduced. However, the reduction in the informativeness of short sales is driven by

stocks that are least likely constrained. Third, a stock's short-selling activity is an influential factor in determining whether exchanges introduce options.

The rest of this paper follows: Section II discusses the relevant literature and develops my hypotheses. Section III presents a description of the data used in the analysis while Section IV provides the tests of the empirical predictions. Section V concludes the paper.

II. Prior Literature and Hypotheses

Nagel (2005) argues that there are two different types of short-sale constraints. The first type of short-sale constraints are indirect constraints, which exist because of institutional or cultural reasons. Almazan et al. (2004) provide an example of indirect constraints by showing that 30 percent of mutual funds are allowed by their charters to sell stocks short, however, only three percent of funds engage in short-sale trading. Nagel argues that indirect short-sale constraints imply that institutional or cultural reasons limit the amount of short selling that occurs in the market. The second type of short-sale constraints are direct constraints, which exist because short selling can be costly. Because short sellers must borrow shares from investors who are willing to lend, the cost of short-selling depends on the loan supply and demand. When the loan supply (demand) is low (high), the cost of short selling is high.

Theoretical research predicts that short-sale constrained stocks will be overvalued. Miller (1977) posits that in the absence of short selling, enthusiastic buyers overprice stocks. When short-sale constraints are removed, the supply of stocks increases as pessimistic traders are able to sell short to optimistic traders. The outward shift in the supply curve causes stock prices to decrease. Jarrow (1980) argues that the relaxation of

short-sale constraints may either increase or decrease prices because investors may use short sales to finance their demand for other stocks, which they optimistically view. Diamond and Verrecchia (1987) focus on short-sale constraints in a rational expectations framework and predict that prices of short-sale constrained stocks adjust more slowly than the prices of unconstrained stocks. They argue that option introductions can decrease the cost of short selling as options can be used as a substitute for short sales.

When examining the transactions costs of short sales, Asquith and Meulbroek (1995) argue that proceeds to an ordinary investor from holding a short position are held by the seller's broker, which acts as an indirect cost. Danielsen and Sorescu (2001) argue that option market makers can hedge their positions at lower costs than ordinary investors because market makers can earn interest on the proceeds of their short sales that are similar to the rates for margin loans they use to fund long-short positions. Evans et al. (2008) discuss other reasons why options facilitate lower short-selling costs. The authors argue that option market makers can sell stocks short without finding shares to deliver, suggesting that they have an advantage over other market participants. With option market makers short selling at lower costs, an increase the amount short volume occurs, which resembles a mitigation of short-sale constraints.

Figlewski and Webb (1993) test whether short-sale constraints are relaxed when options are introduced and find that optionable stocks exhibit higher levels of short interest than non-optionable stocks. Danielsen and Sorescu (2001) find that aggregate short interest increases around option introductions and argue that increasing short interest is evidence of relaxed short-sale constraints resulting from option introductions.

In examining whether option introductions relax short-sale constraints, Mayhew and Mihov (2005) approximate post-introduction short activity with bearish option volume. Following Easley, O'Hara, and Srinivas (1998), who define bearish volume as buyer-initiated put volume plus seller-initiated call volume, Mayhew and Mihov do not find abnormal bearish option volume shortly after options are introduced. The implications of this finding suggest that if bearish volume does not increase, then option market makers will not increase the level of short selling as a hedge against bearish volume. However, Mayhew and Mihov do not determine if short-sale constraints are binding in the pre-introduction period.

Asquith, Pathak, and Ritter (2005) argue that short-sale constraints are likely binding for stocks with low institutional holdings because stocks with less institutional holdings have a smaller loan supply and are more difficult to sell short. Similarly, Arnold et al. (2005) argue that small cap stocks are less borrowable and therefore, face greater short-sale constraints. Examining smaller cap stocks and stocks with lower institutional holdings provide an opportunity to test whether short-sale constraints are widespread in the pre-introduction period.

D'Avolio (2002) finds that over 90 percent of stocks are borrowable with loan fees of only 25 basis points per year, suggesting that costs of shorting are reasonably low. Diether, Lee, and Werner (2007) find that nearly 24 (31) percent of trading volume is made up from short sales on the NYSE (NASDAQ). The recent findings suggest that short-sale constraints are not widespread, which warrants a further examination of the severity of short-sale constraints around option introductions. The finding of abnormal short-selling

activity prior to an option listing, particularly for stocks that are most likely constrained, is evidence of, what I term the *unconstrained hypothesis*.

In addition to examining the severity of short-sale constraints around option introductions, I also test the informational effect of short sales around option listings. Research finds that short sellers are informed about the true value of stocks. Diamond and Verrecchia (1987) present a theoretical model that predicts stock prices negatively adjust to increases in the level of short selling, suggesting that short sellers are informed about future stock price movements. Desai et al. (2002) examine the relation between returns and short interest and find that increases in the level of short interest significantly decreases returns for NASDAQ stocks. Aitken et al. (1998) use short-sale transactions data from the Australian Stock Exchange and find that prices adjust, on average, within 15 minutes of a short sale.[1] Boehmer, Jones, and Zhang (2008) find that lightly shorted stocks tend to outperform heavily shorted stocks for a 20-day holding period. They argue that institutional short sellers are driving their results, but in general, short sellers are indeed informed. Similarly, Diether, Lee, and Werner (2007) find that short sellers are contrarian in contemporaneous and past returns and are able to predict future negative returns, thus adding to the argument that short sellers are informed.

Figlewski and Webb (1993) do not find that options reduce the information content of short sales as they show that monthly short interest is similarly able to predict negative next year returns for both stocks that have listed options and stocks that do not have listed options. However, Figlewski and Webb recognize that using monthly short-interest data to test the informational effect of short selling optionable stocks provides limitations. They express that using "data on short-sale transactions" would be more ideal, however, they

[1] The Australian Stock Exchange reveals that a trade is a short sale upon execution.

note that "these [data] are unavailable for individual stocks (pg. 763)". The use of short-sale transactions data that is pooled around an option introduction can further test the *substitute hypothesis* or the hypothesis that informed, pessimistic traders will prefer using options as a substitute for short sales.

Using short-sale transactions data, I also investigate whether short-selling activity is a determinant in the option listing decision. Mayhew and Mihov (2004) offer the following comment on the exchange's decision to list options.

> "Generally, stocks are selected for option listing by committees composed of members of the exchange, after soliciting feedback from the general membership. Presumably, the main objective for an exchange is to maximize long-term profits for its members. In practice, according to industry sources, this amounts to listing those options expected to generate the highest trading volume (pg. 450)."

Jennings and Starks (1986) argue that listing decisions are based on a candidate's attributes like stock volatility, trading activity, and investor interest. Mayhew and Mihov (2004) find that volume, volatility, and firm size positively affect the listing decision by exchanges.

Danielsen, Van Ness, and Warr (2007) find that bid-ask spreads are negatively related to the exchanges' decision to list options. The intuition that drives the notion of liquidity as a determinant in the listing decision is that liquidity of the spot asset impacts the cost of hedging when traders engage in dynamic hedging in the spot market.

Because of the substitutability between short sales and options, it can be argued that a stock's short-selling activity may be an important factor in the listing decision by exchanges. If certain stocks have high levels of short selling, then exchanges are likely to believe that these stocks are good candidates for option listings because options provide investors with unfavorable information the opportunity to create relatively low-risk, synthetic short positions by writing call options or buying put options. Short-selling

activity as a determinant in the listing decision is consistent with, what I denote the *listing hypothesis*.

