

Innovation efficiency and stock market reaction to corporate innovation: The role of options trading and investor attention

Zih-Ying Lin and Tao-Hsien Dolly King*

* Zih-Ying Lin is at the Department of Finance and International Business, Fu Jen Catholic University, Taiwan. Tao-Hsien Dolly King (corresponding author) is at the Department of Finance, University of North Carolina at Charlotte, 9201 University City Blvd. Charlotte, NC 28223, USA; Email: tking3@charlotte.edu. The authors are extremely grateful to the Fundamental Research Funds from the National Science and Technology Council of Taiwan for their financial support given to this study.

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ABSTRACT

This research examines how innovation efficiency predicts the returns of patent grant announcements when firms previously applied for patents on days with higher options trading activity. We find that innovation efficiency positively predicts future announcement returns. This relationship is more significant when investor attention is less distracted, which we capture using fewer concurrent announcements and non-Friday announcements as proxies for lower distraction. Our results suggest that options trading activity can enhance the predictive power of innovation efficiency. We further examine how this predictability extends to future firm performance and selling, general, and administrative (SG&A) expenses, particularly when options trading volume is elevated in the days leading up to patent application announcements. We continue to find that options trading activity enhances the positive predictability of firm performance and the negative predictability of expenses.

Keywords: Options trading; innovation efficiency; patent announcement; investor attention.

JEL Classification: G14, G12, O31.

1. Introduction

Prior research has demonstrated that options markets embed valuable information, which can be used to forecast future stock returns (Cremers and Weinbaum, 2010; Pan and Poteshman, 2006; Roll et al., 2010). Building on this foundation, subsequent studies employ option-implied information measures to anticipate stock performance following various corporate events, including earnings announcements (Atilgan, 2014), mergers and acquisitions (Augustin et al., 2019; Chan et al., 2015), spin-offs (Augustin et al., 2020), bankruptcy filings (Ge et al., 2019), stock splits (Gharghori et al., 2017), share repurchases (Hao, 2016), and changes in analyst recommendations (Hayunga and Lung, 2014). Few studies examine the relationship between options volume and firms' innovation. Blanco and Wehrheim (2017) investigate how financial derivatives affect corporate innovation and find a positive relationship between options volume and patent output, measured by patent citations. Bernile et al. (2025) suggest that the listing of options is associated with superior innovation outcomes. Although there is limited research on firms' patent announcements, Li et al. (2024) focus on patent grant announcements and show that the option-to-stock volume (O/S) ratio effectively predicts future patent quality. As mentioned above, we infer that options trading may contain information about patents and that firms with higher options trading activity tend to generate more favorable patent outcomes.

Patent-related announcements involve application and grant events, separated by an average time lag of over three years, unlike most corporate events. While prior research has primarily examined patent grant announcements (Kogan et al., 2017; Li et al., 2024), it remains unclear whether relevant patent information is released before the grant event, such as at application filing. We conjecture that valuable information regarding the patent is released and picked up by market participants at the time of the application. Information conveyed can signal the quality of the patent and the

probability of being granted, thus predicting stock price reaction to grant announcements and affecting post-grant firm value. To proxy for the information released at the time of application, we construct a measure of innovation efficiency. Patent applications are viewed as indicators of innovation outcomes, whose value can be estimated by the total dollar value associated with the application. By dividing the patent value by R&D expenditure, we arrive at a measure of R&D efficiency in generating innovation dollars. Following Shen and Zhang (2018), we refer to this measure as innovation efficiency. In this study, we examine how innovation efficiency serves as a predictor for grant announcement returns and firm value. Given the information contained in options trading and its link to corporate innovation, we analyze the role of options trading in the relationship between innovation efficiency and grant announcement returns or firm value.

This study integrates insights from behavioral finance by exploring how investor attention affects the impact of options trading on the predictive power of innovation efficiency on the stock reaction to patent grant announcements. One way to measure investor attention is by using competing announcements. Hirshleifer et al. (2009) use the number of announcements made on the same day as a proxy for investor information overload and suggest that when more competing announcements occur on a single day, investors are less attentive to individual announcements. Frederickson and Zolotoy (2016) find that when faced with competing earnings announcements, investors prioritize based on a firm's visibility. Wang et al. (2018) suggest that fewer competing announcements attract more investor attention and lead to a stronger stock market response. Based on previous studies, we use the number of competing announcements on the same date as a proxy for investor attention.

Another way to capture investor attention using the announcement date is by considering whether it falls on a Friday. Della et al. (2009) suggest that investors pay

less attention to stock valuations on Fridays, resulting in them being less attentive to earnings announcements released on Fridays compared to those made on other days. They find that Friday announcements are associated with more muted initial stock market reactions, followed by stronger post-announcement stock price drifts. Similarly, Louis and Sun (2010) find that investors pay less attention to merger announcements made on Fridays, resulting in weaker market reactions. Wang et al. (2018) also examine the impact of Fridays on earnings announcement returns, particularly when options trading volume is high before the announcement. They find that stock market responses are stronger for announcements made on non-Fridays. Based on these findings, we examine the timing of announcements (Friday vs. non-Friday) as a way to capture investor attention and analyze how investor distraction influences the link between innovation efficiency and stock market reactions.

Innovation is crucial to firm growth (Bloom and Van Reenen, 2002; Pástor and Veronesi, 2009). Studies have suggested that using patents and citations to measure innovation quality is associated with firm value and corporate decision-making (Bena and Li, 2014; Hall et al., 2005). If options trading volumes reflect information regarding patent quality, they should add to the information reflected by innovation efficiency in analyzing patent applications and enhance the predictive power of innovation efficiency on post-grant firm value. We examine firms' performance in the year following a patent grant and assess whether innovation efficiency predicts future firm value, especially when the patent application announcement is accompanied by high options trading volumes.

