Does Informed Options Trading Prior to Innovation Grants Announcements Reveal the Quality of Patents?

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Abstract

This study examines informed options trading prior to innovation grants announcements. We present that informed options traders reveal their private information about firms' innovative efficiency through their trading activities surrounding the date of firms' innovation grants announcements and find that the abnormal call option volume of innovative firms surrounding the announcement windows is positively related to the amounts of cumulative citations for each patent and firms' operating performance. Furthermore, robustness tests show that 1) such evidence is stronger in higher information asymmetric firms and 2) in firms that offer greater risk incentives to their CEO; and 3) higher leverage options contain more information, which is consistent with previous studies.

Keywords: Informed options trading; Innovation grants announcements; The quality of patent.

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1. Introduction

Investors sift through a great number of information events that bombard securities markets each day to determine which ones contain realistic information that may impact their trading. The main method for processing information is through the trading activities of informed traders in securities markets, especially those of corporate insiders. Therefore, numerous studies in the literature have investigated the topic of informed trading prior to the announcement of important corporate finance events. Most researchers focus on mergers and acquisitions (M&As) or earnings announcements and provide evidence of either informed investors or corporate insiders trading prior to these events' announcement date.[1] Consequently, the major focus of investigating trading activities in the securities markets has been on decoding firms' private information no matter whether trades are initiated by informed traders or corporate insiders.

We first examine informed options trading prior to innovation grants announcements. The announcement of firms' innovation grants is quite different from

[1] The category of informed trading studies includes the following: Bodnaruk, Massa, and Simonov (2009) find that financial conglomerates, to which bidders' M&A advisors belong to, take a position in M&A targets before the takeover announcement; Dai, Massoud, Nandy, and Saunders (2012) provide evidence on the abnormal trading activities of hedge funds in the stock and stock options of M&A targets and the acquirer firms; Ashraf and Jayaraman (2014) note that active institutions (i.e., investment companies, money managers, and independent investment advisors) increase their holdings of the acquirer stock during the announcement quarter and gain high abnormal returns upon the event announcement. The category of corporate insider trading studies includes the following: Cohen, Malloy, and Pomorski (2012) decode insiders' trading and find that "opportunistic" insiders' trades yield value-weighted abnormal returns of 82 basis points per month. Augustin, Brenner, and Subrahmanyam (2015) find that 25% of takeovers have positive abnormal volumes in the options market and further use Thomson Reuters insider filings to provide evidence of inside trading.

alternative firms' news about current performance such as earnings announcements or about more tangible investment projects such as M&A announcements. Unlike news of firms' current performance, innovation grants news presents greater difficulty for investors to process information, as it contains the prospects for new technologies; compared to firms' M&A events, an innovation grant investment is less tangible and exhibits higher uncertainty.[2] Inevitably, firms' innovation grants announcements lead to significant information asymmetry between investors and enterprises (Aboody and Lev, 2000; Hall, Jaffe, and Trajtenberg, 2001).

The existence of such information asymmetry drive us to dig deeper into abnormal trading activities prior to or on the date of an innovation grant announcement in order to investigate how accurately these abnormal trades are processing firms' innovation grant information. We choose the stock options market for our observation, because of the following two reasons. First, in the literature there exists a great amount of supporting evidence on informed traders choosing to trade in the options market.[3] Second, the options market is less regulated than the stock market, and this fact allows insider trading to be more feasible in the options market (Augustin, Brenner, and

[2] Mansfield (1968) indicates that most innovation grants are riskier than other projects, because of the high failure rate. Cochrane (1991, 1996) show that intangible capital is an important element of the various inputs of innovation activities.

[3] There indeed is a huge strand of relative studies. To save space, we recommend the following representative articles: informed traders choose to trade in the options market in the presence of asymmetric information (Easley, O'Hara, and Srinivas (1998)); differences in opinions (Cao and Ou-Yang (2009)); short-sale constraints (Johnson and So (2012)); and margin requirement and wealth constraints (John, Koticha, Narayanan, and Subrahmanyam (2003)).

Subrahmanyam, 2015).

This study provides the first evidence that informed options trading contains *valid* private information about the efficiency of innovation grants. A firm's innovative efficiency is intangible and difficult to define. Thus, most prior studies use an output measure relative to an input measure, such as patents and patent citations per dollar of research and development (R&D) investment, to define innovative efficiency, with the purpose of investigating whether innovative efficiency can predict higher future stock returns and firms' performance.[4] According to patent data surveyed by the National Bureau of Economic Research (NBER) from 1996 to 2006, more than half of patents are not effective for each patent granted year, because their total cumulative citations over 10 years amount to less than 10 times. On the other hand, the percentage of effective patents is quite small (less than 1% of total patents for each granted year).[5] In fact, not all patents are of equal economic value, and an increase in the number of patents granted need not coincide with greater usage. This fact motivates us to investigate the information accuracy of abnormal options trading volume prior to innovation grants announcements. More specifically, our objective is to look at innovative efficiency by first observing the abnormal trading activities prior to a firm's

[4] One may refer to Cochrane (1991, 1996), Liu, Whited, and Zhang (2009), and Hirshleifer, Hsu, and Li (2013).

[5] For detailed information, please refer to Table A-1.

innovation grants announcement.

Figure 1-1 and Figure 1-2 illustrate the comparison between the average call and put volume around the event windows of innovation grants announcements [-1,+1] and the average call and put volume of each trading day that is not on the day of the specific event. We observe that the average options volume around the events is at least double the average options volume of no particular event, especially for the average call options volume. Furthermore, the difference in call and put volumes around some of the event windows is more significant than the others, indicating that call options are traded more significantly around these particular event dates. Supposing that such a particular call-put volume imbalance implies innovative efficiency provided by informed traders, we find a positive relation between informed trading activities and the efficiency of firms' innovation grants.

The first stage of the empirical results provides evidence that this abnormal options volume has a positive relation with buy-and-hold abnormal returns, which are calculated by Truong and Corrado (2014), around the event windows [-1,+1]. However, the positive relation disappears after the event windows [+2,+20]. It indicates that options trading activities around innovation grants events indeed contain particular information about firms' innovation grants.

The second stage of the empirical investigation provides further evidence about

the relation between these trading activities and privative information about the firms' innovative efficiency. Porter (1992) famously argues that, "To compete effectively in international markets, a nation's businesses must continuously innovate and upgrade their competitive advantages." Following this line of thought, the major purpose of firms to grant patents is to prevent new market entry by their competitors by forbidding them to produce unless citing such patents. Therefore, those firms with more cited patents potentially have more positive effects on their innovative efficiency.