III. Data Description

This study uses a sample of common stocks that are traded on the NYSE and NASDAQ and introduce options during 2005 and 2006. Option introductions are obtained from the Option Clearing Corporation. The sample is restricted to stocks that have data on the Center for Research on Security Prices (CRSP) and stocks that have trading data for a 61-day window around the option listing. The total number of common stocks (CRSP share code 10 or 11) in the listing sample is 399.[2]

Using short-sale transactions data that is made available in response to Regulation SHO (January, 2005), the daily short-selling activity is calculated for each stock in the sample. From CRSP, daily returns, volume, market capitalization, shares outstanding, and prices are obtained and the return volatility is calculated by taking the standard deviation of daily returns from day *t-10* to day *t*, where day *t* is the current trading day.

Table 1 reports statistics that describe the sample before and after options are introduced. Panel A reports statistics for the daily price, return volatility, return, and turnover from CRSP, as well as the amount of daily short turnover and the number of short sales obtained from the SHO data before the option is listed. Turnover is calculated by dividing the daily volume by the number of shares outstanding while short turnover is defined as the daily short volume divided by the number of shares outstanding. Panel B reports the statistics after the option is introduced while Panel C reports the difference-in-means tests between Panel A and Panel B, respectively.

[2] There is 468 ordinary common stocks (CRSP share code 10 or 11) that list options during the sample time period. After restricting stocks to have 30 days of trading data before and after, the number of stocks is 399 of which, 244 stocks are listed on Nasdaq while 155 stocks are listed on the NYSE.

The average stock in the listing sample has a price of $20.76 and daily turnover (short turnover) of one percent (0.2 percent) before the option introduction. Further, volatility has a mean of 0.0283 while the average return is 0.0015 before the option introduction. Panels B and C report that returns and volatility decrease after options are introduced while turnover, short turnover, and the number of short sales increase after the listing. The significant increase in short-selling activity is consistent with Danielsen and Sorecu (2001), who find that finds monthly short interest increases after option listings. Researcher argues that short activity is higher for optionable stocks because of relaxed short-sale constraints (Figlewski and Webb, 1993).

IV. Empirical Results

This section first examines whether short-sale constraints are binding in the pre-introduction period. Boehmer, Jones, and Zhang (2008) and Diether, Lee, and Werner (2007) find that short volume makes up a substantial portion of trade volume on both the NYSE and NASDAQ, suggesting that constraints are not widespread. The unconstrained hypothesis suggests that short-sale constraints will not be binding in the pre-introduction period, which implies that constraints will not be meaningfully relaxed around option introductions.

The return predictability of short sales around option introductions is also examined. Figlewski and Webb (1993) do not find that monthly short interest is more informed for stocks with listed options than for stocks without listed options using yearly observations. I test whether short sellers become less able to predict negative next day returns once options are introduced using pooled short-sale data at the daily level. The notion that informed, pessimistic investors prefer options to short sales is consistent with,

what I term, the substitute hypothesis. Figlewski and Webb suggest that the substitutability between options and short sales is caused by short-sale constraints. In order to provide more robust tests of the substitute hypothesis, I examine the information contained in short sales of stocks that are most likely constrained around option listings. Indeed, pessimistic investors may prefer options to short sales, however, if the unconstrained hypothesis holds, then binding short-sale constraints prior to the option listing is not a plausible explanation for the substitutability between options and short sales.

IV.A. Short-Sale Constraints around Options Introductions

Table 1 shows that short-selling activity increases for stocks after option introductions. However, in attempt to isolate the economic significance of the introduction, I examine a 61-day window around the listing. Previous research uses monthly short-interest data provided by the exchanges, where short interest is defined as the uncovered short volume divided by the number of shares outstanding for a particular point in time each month. For consistency, I examine the daily short turnover, which is the number of shares shorted *per day* relative to the number of shares outstanding. It is important to note a difference between monthly short interest and daily short turnover. Regulation SHO data does not contain covering information, so the short turnover is the total number of shares shorted (covered and uncovered) relative to the total number of shares outstanding.

Following Asquith, Pathak, and Ritter (2005) and Arnold et al. (2005), the sample of stocks that list options is sorted into quartiles based on institutional holdings and market cap, respectively. D'Avolio (2002) show that stocks in the lowest institutional holdings and lowest market capitalization quartiles are likely to be stocks that face the greatest short-

sale constraints. Stocks are also sorted into quartiles based on the number of shares outstanding as a measure of robustness. If constraints are more likely to bind for stocks with fewer borrowable shares, then the number of shares outstanding may also be a good approximation for loan supply. The different measures of short-selling activity are examined in the pre-introduction period for stocks in each quartile. If constraints are binding, then stocks in the lower quartiles will have significantly less short-selling activity than stocks in the higher quartiles during the pre-introduction period.

After sorting stocks into different portfolios, the cross-sectional mean of the short turnover is estimated before and after the option introduction. Table 2 Panel A shows that, for the sample of 399 stocks that list options, short turnover does not increase after options are introduced. Instead, the panel shows that daily short interest decreases although the difference is only marginally significant. Examining the results in the various quartiles, it appears that short-sale constraints are not widespread. If stocks in the lowest quartile (QI) are likely the most constrained, then the option listing should have the greatest impact on the relaxation of constraints and short-selling activity should significantly increase. Panel A shows that there is not a significant increase in short turnover for stocks in the lowest quartile. The results appear robust to the different approximations of the loan supply.

Table 2 Panel B compares the short turnover between quartiles before and after the option listing. If short-sale constraints are binding in the pre-introduction period, then short turnover will be significantly less for stocks in QI than for stocks in the other quartiles. Panel B reports that short turnover is higher for stocks in QI than for stocks in the other quartiles suggesting that short-sale constraints are not binding in the pre-introduction period. Again, the results appear robust to whether stocks are sorted into

market cap or shares outstanding quartiles. The results in Table 2 strongly support the unconstrained hypothesis, suggesting that short-sale constraints are not binding prior to the options introductions.

Following Lakonishok and Vermaelen (1986), Koski and Scruggs (1998), and Sias (2004), I standardize the short-selling measure by taking the difference between the daily short-measure for stock *i* on day *t* and the time series mean for stock *i* and dividing the difference by the standard deviation of the measure for stock *i* across the sample time period. The standardization procedure is shown below.

$$Standardized\ Measure_{i,t} = \frac{Measure_{i,t} - \overline{Measure_i}}{\sigma(Measure_i)} \quad (1)$$

where $\overline{Measure}_i$ is the mean of the measure for stock *i* during the sample time period and $\sigma(Measure_i)$ is the standard deviation of the measure for stock *i* during the sample time period. This standardization procedure allows the measure for each stock on each day to be similarly distributed with a zero mean and a unit variance.

Panels C and D of Table 2 present a replication of the analysis in panels A and B using the standardized short volume in equation (1). The results are similar to the findings in Panels A and B as short activity for stocks in the lowest quartile is significantly higher than short activity for stocks in the other quartiles before the option listing.

The results in Table 2 support the unconstrained hypothesis. Short-sale constraints do not appear to be binding in the pre-introduction period and are therefore, not meaningfully relaxed when options are listed as short activity for stocks that are most likely constrained is greater than short activity for stocks that are least likely constrained before options are introduced.