Our results are summarized as follows. First, we find that innovation efficiency constructed at the time of the patent application significantly and positively predicts stock returns around patent grant announcements. This suggests that disclosing a firm's innovation efficiency at the time of the patent application signals valuable information

about patent quality, which can predict future stock performance. Second, we examine how options trading activity affects the predictability of innovation efficiency. The results show that options trading at the time of patent application positively enhances the relationship between innovation efficiency and stock returns around grant announcements. More importantly, options trading volume at patent application announcement is found to reflect insightful information about patent quality and therefore adds to the predictive power of innovation efficiency. Third, we consider the effect of investor attention and examine whether increased investor attention during patent application announcements leads to improved predictability of innovation efficiency. Our results show that the predictive power of innovation efficiency is stronger when there are fewer application announcements on the same day or when the announcements are not made on a Friday. Finally, we find that innovation efficiency helps predict future firm performance and SG&A expenses, particularly when options trading activity is high at the time of patent application. This result lends further support for the argument that innovation efficiency and options trading reflect or impound information related to the patent at the time of application, leading to impacts on future firm performance.

The rest of the paper is organized as follows: Section 2 details the development of our hypotheses; Section 3 presents the data, empirical methodology, and empirical measures used; Section 4 discusses the empirical results and additional issues; and Section 5 provides the conclusions.

2. Hypotheses

As discussed above, we argue that information disclosed at the time of patent application signals patent quality and prospects and can predict grant announcement returns. Innovation efficiency, the dollar value of innovation outcome (i.e., patent

applications) relative to R&D expenses, proxies for the information released at the time of application. In other words, innovation efficiency, a proxy for patent information, is a predictor of stock price reaction to grant announcements. We further consider the role of options trading in this relation. It has been well documented that options trading before patent grant announcement contains information about patent quality (Li et al., 2024). We conjecture that patent application announcements also contain valuable information about patent quality and prospects. Informed traders, who are sophisticated investors, may have private information that is released through their trading activity in the pre-application period. Thus, options trading at the time of application offers insights into patent quality, thereby serving as an information source complementary to innovation efficiency.

Note that speculative or transient investors can also trade in the pre-patent application period, i.e., not all trades are by informed traders. For example, speculative investors can adopt a straddle strategy before the application announcements and earn a profit from the anticipated price volatility (Gao et al., 2018). Regardless of the specific incentives (information, trading strategy, or others) driving investors to trade options, heightened investor attention before patent application announcements leads to more active pre-patent application options trading. Israeli et al. (2022) utilize overall trading volume to measure investor attention and suggest that investors are susceptible to distractions in their reactions to earnings announcements. As a result, pre-patent options trading also serves as a proxy for investor attention.

Based on the above discussion, pre-patent application options trading conveys patent information and serves as a proxy for investor attention. To the extent that more information conveyed and increased investor attention enhance the predictability of innovation efficiency, we expect that patent application events with a higher level of options trading exhibit stronger predictability of grant announcement returns and are

associated with more favorable post-grant firm performance. Our first hypothesis is formulated as follows:

Hypothesis 1: Innovation efficiency at the time of patent application predicts patent grant announcement returns or post-grant firm performance. The link is stronger when the pre-application options trading is higher.

We further consider the synergistic effects of pre-application options trading and other measures of investor attention in Hypotheses 2 and 3. We focus on two widely used proxies for investor attention: (1) the number of announcements made on a single day and (2) whether the announcement is made on a Friday versus a non-Friday. Hirshleifer et al. (2009) use the number of announcements made on a single day as a measure of information overload. When more competing announcements are made on the same day, investors are exposed to greater distraction, making them less attentive to each announcement. Wang et al. (2018) also find that the stock market's response is stronger when fewer events are announced on the same day. By combining information overload with pre-application options trading, we derive a number of testable implications. By dividing the sample into two groups based on the number of announcements made on a single day, we examine whether the effect of pre-application options trading on the predictability of innovation efficiency on grant announcement returns differs between the two groups. Given that increased investor attention enhances the stock market reaction, we expect innovation efficiency to have stronger predictability of stock price reaction to grant announcements when pre-patent-application options trading is high, and the patent application occurs on days with fewer competing announcements. The second hypothesis is formulated as follows:

Hypothesis 2: The predictability of innovation efficiency should be stronger when

pre-patent application options trading is high and when there are fewer competing announcements on the announcement date.

Della et al. (2009) examine earnings announcements and find that those made on Fridays lead to an immediate stock reaction that is 15% weaker, while the delayed market response is 70% stronger, compared to announcements made on other weekdays. This suggests that investors are less attentive to earnings news released on Fridays. Wang et al. (2018) find that the stock market's response is stronger when announcements are on non-Fridays, especially when options trading is higher before earnings announcements. We thus use the distinction between Friday and non-Friday announcements to capture variations in investor attention during patent application announcements. Specifically, we categorize all patent application announcements into two groups based on whether the announcement date falls on a Friday or not, and then compare the effect of pre-application options trading across these groups. Assuming investors are indeed more distracted on Fridays, we hypothesize that innovation efficiency at application announcements with higher pre-application options trading and that are made on non-Fridays should exhibit stronger predictability of grant announcement returns. Based on this reasoning, we construct our third hypothesis as follows:

Hypothesis 3: The predictability of innovation efficiency is expected to be stronger for application announcements with an elevated pre-patent application options trading and occurring on non-Fridays.

3. Data and Methodology

This section details the data and empirical models that form the basis of our analysis. In Section 3.1, we introduce our primary dataset, which includes key patent-related metrics—grant dates, application dates, innovation value, and forward

citations—along with market variables such as options trading volume and open interest. The sample period spans January 1996 through December 2022. Section 3.2 then presents our baseline regression model and discusses the integration of options trading volume into the analysis.

3.1 Sample construction

Our primary data on innovation value and patent citations is sourced from the Patent Citation Data File provided by Professor Stoffman’s website. This file includes the aggregate value of innovation (both nominal and CPI-deflated to 1982 dollars), forward citations, patent application announcement dates, and patent grant announcement dates. The patent data, which covers the period from 1996 to 2022, is consistent with the methodology described in Kogan et al. (2017). Market and accounting variables were collected from the following sources: firms’ stock prices are obtained from the Center for Research in Security Prices (CRSP), all accounting data are matched using the Standard & Poor’s (Compustat) database, and options trading volumes are sourced from OptionMetrics. For sample consistency, we exclude finance and utility firms (CRSP share codes 10 and 11). The final sample consists of 1,190,771 patent grant/application announcements spanning 1996 to 2022. This corresponds to 15,340 firm-year observations for patent grants and 14,506 firm-year observations for patent applications. Table 1 provides a detailed breakdown of the event counts and firms included in our sample. We observe a generally increasing pattern in the number of grant or application events over time. The peak occurs in 2019 for grants and 2012 for applications. We can see that the number of grant events in 1996 and 1997, or the number of application events in 2021 and 2022, is quite small. Most patent grants in 1996 and 1997 were applied for before 1996, and most applications in 2021 and 2022 have not yet been granted. Additionally, our sample covers 38 industries. The industries

with the largest patent holdings are classified under the two-digit SIC codes 36 (Electrical and Electronic Equipment), 73 (Business Services), and 35 (Industrial and Commercial Machinery and Computer Equipment).