We use the amounts of cumulative citations for each patent, which are direct observations of each patent's contribution, to measure the efficiency of firms' innovation. In addition, we employ several firm operating performance measures, such as Tobin's Q, cash flow, and earnings, to be the alternative performance measures of firms' innovative efficiency (Hall, Jaffe, and Trajtenberg, 2005; Hirshleifer, Low, and Teoh, 2012; Kaplan and Zingales, 1997; Hirshleifer, Hsu, and Li, 2013).[6] Our results provide evidence that firms with higher abnormal call option volume surrounding innovation grants events result in both higher total amount of cumulative citations and operating performance after one year.

[6] We measure cash flow as the sum of earnings before extraordinary items (item18) and depreciation (item14), and earnings denote operating income before depreciation (item13). Tobin's Q is defined as (market value of equity (item199*item25) plus book value of assets (item6) minus book value of equity (item60) minus balance sheet deferred taxes (item74, set to zero if missing)) divided by book value of assets (item6).

To further examine whether the information asymmetry of innovative firms influences informed options trading surrounding the event windows of innovation grants, we include the probability of informed trading provided by Easley, O'Hara and Srinivas (1998). As such, we find that abnormal options trading surrounding these event windows is more pronounced in higher information asymmetric innovative firms. This fact confirms that informed traders tend to trade in the options market when a firm exhibits high information asymmetry.

Holmstrom (1989) indicates that firms' innovation requires risk-taking. Therefore, under non-executive employee stock options, employee wealth positively relates to stock return volatility, incentivizing employees to take more risk during the innovation process. Chang, Fu, Low, and Zhang (2015) and Chen, Podolski, and Veeraraghavan (2015) show that employee compensation and employee benefits are key factors affecting innovative success. In our study we also robustly examine whether firms with higher risk incentives for chief executive officers (CEOs) generate greater motivation for informed traders to trade innovation grants events. The empirical results offer that firms with higher CEO risk incentives product more significant abnormal trading around the event windows of innovation grants.

Aside from the different firm characteristics that might affect the motives of informed traders to trade innovative firms, the various types of stock options are also a

major consideration when informed traders want to trade innovative firms' stock options. Numerous studies have mentioned that higher leverage options are the type most preferred by informed traders.[7] We therefore robustly examine abnormal options trading that is more pronounced in at-the-money (ATM) and out-of-the-money (OTM) contracts, in order to confirm that options with higher leverage contain more information.

The paper continues as follows. Section 2 discusses the data and summary statistics. Section 3 describes the relation between options trading and the magnitude of a stock price's response to an innovation grant announcement. Section 4 presents evidence of options trading revealing the quality of firms' innovation grants efficiency. Section 5 examines the robustness of the results, and section 6 concludes.

2. Data

We construct our sample by using innovation grants announcements obtained from the National Bureau of Economics Research (NBER) Patent Citation Data File for the period 1996-2006. These innovated firms' stock prices are taken from the Center for Research in Security Prices (CRSP) database. Financial and utility firms (with CRSP share codes of 10 and 11) are excluded from our sample. The sample firms' balance

[7] See Chakravarty, Gulen, and Mayhew (2004), Pan and Poteshman (2006), and Ni, Pan, and Poteshman (2008) for more detailed discussions.

sheet items are matched from Standard & Poor's (S&P) Compustat database. Table 1 describes the number of innovation grants announcement events and firms that make up our sample. We find that number of innovated firms each year is quite uniform during our sample period.

<Table 1 is inserted about here>

For the options trading volume analysis, we take daily call and put option volume data from the OptionMetrics database.[8] We use all the options volume classified by all maturity and moneyness and also consider the subsample options volume based on different moneyness (out-of-the money, at-the-money, and in-the-money). Following Roll, Schwartz, and Subrahmanyam (2009) and Truong and Corrado (2014), we construct three measures for the average options trading (dollar) volume around the innovation grants announcement date as follows: (1) average total options trading (dollar) volume (OPTVOL/OPTDOLLARVOL), (2) average call options trading (dollar) volume (CALLVOL/CALLDOLLARVOL), and (3) average put options trading (dollar) volume (PUTVOL/PUTDOLLARVOL).

The left axis of Figure 1-1 shows OPTVOL, CALLVOL, and PUTVOL around the event window of innovation grants announcements [-1,+1], and the right axis of Figure 1-1 shows the difference between CALLVOL and PUTVOL. Compared with

[8] All of the stock options are American style.

the average daily trading volume of call and put volume described in Figure 1-2, we find that the trading volume of both call and put options around the event date are double the average daily trading volume of the corresponding call and put options, especially the call options. We note that the extreme imbalance in trading volume between call and put options around the event window [-1,+1] is more significant. This fact indicates that call options, which contain more informed opinions of patents efficiency, are more significantly traded during innovation grants announcements.

<Figure 1 is inserted about here>

We also consider abnormal options trading volume around the event window of innovation grants announcements [-1,+1]. We use three abnormal options trading volume measures, corresponding to total options (dollar) volume (AB_OPTVOL/ AB_OPTDOLLARVOL), call options (dollar) volume (AB_CALLVOL/ AB_CALLDOLLARVOL), and put options (dollar) volume (AB_PUTVOL/ AB_PUTDOLLARVOL). These measures used herein are calculated as follows:

$$AB\_OPTVOL = OPTVOL(-1,+1) / OPTVOL(-20,-11) - 1 \quad (1)$$

$$AB\_CALLVOL = CALLVOL(-1,+1) / CALLVOL(-20,-11) - 1 \quad (2)$$

$$AB\_PUTVOL = PUTVOL(-1,+1) / PUTTVOL(-20,-11) - 1, \quad (3)$$

where OPTVOL(-1, +1), CALLVOL(-1,+1), and PUTVOL(-1,+1) are total options volume, call options volume, and put options volume around the event windows [-1,+1],

respectively. OPTVOL (-20,-11), CALLVOL (-20,-11), and PUTVOL (-20,-11) are total options volume, call options volume, and put options volume around the event windows [-20,-11], respectively. Equations (1) to (3) are also replaced by the total option dollar volume, call option dollar volume, and put option dollar volume.

We calculate the abnormal returns for windows before, during, and after the innovation grants announcements, as suggested by Truong and Corrado (2014). Buy and hold abnormal returns from the three different windows are defined as follows:

$$\mathrm{BHAR}(-1,+1)_i = \prod_{t=-1}^{t=+1}(1+r_{i,t}) - \prod_{t=-1}^{t=+1}(1+\mathrm{dec}_{i,t}) \quad (4)$$

$$\mathrm{BHAR}(-10,-2)_i = \prod_{t=-10}^{t=-2}(1+r_{i,t}) - \prod_{t=-10}^{t=-2}(1+\mathrm{dec}_{i,t}) \quad (5)$$

$$\mathrm{BHAR}(+2,+20)_i = \prod_{t=+2}^{t=+20}(1+r_{i,t}) - \prod_{t=+2}^{t=+20}(1+\mathrm{dec}_{i,t}), \quad (6)$$

where $r_{i,t}$ is the return on stock i on day t relative to the innovation grants announcement, and $\mathrm{dec}_{i,t}$ is the equally-weighted return from the size decile that stock *i* belonged to on day *t*.