IV.B. Return Predictability around Option Introductions

This subsection tests the substitute hypothesis, which suggests that informed, pessimistic investors prefer using options to short sales. The substitute hypothesis is based on the argument of Figlewski and Webb (1993), who contend that short sellers become less able to predict negative returns after options are introduced. Figlewski and Webb suggest that the reduction in the information contained in short sales is consistent with the idea that options reduce the informational inefficiency caused by short sale constraints. The authors argue that reduced information contained in short sales after options are listed is due to a decline in the informational impact of short-sale constraints. However, when combined with the evidence supporting the unconstrained hypothesis, the substitute hypothesis suggests that the substitutability between options and short sales is not caused by binding, pre-introduction short-sale constraints. In order to test substitute hypothesis, the following equation is estimated.

$$ret_{i,t+1,t+d} = \beta_0 + \beta_1 vto_{t+1,t+d} + \beta_2 rvolt_{t+1,t+d} + \beta_3 pvolt_{t+1,t+d} + \beta_4 size_t + \beta_5 v\_r_{i,t} + \beta_6 LOW\_Q_i + \beta_7 v\_r_{i,t} \times LOW\_Q_i + \beta_8 OPT_{i,t} + \beta_9 OPT_{i,t} \times v\_r_{i,t} + \beta_{10} OPT_{i,t} \times v\_r_{i,t} \times LOW\_Q_i + \varepsilon_{i,t+1,t+d} \quad (2)$$

The dependent variable is the cumulative return from day $t+1$ to day $t+d$, where $d = \{0, 1, 2\}$. The independent variables included in equation (2) are share turnover (turn), return volatility (rvolt), price volatility (pvolt), and market capitalization in $billions (size). Similar to Diether, Lee, and Werner (2007), price volatility is defined as the difference between the daily high price and the daily low price divided by the daily high price. It is anticipated that volume (Chordia, Roll, and Subrahmanyam, 2001) and volatility will positively affect next day returns, and market capitalization will be negatively related to next day returns (Banz, 1981, Fama and French, 1992, Fama and French, 1996). Diether,

Lee, and Werner find that short volume relative to total trade volume predicts negative next day returns. Therefore, relative short volume (v_r) is included in order to test the informativeness of daily short-selling activity. OPT is a dummy variable capturing the time period after the option is introduced while LOW_Q is a dummy variable that is equal to one if stock *i* is in the lowest institutional ownership quartile.[3]

The variables of interest are the relative short-selling variables and the interaction of the short-selling variables with the dummy variables. A negative estimate for β_5 suggests that short sellers can predict negative next day returns prior to the option introduction. The total short-selling effect on next day returns after options are listed is the sum of β_5 and β_9. A positive estimate for β_9 is consistent with the substitute hypothesis and suggests that there is a reduction in the level of information contained in short sales because informed, pessimistic investors prefer options to short sales. Using a sample of stocks with listed options and a sample of stocks without listed options, Figlewski and Webb (1993) do not find a significant difference in the information contained in monthly short interest between samples. However, they recognize that monthly short interest data present limitations in their analysis.

Figlewski and Webb (1993) argue that the reason that short sellers of optionable stocks would be less able to predict negative returns than short sellers of stocks without options is because of a reduction in the informational impact of short-sale constraints that occurs at the listing. In equation (2), the estimates for β_7 and β_{10} provide the net effect of option listings on the information contained in short sales of stocks that are most likely constrained. If pessimistic investors prefer using options to short sales because of binding

[3] In addition, equation (2) is estimated using market capitalization quartiles (Arnold et al., 2005) and shares outstanding quartiles. The results are not tabulated but are qualitatively similar.

short-sale constraints, then short sellers of stocks that are most likely constrained will drive the reduction in the information contained in short sales. The evidence in Table 2 suggests that short-sale constraints are not binding in the pre-introduction period. Therefore, the decrease in the level of information contained in short sales when options are introduced is not driven by short-sale constraints.

The results from estimating equation (2) are reported in Table 3. A Hausman test rejects the presence of random effects. However, differences across stocks and days are observed so equation (2) is estimated using fixed effects.[4] Columns (1), (4), and (7) show the informativeness of short sellers after controlling for other factors that may influence next day returns. As expected, turnover (size) is positively (negatively) related to next day returns. The estimate for return volatility is positive but only marginally significant in column (7). In columns (2), (5), and (8), the results show that short sellers are able to predict negative returns before options are introduced as the estimates for β_5 are significantly negative at the 1% level. Consistent with the substitute hypothesis, short sellers become less able to predict negative next day returns as the estimate for β_9 is positive, suggesting that introducing options reduces the information contained in short sales. Comparing the results to Figlewski and Webb, who do not find that monthly short interest contains less information for stocks with options than for stocks without options, I find that indeed, information contained in daily short activity is reduced when options are listed.

Thus far, the results from Table 3 support the substitute hypothesis. However, Figlewski and Webb (1993) argue that any reduction in information contained in short

[4] When including the dummy variable LOW_Q, I do not use a fixed effects method because the dummy variable is constant in the time series. However, Table 7 Columns 3, 6, and 9 report p-values obtained from robust White (1980) standard errors.

sales is caused by pessimistic investors preferring options to short sales because of high short-selling costs. While Table 3 shows that short sellers become less able to predict negative returns once options are introduced, the objective of this analysis is to determine if the reduction in information is due to binding short-sale constraints.

Tests of whether the substitutability between short sales and options is caused by binding short-sale constraints are contained in columns (3), (6), and (9). If short-sale constraints do not matter, the interaction between short activity and the dummy variable, capturing the effect of stocks with low institutional ownership (LOW_Q), will be non-negative. A non-negative estimate for β_7 suggests that short sellers of stocks that are most likely to be constrained are not more informed than short sellers of stocks that are least likely constrained prior to the option introduction.

The estimates for β_7 generally suggest that there may not be information in short-sale constraints prior to option introductions because constraints are not binding. Surprisingly, the estimate for β_{10}, which tests whether the information in short sales of stocks that are most likely constrained changes around the option introduction, is significantly negative suggesting that more information is contained in short sales of stocks that are most likely constrained after the introduction.[5] The latter finding contradicts the argument of Figlewski and Webb (1993) and supports the notion that short sale constraints are not binding in the pre-introduction period.

IV.C. Option Listing Decisions

Using a standard event study method, preliminary tests of the listing hypothesis are reported, which suggests that stocks with high short-selling activity make good candidates

[5] I also perform the analysis using the lowest market cap quartile for LOW_Q and the lowest shares outstanding quartile for LOW_Q and results are qualitatively similar.

for option listing because of the substitutability between options and short sales. A second sample is created containing NYSE and NASDAQ common stocks that are eligible but do not list options. Mayhew and Mihov (2004) define and report historical changes in the listing eligibility requirements for stocks. Since 1991, eligible stocks must be listed on a national exchange, have at least 7 million shares of public float; have at least 2,000 shareholders; have at minimum 2.4 million shares of trading volume in the 12 months prior to the listing; and have a price of $7.50 per share for the majority of trading days for 3 months prior to the listing.

From the universe of NYSE and NASDAQ common stocks that do not have listed options and are not included in the listing sample, I include in the control sample, stocks that meet the volume and price requirements. Mayhew and Mihov (2004) establish eligibility based on public float using proprietary data. They find that insiders hold, on average, around 10 percent of shares outstanding. Because of data limitations, my control sample includes stocks that have at least 7.7 million shares outstanding, which assumes that 10 percent of the shares outstanding are held by insiders. Similar to Mayhew and Mihov, the control sample to stocks is not restricted based on the number of shareholders criteria.[6] The number of eligible common stocks (CRSP share code 10 or 11) that do not list options is 907.

A control stock from the sample of eligible stocks is matched to each stock in the listing sample following Huang and Stoll (1996), Bessembinder (1999), Bessembinder and Kaufman (1997a, 1997b), and Chung, Van Ness, and Van Ness (2001). When matching control stocks to the stocks in the listing sample, the following score is created:

[6] Mayhew and Mihov argue that the number of shareholders reported on a firm's 10K report only reflects the that number of registered shareholders. They find many instances where their proprietary data differs from the 10K report and choose not to include this criteria when establishing their control sample.

$$\sum_{k}\left[\frac{Y_k^C - Y_k^L}{\left\{\left(Y_k^C + Y_k^L\right)/2\right\}}\right]^2 \qquad (3)$$

Three stock attributes are included in Y_k; daily turnover, volatility, and market capitalization, which are found to be determinants by Mayhew and Mihov (2004). The superscript C (L) denotes whether the stocks are taken from the control (listing) sample and Σ denotes the summation over k = 1 to 3. I select, without replacement, control stocks with the smallest score to match with each stock in the listing sample.[7]

Table 4 reports statistics that describe both the listing sample and the control sample for several stock characteristics. Panel A reports the statistics for listing sample while panel B presents the statistics for the control sample. As expected, market cap, return volatility, and turnover are similar between the two samples. The average stock in the listing sample appears to have more short turnover and a higher number of short sales than the average stock in the control sample, which is consistent with Figlewski and Webb (1993). Returns and prices appear to be higher for the listing sample than for the control sample.