<TABLE 1 ABOUT HERE>

Table 2 shows a summary of the variables used in this study, including their means, standard deviations, and the 10th, 50th, and 90th percentiles. We find that the abnormal patent grant announcement return has a positive mean value, implying that a firm's patent grant is viewed as good news by the stock market. Innovation efficiency measures, including the value of innovation and forward citations, have means between 1.5 and 2.5, indicating that R&D investment is generating a solid return of innovation outcomes. We also present the summary statistics of the control variables. Following Wang et al. (2018), we first include stock trading volume (StkVol), past stock return (PastRet), stock price runup (Runup), and firm size (SIZE). Drawing from the innovation literature (Blanco and Wehrheim, 2017; Shen and Zhang, 2018; Li et al., 2024), we include asset intangibility (INTAN), leverage (LEV), cash ratio (CASH), and cash flow (CF) as additional control variables. The summary statistics of the control variables are qualitatively consistent with those in the existing literature. Table A1 provides the definitions of all variables.

<TABLE 2 ABOUT HERE>

3.2 Empirical specification

We examine the predictive power of innovation efficiency for stock returns around patent grant announcements by estimating the following regression model. The first specification is as follows:

$$\begin{aligned}
AnnRet_{i,[t-1,t+1]} = & \omega_0 + \omega_1 INNOefficiency_i + \omega_2 StkVol_{i,t-31} + \\
& \omega_3 PastRet_{i,[t-210,t-31]} + \omega_4 Runup_{i,[t-30,t-2]} + \omega_5 SIZE_{i,t-31} + \\
& \omega_6 INTAN_{i,y} + \omega_7 LEV_{i,y} + \omega_8 CASH_{i,y} + \omega_9 CF_{i,y} + \varepsilon_{i,t}
\end{aligned} \tag{1}$$

where *AnnRet* is the cumulative abnormal returns cumulated over the event window [t-1, t+1], and t is the patent grant announcement date. *INNOefficiency* measures innovation efficiency as innovation dollar value or forward citations divided by the firm's R&D expenses in year ya-1 or ya-2. Year ya is the fiscal year ending closest to the patent application announcement date t. Similar to Shen and Zhang (2018), we use three types of innovation efficiency measures. The first measure is *xi_nomial1* (*xi_nominal2*), which is the aggregate nominal innovation value of patents applied by firm i in year ya, divided by the firm's inflation-adjusted R&D expenses in year ya-1 (ya-2). The second measure is *xi_real1* (*xi_real2*), which is the aggregate real innovation value, based on patents applied by firm i in year ya, divided by the inflation-adjusted R&D expenses in year ya-1 (ya-2). The third measure is *cites1* (*cites2*), which is the aggregate number of forward citations to patents applied for by firm i in year ya, scaled by the inflation-adjusted R&D expenses in year ya-1 (ya-2). Each grant event has an *INNOefficiency* value based on its application year (ya).

Because we focus on cumulative abnormal returns, we control for stock trading activity by including stock trading volume (*StkVol*), past return (*PastRet*), and stock price run-up (*Runup*). In particular, *Stkvol* is the average stock trading volume during the month prior to the patent grant announcement date t, where trading volume is defined as the number of shares traded scaled by the number of shares outstanding. *PastRet* is defined as the buy-and-hold stock return cumulated over [t-210, t-31]. *Runup* is defined as the abnormal stock returns cumulated over [t-30, t-2]. Firm size (*SIZE*) is defined as the natural logarithm of the product of shares outstanding and the closing

price on day $t-31$. We also include firm characteristics as additional control variables, including asset intangibility (INTAN), leverage (LEV), cash ratio (CASH), and cash flow (CF) at grant announcement year y . We control for the firm-fixed, industry-fixed, and year-fixed effects in our regression model. The standard error is clustered at the firm level.

We further incorporate the role of options trading into our framework by including an interaction term between innovation efficiency and an options trading variable. The regression equation is specified as follows:

$$\begin{aligned}
AnnRet_{i,[t-1,t+1]} = & \omega_0 + \omega_1 INNOefficiency_i + \omega_2 op130d + \\
& \omega_3 INNOefficiency_i \times op130d + \omega_4 StkVol_{i,t-31} + \\
& \omega_5 PastRet_{i,[t-210,t-31]} + \omega_6 Runup_{i,[t-30,t-2]} + \omega_7 SIZE_{i,t-31} + \\
& \omega_8 INTAN_{i,y} + \omega_9 LEV_{i,y} + \omega_{10} CASH_{i,y} + \omega_{11} CF_{i,y} + \varepsilon_{i,t}
\end{aligned} \tag{2}$$

where the options trading volume is defined as the trading volume scaled by open interest, averaged over the 30-day window $[t-30, t-1]$, where t is the patent application announcement date. $op130d$ is a dummy variable equal to one if the options trading volume is above the median options trading volume during the sample period, and zero otherwise.

4. Empirical Results

This section examines how innovation efficiency predicts patent grant announcement return. Section 4.1 presents the baseline regression results and the exploration of several channels supporting the predictability of innovation efficiency on grant announcement returns. Section 4.2 examines how the options activities enhance the predictability power of innovation efficiency. Section 4.3 reports the robustness tests of excluding earnings announcements and deleting winner or loser

stocks near the patent application events. We also show results using different options trading activity windows. Section 4.4 investigates the effect of investor attention. Section 4.5 discusses how innovation efficiency affects future performance.