Table 2 presents summary statistics for both the dependent and independent variables used in this study, including the means, medians, standard deviations, and 10%, 50%, and 90% percentiles. We find that the buy-and-hold abnormal returns on average are close to zero around the innovation grants announcement window [-1,+1]. This fact indicates that the abnormal returns of our innovated announcement firms are alternatively either positive or negative and are on average no different from zero.

Table 2 also reports our measure of option volume. One can find that call options are traded significantly more than put options around the innovation grants announcement window [-1,+1]. The abnormal total options volume (AB_OPTVOL) is 63%, the abnormal call volume (AB_CALLVOL) is 87%, and the abnormal put volume (AB_PUTVOL) is 192% more than the average volume of the pre-grant announcement period. Similarly, the abnormal option dollar volumes are all significantly different from the pre-grant announcement period.

The first firm characteristic measure that we consider for the probability of informed trading (PIN measure) is the identification of the firms' information asymmetry.[9] To further examine whether our study shows robustness based on firms with different CEO incentives, we include executive compensation data obtained from Execucomp. We use both measures of CEOs' options holding and options vega calculated from CEOs' options positions, thus representing their risk incentives.[10] Table 2 also shows the summary statistics of PIN, the risk incentive measures, and the control variables in the last few columns. Our control variables include market capitalization (SIZE), the book-to-market ratio (BM), the stock price 20 days prior to the innovation grants announcement (PRICE), the average dollar stock trading volume

[9] Following Easley, O'Hara, and Srinivas (1998) and Easley, Kiefer, and O'Hara (2002), we obtain the PIN values from the Stephen Brown website.

[10] The options vega are obtained from the Lalitha Naveen website (http://sites.temple.edu/lnaveen/data/).

from day -20 to day -11 relative to the innovation grants announcement (STOCKVOL), and the momentum (MOM).

<Table 2 is inserted about here>

3. Options trading and magnitude of stock price response to innovation grants announcement

The first objective of our study is to investigate informed options trading before, during, and after innovation grants announcements. We use panel regression to examine the relation between options volumes and a firm's buy-and-hold stock abnormal returns. The model specification is as follows:

$$BHAR = a_0 + \beta_1 Options\_trading + X'\beta + \varepsilon, \quad (7)$$

where $BHAR$ is the buy-and-hold stock abnormal return before the innovation grants announcement window [-10,-2], during the announcement window [-1,+1], and after the announcement window [+2,+20], respectively. $Options\_trading$ denotes the OPTVOL/CALLVOL/PUTVOL and/or OPTDOLLARVOL/CALLDOLLARVOL/ PUTDOLLARVOL around the innovation grants announcement window [-1,+1]. We use market capitalization in millions of US dollars (SIZE), the book-to-market ratio (BM) to proxy for growth opportunities, the stock price 20 days prior to the innovation grants announcement (PRICE), and the average dollar stock trading volume from day -20 to day -11 relative to the innovation grants announcement (STOCKVOL) as proxies

for a stock's liquidity and transaction costs. Lastly, MOM is defined as the buy-and-hold stock return over the past 12 months.

Table 3 reports our empirical results of panel regression. In Panel A, the dependent variable is the value of the 3-day buy-and-hold abnormal return during grants announcements - that is, BHAR [-1,+1]. We find that the coefficients of both options trading volumes and options trading dollar volumes are positively (negatively) significant for total and call options (put options), indicating options' trading volume response to private information during innovation grants announcement events. Panel B of Table 3 reports the value of the pre-grants-announcements buy-and-hold abnormal return - that is, BHAR [-10,-2]. The coefficients on CALLVOL and CALLDOLLARVOL in columns 2 and 5 are respectively 0.0002 and 0.0001 with a significant t-statistic. The pre-grants announcement stock price reaction to the options trading volume is significantly smaller than that of the options trading volume during grant announcement events. Panel C of Table 3 shows the value of the post-grants-announcements buy-and-hold abnormal return - that is, BHAR [+2,+20]. Panel C of Table 3 shows evidence that options' trading volume response to the stock price in the post-grants-announcement period is disappearing.

<Table 3 is inserted about here>

For specifically investigating whether informed call options trading contains

information on the quality of firms' innovation grants, we focus on those innovated firms with positive buy-and-hold abnormal returns, BHAR [-1,+1]. Therefore, the dependent variable of equation (7) is replaced by positive buy-and-hold abnormal returns, BHAR [-1,+1]>0, and we then use the average abnormal options (dollar) volume during the innovation grants announcement window [-1,+1] as the independent variable.

Table 4 reports the results of regressions for the firms with positive buy-and-hold abnormal returns during innovation grants announcements. The results show that only the call options volume is significantly positively related with the 3-day buy-and-hold abnormal returns surrounding these announcements. Similar results appear in the regression of independent variables replaced with abnormal dollar options volume. This fact motivates us to investigate whether abnormal call volume indeed reveals the efficiency of a firm's innovation grants due to low percentage of efficient patents that we mentioned in Table A-1.

<Table 4 is inserted about here>

4. Options trading and quality of firms' innovation grants efficiency

To investigate whether this abnormal trading volume indeed contains information about the quality of firms' innovation grants, we further examine if the innovated firms, which are traded by more call options during the innovation grants announcement

window [-1,+1], present better performance than those that are not traded by more call options. We sort the firms, which have positive 3-day buy-and-hold abnormal returns, by their abnormal call (dollar) volume during their grants event window [-1,+1] into three groups of low (<30%), medium (30-70%), and high (>70%).

Hall, Jaffe, and Trajtenberg (2005) show that forward citations are related to firm value. We use the total amount of cumulative citations for each patent over the 10 years from 1996 to 2006 granted by firms to evaluate the quality of firms' innovation grants efficiency.[11] Panel A of Table 5 reports the results of the average amount of cumulative citations over 10 years, and we classify firms into three groups of low, medium, and high abnormal call (dollar) volume. We can see that the average amount of cumulative citations of the highest abnormal call (total) volume category is higher than that of the lowest abnormal call (total) volume category at the 1% level of significance. This fact indicates that innovation firms, which have more call options trading within the announcement date, have better patent citations than those firms that are not traded by more call options.

Following Hall, Jaffe, and Trajtenberg (2005) and Hirshleifer, Low, and Teoh (2012), we use Tobin's Q, cash flow, and earnings to denote firms' operating

[11] Our innovation grants efficiency is different from the alternative measures, such as patents granted scaled by R&D capital or adjusted patent citations scaled by R&D expenses, as suggested by Hirshleifer, Hsu, and Li (2013) in several ways. We use the total amount of cumulative citations for each patent in order to catch the cumulative contributions of each patent rather than the ratio of innovated output related to R&D input.

performance. For specifying firms' operating performance that is contributed from their innovation grants, we examine those measures in the first year after firms' innovation grants announcement. Panel B of Table 5 reports the average Tobin's Q of firms classified by three groups of low, medium, and high abnormal call (dollar) volume. We find that the average Tobin's Q of firms with high abnormal call (dollar) volume is significantly better than those with low abnormal call (dollar) volume. Panel C of Table 5 reports the average cash flows of firms classified by the three groups of low, medium, and high abnormal call (dollar) volume. We also find that firms with higher abnormal call (dollar) volume have significantly larger cash flows than those with lower abnormal call (dollar) volume. Similar results appear in Panel D of Table 5 when we use earnings as the proxy of firms' performance measure.

