Option introduction, short sale constraints and the speed of stock price adjustment to negative news

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Abstract

This article investigates the effect of option introduction on short sale constraints. I find that post option improvement in adjustment efficiency is isolated to short sale constrained (low institutional ownership) stocks responding to negative information. No significant improvement in adjustment efficiency is found in response to positive information, across all short sale constraint levels. Prior to option introduction, short sale constrained stocks adjust to negative information 19% slower than unconstrained stocks. Following option introduction that difference is reduced to 3%, indicating that option introduction eliminates 84% of the disparity in price efficiency between short sale constrained and unconstrained stocks.

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"Short sellers occupy a position in the stock market like that of predators in nature: necessary but unloved" (Sauer, 2006). Through history short sales have been both reviled and lauded by investors. Short selling "bear raids" were widely perceived by many investors as a cause of the 1929 stock market crash (U.S. SEC, 2007). Others recognize the important contribution of short selling to the process of price discovery. The argument for the critical role of short sales in stock price adjustment dates back to Miller (1977). In a market where short selling is constrained, it is difficult for pessimistic investors who do not hold the asset to trade on their opinions. Thus, short sale constraints result in negative information being withheld from the market, leading to delayed stock price adjustment to negative news (Diamond and Verrecchia, 1987). Once option trading is introduced, investors may take synthetic short positions; this allows more rapid incorporation of negative information into stock prices and leads to improved market efficiency.

I conduct an event study of the economic importance of option introduction in lowering the price inefficiencies associated with short-sale constraints, utilizing 1732 option introduction events from 1981-1997.[1] To measure the post option reduction in short sale constraints I examine the change in stock price adjustment efficiency as measured by the adjustment delay measures defined in Hou and Moskowitz (2005).[2] The Hou and Moskowitz model assesses the significance of lagged market returns for predicting stock returns. The greater the number of lagged market returns that are significant for predicting stock returns, the greater the delay in adjustment to new information.

Based on the post option change in adjustment efficiency I test two hypotheses. First, as short sale constraints are relaxed, post option improvement in the speed of adjustment should be greatest for stocks with low short sale loan supply, for which short sale constraints are most likely binding.

[1] As used in Mayhew and Mihov (2004).

[2] The Hou and Moskowitz (2005) model is similarly used to quantify the extent of short sale constraints by Saffi and Sigurdsson (2007).

Second, as short sale constraints impede only negative information from being impounded in stock prices, post option improvement in adjustment efficiency should be more pronounced for negative relative to positive news.

There is a rich literature which examines the relation between option trading and stock market efficiency. For example, Jennings and Starks (1986), Skinner (1990), Damodaran and Lim (1991) and Damodaran and Lim (1992) all document either an improvement in stock market efficiency following option introduction or a quicker rate of stock price adjustment for optioned stocks. Post option improvements in market efficiency can be attributed to several alternate factors beyond the reduction of short sale constraints; such as endogenous stock characteristics (Mayhew and Mihov, 2004), increased information collection (Damodaran and Lim, 1991) and improvements in liquidity (Fedenia and Grammatikos, 1992). Thus, research exploring the effect of option introduction on short sale constraints must isolate the "short sale effect" from myriad simultaneous and complementary factors contributing to improved market efficiency.

Jennings and Starks (1986), Skinner (1990) and Damodaran and Lim (1991) each examine the general effect of option introduction on market efficiency but do not study the potential effect of short sale constraints.[3] In an unpublished working paper, Damodaran and Lim (1992) compare cumulative abnormal returns in the 20 days surrounding earnings announcements before and after option introduction and find that prices adjust to negative earnings news faster after option introduction. As short sale constraints are likely to influence the response to negative earnings news, this finding supports the hypothesis that option introduction reduces short sale constraints.

[3] Damodaran and Lim (1991) do however include an analysis of the change in institutional ownership surrounding option introduction and find a positive relation between increased institutional interest and higher stock price adjustment (though not to negative news). They attribute this result to increases in liquidity and reductions in noise trading related to higher institutional ownership.

However, Damodaran and Lim (1992) do not test for a direct relation between improved market efficiency and short sale constraints and do not control for endogenous stock characteristics associated with option introduction. By contrast, this article is the first to test for a direct relation between the relaxation of short sale constraints and improved price adjustment efficiency resulting from option introduction, while simultaneously controlling for endogenous stock characteristics and alternate effects.

I find evidence broadly supportive of the Diamond and Verrecchia (1987) hypothesis that option introduction reduces short sale constraints. To proxy for short sale loan supply I use institutional ownership, as institutional investors in long positions provide the majority of shares for short sale loans (D'Avolio, 2002).[4] In support of Hypothesis 1, I find that the greater average stock price adjustment efficiency of optioned stocks documented in the extant literature is driven entirely by short sale constrained stocks. Only stocks with very low institutional ownership (institutional ownership of 0%), for which short sale constraints are most likely binding, realize a significant post option improvement in the speed of adjustment.

In support of Hypothesis 2, I find that the post option improvement in adjustment efficiency for short sale constrained stocks is limited to negative news. Specifically, while these stocks see a significant post option improvement in the speed of adjustment to negative news, there is no significant improvement in the speed of adjustment to positive news. To my knowledge, this is the first paper to report this result. Prior to option introduction, short sale constrained stocks adjust to negative news 19% slower than unconstrained stocks. Following option introduction that difference is reduced to 3%, indicating that option introduction eliminates 84% of the disparity in efficiency between short sale constrained and unconstrained stocks. Collectively, the results in this paper

[4]Institutional ownership is defined as percentage of total shares outstanding held by institutional investors.

provide strong evidence that option introduction materially reduces the effects of short sale constraints by improving informational efficiency in the stock market.

The remainder of this article is organized as follows. Section I reviews the related literature in more detail. Section II describes the sample utilized in the article. Section III analyzes the effect of option introduction on the speed of stock price adjustment in a general context. Section IV analyzes the separate effect of option introduction on stock price adjustment to negative relative to positive information and Section VI concludes the article.

I. Related Literature

This article relates to two bodies of research: (1) the effect of option introduction on short sale constraints and (2) the effect of options on price adjustment of the underlying stock. Subsection A reviews the extant empirical results related to option introduction and short sale constraints. Subsection B describes the process by which option introduction may affect the efficiency of stock price adjustment.

A. *Option Introduction and Short Sale Constraints*

Empirical work testing the effect of option introduction on short sale constraints can be characterized as following four different approaches. First, several authors have investigated the change in short interest following option introduction. If option book makers face lower short selling constraints than the average investor, option introduction may result in increased short interest as option book makers hedge synthetic short positions taken by individual investors in the option market. In support of this hypothesis, Damodaran and Lim (1992), Danielsen and Sorescu

(2001) and Figlewski and Webb (1993) all find short interest increases following option introduction.

Second, Mayhew and Mihov (2005) investigate option trading volume following option introduction. If option introduction eases short sale constraints, a positive correlation would be expected between bearish, high option trading volume and the severity of short sale constraints as pessimistic investors take synthetic short positions. After examining nine proxies for short sale constraints, either no relationship or a significantly negative relationship between short sale constraint proxies and option trading volume was found. While this finding lends little support to the Diamond and Verrecchia (1987) hypothesis, it is possible that the option market contributes to the price discovery of the underlying stock via other mechanisms (other than trading volume). For example, Chan et al. (2002) examine the intraday interdependence of order flows and price movements for actively traded New York Stock Exchange (NYSE) stocks and Chicago Board Options Exchange (CBOE) traded options. Their findings indicate that while information in the stock market is contained in both quote revisions and in net trade volume[5], information in the option market is contained only in quote revisions.