4.1 Baseline regression results

As discussed above, we use three measures for innovation efficiency calculated at the time of the patent application to predict the announcement returns around grant announcements. We run the regression model specified in Equation (1) and present the baseline results in Table 3. In particular, we regress the grant announcement returns on innovation efficiency as the variable of interest, with stock price activity and firm characteristics as control variables. We find that innovation efficiency positively predicts the stock market reaction to patent grant announcements, particularly when measured using nominal and real (CPI-adjusted) innovation value and scaled by previous one or two years' R&D expenses. However, innovation efficiency measured by forward patent citations does not effectively predict the announcement returns. More forward citations do not necessarily indicate higher innovation value. To further support our arguments, we re-run the analysis using a subsample where innovation value and forward citations are greater than the sample-period median and report the results in Table A2. The coefficients of innovation efficiency based on forward citations are significantly positive, regardless of whether we consider R&D expenses lagged by one or two periods. This implies that using forward citations as a measure of innovation efficiency may not be as strong as a driver compared to the other two measures. We explore the effectiveness of these measures further in the analysis below.

<TABLE 3 ABOUT HERE>

4.2 The effect of options trading activities

Previous studies indicate that options trading volume prior to a firm's

announcement contains information and can predict future announcement returns (Atilgan, 2014; Chan et al., 2015; Hao, 2016). If options help disseminate information, then options trading volume may enhance the predictability of innovation efficiency. Wang et al. (2018) find that the stock market's response is stronger when options trading volume is higher before earnings announcements. Li et al. (2024) suggest that option-implied information prior to patent grant announcements reveals information about patent quality. Building on this, we further examine the role of options trading in the context of patent application announcements. Based on the options trading volume in the 30 days before the application announcement, we use *op130d*, a dummy variable equal to one if the options trading volume is above the median, to represent the level of options trading activity. We run the empirical model as specified in Equation (2), which contains the interaction of innovation efficiency and the options trading variable. Table 4 reports the results. We find that the coefficient of the interaction term between options trading and innovation efficiency is significantly positive, regardless of the proxy used for innovation efficiency. This suggests that options trading conveys information related to patents and enhances the ability of innovation efficiency to positively predict market reactions. We note that forward citations have a significant and positive impact on grant announcement returns when options trading is high. This finding indicates that forward citations remain a solid predictor, conditioning on an environment with active options activity. Overall, our results are consistent with Hypothesis 1.

<TABLE 4 ABOUT HERE>

4.3 Robustness tests

Li et al. (2024) and Chu et al. (2025) highlight the importance of accounting for the impact of other informational corporate events occurring near the announcement dates under investigation. To address this concern, we first consider one of the most

influential and periodic corporate announcements, earnings reports. To minimize the potential impacts of earnings announcements on our analysis, we exclude observations where the patent application announcement date falls within five days of an earnings announcement and rerun the regression model shown in Equation (2). The results reported in Panel A of Table 5 remain qualitatively similar to those reported in Table 4. In addition, the literature suggests that one of the most notable events for stocks is being listed as a winner or loser for the day. Following Li et al. (2021) and Choy and Wei (2023), we consider stock performance prior to the patent application announcement by identifying “winner” and “loser” stocks. We rank stocks based on their daily returns, with winners and losers defined as the top/best 80 and bottom/worst 80 stocks in the CRSP universe, respectively (Kumar et al., 2019; Li et al., 2021). If a firm’s stock is a winner or loser on the trading day before the patent application announcement date, we delete the associated observation from our sample. Panel B presents the results after excluding the winner- or loser-linked observations. We find that the results are consistent with our main findings shown in Table 4.

<TABLE 5 ABOUT HERE>

The primary analysis centers on options trading activity within the $[t-30, t-1]$ window. To validate the findings presented in Table 4, we further analyze pre-announcement options trading using two alternative event windows, a 3-day window of $[t-1, t+1]$ and a 6-day window of $[t-7, t-2]$, where t is the patent application date. Similarly, we define $op123d$ ($op27d$) to be a dummy variable equal to one if the options trading volume is above the median, and zero otherwise. Panel A of Table 6 presents the results when the three-day window is used. We find that the coefficients of the interaction term of innovation efficiency and options trading variable are significantly positive for all three innovation efficiency measures. Panel B results based on the 6-day window remain robust by yielding significant and positive coefficients on the

interaction variable. Overall, the robustness tests in which we minimize the potential impacts of other informational announcements and adopt alternative windows of options trading activity confirm the robustness of the main findings.

<TABLE 6 ABOUT HERE>

4.4 The effect of investor attention

We examine how investor attention affects the role of options in the predictive power of innovation efficiency and link this to behavioral finance considerations. Hirshleifer et al. (2009) point out that when multiple competing announcements are made on the same day, investors are less attentive to each announcement. Similarly, Wang et al. (2018) suggest that fewer competing announcements can attract more investor attention and enhance the stock market's response. Based on this, we sort all patent application announcements into two groups: "many announcements" when the number of same-day events exceeds the median number of announcements for that day, and "few announcements" otherwise. We expect that the observations in the "few announcements" group should receive more investor attention; therefore, the enhancing effect of options trading on the link between innovation efficiency and grant announcement returns should be stronger than the events in the "many announcements" group.

Panel A of Table 7 presents the results for the "many announcements" group, and Panel B shows the results for the "few announcements" group. The coefficients on the interaction term between innovation efficiency and options trading activity for the "few announcements" group are all positive and more statistically significant compared to those in the "many announcements" group. This finding suggests that when fewer competing announcements occur on the announcement date, investor attention is more concentrated on the information related to the patent application, thereby strengthening the impact of options trading on the predictability of innovation efficiency.

<TABLE 7 ABOUT HERE>

Announcements made on Fridays may distract investors more than those made on other days. Della et al. (2009) indicate that investors pay less attention to stock valuations on Fridays, making them less attentive to earnings announcements released on Fridays compared to those made on non-Fridays. Similarly, Louis and Sun (2010) find that investors are less responsive to merger announcements made on Fridays, resulting in weaker stock market reactions. Wang et al. (2018) also find that the market response is stronger for announcements made on non-Fridays. Using the patent application dates, we separate the sample into Friday announcements and non-Friday announcements groups. We rerun the regression model specified in Equation (2) and report the results in Table 8. Panel A presents the results for the Friday group. The results show that none of the coefficients on the interaction term are significant across all six regressions. On the other hand, the results for the non-Friday group in Panel B indicate that all the coefficients on the interaction term between innovation efficiency and options trading activity are positive and statistically significant. This result suggests that the predictive power of innovation efficiency, amplified by options trading, is stronger when announcements are made on days when investor attention is less distracted. In sum, our findings are consistent with both Hypotheses 2 and 3.