<Table 5 is inserted about here>

5. Robustness

This section robustly examines the options trading and magnitude of the stock price response to innovation grants announcements based on different types of innovative firms and different types of options.

5.1 Options trading volume based on different firms' information asymmetry

We modify the regression model of Eq. (7) to consider the effect of information asymmetry as follows:

$$BHAR = a_0 + \beta_1 PIN + \beta_2 Options\_trading$$

$$+\beta_3 Options\_trading * PIN + X'\beta + \varepsilon, \quad (8)$$

where PIN is the probability of informed trading and proxies for information asymmetry. $Options\_trading$ defines OPTVOL/CALLVOL/PUTVOL around the innovation grants announcement window [-1,+1].

We follow Easley, O'Hara, and Srinivas (1998), who indicate that firms with greater information asymmetry attract more informed investors to trade in the options market. Table 6 robustly presents the same arguments of Easley, O'Hara, and Srinivas. We find that the most significantly positive coefficient of the interaction of PIN and call (options) volume, which indicates abnormal options trading, is more obvious in firms with higher information asymmetry. Therefore, we propose that abnormal options trading volume potentially contains more information about firms with higher information asymmetry.

<Table 6 is inserted about here>

5.2 Options trading volume based on different CEO risk incentives

We also modify the regression model of Eq. (7) to consider the effect of CEO risk incentives as follows:

$$BHAR = a_0 + \beta_1 CEO\_incentive + \beta_2 Options\_trading$$

$$+\beta_3 Options\_trading * CEO\_incentive + X'\beta + \varepsilon, \quad (9)$$

where $CEO\_incentive$ denotes CEO options and/or CEO vega. CEO options and CEO vega are dummy variables that take the value of 1 in those cases where the CEO holds an options position and when the CEO vega is larger than zero and not missing; otherwise it is 0. $Options\_trading$ defines OPTVOL/CALLVOL/PUTVOL around the innovation grants event windows [-1,+1].

Chang, Fu, Low, and Zhang (2015) indicate that if a CEO holds a greater stock options position, then there is more incentive to take risk with the firms' investments. Panel A of Table 7 shows that the coefficient of the interaction of CEO-held options value and call (options) volume is positively significant related with the 3-day abnormal returns during the time window of firms' innovation grants announcements. An investigation of an alternative proxy for CEO incentives, shown in Panel B of Table 7, presents similar results. Therefore, we propose abnormal option trading volume potentially contains more information in firms with higher CEO risk incentives.

<Table 7 is inserted about here>

5.3 Options trading volume based on different moneyness of options

We follow Easley, O'Hara, and Srinivas (1998), who indicate that higher options leverage attracts more informed traders to participate in the options market. We thus use the moneyness of options for classifying the leverage of options. We regroup our sample into three categories, out-of-the money (OTM), at-the-money (ATM), and in-

the-money (ITM), and find that most options traded during the innovation grants announcement window [-1,+1] are ATM and OTM options.[12] Table 8 shows evidence that the call (options) volume is particularly more pronounced in ATM and OTM contracts. Therefore, we propose that abnormal options trading potentially contains more information in those types of higher leverage options, such as ATM and OTM options.

<Table 8 is inserted about here>

6. Conclusions

How does the trading of firms' stock options reveal valid information about firms' innovative efficiency? This paper looks to answer this question by examining informed options trading prior to innovation grants announcements. We find that abnormal options volume prior to firms' innovation grants announcements has a positive relation with 3-day buy-and-hold abnormal returns surrounding the announcement events.

Our results provide evidence that firms with higher abnormal call options volume surrounding the innovation grants announcement events result in both higher amounts of cumulative citations for those patents and operating performance after one year. This fact indicates that informed options traders indeed reveal their private information about

[12] Table A-2 shows the detailed information of different categories of call options' moneyness. We sort the observations into five groups of moneyness, where moneyness is defined as S/K, the ratio of the stock price S to the strike price K. Out-of-the-money (OTM) corresponds to S/K ranging from 0.80 to 0.95, at-the-money (ATM) corresponds to S/K ranging from 0.95 to 1.05, and in-the-money (ITM) corresponds to S/K ranging from 1.05 to 1.20.

innovative efficiency through their patterns of options trading.

We finally also confirm that innovative firms with higher information asymmetry and innovative firms with higher CEO risk incentives attract more informed traders to trade their stock options prior to innovation grants announcements. Furthermore, informed traders prefer to trade ATM and OTM options, which are more sensitive to stock price variation and offer higher leverage.

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Figure 1-1: Abnormal Trading Volume around the Event Windows

Figure 1-1 (left axis) shows the average call and put volume on the innovation grants announcement date, which is calculated by the mean of total call and put volume around the event window [-1,+1], respectively. Figure 1-1 (right axis) shows the difference of average call minus put volume for each event date.

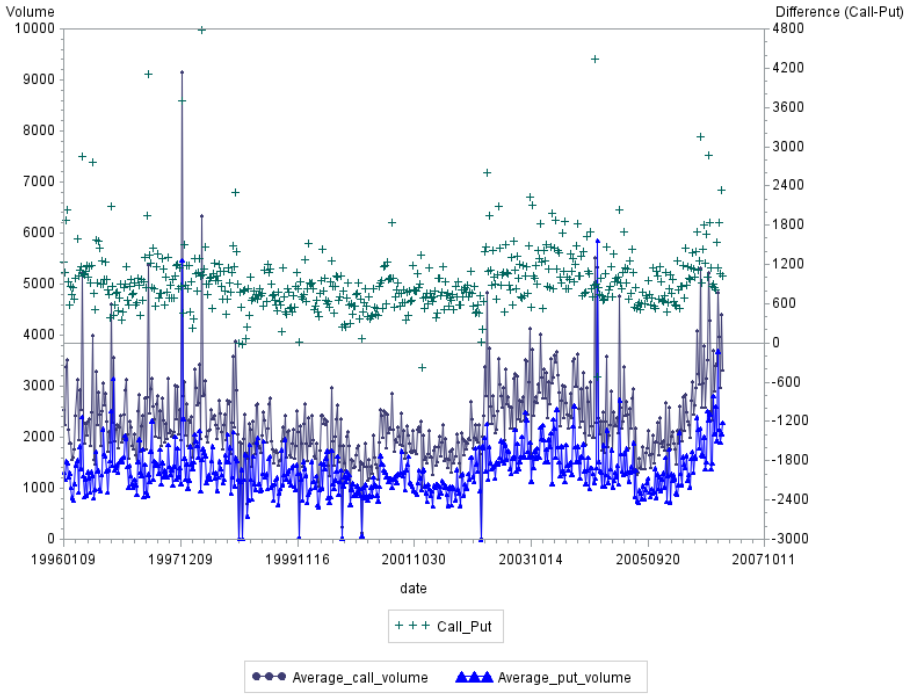

Figure 1-2: Daily Trading Volume of Call and Put Options

Figure 1-2 (left axis) shows the average call and put volume of each trade date during our sample period. Figure 1-2 (right axis) shows the difference of average call minus put volume for each trade date.