If higher short-selling activity is a determinant in the listing decision, then stocks that are similar to the control stocks in other potential determinants (turnover, volatility, and market cap) are expected to have higher short-selling activity. In order to further examine short-selling activity before the introduction, I calculate an abnormal measure for both the daily short volume and short turnover. Using the following equation, I calculate the difference between the daily short measure on day *t* and the mean of the measure during a benchmark period.

[7] I also match control stocks to stocks that list options that are listed on the same exchange (NYSE or NASDAQ). That is, I match the control sample to the listing sample based on the three stock attributes that are similarly listed by the NYSE or NASDAQ.

$$Abnormal\ Measure = Measure_{i,t} - \overline{Measure}_{i,t-60,t-31} \quad (4)$$

where the benchmark period is defined as the time period [*t-60* to *t-31*].

Table 5 Panel A presents the results of an event study using the raw value of short turnover, the abnormal measure of short turnover (equation (4)), and the standardized measure of short turnover (equation(1)). Short-selling activity does not increase after the option listing, which supports the results of Table 2. However, short selling of stocks that list options is significantly greater than stocks that are eligible but do not list both before and after the introduction. The results are robust to both the abnormal and standardized measures. Table 5 Panel B presents the same analysis as Panel A using daily short volume. The results are qualitatively similar.

Figures 1A and 1B show the time series of standardized short-selling activity for the 61-day window around the introduction. The figures are striking for both the short turnover and daily short volume. It appears that, after the event day, short selling decreases although there is still a substantial difference between the control sample and the listing sample. Interestingly, the figures show abnormal short-selling activity in the pre-introduction period. Combined with the results in Table 5, short-selling activity does not increase once options are introduced, which is consistent with earlier findings.

Danielsen, Van Ness, and Warr (2007) note that "according to options exchange personnel, listing decisions for stock options are usually made a week to a month before the option is introduced (p. 8)". The authors find a distinct regime shift in trading variables in the month prior to the introduction. Using the standardization procedure in equation (1), I examine volume and volatility around the introduction of options, which Mayhew and Mihov (2004) find to be important determinants in the listing decision. If listing decisions

are made by exchanges in the month before the introduction, then one may expect to see abnormal volume and volatility between samples prior to the option introduction. For further tests of the listing hypothesis, I determine whether short-selling activity for stocks that list options follows a similar pattern as volume and volatility in the pre-introduction period.

Figures 2A and 2B show the pattern of volume and return volatility around option introductions, which are standardized using equation (1). The figures show that volume and return volatility are increasing in the pre-introduction period for stocks that list options. As Danielsen, Van Ness, and Warr (2007) note, listing decisions are generally made in the month before the listing. It is apparent from the figures that stocks that list options have higher volume and volatility than stocks that are eligible but do not list options prior to the introduction, suggesting that volume and volatility are indeed important determinants in the listing decision by exchanges.

Comparing the pattern of short-selling activity in figures 1A and 1B to the pattern of volume and volatility, it appears that short-selling activity is also an important determinant in the listing decision. The figures offer an important explanation to previous tables. Consistent with Danielsen and Sorescu (2001), Table 1 shows that short turnover and the number of short sales increases after the introduction. However, when examining the 61-day window around the introduction, Tables 2 and 4 report that short-selling activity does not increase after option introductions. From the figures, it appears that the reason short-selling activity does not increase immediately at the introduction is due to the large amount of short volume that is being executed in the 30 days prior to the listing, suggesting that constraints are not binding before the option listing. Further, the large amount of short

volume during the 30 days prior to the option listing suggests that exchanges choose to list options for stocks with high short-selling activity.

Following similar methods used in Mayhew and Mihov (2004) and Danielsen, Van Ness, and Warr (2007), I further test the listing hypothesis in a limited dependent variable framework. The dependent variable is equal to one if on day *t*, stock *i* lists an option. Shumway (2001) cites a dependence problem when using panel data in the probit or logit framework, but argues that adjusting the sample size of the logit estimation can account for the dependence of observations. When stock *i* lists an option on day *t*, the dependent variable equals one. The dependent variable will also be equal to one on day *t+1* and the dependent variables on day *t* and *t+1* will not be independent. To overcome the dependence problem, Danielsen, Van Ness, and Warr (2007) follow Shumway and exclude all observations after the option is listed. They denote this method as an event-history method. Following Danielsen, Van Ness, and Warr, I attempt to determine which factors affect the listing decision using an event history method by estimating the following equation.

$$List_{i,t} = \beta_0 + \beta_1 volume_{-30,-10} + \beta_2 ab\ vol + \beta_3 rvolt_{-30,-10} + \beta_4 ab\ volt + \theta_{1j} short\ act_{-30,-10} + \theta_{2j} ab\ sh\_act + \beta_5 price_{-20} + \beta_6 ln\ cap_{i,t} + \varepsilon_{i,t} \quad (5)$$

Similar to past research, independent variables include the average daily volume from day *t-30* to day *t-10*. Following Mayhew and Mihov, I create abnormal measures for each variable. Ab vol is the abnormal volume, defined as the average volume from day *t-30* to day *t-10* divided by the average volume from day *t-60* to day *t-31*.[8] Similarly, rvolt and ab volt are included as independent variables. Short volume, short turnover, and relative short

[8] Mayhew and Mihov define a similar variable but use a benchmark of 125 days before the option introduction. Because short-sale data is not available for the year 2004 and I do not wish to lose some stocks that list options before June of 2005, a different benchmark is used.

volume, are included as three measures of short activity. Similar to Danielsen, Van Ness, and Warr, the price on day *t-20* and the natural log of market capitalization are also included.

The estimation of equation (5) is performed for the 399 stocks that list options and the 907 eligible stocks that do not list options. The expected signs of the estimates for *ab vol* and *ab volt* are positive. Danielsen, Van Ness, and Warr (2007) find a positive estimate for *price* and a negative estimate for *size*. For evidence of the listing hypothesis, the estimate for θ_2 is expected to be positive. A positive estimate for θ_2 suggests that, after controlling for other listing determinants, short-selling activity is an important factor in the listing decision.

The results of estimating equation (5) using a fixed effects logistic regression are reported in Table 6. The results are generally consistent with Danielsen, Van Ness, and Warr (2007) and Mayhew and Mihov (2004). In column (1), abnormal volume, abnormal volatility, and price are positively related to the listing decision (although the estimate for abnormal volume is not significant). Similar to Danielsen, Van Ness, and Warr, size is negatively related to the listing decision. When including the short-selling measures, short activity is an important determinant in the listing decision.

In column (2), the estimate for abnormal short volume is significantly positive. Surprisingly, when including the short volume in the regression, the estimate for volume becomes significantly negative, suggesting that perhaps a stock's short-selling activity relative to its trading activity is an important determinant. In column (4), the relative short activity (*v_r*) is included without volume because volume is controlled for in the denominator of the ratio. The results in column (4) show strong evidence that relative short

activity is an important determinant in the listing decision. In column (5), volume and the relative short activity are included and the estimate for volume is again positive while the estimate for the relative short measure is positive and strongly significant, suggesting that exchanges choose to list options for stocks that have high short activity relative to total trade activity.