<TABLE 8 ABOUT HERE>

4.5 Future firm performance

Prior research highlights the importance of innovation as a key driver of firm growth (Bloom and Van Reenen, 2002; Pástor and Veronesi, 2009). The quality of innovation is associated with firm value and plays a significant role in shaping corporate decision-making (Bena and Li, 2014; Hall et al., 2005). Thus, we investigate the extent to which innovation efficiency predicts firm performance after a patent grant

announcement. We use Tobin's Q and selling, general, and administrative (SG&A) expenses as proxies for firm performance and operating costs, respectively (Chu et al., 2025). Based on the empirical model shown in Equation (2), we replace the dependent variable AnnRet with Tobin's Q (SG&A) and report the regression results in Table 9. Panel A presents that innovation efficiency positively predicts future firm performance in the years following the patent grant announcement, and options trading activity enhances this predictive power, particularly when innovation efficiency measures are based on the nominal and real value of patents. Conversely, Panel B indicates that higher innovation efficiency is associated with lower future SG&A expenses. However, options trading activity before the patent application announcement does not help strengthen this negative relationship.

<TABLE 9 ABOUT HERE>

5. Conclusions

This paper explores the role of investor attention in the predictability of innovation efficiency in stock returns following patent grant announcements. Using pre-application announcement options trading as a proxy for investor attention, we find that higher investor attention leads to faster incorporation of new information, particularly in the presence of more active options trading, which further enhances the predictability of innovation efficiency. Additionally, we adopt two alternative proxies for investor attention and find strong evidence that when investors are most attentive, the predictability of innovation efficiency is stronger. The predictability is weaker when investors are least attentive.

Our findings highlight the importance of investor attention in explaining the predictability of innovation efficiency. We posit that informed traders may trade options to capitalize on their private information, making them highly attentive investors. However, pre-patent application options trading may also be driven by other motives,

such as speculation. For example, speculative investors may engage in trading strategies like straddles to profit from anticipated price volatility. Regardless of whether options trading is motivated by private information or speculation, heightened investor attention prior to patent application announcements consistently leads to more active pre-application options trading. While interpreting innovation efficiency based on the scientific value of a patent presents challenges, investor attention may help uncover useful information through trading signals associated with a firm's patents.

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Table A1. Variable definitions

Variable	Definition	Source
xi_nominal1 xi_nominal2	xi_nominal1 (xi_nominal2) is the aggregate value of innovation in millions of nominal dollars that was applied for by firm i in year ya, scaled by the R&D expense in year ya -1 (ya -2) in millions of dollars.	Professor Stoffman's website/Compustat
xi_real1 xi_real2	xi_real1 (xi_real2) is the aggregate value of innovation deflated to 1982 dollars using the CPI that was applied for by firm i in year ya, scaled by the R&D expense in year ya -1 (ya -2) in millions of dollars.	Professor Stoffman's website/Compustat
cites1 cites2	cites1 (cites2) is the aggregate number of forward citations that were applied for by firm i in year ya, scaled by the R&D expense in year ya -1 (ya -2).	Professor Stoffman's website/Compustat
op130d	Options trading volume scaled by the open interest, averaged over [t-30, t-1], where t is the patent application announcement date. op130d equals one if this value is above the median for the sample period, and zero otherwise.	OptionMetrics
op123d	Options trading volume scaled by the open interest, averaged over [t-1, t+1], where t is the patent application announcement date. op130d equals one if this value is above the median for the sample period, and zero otherwise.	OptionMetrics
op27d	Options trading volume scaled by the open interest, averaged over [t-7, t-2], where t is the patent application announcement date. op130d equals one if this value is above the median for the sample period, and zero otherwise.	OptionMetrics
AnnRet	The announcement return is defined as the abnormal returns based on the market model and cumulated over the event window [t-1, t+1], where t is the patent grant announcement date.	CRSP
Runup	The pre-announcement stock price run-up is defined as the abnormal stock returns based on the market model and cumulated over [t-30, t-2], where t is the patent grant announcement date.	CRSP
PastRet	Past stock return is defined as the buy-and-hold stock return cumulated over [t-210, t-31], where t is the patent grant announcement date.	CRSP
SIZE	Firm size is the natural logarithm of shares outstanding multiplied by the closing price on date t-31, where t is the grant announcement date.	CRSP
Stkvol	The average stock trading volume in the 1 month before the patent grant announcement date t, which trading volume is defined as shares traded scaled by the number of shares outstanding.	CRSP
INTAN	Intangible assets scaled by the book value of total assets measured in year y-1, where y is the grant announcement year.	Compustat
LEV	Leverage ratio measured by the sum of short-term debt and long-term debt scaled by the market value of total assets in year y-1, where y is the grant announcement year.	Compustat

CASH	Cash ratio measured by cash scaled by the book value of total assets in year y-1, where y is the grant announcement year.	Compustat
CF	Cash flow is the sum of income before extraordinary items and depreciation and amortization, scaled by the net PP&E in year y-1, where y is the grant announcement year.	Compustat
Tobin's Q	The book value of assets minus book value of equity plus market value of equity divided by book value of assets in year y+1, where y is the grant announcement year.	Compustat
SG&A	The annual selling, general, and administrative expenses deflated by total sales in year y+1, where y is the grant announcement year.	Compustat

Table A2. Innovation efficiency and grant announcement returns: Above median subsample only