Third, researchers have examined return behavior following option introduction. If option introduction reduces short sale constraints, it would be expected to be predictive of negative abnormal returns as historical negative information withheld from the market is impounded in stock prices. Using the value weighted market index as a reference portfolio, Sorescu (2000) and Danielsen and Sorescu (2001) find for options listed from 1980 to 1995 the underlying stock experiences negative abnormal returns following option introduction. Mayhew and Mihov (2005) undertake the same analysis using a control sample of non-optioned stocks which have similar characteristics to those selected for option introduction. The control portfolio is found to exhibit

[5] Buyer initiated trading volume minus seller initiated trading volume.

similar negative abnormal returns, suggesting that the relationship between option introduction and negative abnormal returns may be spurious and more a result of stock characteristics at the time of option listing.

Fourth, the approach of this paper and other authors has been to investigate the efficiency by which negative and positive information is incorporated into stock prices following option introduction. Several authors have investigated the general (unrelated to option introduction) effect of short sale constraints on stock price adjustment efficiency. For example, Nagel (2005) reports that stocks with low institutional ownership (short sale constrained) tend to over-react to positive cash flow news and under-react to negative cash flow news. Reed (2003) finds that stocks with low rebate rates (low short sale loan supply) have larger reactions to positive earnings announcements and the incorporation of information into stock prices is slower when short selling is constrained. Greenwood (2006) examines corporate events in Japan in which firms reduce their float, inducing short sale constraints. Consistent with the theory that short sale constraints freeze out pessimistic investors, stock prices rise (fall) when float is contracted (released).

Focusing on the effects of the existence of options, Damodaran and Lim (1992) examine stock return processes following option introduction, focusing on mean reversion and skewness. Using a sample of 200 firms with option introduction from 1977-1984, they conduct an event study of cumulative abnormal returns over the 20 days surrounding earnings announcements before and after option introduction. They find that, following option introduction, a greater amount of the information related to earnings announcement shocks is impounded in stock prices in the ten days prior to earnings announcements and that prices adjust more quickly to negative earnings shocks after option introduction. They interpret these results as supportive of the hypothesis that easing of short sale constraints allows stock prices to adjust more rapidly to negative information.

As shown by Mayhew and Mihov (2005), a viable alternative hypothesis is that endogenous stock characteristics common at the time of option introduction contribute to faster incorporation of negative information into stock prices. I extend the work of Damodaran and Lim (1992) by controlling for endogenous stock characteristics utilizing the control methodology specified by Mayhew and Mihov (2004). Further, I utilize a much larger sample (1732 firms) over a longer time frame (1981 – 1997) to test for a direct relation between improved post option price adjustment and short sale constraints.

More recently, Bris et al. (2007) complete cross-sectional and time series tests of the effect of short sale restrictions on the efficiency of 46 equity markets around the world. They find evidence that in markets where short selling is prohibited, or not practiced, market returns display significantly less negative skewness, demonstrating that the reaction to negative new information is muted in those markets. Using a dummy variable which equals one when put options are feasible in a given market and is otherwise zero, they find that put options have no significant effect on market efficiency in the presence of short selling restrictions.

I contribute to and extend the findings of Bris et al. (2007) in two fundamental ways. First, Bris et al. utilize weekly return data to construct two measures of market efficiency, one which measures the response of stock returns to contemporaneous market and world index returns and a second which measures cross autocorrelations between market returns lagged one week and stock returns. This article employs a stock price adjustment model which allows the utilization of daily data with multiple lags to assess differences in the rate in which negative and positive information are impounded in stock prices. Using Akaike's and Schwarz's information criterion, I estimate that over 75% of stocks in the test sample adjust to negative news within 5 days. Thus, the model utilized in this paper is able to detect improvements in stock price adjustment potentially overlooked when utilizing weekly data. Second, Bris et al. (2007) calculate average adjustment efficiencies by country and then evaluate the significance of the existence of put options in the presence of short selling restrictions at the country level. In contrast, I investigate the effect of option introduction at the stock level in the U.S. stock market allowing a more direct analysis.

B. Option Introduction and the Speed of Stock Price Adjustment

Option introduction has the potential to improve the speed of stock price adjustment to new information via three unique mechanisms. First, on average, option introduction reduces the bid-ask spread of the underlying equity (Fedenia and Grammatikos, 1992), thereby reducing transaction costs and the magnitude of disparity between stock price and the perceived value necessary to trigger trading. Thus, smaller magnitude information events should be incorporated into stock prices more rapidly following option introduction.

Second, the option exchange provides an alternative venue by which private information and pessimistic opinions may be made public and contribute to price discovery of the underlying stock. In a general context, investors with access to private information can choose to trade on either the stock or option market. On average, Chakravarty et al. (2004) find the option market contribution to price discovery to be approximately 17%. In the context of option introduction for a short sale constrained stock, informed investors with negative information who wish to short the stock are forced to trade on the option market. Thus, the expected contribution of the option market in that context would likely be higher.

Third, as pessimistic investors take synthetic short positions on the option market, the option book maker presumably hedges his exposure via short selling, placing downward price pressure on the underlying stock. The obvious question becomes how the option book maker is able to hedge his position via short sales, when the pessimistic investor is not? For several reasons, the option book maker has access to short sale loan supply not available to the average investor.

First, transaction costs related to short selling can vary across agents depending on trading volume and frequency. In a typical short sale contract, the short seller borrows the shares from his broker and the proceeds of the sale guarantee the loan and generate interest. The broker returns a portion of the interest to the short seller at the conclusion of the contract, known as the rebate rate. Where loan demand exceeds loan supply, rebate rates may become negative, indicating the borrower pays a fee to the lender for the opportunity to borrow the stock. In support of Miller's 1977 theory, stocks with negative rebate rates (high loan demand) tend to under perform in the future, indicating over pricing (Jones and Lamont, 2002). Brokers vary rebate rates and share availability preferentially across clients, with high volume customers receiving more favorable treatment (Evans et al., 2003). Thus, short sales for low loan supply (negative rebate rate) stocks may be impossible or prohibitively costly for the average investor relative to high volume borrowers, such as option book makers.

Second, exchange rules require most market participants to demonstrate they are able to borrow low rebate rate stocks prior to short selling (Evans et al., 2003). Market book makers are exempt from this requirement by NASD rule 3370. If unable to locate shares following initiation of the short sale, the book maker has the additional option to fail to deliver. Once the book maker fails to deliver, one of two scenarios occur. The buyer's broker may allow the failure to deliver to continue as long as the short sale contract is open. In this situation the consequence of failing to deliver is forgoing the interest on the proceeds of the sale but the short position is effectively maintained without delivery (Evans et al., 2003). Alternatively, the buyer's broker may insist on delivery and file a notice of intention to buy-in, in which case the short seller has two days to deliver the shares or the buyer purchases the shares on the short seller's account (Evans et al., 2003). In the event of a buy-in, the market maker must short sell again to re-establish the position, incurring execution costs plus the difference between the buy-in and market price. Utilizing a two year database of short sale transaction data for 1998 and 1999, Evans et al. (2003) find buy-ins occur in only 0.12% of failures to deliver. Thus, exchange rules give option book makers a regulatory advantage which allows them to short sell without actually borrowing stock.

II. Sample Description

A. Test Sample

Included in the test sample are all stocks for which an option was introduced from January 1981 through January 1997 as used in Mayhew and Mihov (2004). The original Mayhew and Mihov dataset was provided by the CBOE and includes all option introductions on the CBOE, the American, Philadelphia, Midwest and Pacific Stock Exchanges from January 1973 – January 1997.