Danielsen, Van Ness, and Warr (2007) report that their results are robust to using different time windows. Equation (5) is estimated using the time window t-40 to t-20, which is reported in Danielsen, Van Ness, and Warr.[9] Table 7 shows the results of the fixed effect logistic regression. Similar to the results in Table 6, abnormal volatility and price are positively related to the listing decision while market capitalization is negatively related to the listing decision. The estimate for abnormal volume is positive but not significant. In each specification, the estimate for abnormal short activity is positive, suggesting that exchanges list options for stocks with high short-selling activity. As in Table 6, it appears that relative short-selling activity is an important determinant in the listing decision; a result consistent with the listing hypothesis.

V. Conclusion

In an extension to the theoretical models of Jarrow (1980) and Miller (1977), Danielsen and Sorescu (2001) predict that short interest increases after options are introduced because short-sale constraints are mitigated at the option listing. Mayhew and Mihov (2005) argue that, if short-sale constraints are keeping prices artificially high, then once options are introduced, excessive bearish option volume should occur immediately. Mayhew and Mihov do not find abnormal bearish option volume shortly after the introduction of options. When examining a 61-day window around an option introduction,

[9] The benchmark for calculating the abnormal independent variables is t-60 to t-41.

I document that short-selling activity does not increase after option listings. As D'Avolio (2002), Asquith, Pathak, and Ritter (2005), Nagel (2005), and Arnold et al. (2005) show, stocks with lower institutional holdings and smaller market cap are more likely to face binding short-sale constraints. Results in this paper show that short-selling activity for stocks with low institutional holdings, low market cap, and fewer shares outstanding is greater than short-selling activity for other stocks before option introductions, suggesting that short-sale constraints are not binding in the pre-introduction period.

Figlewski and Webb (1993) argue that short sales will contain less information after options are introduced because of a reduction in the informational inefficiencies caused by short-sale constraints. This paper shows that short-sale constraints are not binding prior to option introductions, which warrants additional tests of Figlewski and Webb's contention. Figlewski and Webb are unable to find evidence that short interest for optionable stocks is less informed than short interest for stocks that do not have listed options using monthly data, although they mention that tests using finer short-sale data would be more ideal. Using short-sale data at the daily level, I document that short sellers are able to predict negative next day returns before options are introduced and become less able to predict negative returns after the option listing. However, the results of this analysis delineate from the explanation of Figlewski and Webb (1993) as the reduction in the information contained in short sales is driven by stocks that are least likely short-sale constrained. The latter findings suggest that while pessimistic investors may prefer options to short sales, the substitutability between options and short sales is not caused by binding short-sale constraints.

Because short-sale constraints do not appear to be binding, I test whether short-selling activity is a determinant in the listing decision by options exchanges. Results show that short activity is highest in the 30 days before the option listing, which is when listing decisions are generally made (Danielsen, Van Ness, and Warr, 2007). After controlling for volume, volatility, and market cap, which Mayhew and Mihov (2004) find are important determinants in the listing decision, I show that a stock's short-selling activity is indeed an important factor in the listing decision.

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Table 1

Descriptive Statistics Before and After Option Introductions

The table reports descriptive statistics before and after the option listing for stocks in the listing sample. *Price* is the daily close price, while *return volatility* is measured as the standard deviation in returns from day t-10 to day t, where day t is the current trading day. *Return* is the CRSP daily return. *Turnover* (*short turnover*) is the daily total trade (short sale) volume divided by the number of shares outstanding and the *number of shorts* is the daily number of short sales executed. Panel A report the statistics before the option is introduced while Panel B reports the statistics for the listing sample after the option is introduced. Panel C reports the difference in the cross-section daily means from before and after the option listing. The p-values, reported in parentheses, tests whether or not the difference is significantly different from zero.

Panel A. Descriptive Statistics Before the Option Introduction						
	Price	Return Volatility	Return	Turnover	Short Turnover	Number of Shorts
Mean	20.76	0.0283	0.0015	0.0109	0.0014	109.96
St. Dev	15.88	0.0125	0.0040	0.0126	0.0012	101.42
Min	1.38	0.0050	-0.0283	0.0013	0.0000	0.00
Max	107.05	0.1082	0.0332	0.1848	0.0095	863.18
Panel B. Descriptive Statistics After the Option Introduction						
Mean	22.78	0.0264	0.0005	0.0134	0.0020	210.19
St. Dev	17.28	0.0109	0.0027	0.0145	0.0017	173.63
Min	1.41	0.0032	-0.0199	0.0011	0.0000	0.00
Max	140.21	0.1058	0.0162	0.2111	0.0119	1,535.01
Panel C. Difference in Descriptive Statistics Before and After the Option Introduction						
Difference	-2.02*	0.0019**	0.0010***	-0.0025**	-0.0006***	-100.20***
t-statistic	(0.096)	(0.031)	(0.000)	(0.014)	(0.000)	(0.000)

*,**,*** Statistically significant at the 0.10, 0.05, 0.01 level

Table 2

Short Selling of Constrained and Unconstrained Stocks

The table presents univariate statistics for a measure similar to relative monthly short interest. I calculate the relative daily short turnover by dividing the daily short volume by the number of shares outstanding. I sort the stocks into quartiles based on the level of institutional holdings, market cap, and shares outstanding. I calculate the mean of the daily short interest (standardized short volume) before and after the introduction and report the difference in panel A (C). In panel B (D), I calculate the difference in the daily short interest (standardized short volume) between the specified quartiles in the pre-introduction period and the post-introduction period, respectively.

Panel A. Sample of stocks that listed options

	Institutional Holdings Quartiles			Market Capitalization Quartiles			Shares Outstanding Quartiles		
	Before Introduction	After Introduction	Difference	Before Introduction	After Introduction	Difference	Before Introduction	After Introduction	Difference
All Stocks	0.0025	0.0023	0.0002*	0.0025	0.0023	0.0002*	0.0025	0.0023	0.0002*
			(0.084)			(0.084)			(0.084)
Q I (low)	0.0026	0.0026	-0.0000	0.0028	0.0025	0.0003*	0.0030	0.0029	0.0001
			(0.920)			(0.095)			(0.412)
Q II	0.0027	0.0025	0.0002	0.0024	0.0021	0.0003***	0.0026	0.0022	0.0004***
			(0.153)			(0.008)			(0.006)
Q III	0.0021	0.0019	0.0002	0.0023	0.0021	0.0002*	0.0020	0.0021	0.0001
			(0.085)			(0.061)			(0.503)
QIV (high)	0.0024	0.0021	0.0003**	0.0021	0.0021	0.0000	0.0020	0.0017	0.0003***
			(0.019)			(0.810)			(0.004)

Panel B. Difference between Quartiles

	[QI – QII]	[QI – QIII]	[QI-QIV]	[QI – QII]	[QI – QIII]	[QI-QIV]	[QI – QII]	[QI – QIII]	[QI-QIV]
Before	-0.0001	0.0004***	0.0002	0.0004**	0.0005***	0.0007***	0.0004**	0.0010***	0.0010***
	(0.384)	(0.000)	(0.145)	(0.035)	(0.003)	(0.000)	(0.010)	(0.000)	(0.000)
After	-0.0001	0.0005***	0.0005***	0.0004***	0.0004***	0.0004***	0.0007***	0.0009***	0.0012***
	(0.459)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Panel C. Sample of stocks that listed options									
	Institutional Holdings Quartiles			Market Capitalization Quartiles			Shares Outstanding Quartiles		
	Before Introduction	After Introduction	Difference	Before Introduction	After Introduction	Difference	Before Introduction	After Introduction	Difference
All Stocks	0.2049	0.1565	0.0484***	0.2049	0.1565	0.0484***	0.2049	0.1565	0.0484***
			(0.002)			(0.002)			(0.002)
Q I (low)	0.3330	0.3549	-0.0220	0.3625	0.3186	0.0439	0.2427	0.2260	0.0167
			(0.555)			(0.222)			(0.603)
Q II	0.2415	0.1668	0.0747**	0.2610	0.1403	0.1207***	0.3192	0.2188	0.1004***
			(0.019)			(0.000)			(0.003)
Q III	0.0811	0.0426	0.0385	0.1694	0.1193	0.0501*	0.1256	0.1046	0.0210
			(0.171)			(0.075)			(0.484)
QIV (high)	0.1661	0.0261	0.1400	-0.0100	0.0258	-0.0360	0.1155	0.0603	0.0551*
			(0.242)			(0.219)			(0.059)
Panel D. Difference between Quartiles									
	[Q1 – Q2]	[Q1 – Q3]	[Q1-Q4]	[Q1 – Q2]	[Q1 – Q3]	[Q1-Q4]	[Q1 – Q2]	[Q1 – Q3]	[Q1-Q4]
Before	0.0920**	0.2520***	0.1670***	0.1010***	0.1930***	0.3730***	0.0764**	0.1127***	0.1270***
	(0.013)	(0.000)	(0.000)	(0.007)	(0.000)	(0.000)	(0.035)	(0.000)	(0.000)
After	0.1880***	0.3120***	0.2290***	0.1780***	0.3186***	0.2930***	-0.0070	0.1210***	0.1660***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.810)	(0.000)	(0.000)