This table presents sub-sample regression results examining the relationship between innovation efficiency and announcement returns, conditional on innovation value and forward citations being above the median. Innovation efficiency includes the value of innovation in millions of nominal dollars, the value of innovation deflated to 1982 (million) dollars using the CPI, and forward citations. Table A1 summarizes the variable definitions and data sources. The interaction between industry and year fixed effects and firm fixed effects are considered. T-statistics are reported in parentheses and standard errors clustered at the firm level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	AnnRet					
xi_nominal1	0.0028***					
	(7.22)					
xi_real1		0.0029***				
		(6.98)				
cites1			0.0015***			
			(3.79)			
xi_nominal2				0.0023***		
				(7.84)		
xi_real2					0.0024***	
					(7.51)	
cites2						0.0013***
						(3.82)
StkVol	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000
	(-0.81)	(-0.79)	(-0.10)	(-0.77)	(-0.75)	(-0.13)
PastRet	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001
	(-0.08)	(-0.10)	(-0.13)	(-0.07)	(-0.09)	(-0.12)
Runup	-0.0268***	-0.0268***	-0.0261***	-0.0267***	-0.0266***	-0.0260***
	(-6.11)	(-6.10)	(-5.93)	(-6.11)	(-6.10)	(-5.93)
SIZE	-0.0073***	-0.0073***	-0.0063***	-0.0072***	-0.0071***	-0.0062***
	(-6.32)	(-6.32)	(-5.44)	(-6.23)	(-6.22)	(-5.43)
INTAN	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000
	(-0.10)	(-0.05)	(-0.05)	(-0.17)	(-0.12)	(-0.10)
LEV	0.0105***	0.0103***	0.0066***	0.0096***	0.0094***	0.0064***
	(4.28)	(4.22)	(2.95)	(4.10)	(4.04)	(2.90)
CASH	-0.0144*	-0.0143*	-0.0133**	-0.0122*	-0.0122*	-0.0123*
	(-1.94)	(-1.92)	(-1.97)	(-1.71)	(-1.70)	(-1.86)
CF	0.0002	0.0001	0.0012	0.0004	0.0003	0.0013
	(0.08)	(0.06)	(0.66)	(0.20)	(0.18)	(0.68)
Intercept	0.1206***	0.1211***	0.1074***	0.1190***	0.1193***	0.1077***
	(5.81)	(5.88)	(5.15)	(5.76)	(5.81)	(5.16)
Fixed effects	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm
N	287847	287847	287847	287847	287847	287847
adj. R^2	0.027	0.027	0.026	0.027	0.027	0.026

Table1. Number of patent grant announcements and number of firms by year

This table reports the number of patent grants and application announcements, as well as the number of firms by year, for the sample period from 1996 to 2022. It also shows the average number of days between the patent application date and the patent grant date.

Grant year	No. of grant events	No. of firms	Application year	No. of application events	No. of firms
1996	212	75	1996	24,358	434
1997	5071	295	1997	32,240	573
1998	18,288	483	1998	30,420	583
1999	25,543	565	1999	31,330	567
2000	27,688	573	2000	37,399	615
2001	23,168	568	2001	39,527	631
2002	31,516	604	2002	39,352	607
2003	33,190	638	2003	39,486	569
2004	27,694	626	2004	38,197	597
2005	30,847	626	2005	39,451	580
2006	36,689	649	2006	38,371	583
2007	26,730	598	2007	43,726	609
2008	28,545	575	2008	41,335	573
2009	35,697	619	2009	35,444	532
2010	43,988	629	2010	39,328	572
2011	44,191	663	2011	64,415	714
2012	41,286	671	2012	69,207	665
2013	61,688	730	2013	68,649	671
2014	73,618	731	2014	67,240	645
2015	75,876	703	2015	68,927	572
2016	65,353	637	2016	66,370	505
2017	77,291	607	2017	66,215	473
2018	72,023	560	2018	62,247	461
2019	78,459	529	2019	59,489	440
2020	66,106	489	2020	38,414	381
2021	68,990	461	2021	9,299	287
2022	71,024	436	2022	335	67
Total	1,190,771	15,340	Total	1,190,771	14,506

Table 2. Summary statistics

This table reports summary statistics of our sample. AnnRet is the abnormal returns in decimal form cumulated over the event window $[t-1, t+1]$, and t is the patent grant announcement date. Innovation efficiency is measured at the time of application announcements and is measured relative to the R&D expenditures from the previous one or two years. It incorporates the value of innovation in millions of nominal dollars (xi_nominal1 or xi_nominal2), the value of innovation deflated to 1982 dollars using the Consumer Price Index (xi_real1 or x_real2), and the number of forward citations (cites1 or cites2). All the innovation efficiency measures take natural logarithms. All the other control variables are measured at the time of the grant announcements. Table A1 presents variable definitions and data sources.

	Mean	SD	P10	P50	P90
AnnRet	0.0004	0.0341	-0.0302	0.0001	0.0316
xi_nominal1	2.3331	1.1262	0.5050	2.3524	3.7819
xi_real1	1.6819	0.9616	0.2165	1.6075	2.9747
cites1	1.5743	1.1482	0.2431	1.4098	3.1340
xi_nominal2	2.4079	1.1768	0.4931	2.3979	3.9247
xi_real2	1.7508	1.0168	0.2135	1.6611	3.1348
cites2	1.6407	1.2139	0.2413	1.4497	3.3189
StkVol	9.9366	9.1372	3.4265	7.1302	19.4816
PastRet	-0.0015	0.2149	-0.2286	-0.0014	0.2183
Runup	-0.0001	0.0872	-0.0884	0.0005	0.0874
SIZE	17.1760	1.9830	14.4396	17.5091	19.2576
INTAN	0.2007	0.2867	0.0005	0.1424	0.4700
LEV	0.4359	0.1867	0.2102	0.4159	0.7163
CASH	0.0731	0.0521	0.0176	0.0616	0.1403
CF	0.1236	0.1235	0.0333	0.1207	0.2390
N	1,190,771	1,190,771	1,190,771	1,190,771	1,190,771