As a proxy for short sale constraints I use institutional ownership measured in terms of shares held.[6] Intuitively, investors in large, long positions would be best suited to fulfill the supply side of short sale loan transactions. In support of this hypothesis, D'Avolio (2002) documents that institutional investors provide the majority of stock loan supply for short selling.[7] Institutional ownership data are obtained from the Shareworld 13F Filing database as maintained by Thomson Financial. The Shareworld 13F database tracks, by quarter, the share holdings of institutional investors based on 13F filings made with the U.S. Securities and Exchange Commission. Any manager with more than $100 million at their discretion is required to make a quarterly filing of a 13F for every security holding in excess of $200,000 or 10,000 shares. Additionally, the Shareworld 13F database tracks ownership profiles of non-U.S. equities based on the Information Sheets and

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[6] Results are robust to an alternative specification using the number of institutional owners instead of shares held.

[7] Following research by Nagel (2005), Asquith et al. (2005), Chen et al. (2002) and others it is widely held that institutional ownership is an effective proxy for short sale constraints.

Shareholder Reports of both Domestic and Foreign Mutual Funds. The institutions represented in Shareworld include mutual funds, banks, insurance firms, and pension funds. At the time of dataset construction, the Shareworld database tracked 13F filings from 1980 through 2005. As stock and return characteristics one year before and after option introduction are desired, all option introductions prior to 1981 are excluded. Additionally, stocks for which the option delisted within one year of introduction are also excluded (108 stocks).

Figure 1 presents mean quarterly institutional ownership for the test sample one year pre and post option introduction. Through the four quarters preceding option introduction, mean institutional ownership steadily increases from a level of 27% to 33% of total shares outstanding. The average number of institutional investors holding shares in each stock experiences a similar increase over the same timeframe.

[Insert Figure 1 approximately here]

Stocks under consideration for option listing are known only to the members of the board of the option exchange and option introduction announcements are made public the day prior to the initiation of trading. Given the timing of option introduction announcements, the increase in institutional ownership prior to option introduction does not reflect a desire for institutions to hold stocks that eventually have traded options. Mayhew and Mihov (2004) document that option exchanges tend to select stocks with high volatility, trading volume and name recognition when determining new listings. The increase in institutional ownership preceding option introduction reflects that institutional investors are attracted to a similar set of stock characteristics.

Panel A of Table I presents summary statistics for the test sample at the time of option introduction. The mean and median stock prices[8] at the time of option introduction are $26.45 and $23.25 respectively. On average, stocks in the test sample trade 120,000 shares per day, which represents a turnover of 0.7% of total shares outstanding (annualized turnover ratio of 1.75). Mean market capitalization is $805 million but the mean is biased upwards by several high market capitalization stocks, reflected by the median market capitalization value of $470 million. Stocks within the sample tend to attract moderate institutional interest, with average institutional ownership of 33% of total shares outstanding.

[Insert Table 1 approximately here]

B. Control Sample

Unlike stock exchanges, the decision to list an option is made at the discretion of the board of the option exchange (CBOE, 2007). Assuming the primary motivation of an option exchange is to maximize the long term profitability of the exchange, the board will select stocks which are likely to generate the largest, long term trading volume (Mayhew and Mihov, 2004). Mayhew and Mihov (2004) find that stocks with high market capitalization, trading volume and volatility are favored for option listing. Thus, the non-random selection process of option exchanges introduces potential endogeneity biases which must be controlled for in option introduction event studies.

To construct the control sample I utilize the methodology developed by Mayhew and Mihov (2004). Using the same base option introduction dataset from the CBOE as used to construct the

[8] Stock price, volume and shares outstanding data were obtained from the Center for Research in Security Prices database.

test sample, Mayhew and Mihov estimate a logit model on pooled monthly observations for all stocks classified as eligible for option listing but not yet optioned,

$$L(LIST) = \beta_0 + \beta_1 VOL + \beta_2 STD + \beta_3 ABVOL + \beta_4 ABSTD + \beta_5 Size + \varepsilon \tag{1}$$

where L(LIST) is the log-odds ratio that a stock will be selected for option listing. VOL is the average daily trading volume over the 250 trading days prior to the 15^{th} of the month. STD is the annualized standard deviation of log returns over the same interval. ABVOL is the ratio of 30 day to 250 day average daily trading volume, ABSTD is the analogous measure for standard deviation and SIZE is the market capitalization of the firm in constant 1996 dollars. Mayhew and Mihov report time varying, standardized coefficients for the model which I then utilize for development of a control data set of non-optioned stocks with a high likelihood of future option introduction.[9]

To develop the pool of potential control stocks, from the universe of stocks tracked by the Center for Research in Security Prices (CRSP), I remove all stocks for which option trading was introduced from January 1973 – January 1997. For the purposes of development of the control sample, VOL is calculated as the average trading volume over the 250 days prior to option introduction. STD is calculated as the annualized standard deviation of log returns over the same interval. ABVOL and ABSTD are calculated in an analogous manner to Mayhew and Mihov (2004) and SIZE is calculated as market capitalization the day prior to option introduction. Utilizing the option introduction date for each stock, these five sorting variables are compiled for all stocks in the control pool which were actively traded one year before and after option introduction.

[9] An excerpt from Table 2 of Mayhew and Mihov (2004) which summarizes the standardized coefficient values for the logit model appears in Appendix A.

Utilizing the time span specific coefficients from the Mayhew and Mihov (2004) model (setting $\beta_0 = 0$), the log-odds likelihood ratio of future option introduction was estimated. As institutional ownership is used as the proxy for short sale constraints, it is desirable for the control sample to have a distribution of ownership similar to the test sample. Thus, from the ten stocks with the highest likelihood of future option introduction, the stock which matched the corresponding test sample stock most closely on institutional ownership is selected for the control sample. Each stock selected for inclusion in the control sample is removed from the universe of potential control stocks for subsequent matching exercises. The end result of the process is the construction of a control sample of 1732 stocks, each matched to a specific stock in the test sample based on weighted volume, abnormal volume, volatility, abnormal volatility, size and institutional ownership.

III. Option Introduction and Stock Price Adjustment Efficiency

The first question of my analysis examines whether option introduction contributes to the relaxation of short sale constraints. Diamond and Verrecchia (1987) argue that by excluding pessimistic investor's negative stock value opinions from the stock market, short sale constraints impeded the speed which information is impounded into stock prices. As argued earlier, option introduction has the potential to influence the efficiency of the underlying stock price via any of three mechanisms: 1) improved liquidity, 2) the provision of an alternative trading venue which contributes to price discovery, and 3) the hedging activity of the option book maker as investors take synthetic short positions. Improvements in stock price efficiency related to the first channel would be expected to be most pronounced for small, illiquid stocks with higher relative pre option bid-ask spreads.

In relation to channel two, Anand and Chakravarty (2003) find evidence of what they term "stealth trading" where informed traders fragment their trades by alternating medium sized trades between the option and stock market in an effort to hide the value of their private information. Post option introduction, private information would be expected to become public more rapidly for stocks with low stock market liquidity as stealth traders utilize the liquidity of the option market to realize their desired position.