*,**,*** Statistically significant at the 0.10, 0.05, 0.01 level

Table 3

Daily Regression Results

The table reports the results of regressing the cumulative return for stock i from day t+1 to day t+d, where d = {0, 1, and 2}, on several stock characteristics for stock i on day t. The independent variables are the natural log of volume, volatility, price volatility (p_volt), the natural log of capitalization, and the short volume ratio (v_r), which is the daily short volume divided by the daily total trade volume. I also include a two dummy variables, OPT, which is equal to unity if the day is, or after the day the option is introduced and LOW_Q, which is equal to one if stock i is in the lowest institutional holdings quartile. The model is specified below.

$$ret_{i,t+1,t+d} = \beta_0 + \beta_1 vto_{t+1,t+d} + \beta_2 rvolt_{t+1,t+d} + \beta_3 pvolt_{t+1,t+d} + \beta_4 size_t + \beta_5 v\_r_{i,t} + \beta_6 LOW\_Q_i + \beta_7 v\_r_{i,t} \times LOW\_Q_i + \beta_8 OPT_{i,t} + \beta_9 OPT_{i,t} \times v\_r_{i,t} +$$

$$\beta_{10} OPT_{i,t} \times v\_r_{i,t} \times LOW\_Q_i + \varepsilon_{i,t+1,t+d}$$

A Hausman test rejects the presence of Random Effects while an F-test finds fixed effects by stock and date. The estimates from a two-way fixed effect regression are reported with the corresponding p-values (in parentheses) in columns 1, 2, 4, 5, 7 and 8. I do not use a fixed effects regression when including LOW_Q in the equation because this dummy variable does not change across the time series. I do, however, report the p-values using the White (1980) heteroskedastic robust standard errors.

	ret_{t+1}			$ret_{t+1,t+2}$			$ret_{t+1,t+3}$		
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
$Intercept_t$	-0.0153***	-0.0129***	-0.0017***	-0.0284***	-0.0237***	-0.0009***	-0.0422***	-0.0353***	0.0001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.007)	(0.000)	(0.000)	(0.732)
$vto_{t+1,t+d}$	0.0861***	0.0868***	0.0869***	0.1650***	0.1665***	0.1647***	0.2205***	0.2231***	0.2193***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$rvolt_{t+1,t+d}$	0.0924***	0.0914***	0.0758***	0.1463***	0.1442***	0.1371***	0.2180***	0.2147***	0.2209***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$pvolt_{t+1,t+d}$	0.0611***	0.0606***	0.0133***	0.0824***	0.0811***	0.0266***	0.0979***	0.0955***	0.0798***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$size_t$	-0.79523***	-0.8299***	0.0929**	-1.6065***	-1.6688***	0.0647	-2.3736***	-2.4661***	0.0217
	(0.000)	(0.000)	(0.016)	(0.000)	(0.000)	(0.239)	(0.000)	(0.000)	(0.747)
v_r_t	-0.0013**	-0.0022***	-0.0013**	-0.0020***	-0.0035***	-0.0026***	-0.0022***	-0.0045***	-0.0035***
	(0.017)	(0.001)	(0.029)	(0.007)	(0.000)	(0.002)	(0.007)	(0.000)	(0.001)
LOWq			-0.0005**			-0.0005			-0.0004
			(0.048)			(0.214)			(0.443)
$v_r_t \times$LOWq			0.0017			0.0039*			0.0047*
			(0.309)			(0.055)			(0.058)
OPT		-0.0028***	-0.0014***		-0.0055***	-0.0028***		-0.0081***	-0.0046***
		(0.000)	(0.000)		(0.000)	(0.000)		(0.000)	(0.000)
$OPT \times v\_r_t$		0.0029***	0.0016**		0.0046***	0.0023**		0.0069***	0.0046***
		(0.002)	(0.035)		(0.000)	(0.034)		(0.000)	(0.002)
$OPT \times v_r_t \times$LOWq			-0.0022			-0.0067**			-0.0078**
			(0.154)			(0.013)			(0.017)
Adj. R^2	0.1124	0.1128	0.0119	0.1280	0.1289	0.0151	0.1326	0.1338	0.0178
Stock Fixed Effects	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No
Date Fixed Effects	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No

*,**,*** Statistically significant at the 0.10, 0.05, 0.01 level

Table 4
Descriptive Statistics
The table presents statistics for the sample of 399 stocks that introduced an option during 2005 and 2006. Panel A reports the daily average value for several stock characteristics, equally-weighted by stock. *Market Capitalization* is the daily market cap, while *volatility* is measured as the standard deviation in returns from day t-10 to day t, where day t is the current trading day. *Price* is the daily ending price and *Shares Outstanding* are the number of shares outstanding while *Capitalization* is the daily market cap. *Turnover* (*short turnover*) is the daily total trade (short sale) volume divided by the number of shares outstanding and the *number of shorts* is the daily number of short sales executed. Panel B reports the descriptive statistics for the matched sample, where a stock is matched based on volume, volatility, and market capitalization, following Chung, Van Ness, and Van Ness (2001).

Panel A. Descriptive Statistics for the Introduction Sample

	Market Capitalization	Volatility	Turnover	Returns	Price	Shares Outstanding	Short Turnover	Number of Short Sales
Mean	969,788	0.0271	0.0115	0.0010	21.87	48,231,859	0.0017	162.70
St. Dev	2,028,079	0.0101	0.0106	0.0018	16.44	73,746,675	0.0013	131.09
Min	42,448	0.0085	0.0016	-0.0152	1.39	8,614,702	0.0000	0.00
Max	28,460,925	0.0856	0.1452	0.0120	117.88	985,608,575	0.0102	862.56

Panel B. Descriptive Statistics for Matched Sample

Mean	994,140	0.0196	0.0082	0.0003	21.50	37,530,491	0.0013	129.80
St. Dev	2,152,375	0.0083	0.0067	0.0012	13.80	49,524,595	0.0011	151.61
Min	42,735	0.0010	0.0009	-0.0086	1.78	3,751,571	0.0000	0.00
Max	29,592,612	0.0562	0.0557	0.0057	92.67	683,934,456	0.0066	1,196.32

Table 5

Short-Selling Activity Around Option Introductions

The table reports the mean standardized values of short-selling activity around option introductions. The daily short interest and the daily short volume are reported in panels A and B, respectively. I report the raw measures of the short measures along with the abnormal and the standardized measures using equations (2) and (3). The difference between the listing sample of stocks and the matched sample is calculated and a t-test determines whether or not the difference is statistically significant. The p-values are reported in parentheses.