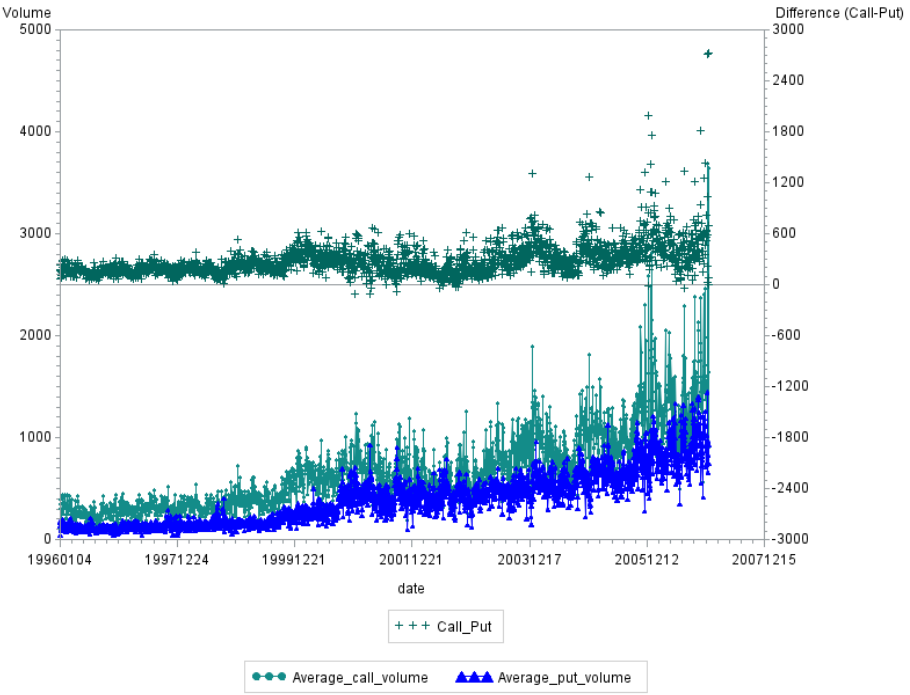

Table 1 Number of Innovation Grants Announcements

This table shows the number of innovation grants announcements during our sample years from 1996 to 2006. The last column presents the numbers of firms that cover these events.

Year	No. of Events	No. of Firms
1996	4,762	257
1997	5,351	327
1998	6,071	355
1999	5,736	312
2000	5,802	302
2001	6,086	309
2002	5,698	299
2003	6,544	297
2004	6,212	296
2005	5,702	293
2006	4,721	228
Total	62,685	3,275

Table 2 Summary Statistics

This table reports the summary statistics for the period 1996–2006. BHAR is the stock's buy-and-hold return minus the buy-and-hold return of the stock's size decile. OPTVOL, CALLVOL, and PUTVOL are average daily total, call, and put options trading volume in the period from day -1 to day +1 relative to the innovation grants announcement. OPTDOLLARVOL, CALLDOLLARVOL, and PUTDOLLARVOL are average daily total, call, and put options trading dollar volume in the period from day -1 to day +1 relative to the innovation grants announcement. STOCKVOL is the average dollar stock trading volume from day -20 to day -11 relative to the grants announcement. AB_OPTVOL, AB_CALLVOL, and AB_PUTVOL are average abnormal total options volume, average abnormal call options volume, and average abnormal put options volume, measured as the percent difference of average daily announcement period volume over days -1 to +1 from average daily pre-grants-announcement volume on days -20 to -11. AB_OPTDOLLARVOL, AB_CALLDOLLARVOL, and AB_PUTDOLLARVOL are average abnormal total options dollar volume, average abnormal call options dollar volume, and average abnormal put options dollar volume, measured as the percent difference of average daily announcement period volume over days -1 to +1 from average daily pre-grants-announcement volume on days -20 to -11. SIZE and BM are the market value of equity ($ millions) and book-to-market ratio at the beginning of the calendar year. CEO options are calculated by the sum of the granted value of option divided by Total CEO compensation. CEO vega is the dollar change ($ thousands) in a CEO's stock and stock compensation portfolio if the stock volatility increases by 1%. PRICE is the stock price 20 days prior to the grants announcement, PIN is probability of informed trading, and MOM is defined as the buy-and-hold stock return over the past 12 months.

Variables	P10	P50	P90	Mean	SD
BHAR[-1,+1]	-0.0457	-0.0014	0.0466	-0.0004	0.0459
BHAR[-10,-2]	-0.0858	-0.0044	0.0821	-0.0021	0.0809
BHAR[+2,+20]	-0.1284	-0.0089	0.1188	-0.0046	0.1199
STOCKVOL	3997.7563	34063.4675	234232.0462	94936.0149	184664.8000
OPTVOL	15.6667	565.6667	9255.6667	3667.1425	10467.8353
CALLVOL	9.0000	357.3333	5708.3333	2308.7887	7064.8800
PUTVOL	1.0000	155.3333	3433.6667	1358.3539	4089.2579
OPTDOLLARVOL	24.3833	1290.4917	25903.4833	12402.2658	56508.5406
CALLDOLLARVOL	12.8333	794.6250	16314.6833	7950.4364	45312.5272
PUTDOLLARVOL	1.1875	307.9583	8640.3500	4451.8294	23022.9776
AB_OPTVOL	-0.7932	-0.1612	1.8627	0.6355	10.6922
AB_CALLVOL	-0.8246	-0.1729	2.1191	0.8705	11.4200
AB_PUTVOL	-0.9636	-0.2555	2.5932	1.9075	47.7895
AB_OPTDOLLARVOL	-0.8321	-0.1941	2.2844	1.1780	27.6265
AB_CALLDOLLARVOL	-0.8638	-0.2127	2.6350	1.9283	66.5347
AB_PUTDOLLARVOL	-0.9756	-0.2894	3.1916	3.3770	90.2238
CEO options	0.0000	0.4105	0.8658	0.4360	0.3645
CEO vega	68.5952	351.4768	1634.0923	665.5281	924.8527
PIN	0.0012	0.0986	0.1722	0.1047	0.0769
MOM	-0.3578	0.1218	0.8164	0.2479	0.9549
BM	0.2001	0.4737	0.8072	0.4953	0.2335
PRICE	12.5000	37.2500	76.8750	41.7714	26.9046
SIZE	0.7227	6.2109	63.6833	23.4494	47.1863