Finally via channel three, improvements in stock price adjustment efficiency would be expected to be most pronounced for short sale constrained stocks (proxied by low institutional ownership). In general support of these conjectures, Jennings and Starks (1986) and Skinner (1990) show that, on average, optioned stocks adjust more rapidly to new information. Motivated by this literature I hypothesize that option introduction will mitigate short sale constraints and contribute to improvement in stock price adjustment efficiency for low institutional ownership stocks:

> ***Hypothesis 1****: As short sale constraints are relaxed, post option improvements in the speed of stock price adjustment should be greatest for small (low float), illiquid stocks with low short sale loan supply for which short sale constraints are most likely binding.*

A. Speed of Stock Price Adjustment Measures

To measure the speed which new information is impounded in stock prices I utilize the stock price adjustment delay measures developed by Hou and Moskowitz (2005)[10]. In the full model,

[10] An additional proxy for efficiency commonly used is the R^2 of the market model regression, for example see Morck, Yeung and Yu (2000), Durnev, Morck and Yeung (2004) and Bris, Goetzmann and Zhu (2006). Saffi and Sigurdsson (2007) find that stocks in the upper decile of lending supply have R^2 values 60% greater than stocks is the lower decile. These results are consistent with those of Kelly (2005), Hou, Peng and Xiong (2006) and Yang and Zhang (2006). From

close–close returns are regressed on contemporaneous and lagged market returns. The R^2 and coefficient values of the lagged model are then contrasted to the base model values, which includes only contemporaneous market returns. In this model, the market return[11] is utilized as a proxy for the new information to which individual stock prices respond.

$$r_{j,t} = \alpha_j + \beta_j^0 R_{m,t} + \varepsilon_{j,t} \qquad \textbf{\textit{(base model)}} \tag{2}$$

$$r_{j,t} = \alpha_j + \beta_j^0 R_{m,t} + \sum_{n=1}^{5} \beta_j^n R_{m,t-n} + \varepsilon_{j,t} \qquad \textbf{\textit{(full model)}} \tag{3}$$

Here $r_{j,t}$ is the return of stock *j* on day *t*, $R_{m,t}$ is the market return on day *t* and $R_{m,t-n}$ is the market return *n* days prior to day *t*. In the full model, if the stock responds immediately to new information, β_j^0 will be significantly different from zero, but none of the β_j^n will differ significantly from zero. On the other hand, if the response is delayed β_j^0 will be less significant or insignificant and some or all of the β_j^n will be significantly different than zero.

Using Akaike's and Schwarz's information criterion (AIC and SIC respectively) the goodness of fit of the full model is optimized with the inclusion of five lags for 77% (using AIC) and 96% (using SIC) of the test sample stocks. Further optimization of AIC and SIC values for the remainder

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these results Saffii and Sigurdsson (2007) conclude that short sale constraints affect R^2s in the opposite direction to that caused by increases in corporate efficiency. Based on the contradictory interpretations of the market model R^2 measure in the context of short sales I elect not to include it as an efficiency measure in this article.

[11] The Equal Weighted Index Return (excluding distributions), as maintained on the Center for Research in Security Prices database, was utilized as a proxy for market return.

of the stocks requires the inclusion of 6 or more additional lags. Five lags are selected to optimize the AIC / SIC values for the majority of stocks in the sample[12].

The first delay measure, the R^2 Ratio, measures the proportional difference between the explanatory power of contemporaneous versus lagged market returns to predict stock returns.

$$D_{rsq} = 1 - \frac{R^2_{base}}{R^2_{full}} \tag{4}$$

The faster new information is incorporated into individual stock prices, the smaller the difference between the R^2 of the full model and the base model, as lagged market returns add little by the way of explanatory power. Thus, as the speed of stock price adjustment increases the D_{rsq} delay measure decreases.

The second delay measure, the Coefficient Ratio, measures the ratio of the lag weighted sum of the lagged market return coefficients relative to the sum of all the regression coefficients. Similar to the R^2 Ratio delay measure, the greater the delay in stock price adjustment, the larger the lagged regression coefficients and the larger the D_{sum} delay measure.

$$D_{sum} = \frac{\sum_{n=1}^{5} n(abs(\beta_j^n))}{abs(\beta_j^0) + \sum_{n=1}^{5} abs(\beta_j^n)} \tag{5}$$

The third delay measure, the Standard Error Adjusted Coefficient Ratio, augments the Coefficient Ratio measure by weighting each coefficient by its standard error. Thus the significance of each coefficient is considered, whereas the raw Coefficient Ratio only considers the magnitude of the regression coefficients.

[12] Results are robust when replicated with the inclusion of 10 or 15 lags in the model.

$$D_{se} = \frac{\sum_{n=1}^{5} \frac{n(abs(\beta_j^n))}{se(\beta_j^n)}}{\frac{abs(\beta_j^0)}{se(\beta_j^0)} + \sum_{n=1}^{5} \frac{abs(\beta_j^n)}{se(\beta_j^n)}} \tag{6}$$

B. Univariate Analysis

As the correlation between the D_{sum} and D_{se} delay measures is in excess of 0.9 in both the pre and post option periods across all models, in the interest of brevity, only D_{rsq} and D_{se} values are reported for each model throughout the article. The D_{sum} values are available upon request. Panel A of Table III presents the mean D_{rsq} and D_{se} values for the pre option introduction period, sorted by institutional ownership (the short sale constraint proxy) to capture cross-sectional variation across short sale constraint levels. D'Avolio (2002) and Asquith et al. (2005) document that short sale constraints likely apply only to a small proportion of the market, generally small, illiquid stocks with very low institutional ownership. Based on these findings, the stocks in the test sample are sorted into three groupings: low (0 %), moderate (0.1 – 50.0 %) and high (> 50.0 %) institutional ownership. The post option change in the speed of stock price adjustment is calculated as the difference in the delay measures calculated over the year preceding and following option introduction. A decrease in either delay measure indicates a decrease in the power of lagged market returns to explain stock returns which suggests an improvement in the speed of stock price adjustment.

[Insert Panel A of Table III approximately here]

Hypothesis 1 predicts that post option improvements in the speed of adjustment will be greatest for small, illiquid and short sale constrained stocks. Based on this prediction, stocks in the low institutional ownership grouping, for which short sale constraints are most likely binding, should have the highest pre option delay measures and should realize the largest improvements in stock price efficiency ($\Delta D < 0$). Further, this improvement should be isolated to the test sample, as the control sample, having not undergone option introduction should not realize any significant improvement in stock price efficiency.

In support of Hypothesis 1, only stocks in the test sample, with low institutional ownership levels (0 %) realize significant post option improvement in the speed of adjustment. As institutional ownership increases across groupings, the speed of adjustment improves in the pre option introduction period, potentially due to reduced short sale constraint levels. Prior to option introduction, stocks in the highest institutional ownership category (>50%) on average adjust to new information 26% faster than stocks with 0% institutional ownership (based on the D_{rsq} pre measure).

C. Multivariate Analysis

As determinants of stock price adjustment efficiency, I use institutional ownership (INST), the change in institutional ownership (ΔINST), book to market (BK/MK), turnover (TURN), illiquidity (ILLIQUIDITY), size (SIZE) and the standard deviation of stock returns (VOLATILITY)[13]. INST is the percentage of total shares outstanding held in aggregate by institutional investors in the option introduction quarter. For regression models which focus on the pre option introduction period, ΔINST is the change in institutional ownership the four quarters preceding option introduction. Likewise for regression models that contrast stock characteristics pre and post option introduction, ΔINST is the change in institutional ownership between four quarters before to four quarters after

[13] The selected determinants of stock price adjustment are similar to those used in Hou and Moskowitz (2005) and variables found to influence short sale constraint levels in Nagel (2005). They are also consistent with variables found by Mayhew and Mihov (2004) to predict option introduction likelihood.

option introduction. BK/MK is book value[14] in the year of option introduction divided by market capitalization the day before option introduction. TURN is the mean daily turnover[15] over the year preceding option introduction. ILLIQUIDITY is the average weekly Amihud Illiquidity Ratio (Amihud, 2002) over the year preceding option introduction:

$$IR_d = \frac{|r_d|}{Volume_d} \tag{7}$$

where r_d is the close-close weekly return and $Volume_d$ is the dollar value of aggregate weekly volume[16], both in week *d*. SIZE is market capitalization the day prior to option introduction. VOLATILITY is the standard deviation of daily stock returns over the year preceding option introduction.