Table 3. Innovation efficiency and patent announcement return

This table presents the results of the regression models on the relationship between innovation efficiency and announcement returns. Innovation efficiency accounts for R&D spending from the past one or two years and includes three key components: the nominal value of innovation in millions of dollars (xi_nominal), its real value adjusted to 1982 dollars using the CPI (xi_real), and the number of forward citations (cites). The interaction between industry and year fixed effects, and the firm fixed effects are considered. T-statistics are reported in parentheses and standard errors clustered at the firm level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	AnnRet					
xi_nominal1	0.0022***					
	(6.90)					
xi_real1		0.0023***				
		(6.77)				
cites1			0.0000			
			(0.24)			
xi_nominal2				0.0018***		
				(6.64)		
xi_real2					0.0019***	
					(6.42)	
cites2						0.0000
						(0.11)
StkVol	-0.0000	-0.0000	0.0000	-0.0000	-0.0000	0.0000
	(-0.31)	(-0.30)	(0.45)	(-0.21)	(-0.20)	(0.45)
PastRet	-0.0027***	-0.0028***	-0.0027***	-0.0027***	-0.0027***	-0.0027***
	(-3.97)	(-4.01)	(-3.88)	(-3.90)	(-3.95)	(-3.87)
Runup	-0.0157***	-0.0157***	-0.0151***	-0.0157***	-0.0156***	-0.0151***
	(-7.21)	(-7.17)	(-6.80)	(-7.16)	(-7.13)	(-6.80)
SIZE	-0.0032***	-0.0031***	-0.0026***	-0.0032***	-0.0031***	-0.0026***
	(-7.89)	(-7.78)	(-6.66)	(-7.81)	(-7.72)	(-6.67)
INTAN	-0.0002	-0.0002	0.0000	-0.0002	-0.0002	0.0000
	(-0.65)	(-0.56)	(0.07)	(-0.68)	(-0.60)	(0.07)
LEV	0.0041**	0.0040**	0.0000	0.0034**	0.0033*	0.0000
	(2.41)	(2.32)	(0.02)	(1.98)	(1.92)	0.00
CASH	0.0013	0.0012	0.0016	0.0025	0.0023	0.0016
	(0.37)	(0.33)	(0.44)	(0.70)	(0.65)	(0.45)
CF	-0.0031	-0.0031	-0.0027	-0.0029	-0.0030	-0.0027
	(-1.39)	(-1.41)	(-1.19)	(-1.31)	(-1.33)	(-1.19)
Intercept	0.0489***	0.0487***	0.0442***	0.0489***	0.0485***	0.0443***
	(7.05)	(7.04)	(6.38)	(7.01)	(7.00)	(6.42)
Fixed effects	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm
N	1,190,771	1,190,771	1,190,771	1,190,771	1,190,771	1,190,771
adj. R^2	0.018	0.018	0.017	0.018	0.018	0.017

Table 4. The effect of options on the predictability of innovation efficiency

This table presents the role of options in the predictability of innovation efficiency. The control variables are the same as those in Table 3. op130 is a dummy variable equal to 1 when the options volumes pre-announcement month is larger than the median and zero otherwise. Table A1 summarizes the variable definitions and data sources. T-statistics are reported in parentheses and standard errors clustered at the firm level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	AnnRet					
xi_nominal1	0.0020***					
	(6.11)					
xi_nominal1×op130d	0.0003***					
	(3.41)					
xi_real1	0.0021***					
	(5.84)					
xi_real1×op130d	0.0004***					
	(3.29)					
cites1	-0.0001					
	(-0.61)					
cites1×op130d	0.0003**					
	(1.98)					
xi_nominal2	0.0016***					
	(5.82)					
xi_nominal2×op130d	0.0003***					
	(3.39)					
xi_real2	0.0017***					
	(5.48)					
xi_nominal2×op130d	0.0004***					
	(3.21)					
cites2	-0.0001					
	(-0.75)					
cites2×op130d	0.0003*					
	(1.93)					
op130d	-0.0007***	-0.0006***	-0.0003	-0.0007***	-0.0006***	-0.0003
	(-3.23)	(-3.07)	(-1.54)	(-3.29)	(-3.08)	(-1.49)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm
N	1,190,771	1,190,771	1,190,771	1,190,771	1,190,771	1,190,771
adj. R ²	0.018	0.018	0.017	0.018	0.018	0.017

Table 5. Robustness checks: Excluding the effect of earnings announcement and winner or loser stock

This table presents the results of the robustness checks of the Table 4 analysis. op130 is a dummy variable equal to 1 when the options volumes pre-announcement month is larger than the median and zero otherwise. In Panel A, the regressions are based on the sample that excludes observations where the patent application announcement date is close to the earnings announcement date within 5 days. In Panel B, the regressions are based on the sample that excludes stocks where the pre-patent application announcement date is a winner or loser stock. Table A1 summarizes the variable definitions and data sources. T-statistics are reported in parentheses and standard errors clustered at the firm level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

AnnRet						
Panel A: Excluding observations with an earnings announcement within 5 days of patent application						
xi_nominal1	0.0020***					
	(6.20)					
xi_nominal1×op130d	0.0003***					
	(3.39)					
xi_real1		0.0021***				
		(5.94)				
xi_real1×op130d		0.0004***				
		(3.29)				
cites1			-0.0001			
			(-0.66)			
cites1×op130d			0.0003**			
			(2.01)			
xi_nominal2				0.0017***		
				(5.92)		
xi_nominal2×op130d				0.0003***		
				(3.35)		
xi_real2					0.0017***	
					(5.59)	
xi_nominal2×op130d					0.0004***	
					(3.19)	
cites2						-0.0001
						(-0.72)
cites2×op130d						0.0003*
						(1.94)
op130d	-0.0007***	-0.0006***	-0.0004	-0.0007***	-0.0006***	-0.0003
	(-3.25)	(-3.12)	(-1.61)	(-3.30)	(-3.10)	(-1.53)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm
N	1,150,810	1,150,810	1,150,810	1,150,810	1,150,810	1,150,810
adj. R^2	0.018	0.018	0.017	0.018	0.018	0.017

Table 5. Robustness checks: Excluding the effect of earnings announcement and winner or loser stock (continued)

AnnRet						
Panel B: Excluding winner or loser stocks on the day before the pre-application announcement						
xi_nominal1	0.0020***					
	(6.13)					
xi_nominal1×op130d	0.0003***					
	(3.38)					
xi_real1	0.0021***					
	(5.87)					
xi_real1×op130d	0.0004***					
	(3.26)					
cites1			-0.0001			
			(-0.55)			
cites1×op130d			0.0003*			
			(1.95)			
xi_nominal2				0.0016***		
				(5.85)		
xi_nominal2×op130d				0.0003***		
				(3.37)		
xi_real2					0.0017***	
					(5.51)	
xi_nominal2×op130d					0.0004***	
					(3.20)	
cites2						-0.0001
						(-0.69)
cites2×op130d						0.0003*
						(1.92)
op130d	-0.0007***	-0.0006***	-0.0003	-0.0007***	-0.0006***	-0.0003
	(-3.21)	(-3.05)	(-1.51)	(-3.28)	(-3.07)	(-1.47)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm
N	1,187,232	1,187,232	1,187,232	1,187,232	1,187,232	1,187,232
adj. R ²	0.018	0.018	0.017	0.018	0.018	0.017