Panel A. Event study of daily short interest around option introductions

	Short Interest			Abnormal Short Interest			Standardized Short Interest		
	Sample	Matched Stocks	Difference (t-statistic)	Sample	Matched Stocks	Difference (t-statistic)	Sample	Matched Stocks	Difference (t-statistic)
[-30 to -1]	0.0025	0.0013	0.0011*** (0.000)	0.0008	-0.0000	0.0008*** (0.000)	0.2283	0.0165	0.2121*** (0.000)
[-20 to -1]	0.0028	0.0013	0.0015*** (0.000)	0.0011	-0.0000	0.0011*** (0.000)	0.3005	0.0245	0.2774*** (0.000)
[-10 to -1]	0.0032	0.0013	0.0019*** (0.000)	0.0015	-0.0001	0.0016*** (0.000)	0.3487	0.0119	0.3403*** (0.000)
[0 to +10]	0.0022	0.0013	0.0009*** (0.000)	0.0007	-0.0001	0.0007*** (0.000)	0.1522	-0.0001	0.1487*** (0.000)
[0 to +20]	0.0022	0.0013	0.0009*** (0.000)	0.0005	-0.0001	0.0006*** (0.000)	0.1489	-0.0040	0.1586*** (0.000)
[0 to +30]	0.0022	0.0013	0.0009*** (0.000)	0.0005	-0.0001	0.0006*** (0.000)	0.1459	-0.0100	0.1570*** (0.000)

Panel B. Daily short volume around option introductions

	Short Volume			Abnormal Short Volume			Standardized Short Volume		
	Sample	Matched Stocks	Difference (t-statistic)	Sample	Matched Stocks	Difference (t-statistic)	Sample	Matched Stocks	Difference (t-statistic)
[-30 to -1]	102,905	53,777	49,128*** (0.000)	34,249	-1,457	35,706*** (0.000)	0.2133	0.0791	0.1324*** (0.000)
[-20 to -1]	116,263	54,051	62,212*** (0.000)	47,641	-1,187	48,827*** (0.000)	0.2833	0.0835	0.1990*** (0.000)
[-10 to -1]	138,167	52,137	86,030*** (0.000)	69,608	-3,112	72,721*** (0.000)	0.3366	0.0704	0.2682*** (0.000)
[0 to +10]	97,252	56,362	40,890*** (0.001)	35,489	1,174	34,315*** (0.000)	0.1498	0.0667	0.0753* (0.077)
[0 to +20]	97,499	53,516	43,983*** (0.000)	28,852	-1,676	30,528*** (0.000)	0.1491	0.0525	0.0921*** (0.007)
[0 to +30]	95,079	53,207	41,872*** (0.000)	26,421	-1,987	28,408*** (0.000)	0.1477	0.0462	0.0974*** (0.001)

*,**,*** Statistically significant at the 0.10, 0.05, 0.01 level

Table 6

Pooled Event History Logistic Regression

The table reports the results from estimating the following equation.

$$List_{i,t} = \beta_0 + \beta_1 volume_{-30,-10} + \beta_2 ab\ vol + \beta_3 rvolt_{-30,-10} + \beta_4 ab\ volt + \theta_{1j} short\ act_{-30,-10} + \theta_{2j} ab\ sh\_act + \beta_5 price_{-20} + \beta_6 ln\ cap_{i,t} + \varepsilon_{i,t}$$

The dependent variable is equal to unity if on day t, stock i lists an option. The observations for each day after stock i lists an option are not included. The independent variables (daily volume, volatility, and short activity) are estimated mean during the time period t-30 to t-10. I also include abnormal measures, which are defined as the mean during the time period t-30 to t-10 divided by the mean during the time period t-60 to t-31. I include as measures of short activity, the daily short volume, the daily short interest, and the relative short volume. I also include the price on day t-20 and the natural log of the market capitalization. P-values are reported in parentheses.

	[1]	[2]	[3]	[4]	[5]
intercept	11.8136***	11.7060***	11.9806***	11.1948***	11.2534***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$vol_{-30,-10}$	0.0023	0.0251	0.1189**		0.0033
	(0.477)	(0.353)	(0.017)		(0.468)
ab_vol	0.0065	-0.0244**	0.0005		0.0034
	(0.326)	(0.046)	(0.479)		(0.377)
$rvolt_{-30,-10}$	-0.0231***	-0.0237***	-0.0160***	-0.0235***	-0.0236***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ab_volt	0.4787***	0.4770***	0.3685***	0.4951***	0.4936***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
$sh\_vol_{-30,-10}$		-0.0824			
		(0.411)			
ab_sh_vol		0.0609**			
		(0.035)			
$sh\_int_{-30,-10}$			-0.1139***		
			(0.000)		
ab_sh_int			0.0632*		
			(0.059)		
$sh\_ratio_{-30,-10}$				-0.7936*	-0.7843*
				(0.052)	(0.059)
ab_sh_ratio				0.3309***	0.3294***
				(0.000)	(0.000)
price	0.0144***	0.0144***	0.0186***	0.0146***	0.0148***
	(0.001)	(0.001)	(0.000)	(0.001)	(0.004)
ln cap	-0.3762***	-0.3730***	-0.3995***	-0.3492***	-0.3542***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Wald Statistic	197.5930***	200.2337***	276.9832***	206.3141***	206.4713***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Fixed Effects	Yes	Yes	Yes	Yes	Yes

*,**,*** Statistically significant at the 0.10, 0.05, and 0.01 levels

Table 7

Pooled Event History Logistic Regression – Different Time Window

The table reports the results from estimating the following equation.

$$List_{i,t} = \beta_0 + \beta_1 volume_{-40,-20} + \beta_2 ab\ vol + \beta_3 rvolt_{-40,-20} + \beta_4 ab\ volt + \theta_{1j} short\ act_{-40,-20} + \theta_{2j} ab\ sh\_act + \beta_5 price_{-20} + \beta_6 ln\ cap_{i,t} + \varepsilon_{i,t}$$

The dependent variable is equal to unity if on day t, stock i lists an option. The observations for each day after stock i lists an option are not included. The independent variables (daily volume, volatility, and short activity) are estimated mean during the time period t-40 to t-20. I also include abnormal measures, which are defined as the mean during the time period t-40 to t-20 divided by the mean during the time period t-60 to t-41. I include as measures of short activity, the daily short volume, the daily short interest, and the relative short volume. I also include the price on day t-20 and the natural log of the market capitalization. P-values are reported in parentheses.

	[1]	[2]	[3]	[4]	[5]
intercept	11.8474***	11.7479***	11.9693***	11.1393***	11.4472***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$vol_{-40,-20}$	0.0203	0.0241	0.1397***		0.0281
	(0.317)	(0.369)	(0.008)		(0.271)
ab_vol	0.0045	-0.0162	-0.0003		0.0041
	(0.349)	(0.168)	(0.489)		(0.365)
$rvolt_{-40,-20}$	-0.0210***	-0.0212***	-0.0142***	-0.0207***	-0.0213***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ab_volt	0.4087***	0.4062***	0.3261***	0.4116***	0.4107***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$sh\_vol_{-40,-20}$		0.0482			
		(0.453)			
ab_sh_vol		0.0362*			
		(0.072)			
$sh\_int_{-40,-20}$			-0.1221***		
			(0.000)		
ab_sh_int			0.0927**		
			(0.017)		
$sh\_ratio_{-40,-20}$				-0.4075	-0.3749
				(0.212)	(0.232)
ab_sh_ratio				0.2521***	0.2512***
				(0.000)	(0.000)
price	0.0152***	0.0151***	0.0201***	0.0147***	0.0156***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ln cap	-0.3792***	-0.3759***	-0.4042***	-0.3430***	-0.3685***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Wald Statistic	179.8550***	181.6019***	249.6789***	186.3357***	186.2782***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Fixed Effects	Yes	Yes	Yes	Yes	Yes