Table II presents the correlation matrix for the independent variables used in the speed of stock price adjustment models. Correlation levels are generally below 0.20, with the exception of the correlation between return volatility and turnover (0.56) and between return volatility and size (-0.48). These correlations are intuitive: high volatility stocks tend to be small (low market capitalization) with high turnover.

[14] Book value, obtained from the Compustat database, is defined as common equity plus balance sheet deferred taxes. Book value data could not be located for 13 stocks. For those stocks, book value / market value was set to the average of the test sample. Findings are robust if those 13 stocks are excluded from the sample.

[15] Calculated as daily trading volume divided by shares outstanding.

[16] Weekly returns and aggregate volume are used as opposed to daily values to control for downward bias in the Amihud illiquidity measure which potentially result from thin trading. Results are robust if daily volume and return data is used instead.

[Insert Table II approximately here]

Panel B of Table III presents the cross-sectional regression results for the full model, which allows a more formal analysis of general patterns in the speed of stock price adjustment. The table reports coefficient values for each variable with t-statistic values included in parentheses below the coefficient values. Coefficients significant at conventional levels (α=0.05) are reported in bold face.

[Insert Panel B of Table III approximately here]

Hou and Moskowitz (2005) document that high delay firms tend to be small, volatile and less visible stocks potentially overlooked or neglected by investors. Intuitively, stocks for which prices adjust rapidly will be characterized by a large, active investor base which is able to quickly evaluate and trade on new information and vice versa. I find results consistent with this conjecture. In the pre option introduction period, across both speed of adjustment measures (D_{rsq} and D_{se}), large stocks with high institutional ownership and turnover (negative coefficient values for INST, TURN and SIZE) and low volatility and illiquidity (positive coefficient values for VOLATILITY and ILLIQUIDITY) tend to be stocks with high price adjustment efficiency (low D_{rsq} and D_{se} values). These relations hold within the control sample. Focusing on the D_{se} measure for the test sample in the pre option period, the relations between stock price adjustment efficiency and institutional ownership (t-stat 3.35), size (t-stat 5.72), and illiquidity (t-stat 5.82) are all statistically significant at conventional levels.

The primary test of Hypothesis 1 is conducted by examining the change in stock price adjustment efficiency following option introduction. As short sale constraints are relaxed, new information is expected to be incorporated into stock prices more rapidly, resulting in a reduction in the delay measures (i.e. a negative ΔD). As short sale constraints are most binding for low institutional ownership stocks, a positive coefficient value is expected on INST. Focusing on the ΔD_{se} measure in Panel B of Table III, the relation between the improvement in the speed of stock price adjustment and institutional ownership is positive and significant at conventional levels (t-stat 2.28)[17]. This relation is mirrored in the ΔD_{rsq} delay measure but with reduced significance (t-stat 1.77, significant with $\alpha=0.10$). Note that post option improvements in the speed of stock price adjustment should be greatest in response to negative news. As the full model evaluates the adjustment to both positive and negative news, the relation between adjustment delay and institutional ownership is likely muted in the full model resulting in reduced significance in the D_{rsq} measure. When this model is refined to allow separate responses to positive and negative news the inferences become sharper and significance improves in relation to the D_{rsq} delay measure.

Turning to the control sample results, the INST coefficient in both model 3 and 4 is insignificant at conventional levels, suggesting that the improvement in the speed of stock price adjustment is not focused within a particular institutional ownership level (notably, short sale constrained, low institutional ownership stocks). The overall control sample results support the conclusion that the improvement in adjustment efficiency realized for short sale constrained stocks in the test sample is related to option introduction and not other factors. Overall, the full model regression results are supportive of Hypothesis 1 and demonstrate that the average greater stock price adjustment efficiency of option stocks as documented by Jennings and Starks (1986) and Skinner (1990) is confined to short sale constrained stocks.

[17] This finding is robust to the use of an institutional ownership dummy (equal to 1 if institutional ownership is equal to 0% and otherwise equal to zero) in place of the continuous institutional ownership variable (INST) (t-stat 2.78).

IV. Option Introduction and the Speed of Stock Price Adjustment to Negative News

The second question I examine is whether the post option improvement in adjustment efficiency for short sale constrained stocks documented in Section III is greater for negative or positive information events. For stocks with ample liquidity and stock loan supply for short sales the predicted effect of option introduction on stock price adjustment efficiency would be symmetric between positive and negative information. In contrast, as short sale constraints impede only negative information from being impounded in stock prices, post option improvements in stock price efficiency should be greater in response to negative relative to positive information. Based on these conjectures, I hypothesize:

Hypothesis 2*: As short sale constraints impede the rate which negative information is impounded in stock prices, post option improvement in the speed of stock price adjustment for short sale constrained stocks should be greater when responding to negative relative to positive information.*

A. Speed of Stock Price Adjustment Measures

To allow separate quantification of the speed of adjustment to negative and positive news, I augment the full model with a negative news interaction dummy variable.

$$r_{j,t} = \alpha_j + \beta_j^0 R_{m,t} + \beta_j^{-d0} D_j^0 R_{m,t} + \sum_{n=1}^{5} \beta_j^n R_{m,t-n} + \sum_{n=1}^{5} \beta_j^{-dn} D_j^n R_{m,t-n} + \varepsilon_{j,t} \quad \textbf{\textit{(full-neg model)}} \qquad (8)$$

D_j^0 is set to 1 if the contemporaneous market return is negative, otherwise it is equal to zero. Likewise, each D_j^n is equal to 1 if the market return for that specific lag is negative, otherwise it is equal to zero. Within the full-neg model, the β_j^n coefficients reflect the relation between stock returns and lagged positive market returns while the β_j^{-dn} coefficients reflect the incremental effects of lagged negative market returns.

The measures described in Section III are used to quantify the speed of stock price adjustment to negative and positive information. D_{rsq}^{neg} is calculated as the R^2 Ratio of the full-neg model relative to the full model.

$$D_{rsq}^{neg} = 1 - \frac{R_{full}^2}{R_{full-neg}^2} \tag{9}$$

Higher values of D_{rsq}^{neg} reflect a greater delay in the speed of price adjustment to negative new information. D_{sum}^{neg} and D_{se}^{neg} ,which contrast the β_j^{-dn} coefficients to β_j^0 in the full-neg model, are additional measures of the price delay related to negative market wide news:

$$D_{sum}^{neg} = \frac{\sum_{n=1}^{5} n(abs(\beta_j^{-dn}))}{abs(\beta_j^0) + abs(\beta_j^{-d0}) + \sum_{n=1}^{5} abs(\beta_j^n) + \sum_{n=1}^{5} abs(\beta_j^{-dn})} \tag{10}$$

$$D_{se}^{neg} = \frac{\sum_{n=1}^{5} \frac{n(abs(\beta_j^{-dn}))}{se(\beta_j^{-dn})}}{\frac{abs(\beta_j^0)}{se(\beta_j^0)} + \frac{abs(\beta^{-d0}{}_j)}{se(\beta_j^{-d0})} + \sum_{n=1}^{5} \frac{abs(\beta_j^n)}{se(\beta_j^n)} + \sum_{n=1}^{5} \frac{abs(\beta_j^{-dn})}{se(\beta_j^{-dn})}} \tag{11}$$

To quantify the speed of stock price adjustment related to positive (rather than negative) market news D_{sum}^{pos} and D_{se}^{pos} are calculated as the ratio between the β_j^n coefficients relative to the β_j^0 coefficient in the full-neg model. However, given that the positive and negative interaction effects have an identical effect on R^2, D_{rsq}^{pos} is non-informative in this context.

$$D_{sum}^{pos} = \frac{\sum_{n=1}^{5} n(abs(\beta_j^n))}{abs(\beta_j^0) + \sum_{n=1}^{5} abs(\beta_j^n)} \tag{12}$$

$$D_{se}^{pos} = \frac{\sum_{n=1}^{5} \frac{n(abs(\beta_j^n))}{se(\beta_j^n)}}{\frac{abs(\beta_j^0)}{se(\beta_j^0)} + \sum_{n=1}^{5} \frac{abs(\beta_j^n)}{se(\beta_j^n)}} \tag{13}$$

B. Univariate Analysis

Panel A of Table IV reports mean D_{rsq}^{neg} and D_{se}^{neg} values for the pre option introduction period, sorted by institutional ownership.