Table 3 Regression Results of Full Sample

This table presents six regressions of 3-day abnormal returns around innovation grants announcements, BHAR [-1,+1], BHAR [-10,-2], and BHAR [+2,+20], on a grants-announcement period's options trading (dollar) volume. Abnormal return is the stock's buy-and-hold return less the buy-and-hold return of the stock's size decile. OPTVOL, CALLVOL, and PUTVOL are average daily total, call, and put options trading volume in the period from day -1 to day +1 relative to the grants announcement. OPTDOLLARVOL, CALLDOLLARVOL, and PUTDOLLARVOL are average daily total, call, and put options trading dollar volume in the period from day -1 to day +1 relative to the innovation grants announcement. STOCKVOL is the average dollar stock trading volume from day -20 to day -11 relative to the grants announcement. SIZE and BM are the market value of equity ($ millions) and book-to-market ratio at the beginning of the calendar year. PRICE is the stock price 20 days prior to the grants announcement. MOM is defined as the buy-and-hold stock return over the past 12 months. The full sample period is January 1996 to December 2006. T-statistics are based on two-way clustered standard errors, clustered by firm. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: BHAR[-1,+1]						
	Dependent variable = BHAR[-1,+1]					
	(1)	(2)	(3)	(4)	(5)	(6)
OPTVOL	0.0001					
	(3.61)***					
CALLVOL		0.0004				
		(3.80)***				
PUTVOL			-0.0002			
			(-2.31)**			
OPTDOLLARVOL				0.0000		
				(2.08)**		
CALLDOLLARVOL					0.0000	
					(2.17)**	
PUTDOLLARVOL						-0.0001
						(-4.56)***
PRICE	-0.0441	-0.0390	-0.0561	-0.0544	-0.0588	-0.0521
	(-3.88)***	(-3.37)***	(-4.89)***	(-5.16)***	(-5.65)***	(-4.41)***
SIZE	0.0386	0.0355	0.0446	0.0438	0.0432	0.0376
	(4.45)***	(4.03)***	(4.86)***	(5.19)***	(5.30)***	(4.36)***
STOCKVOL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(-4.29)***	(-4.61)***	(-1.31)	(-4.59)***	(-3.99)***	(0.30)
MOM	-0.1230	-0.1367	-0.1000	-0.1132	-0.1232	-0.1080
	(-0.53)	(-0.59)	(-0.43)	(-0.49)	(-0.53)	(-0.46)
BM	-2.4119	-2.5045	-2.1960	-2.4941	-2.6401	-1.8789
	(-2.53)**	(-2.64)***	(-2.24)**	(-2.55)**	(-2.66)***	(-1.96)*
Year fixed effect	YES	YES	YES	YES	YES	YES
Industry fixed effect	YES	YES	YES	YES	YES	YES
Adjust R squared	0.0021	0.0033	0.0018	0.0019	0.0035	0.0034
Sample size	65863	65863	65863	65863	65863	65863

Table 3 (continued)

Panel B: BHAR[-10,-2]						
	Dependent variable = BHAR[-10,-2]					
	(1)	(2)	(3)	(4)	(5)	(6)
OPTVOL	0.0001					
	(1.21)					
CALLVOL		0.0002				
		(2.21)**				
PUTVOL			-0.0002			
			(-0.97)			
OPTDOLLARVOL				0.0000		
				(2.13)**		
CALLDOLLARVOL					0.0001	
					(2.22)**	
PUTDOLLARVOL						-0.0002
						(-6.39)***
Control variables	YES	YES	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES	YES	YES
Industry fixed effect	YES	YES	YES	YES	YES	YES
Adjust R squared	0.0037	0.0039	0.0037	0.0044	0.0064	0.0053
Sample size	65863	65863	65863	65863	65863	65863

Table 3 (continued)

Panel C: BHAR[+2,+20]						
	Dependent variable = BHAR[+2,+20]					
	(1)	(2)	(3)	(4)	(5)	(6)
OPTVOL	0.0000					
	(-0.09)					
CALLVOL		0.0000				
		(-0.45)				
PUTVOL			0.0001			
			(0.41)			
OPTDOLLARVOL				0.0000		
				(-0.52)		
CALLDOLLARVOL					0.0000	
					(-0.31)	
PUTDOLLARVOL						0.0000
						(-0.50)
Control variables	YES	YES	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES	YES	YES
Industry fixed effect	YES	YES	YES	YES	YES	YES
Adjust R squared	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035
Sample size	65863	65863	65863	65863	65863	65863

Table 4 Regression Results of Events with Positive Buy-and-Hold Abnormal Returns

This table presents six regressions of 3-day abnormal returns around innovation grants announcements, BHAR [-1,+1]>0, on a grants-announcement period's abnormal options trading (dollar) volume. AB_OPTVOL, AB_CALLVOL, and AB_PUTVOL are average abnormal total options volume, average abnormal call options volume, and average abnormal put options volume, measured as the percent difference of average daily announcement period volume over days -1 to +1 from average daily pre-grants-announcement volume on days -20 to -11. AB_OPTDOLLARVOL, AB_CALLDOLLARVOL, and AB_PUTDOLLARVOL are average abnormal total options dollar volume, average abnormal call options dollar volume, and average abnormal put options dollar volume, measured as the percent difference of average daily announcement period volume over days -1 to +1 from average daily pre-grants-announcement volume on days -20 to -11. STOCKVOL is the average dollar stock trading volume from day -20 to day -11 relative to the grants announcement. SIZE and BM are the market value of equity ($ millions) and book-to-market ratio at the beginning of the calendar year. PRICE is the stock price 20 days prior to the grants announcement. MOM is defined as the buy-and-hold stock return over the past 12 months. The full sample period is January 1996 to December 2006. T-statistics are based on two-way clustered standard errors, clustered by firm. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable = BHAR[-1,+1]>0					
	(1)	(2)	(3)	(4)	(5)	(6)
AB_OPTVOL	0.5236					
	(4.15)***					
AB_CALLVOL		0.2882				
		(5.20)***				
AB_PUTVOL			0.0155			
			(1.28)			
AB_OPTDOLLARVOL				0.0926		
				(2.87)***		
AB_CALLDOLLARVOL					0.0335	
					(3.64)***	
AB_PUTDOLLARVOL						0.0020
						(0.86)
PRICE	-0.1200	-0.1199	-0.1220	-0.1213	-0.1214	-0.1221
	(-5.42)***	(-5.41)***	(-5.49)***	(-5.46)***	(-5.47)***	(-5.49)***
SIZE	-0.0900	-0.0896	-0.0893	-0.0899	-0.0897	-0.0894
	(-5.24)***	(-5.22)***	(-5.21)***	(-5.24)***	(-5.23)***	(-5.21)***
STOCKVOL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(4.35)***	(4.31)***	(4.24)***	(4.28)***	(4.26)***	(4.23)***
MOM	1.6423	1.6640	1.6738	1.6634	1.6677	1.6844
	(3.77)***	(3.82)***	(3.85)***	(3.81)***	(3.82)***	(3.87)***
BM	-1.9099	-1.9827	-1.8068	-1.8071	-1.8129	-1.8248
	(-0.95)	(-0.99)	(-0.90)	(-0.90)	(-0.91)	(-0.91)
Year fixed effect	YES	YES	YES	YES	YES	YES
Industry fixed effect	YES	YES	YES	YES	YES	YES
Adjust R squared	0.4559	0.4546	0.4522	0.4534	0.4529	0.4520
Sample size	30117	30117	30117	30117	30117	30117