*,**,*** Statistically significant at the 0.10, 0.05, and 0.01 levels

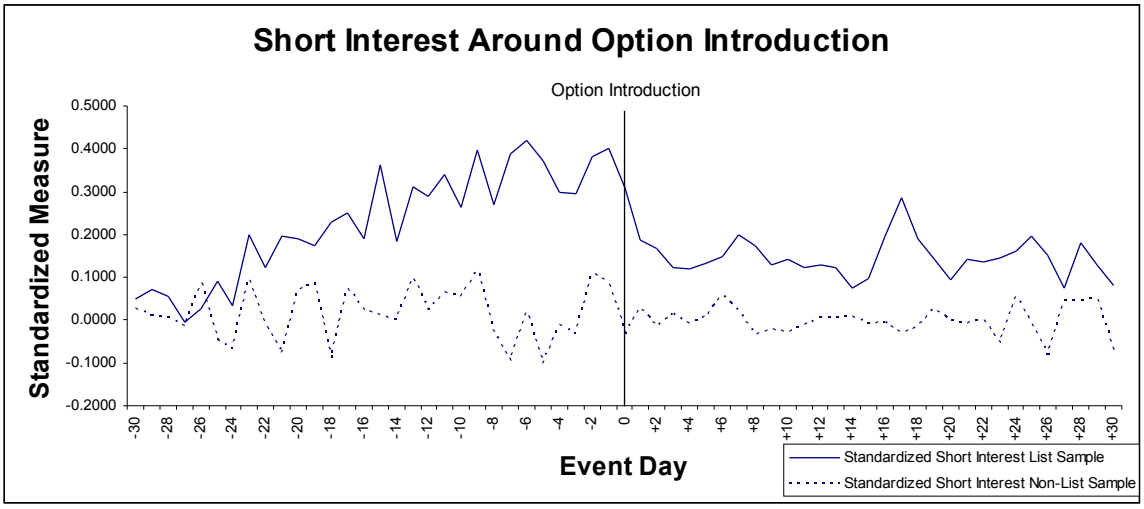

Figure 1A. The figure shows the standardized daily short-interest for the 61-day window around an option introduction. Short Interest is calculated by dividing the short volume by the number of share outstanding for each day in the sample time period.

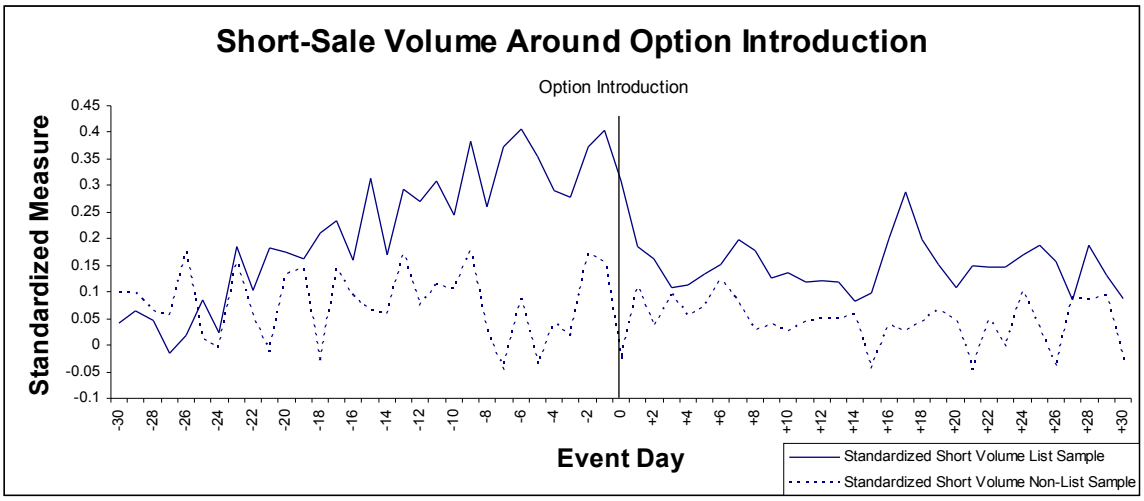

Figure 1B. The figure shows the daily standardized short-sale volume for the 61-day window around an option introduction.

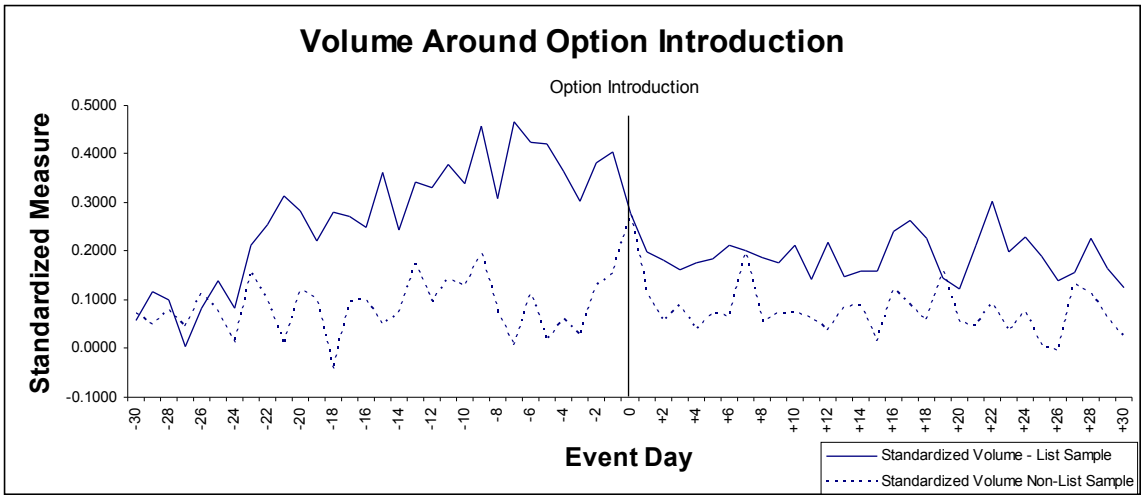

Figure 2A. The figure shows the standardized volume for the 61-day window around an option introduction.

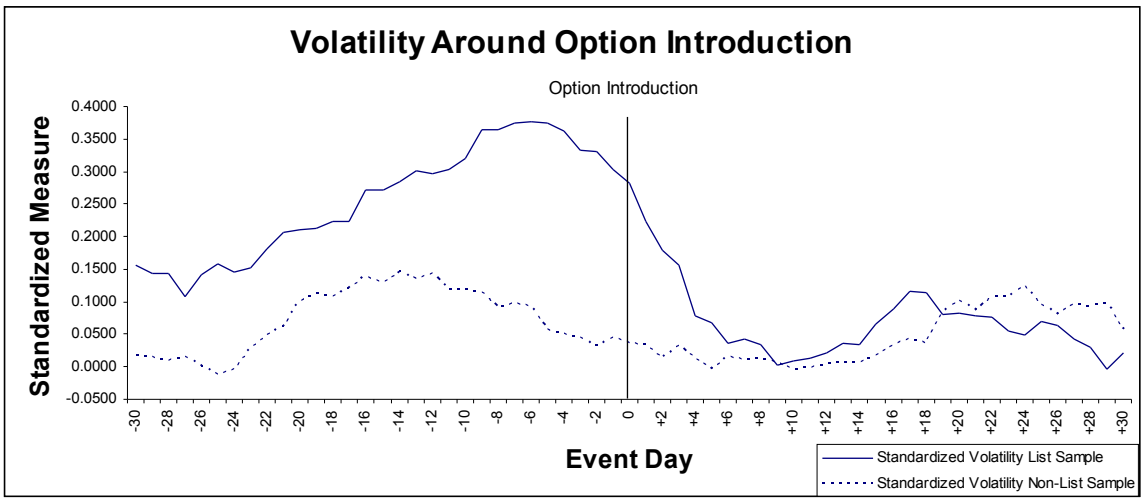

Figure 2B. The figure shows the standardized volatility for the 61-day window around an option introduction. Volatility is measured as the standard deviation of returns from day t to day t-10, where day t is the current trading day.