[Insert Panel A of Table IV approximately here]

As an extension of the predictions of Hypothesis 1, stocks in the low institutional ownership grouping for which short sale constraints bind should have the highest pre option delay measures and should realize the largest relative improvements in adjustment efficiency (ΔD_{rsq}^{neg} <0). Further, this improvement should be isolated to the test sample, as the control sample not having undergone option introduction, should not realize any improvement in stock price adjustment efficiency. In support of this hypothesis and consistent with the findings of Section III, only stocks in the test sample with low institutional ownership levels (0%) realize significant post option improvements in the speed of adjustment to negative information. Based on pre option introduction D_{rsq}^{neg} values, stocks in the highest ownership group (>50%) on average adjust to negative news 19% faster than stocks in the 0% ownership group.

C. Multivariate Analysis

Panel B of Table IV presents the cross-sectional regression results related to the full-neg model. The table reports coefficient values for each variable with t-statistic values included in parentheses below the coefficient values. Coefficients significant at conventional levels (α=0.05) are reported in bold face.

[Insert Panel B of Table IV approximately here]

To verify the findings of Section III in models 1, 2 and 5 I regress pre option, negative and positive stock price efficiency measures on stock price adjustment determinants. Consistent with those findings, stocks with high delays in adjustment to negative and positive information tend to be small, with low institutional ownership and turnover, and high illiquidity and volatility.

Hypothesis 2 predicts that post option improvements in stock price adjustment efficiency should be greatest for short sale constrained stocks responding to negative relative to positive news. Based on this prediction, a positive and significant relation is expected between the improvement in the speed of stock price adjustment to negative news ($\Delta D_{rsq}^{neg} < 0$ in model 3 and $\Delta D_{se}^{neg} < 0$ in model 4) and institutional ownership (INST). Further, the relation between institutional ownership and the improvement in stock price adjustment efficiency for positive news ($\Delta\ D_{se}^{pos}$) should be insignificant (model 6). In support of these predictions, short sale constrained stocks experience a significant (t-stat 2.28) improvement in the speed of stock price adjustment to negative news following option introduction (positive coefficient value for INST variable)[18]. This relationship is mirrored in the $\Delta\ D_{se}^{neg}$ adjustment efficiency measure (t-stat 2.28). In further support of Hypothesis 2, the relationship between the change in the speed of stock price adjustment to positive information ($\Delta\ D_{se}^{pos}$) and short sale constraints (proxied by institutional ownership) is insignificant at conventional levels (t-stat 1.03). Thus, following option introduction only short sale constrained stocks responding to negative news realize significant improvements in adjustment efficiency. Turning to the control sample results, the INST coefficient in both model 3 and 4 is insignificant at conventional levels. These results support the conclusion that the improvement is adjustment efficiency realized for short sale constrained stocks in the test sample is causally related to option introduction and not another factor.

To summarize these results, in support of Hypothesis 1, the post option improvement in stock price adjustment efficiency is confined to small, illiquid stocks with high short sale constraint levels. As predicted by Hypothesis 2, the improvement in adjustment efficiency is further confined to short sale constrained stocks responding only to negative information. The speed of stock price adjustment to positive news in unaffected by option introduction across all short sale constraint levels. These results broadly support the Diamond and Verrecchia (1987) hypothesis that option introduction reduces short sale constraints and contributes to improved stock market informational efficiency. To gauge the significance of these findings, prior to option introduction short sale

[18] This finding is robust to the use of an institutional ownership dummy (equal to 1 if institutional ownership is equal to 0% and otherwise equal to zero) in place of the continuous institutional ownership variable (INST) (t-stat 2.27).

constrained stocks (0% institutional ownership) adjust to negative information 19% slower than unconstrained stocks (> 50% institutional ownership). Post option introduction, this difference is reduced to 3% demonstrating that option introduction eliminates 84% of the negative information efficiency gap between short sale constrained and unconstrained stocks.

V. Conclusion

When short sale constraints bind, pessimistic investors who do not own the stock are constrained from trading on their bearish value opinions resulting in negative information being withheld from the market. Diamond and Verrecchia (1987) argue that option introduction provides an alternative venue for pessimistic investors to realize a synthetic short position, circumventing short sale constraints and improving the speed which negative information is made public.

Motivated by the predictions of the Diamond and Verrecchia (1987) model, I test two hypotheses: (1) the post option improvement in stock price adjustment efficiency should be greatest for short sale constrained stocks and (2) as short sale constraints impede only negative information from being impounded in stock prices, post option improvement in stock price efficiency should be greater in respect to negative relative to positive information.

I find results consistent with these expectations. Following option listing, the improvement in the speed of stock price adjustment is isolated to short sale constrained stocks (0% institutional ownership). Second, a significant improvement in the speed of stock price adjustment is realized only for short sale constrained stocks which are responding to negative news. No significant effect of option introduction on stock price adjustment efficiency is found for stocks responding to positive new information, across all short sale constraint levels. Prior to option introduction, I find that short sale constrained stocks (0% institutional ownership) adjust to negative information 19% slower than unconstrained stocks (> 50% institutional ownership). Following option introduction that difference is reduced to 3%, indicating option introduction eliminates 84% of the price efficiency disparity between short sale constrained and unconstrained stocks. Collectively, the results in this article provide strong evidence that option introduction reduces short sale constraints in a significant manner, improving informational efficiency in the stock market.

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Appendix A

Summarized from Table II of Mayhew and Mihov (2004)

Determinants of Option Listing

This table summarizes the standardized coefficient estimates of the logit model of option listing as a function of characteristics of the underlying stock. VOL is the average daily trading volume over the 250 trading days prior to the 15th of the month. STD is the annualized standard deviation of the log returns over the same interval. ABVOL is the ratio of 30 day to 250 day average daily trading volume, ABSTD is the analogous measure for standard deviation and SIZE is the market capitalization of the firm in constant 1996 dollars. The model is estimated on a population of pooled monthly observations of all stocks that are not yet optioned but are eligible for option listing.

Variable	1980 - 1985	1985 - 1991	1991-1996
VOL	0.0795	-0.0100	0.1196
STD	0.3996	0.2651	0.2616
ABVOL	0.1097	0.1532	0.2512
ABSTD	0.0100	0.0798	-0.0082
SIZE	0.0875	0.2170	-0.0420

Table I

Summary Statistics

Price is the stock price on the day before option introduction. Shares is the average number of shares outstanding in millions over the year prior to option introduction. Volatility is the average standard deviation of daily stock price returns over the year prior to option introduction. Volume is the average daily trading volume in thousands in the year preceding option introduction. Turnover is the average daily turnover in the year preceding option introduction calculated as daily volume/shares outstanding. Size is market capitalization on the day prior to option introduction. Book is book value per share reported for the year which the underlying stock was listed on the option exchange. BK/MK is book value of the stock in the year of option introduction divided by market capitalization of the stock on the day prior to option introduction. INST is the percentage of total shares outstanding which are held by institutional investors in the quarter the stock was listed on the option exchange.