Table 5 Abnormal Trading Activities and Firms' Performance

This table reports the portfolio sorting results for abnormal call options trading (dollar) volume; firms are sorted into three groups based on the average daily announcement period's options (dollar) volume over days -1 to +1, comprising of low <30%, mid 30-70%, and high >70%, with the firm's operating performance in year t+1 being reported for each decile. Total citations are the total amount of cumulative citations from 1996 to 2006. Tobin's Q is calculated as the market value of equity plus book value of assets minus book value of equity minus balance sheet deferred taxes divided by book value of assets. Cash flow is the sum of earnings before extraordinary items and depreciation. Earnings are operating income before depreciation. *** indicates significance at the 1% level. The t-statistics include the Newey-West correction for serial correlation.

Panel A: Total Citations				
Option volume				
	Low	Mid	High	t-value
Total	664.5309	1313.0933	861.8511	(5.30)***
Call	648.4778	1325.9371	860.4758	(5.75)***
Option dollar volume				
	Low	Mid	High	t-value
Total	682.3946	1254.1582	923.9591	(6.17)***
Call	682.6103	1267.0531	906.2457	(5.85)***

Panel B: Tobin's Q				
Option volume				
	Low	Mid	High	t-value
Total	2.5575	2.9416	2.6785	(3.57)***
Call	2.5500	2.9483	2.6761	(3.73)***
Option dollar volume				
	Low	Mid	High	t-value
Total	2.5608	2.9345	2.6846	(3.70)***
Call	2.5596	2.9588	2.6528	(2.90)***

Table 5 (continued)

Panel C: Cash Flow				
Option volume				
	Low	Mid	High	t-value
Total	1088.4604	2157.8493	1453.3957	(7.22)***
Call	1076.2536	2268.3826	1488.3197	(7.12)***
Option dollar volume				
	Low	Mid	High	t-value
Total	1145.5994	2063.6865	1523.8847	(7.07)***
Call	1173.5027	2144.5727	1559.6714	(6.26)***

Panel D: Earnings				
Option volume				
	Low	Mid	High	t-value
Total	1622.1236	3137.6972	2133.4129	(7.44)***
Call	1612.0593	3301.7645	2190.8306	(7.37)***
Option dollar volume				
	Low	Mid	High	t-value
Total	1703.1259	3005.5452	2231.5491	(7.26)***
Call	1736.6858	3138.2652	2288.8695	(6.56)***

Table 6 Trading Activities and Firms' Information Asymmetry

This table presents three regressions of 3-day abnormal returns around innovation grants announcements, BHAR [-1,+1], on a grants-announcement period's options trading volume. OPTVOL, CALLVOL, and PUTVOL are average daily total, call, and put options trading volume in the period from day -1 to day +1 relative to the grants announcement. SIZE and BM are the market value of equity ($ millions) and book-to-market ratio at the beginning of the calendar year. PRICE is the stock price 20 days prior to the grants announcement, PIN is probability of informed trading, and MOM is defined as the buy-and-hold stock return over the past 12 months. The full sample period is January 1996 to December 2006. T-statistics are based on two-way clustered standard errors, clustered by firm. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable = BHAR[-1,+1]		
	(1)	(2)	(3)
PIN	-2.5974	-3.6357	-1.9502
	(-0.84)	(-1.14)	(-0.65)
OPTVOL	0.0001		
	(2.70)***		
CALLVOL		0.0003	
		(3.00)***	
PUTVOL			-0.0003
			(-2.78)***
OPTVOL*PIN	0.0004		
	(2.52)**		
CALLVOL*PIN		0.0010	
		(2.49)**	
PUTVOL*PIN			0.0005
			(1.90)*
PRICE	-0.0445	-0.0392	-0.0567
	(-3.89)***	(-3.39)***	(-4.89)***
SIZE	0.0399	0.0370	0.0448
	(4.54)***	(4.17)***	(4.96)***
STOCKVOL	0.0000	0.0000	0.0000
	(-4.46)***	(-5.10)***	(-1.36)
MOM	-0.1280	-0.1437	-0.1037
	(-0.55)	(-0.63)	(-0.44)
BM	-2.3351	-2.3894	-2.1629
	(-2.46)**	(-2.53)**	(-2.22)**
Year fixed effect	YES	YES	YES
Industry fixed effect	YES	YES	YES
Adjust R squared	0.0022	0.0035	0.0018
Sample size	65863	65863	65863

Table 7 Trading Activities and CEOs' Incentives

This table presents three regressions of 3-day abnormal returns around innovation grants announcements, BHAR [-1,+1], on a grants-announcement period's options trading volume. OPTVOL, CALLVOL, and PUTVOL are average daily total, call, and put options trading volume in the period from day -1 to day +1 relative to the grants announcement. CEO options are a dummy variable that takes the value of 1 in those cases where the CEO holds an options position larger than zero and not missing; otherwise, 0. CEO vega is a dummy variable that takes the value of 1 in those cases where the CEO vega is larger than zero and not missing; otherwise, 0. SIZE and BM are the market value of equity ($ millions) and book-to-market ratio at the beginning of the calendar year. PRICE is the stock price 20 days prior to the grants announcement, and MOM is defined as the buy-and-hold stock return over the past 12 months. The full sample period is January 1996 to December 2006. T-statistics are based on two-way clustered standard errors, clustered by firm. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: CEO options			
	Dependent variable = BHAR[-1,+1]		
	(1)	(2)	(3)
CEO options	0.2241	0.0081	0.4408
	(0.56)	(0.02)	(1.14)
OPTVOL	0.0001		
	(3.08)***		
CALLVOL		0.0003	
		(3.31)***	
PUTVOL			-0.0002
			(-1.93)*
OPTVOL*CEO options	0.0001		
	(1.06)		
CALLVOL*CEO options		0.0002	
		(1.94)*	
PUTVOL*CEO options			0.0000
			(-0.06)
Control variables	YES	YES	YES
Year fixed effect	YES	YES	YES
Industry fixed effect	YES	YES	YES
Adjust R squared	0.0027	0.0041	0.0023
Sample size	65863	65863	65863