Panel A: Test Sample

	Price ($/share)	Shares (million)	Volatility	Volume (1000)	Turnover (%)	Size (million $)	Book ($/share)	BK/MK	INST (%)
N	1732	1732	1732	1732	1732	1732	1719	1719	1732
Mean	26.45	26.74	0.0294	120	0.70	805	17.23	1.01	33
Median	23.25	17.07	0.0279	97	0.51	470	4.31	0.19	34
Std Dev	16.65	30.89	0.0119	105	0.61	103	153.66	11.64	26
Q3	33.50	29.78	0.0369	141	0.95	937	8.80	0.41	54
Q1	15.60	11.22	0.0202	66	0.28	257	1.80	0.08	0

Table II

Test Sample Correlation Matrix

INST is the percentage of total shares outstanding held by institutional investors in the quarter of option introduction. SIZE is market capitalization the day prior to option introduction. BK/MK is book value of the stock in the year of option introduction divided by market capitalization of the stock on the day prior of option introduction. TURN is the average daily turnover in the year preceding option introduction calculated as daily volume/shares outstanding. VOLATILITY is the average standard deviation of daily stock price returns over the year prior to option introduction. Δ INST is the change in institutional ownership between four quarters before and four quarter after option introduction. ILLIQUIDITY is the average weekly Amihud Illiquidity Ratio (Amihud, 2002) over the year preceding option introduction calculated as the absolute weekly return divided by the dollar value of weekly trading volume.

* Relationship significant α= 0.10
** Relationship significant α= 0.05
*** Relationship significant α= 0.01

	INST	BK/MK	TURN	ΔINST	ILLIQUIDITY	VOLATILITY	SIZE
INST	1						
BK/MK	-0.0169	1					
TURN	0.0131	-0.00635	1				
Δ INST	0.153***	0.0243	0.128***	1			
ILLIQUIDITY	-0.111***	0.0179	-0.0033	-0.0194	1		
VOLATILITY	-0.123***	0.0442*	0.560***	0.105***	0.263***	1	
SIZE	-0.0450*	-0.0292	-0.341***	-0.0914***	-0.133***	-0.476***	1

Table III

Panel A: Full Model Mean Delay Measures

Mean D_{rsq} Pre and mean D_{se} Pre are the mean values of each delay measure calculated over the year preceding option introduction for each subset. Mean ΔD_{rsq} and mean ΔD_{se} are the mean changes in each delay measure between the year before and the year after option introduction for each subset. The delay measures are reported for three sample subsets, sorted by the percentage of shares outstanding held by institutional investors in the option introduction quarter (INST).

	Test Sample					*Control Sample*				
INST Range	N	Mean D_{rsq} Pre	Mean D_{se} Pre	Mean ΔD_{rsq}	Mean ΔD_{se}	N	Mean D_{rsq} Pre	Mean D_{se} Pre	Mean ΔD_{rsq}	Mean ΔD_{se}
0 %	442	0.2846	1.49	-0.0248**	-0.1021**	475	0.6291	2.15	-0.0154	-0.020
0.1 – 50.0 %	771	0.2577	1.42	-0.0161	0.0043	1014	0.4678	1.84	0.0038	0.064
> 50.0 %	519	0.2250	1.39	0.0090	0.0027	243	0.3220	1.59	0.0094	0.024

** Change in mean significant α= 0.05

Panel B: Full Model Cross-sectional Regression Results

The table reports coefficient values for each variable with t-statistic values reported below the coefficient values. Coefficients which are significant at conventional levels (α=0.05) are reported in bold face. INST is the percentage of total shares outstanding held by institutional investors in the quarter of option introduction. SIZE is market capitalization the day prior to option introduction. BK/MK is book value of the stock in the year of option introduction divided by market capitalization of the stock on the day prior to option introduction. TURN is average daily turnover in the year preceding option introduction calculated as daily volume/shares outstanding. VOLATILITY is the average standard deviation of stock price returns over the year prior to option introduction. Δ INST is the change in institutional ownership over the time span of each model, either over the four quarters preceding option introduction (pre models) or one year prior to one year following option introduction for delay change models. ILLIQUIDITY is the average weekly Amihud Illiquidity Ratio (Amihud, 2002) for the year preceding option introduction calculated as the absolute weekly return divided by the dollar value of weekly trading volume.

		Dependent Variable	Intercept	INST	ΔINST	SIZE	BK/MK	TURN	VOLATILITY	ILLIQUIDITY	adj R^2
Model 1	*Test Sample*	D_{rsq} *Pre*	**0.25**	**-0.074**	-0.012	-5.72E-09	-2.16E-05	-0.60	**18.31**	**591935**	0.0527
			(13.86)	(3.81)	(0.35)	(1.16)	(0.06)	(0.66)	(2.25)	(6.51)	
		D_{rsq} *Pre*	**0.23**	**-0.075**					**18.56**	**605173**	0.0539
			(17.23)	(4.39)					(3.03)	(6.78)	
	Control Sample	D_{rsq} *Pre*	**0.61**	**-0.49**	-0.079	-3.28E-09	**7.91E-05**	**-8.93**	**0.19**	77.71	0.1843
			(55.06)	(14.85)	(1.09)	(1.41)	(2.43)	(5.59)	(6.31)	(1.96)	
		D_{rsq} *Pre*	**0.61**	**-0.48**			**7.49E-05**	**-8.57**	**0.20**	78.94	0.19
			(55.39)	(15.57)			(2.44)	(5.42)	(6.35)	(1.99)	
Model 2	*Test Sample*	D_{se} *Pre*	**1.50**	**-0.16**	-0.097	**-7.052E-08**	8.47E04	-4.11	22.49	**1198701**	0.0531
			(33.19)	(3.18)	(1.09)	(5.61)	(0.09)	(1.77)	(1.08)	(5.17)	
		D_{se} *Pre*	**1.51**	**-0.14**		**-7.067E-08**				**1296513**	0.0531
			(33.08)	(3.35)		(5.72)				(5.82)	
	Control Sample	D_{se} *Pre*	**2.12**	**-0.89**	-0.22	**-1.12E-08**	**1.52E04**	**-18.71**	**0.33**	136.036	0.1402
			(88.22)	(12.48)	(1.38)	(2.22)	(2.16)	(5.41)	(4.84)	(1.58)	
		D_{se} *Pre*	**2.13**	**-0.87**		**-1.16E-08**	**1.53E04**	**-18.37**	**0.33**		0.1389
			(89.76)	(12.77)		(2.30)	(2.17)	(5.36)	(4.88)		
Model 3	*Test Sample*	Δ D_{rsq}	0.0068	0.039	-0.055	-9.42E-09	4.28E-04	1.35	-11.78	**-401697**	0.0114
			(0.31)	(1.75)	(1.80)	(1.49)	(0.88)	(1.18)	(1.13)	(3.45)	
		Δ D_{rsq}	-0.017	0.039						**-422488**	0.0100
			(1.78)	(1.77)						(3.81)	
		Δ D_{rsq}	**-0.027**	**0.048**							0.002
			(2.91)	(2.20)							
	Control Sample	Δ D_{rsq}	0.00	0.061	**-0.16**	-3.84E-09	-2.37E-05	-0.38	**-0.12**	58.54	0.122
			(0.02)	(1.71)	(3.11)	(1.17)	(0.64)	(0.21)	(3.42)	(1.30)	
		Δ D_{rsq}	0.00	0.052	**-0.16**				**-0.12**		0.125
			(0.02)	(1.49)	(3.12)				(3.37)		
Model 4	*Test Sample*	Δ D_{se}	-0.080	**0.13**	0.099	-9.92E-09	**0.0029**	-0.043	-2.90	-42936	0.0022
			(1.23)	(2.03)	(1.10)	(0.54)	(2.03)	(0.01)	(0.10)	(0.13)	
		Δ D_{se}	**-0.074**	**0.14**			**0.0029**				0.0102
			(2.77)	(2.28)			(2.04)				
	Control Sample	Δ D_{se}	0.0038	0.67	-0.183	-2.50E-09	2.33E-06	2.60	**-0.21**	38.72	0.0025
			(0.13)	(0.83)	(1.61)	(0.42)	(0.03)	(0.64)	(2.63)	(0.38)	

Table IV

Panel A: Full-Neg Model Mean Delay Measures

Mean D^{neg}_{rsq} Pre and mean D^{neg}_{se} Pre are the mean values of each delay measure calculated over the year preceding option introduction for each subset. Mean ΔD^{neg}_{rsq} and mean ΔD^{neg}_{se} are the mean changes in each delay measure between the year before and the year after option introduction for each subset. The delay measures are reported for three sample subsets, sorted by the percentage of shares outstanding held by institutional investors in the option introduction quarter (INST).