Table 7 (continued)

Panel B: CEO Vega

	Dependent variable = BHAR[-1,+1]		
	(1)	(2)	(3)
CEO vega	-0.1368	-0.3267	0.0328
	(-0.35)	(-0.83)	(0.08)
OPTVOL	0.0001		
	(3.06)***		
CALLVOL		0.0003	
		(3.26)***	
PUTVOL			-0.0003
			(-2.00)**
OPTVOL*CEO vega	0.0001		
	(1.25)		
CALLVOL*CEO vega		0.0002	
		(2.07)**	
PUTVOL*CEO vega			0.0000
			(0.25)
Control variables	YES	YES	YES
Year fixed effect	YES	YES	YES
Industry fixed effect	YES	YES	YES
Adjust R squared	0.0027	0.0042	0.0023
Sample size	65863	65863	65863

Table 8 Robustness for Trading Activities around Innovation Grants Events

This table presents six regressions of 3-day abnormal returns around innovation grants announcements, BHAR [-1,+1], on a grants-announcement period's options trading (dollar) volume. Abnormal buy-and-hold return is the stock's buy-and-hold return less the buy-and-hold return of the stock's size decile. CALLVOLATM, CALLVOLOTM, and CALLVOLITM are average daily at-the-money call (ATM), out-of-money (OTM) call, and in-the-money (ITM) call trading volume in the period from day -1 to day +1 relative to the grants announcement. CALLDOLLARVOLATM, CALLDOLLARVOLOTM, and CALLDOLLARVOLITM are average daily ATM call, OTM call, and ITM call trading dollar volume in the period from day -1 to day +1 relative to the innovation grants announcement. STOCKVOL is the average dollar stock trading volume from day -20 to day -11 relative to the grants announcement. SIZE and BM are the market value of equity ($ millions) and book-to-market ratio at the beginning of the calendar year. PRICE is the stock price 20 days prior to the grants announcement. MOM is defined as the buy-and-hold stock return over the past 12 months. The full sample period is January 1996 to December 2006. T-statistics are based on two-way clustered standard errors, clustered by firm. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable = BHAR[-1,+1]					
	(1)	(2)	(3)	(4)	(5)	(6)
CALLVOLATM	0.0015					
	(5.51)***					
CALLVOLOTM		0.0010				
		(2.20)**				
CALLVOLITM			0.0008			
			(1.90)*			
CALLDOLLARVOLATM				0.0005		
				(4.16)***		
CALLDOLLARVOLOTM					0.0001	
					(1.31)	
CALLDOLLARVOLITM						0.0001
						(1.28)
PRICE	-0.0184	-0.0679	-0.0485	-0.0514	-0.0775	-0.0549
	(-1.48)	(-4.13)***	(-3.70)***	(-4.99)***	(-4.89)***	(-4.28)***
SIZE	0.0128	0.0338	0.0153	0.0197	0.0369	0.0181
	(1.52)	(3.30)***	(1.76)*	(2.56)**	(3.86)***	(2.27)**
STOCKVOL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(-5.31)***	(-2.62)***	(-3.74)***	(-5.08)***	(-2.08)**	(-3.66)***
MOM	0.2993	0.8521	1.3794	0.2467	0.8424	1.3731
	(0.50)	(1.56)	(2.52)**	(0.42)	(1.54)	(2.51)**
BM	-3.9349	-1.6599	-1.4051	-4.5719	-1.7225	-1.4463
	(-2.98)***	(-1.06)	(-1.10)	(-3.30)***	(-1.09)	(-1.12)
Year fixed effect	YES	YES	YES	YES	YES	YES
Industry fixed effect	YES	YES	YES	YES	YES	YES
Adjust R squared	0.0032	0.0016	0.0031	0.0055	0.0014	0.0028
Sample size	57196	64717	60743	57196	64717	60743

Table A-1

Table A-1 shows the percentage of cumulative citations amounts for each announced patent granted from 1996 to 2006. The amounts of cumulative citations are calculated by the total times of citations over the 10 years for each announced patent granted from 1996 through 2006. For example, if a patent, which was granted in 1996, has been totally cited 10 times from 1996 to 2006 (over 10 years), then it will be classified into the group of 0-10 total citations for 1996. The data source is from the National Bureau of Economic Research (NBER) website: https://sites.google.com/site/patentdataproject/Home/downloads.

Cumulative Citations (times)	The Year that a Patent Was Granted										
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	6.41	7.55	8.31	9.94	12.48	16.34	23.83	33.85	50.61	74.88	96.93
0-10	55.72	58.00	60.76	63.69	66.46	68.77	68.32	62.73	48.50	25.05	3.07
10-20	19.86	18.91	17.69	15.61	13.35	10.21	5.86	2.70	0.73	0.06	0.00
20-30	7.97	7.19	6.22	5.35	4.16	2.64	1.25	0.50	0.08	0.01	0.00
30-40	3.82	3.41	2.90	2.38	1.64	1.02	0.41	0.13	0.01	0.00	0.00
40-50	2.13	1.74	1.54	1.19	0.83	0.49	0.18	0.04	0.06	0.00	0.00
50-60	1.33	1.01	0.81	0.61	0.40	0.24	0.07	0.02	0.01	0.00	0.00
60-70	0.79	0.64	0.51	0.39	0.26	0.10	0.03	0.02	0.00	0.00	0.00
70-80	0.53	0.43	0.35	0.25	0.14	0.07	0.02	0.01	0.00	0.00	0.00
80-90	0.43	0.31	0.25	0.19	0.09	0.04	0.02	0.00	0.00	0.00	0.00
90-100	0.27	0.17	0.18	0.09	0.05	0.03	0.01	0.00	0.00	0.00	0.00
Above 100	0.74	0.64	0.47	0.32	0.12	0.05	0.01	0.00	0.00	0.00	0.00
Total	100	100	100	100	100	100	100	100	100	100	100

Table A-2

This table presents the mean and the standard deviation (std.) statistics on call option trading (dollar) volumes for the categories of moneyness. We sort the observations into three groups of moneyness, where moneyness is defined as S/K, the ratio of the stock price S to the strike price K. Out-of-the-money (OTM) corresponds to S/K ranging from 0.80 to 0:95, at-the-money (ATM) corresponds to S/K ranging from 0.95 to 1.05, and in-the-money (ITM) corresponding to S/K range from 1.05 to 1.20. The full sample period is January 1996 to December 2006.

Moneyness	Volume (Mean)	Dollar volume (Mean)	Volume (Std.)	Dollar volume (Std.)
ATMC	985.9832	2845.6319	2883.7039	11332.0303
OTMC	586.3388	1871.2415	2482.2637	23727.3749
ITMC	356.8060	2269.0307	2427.8957	26859.7697