	Test Sample					*Control Sample*				
INST Range	N	Mean D^{neg}_{rsq} pre	Mean D^{neg}_{se} pre	Mean ΔD^{neg}_{rsq}	Mean ΔD^{neg}_{se}	N	Mean D^{neg}_{rsq} pre	Mean D^{neg}_{se} pre	Mean ΔD^{neg}_{rsq}	Mean ΔD^{neg}_{se}
0 %	442	0.2104	1.77	-0.0209**	-0.102**	475	0.4079	1.92	-0.0066	-0.038
0.1 – 50.0 %	771	0.1992	1.68	-0.0153	0.004	1014	0.3299	1.84	-0.1022	-0.010
> 50.0 %	519	0.1767	1.67	0.0071	0.003	243	0.2517	1.74	-0.0145	0.031

** Change in mean significant α= 0.05

Panel B: Full-Neg Model Cross-sectional Regression Results

The table reports coefficient values for each variable with t-statistic values reported below the coefficient values. Coefficients which are significant at conventional levels (α=0.05) are reported in bold face. INST is the percentage of total shares outstanding held by institutional investors in the quarter of option introduction. SIZE is market capitalization the day prior to option introduction. BK/MK is book value of the stock in the year of option introduction divided by market capitalization of the stock on the day prior to option introduction. TURN is average daily turnover in the year preceding option introduction calculated as daily volume/shares outstanding. VOLATILITY is the average standard deviation of stock price returns over the year prior to option introduction. Δ INST is the change in institutional ownership over the time span of each model, either over the four quarters preceding option introduction (pre models) or one year prior to one year following option introduction for delay change models. ILLIQUIDITY is the average weekly Amihud Illiquidity Ratio (Amihud, 2002) for the year preceding option introduction calculated as the absolute weekly return divided by the dollar value of weekly trading volume.

Negative new information

		Dependent Variable	Intercept	INST	ΔINST	SIZE	BK/MK	TURN	VOLATILITY	ILLIQUIDITY	R^2_{adj}
Model 1	*Test Sample*	D_{rsq} Neg Pre	**0.21**	**-0.056**	0.013	**-1.79E-08**	-2.57E-04	-1.26	8.82	**358437**	0.0550
			(16.29)	(3.88)	(0.49)	(4.89)	(0.91)	(1.87)	(1.46)	(5.31)	
		D_{rsq} Neg Pre	**0.22**	**-0.055**		**-1.83E-08**				**391082**	0.0547
			(35.59)	(4.36)		(5.69)				(6.04)	
	Control Sample	D_{rsq} Neg Pre	**0.40**	**-0.25**	-0.077	**-3.92E-09**	1.53E-05	**-4.03**	**0.083**	49.99	0.1077
			(53.28)	(11.26)	(1.55)	(2.48)	(0.69)	(3.70)	(3.88)	(1.85)	
		D_{rsq} Neg Pre	**0.40**	**-0.25**		**-4.07E-09**		**-3.91**	**0.086**		0.1059
			(54.49)	(11.52)		(2.57)		(3.63)	(3.88)		
Model 2	*Test Sample*	D_{se} Neg Pre	**1.73**	**-0.169**	0.078	**-5.27E-08**	-2.75E-04	-2.50	38.75	346611	0.0245
			(35.70)	(3.19)	(0.81)	(3.90)	(0.26)	(1.00)	(1.74)	(1.39)	
		D_{se} Neg Pre	**1.72**	**-0.159**		**-5.15E-08**			37.07		0.0245
			(36.27)	(3.37)		(3.84)			(1.99)		
	Control Sample	D_{se} Neg Pre	**1.91**	**-0.283**	-0.068	-6.27E-09	2.16E-05	-0.33	0.079	156.82	0.0140
			(82.35)	(4.07)	(0.10)	(1.19)	(0.41)	(0.03)	(1.06)	(0.96)	
		D_{se} Neg Pre	**1.92**	**-0.307**							0.0133
			(98.64)	(4.93)							
Model 3	*Test Sample*	Δ D_{rsq} Neg	-0.028	**0.040**	-0.28	3.95E-09	**8.42E-04**	0.88	0.66	**-248821**	0.0107
			(1.98)	(2.71)	(1.24)	(1.11)	(2.38)	(1.29)	(0.08)	(3.18)	
		Δ D_{rsq} Neg	**-0.019**	**0.036**			**8.19E-04**			**-260304**	0.0111
			(2.70)	(2.28)			(2.31)			(3.23)	
	Control Sample	Δ D_{rsq} Neg	0.0	-2.56E-04	-0.068	2.68E-10	3.47E-05	-0.85	-0.030	10.90	0.0001
			(0.41)	(0.01)	(1.81)	(0.14)	(1.25)	(0.63)	(1.11)	(0.32)	
Model 4	*Test Sample*	Δ D_{se} Neg	-0.080	**0.133**	-0.099	9.92E-09	**0.0029**	0.431	-2.90	-42936	0.0022
			(1.23)	(2.03)	(1.10)	(0.54)	(2.03)	(0.01)	(0.10)	(0.13)	
		Δ D_{se} Neg	**-0.074**	**0.145**			**0.0029**				0.0041
			(2.77)	(2.28)			(2.04)				
	Control Sample	Δ D_{se} Neg	-0.005	0.043	-0.044	-3.38E-09	-2.13E-05	-2.71	-0.11	-133.33	-0.0014
			(0.17)	(0.51)	(0.37)	(0.54)	(0.24)	(0.63)	(1.25)	(1.24)	

Positive new information

		Dependent Variable	Intercept	INST	ΔINST	SIZE	BK/MK	TURN	VOLATILITY	ILLIQUIDITY	$_{adj} R^2$
Model 5	*Test Sample*	D_{se} Pos Pre	**2.076** (38.65)	**-0.21** (3.54)	-0.023 (0.22)	**-8.59E-08** (5.74)	-5.52E-04 (0.48)	-2.16 (0.79)	16.76 (0.68)	**785806** (2.85)	0.0328
		D_{se} Pos Pre	**2.02** (79.27)	**-0.21** (3.98)		**-7.54E-08** (5.74)				**748545** (2.83)	0.0335
Model 6	*Test Sample*	Δ D_{se} Pos	**-0.16** (2.33)	0.084 (1.20)	-0.034 (0.36)	**4.03E-08** (2.07)	0.0011 (0.74)	2.79 (0.79)	12.24 (0.38)	-36715 (0.10)	-0.0004
		Δ D_{se} Pos	**-0.084** (2.98)	0.069 (1.03)							0.000

Figure 1

Institutional Ownership At The Time Of Option Introduction

The left hand Y axis reports the mean percentage of total shares outstanding held by institutional investors, by quarter, centered on the option listing quarter. The right hand Y axes reports the mean number of institutional investors which have holdings in each stock, in each quarter, over the same time span. List quarter is the quarter of option introduction.