Table 6. Robustness checks: Different options trading windows

This table presents the results of the robustness checks of the Table 3 analysis. We consider different period options trading activities per patent application date. Panel A shows that option activities are estimated during $[t-1, t+1]$. op123d is a dummy variable equal to 1 when the options volumes announcement window $[t-1, t+1]$ is larger than the median and zero otherwise. Panel B shows that option activities are estimated during $[t-7, t-2]$. op27d is a dummy variable equal to 1 when the options volumes announcement window $[t-7, t-2]$ is larger than the median and zero otherwise. Table A1 summarizes the variable definitions and data sources. T-statistics are reported in parentheses and standard errors clustered at the firm level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

AnnRet						
Panel A: op123d						
Options trading window (t-1, t+1)						
xi_nominal1	0.0021***					
	(6.39)					
xi_nominal1×op123d	0.0002***					
	(3.01)					
xi_real1		0.0021***				
		(6.13)				
xi_real1×op123d		0.0003***				
		(3.01)				
cites1			-0.0001			
			(-0.32)			
cites1×op123d			0.0002*			
			(1.89)			
xi_nominal2				0.0017***		
				(6.13)		
xi_nominal2×op123d				0.0002**		
				(2.58)		
xi_real2					0.0018***	
					(5.79)	
xi_nominal2×op123d					0.0002**	
					(2.48)	
cites2						-0.0001
						(-0.42)
cites2×op123d						0.0002*
						(1.70)
op123d	-0.0003*	-0.0003*	-0.0001	-0.0003	-0.0002	-0.0000
	(-1.89)	(-1.66)	(-0.43)	(-1.54)	(-1.24)	(-0.21)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm
N	1,190,771	1,190,771	1,190,771	1,190,771	1,190,771	1,190,771
adj. R^2	0.018	0.018	0.017	0.018	0.018	0.017

Table 6. Robustness checks: Different options trading windows (continued)

AnnRet						
Panel B: op27d						
Options trading window (t-7, t-2)						
xi_nominal1	0.0020***					
	(6.22)					
xi_nominal1×op27d	0.0003***					
	(2.86)					
xi_real1		0.0021***				
		(5.95)				
xi_real1×op27d		0.0003***				
		(3.04)				
cites1			-0.0001			
			(-0.31)			
cites1×op27d			0.0002**			
			(2.02)			
xi_nominal2				0.0017***		
				(5.91)		
xi_nominal2×op27d				0.0003***		
				(3.04)		
xi_real2					0.0017***	
					(5.52)	
xi_nominal2×op27d					0.0003***	
					(3.11)	
cites2						-0.0001
						(-0.48)
cites2×op27d						0.0002**
						(2.10)
op27d	-0.0006**	-0.0005***	-0.0002	-0.0006***	-0.0006***	-0.0002
	(-2.54)	(-2.65)	(-1.30)	(-2.74)	(-2.76)	(-1.36)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm
N	1,190,771	1,190,771	1,190,771	1,190,771	1,190,771	1,190,771
adj. R ²	0.018	0.018	0.017	0.018	0.018	0.017

Table 7. The effect of investor attention: Many versus few announcements on the same date

This table considers investor attention on the predictability of innovation efficiency. We sort all the announcements on the basis of the number of announcements on the patent application date. We use the median number of announcements on a given application date to classify the sample into two groups: the “many announcements” and “few announcements” groups. Panel A reports the results for the “many announcements” group, representing a scenario in which investors are more distracted. Panel B reports the results when investors are less distracted and more attentive. Table A1 summarizes the variable definitions and data sources. T-statistics are reported in parentheses and standard errors clustered at the firm level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

AnnRet						
Panel A: Many announcements						
xi_nominal1	0.0020***					
	(5.03)					
xi_nominal1×op130d	0.0002*					
	(1.70)					
xi_real1		0.0021***				
		(4.92)				
xi_real1×op130d		0.0002				
		(1.57)				
cites1			-0.0002			
			(-0.73)			
cites1×op130d			0.0002			
			(1.42)			
xi_nominal2				0.0017***		
				(5.01)		
xi_nominal2×op130d				0.0002*		
				(1.65)		
xi_real2					0.0018***	
					(4.71)	
xi_nominal2×op130d					0.0002	
					(1.49)	
cites2						0.0000
						(-0.17)
cites2×op130d						0.0002
						(0.97)
op130d	-0.0003	-0.0003	-0.0001	-0.0003	-0.0003	-0.0001
	(-1.38)	(-1.20)	(-0.67)	(-1.36)	(-1.16)	(-0.27)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm
N	600,103	600,103	600,103	600,103	600,103	600,103
adj. R^2	0.020	0.020	0.019	0.020	0.020	0.019

Table 7. The effect of investor attention: Few or many announcements on the same date
(continued)

AnnRet						
Panel B: Few announcements						
xi_nominal1	0.0021*** (6.04)					
xi_nominal1×op130d	0.0004*** (2.76)					
xi_real1		0.0021*** (5.65)				
xi_real1×op130d		0.0005*** (2.72)				
cites1			0.0000 (0.09)			
cites1×op130d			0.0004* (1.82)			
xi_nominal2				0.0017*** (5.89)		
xi_nominal2×op130d				0.0005*** (2.84)		
xi_real2					0.0017*** (5.52)	
xi_nominal2×op130d					0.0005*** (2.75)	
cites2						-0.0001 (-0.39)
cites2×op130d						0.0004* (1.90)
op130d	-0.0010*** (-2.59)	-0.0008** (-2.54)	-0.0006 (-1.61)	-0.0010*** (-2.75)	-0.0008*** (-2.67)	-0.0006* (-1.71)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm
N	590,398	590,398	590,398	590,398	590,398	590,398
adj. R^2	0.019	0.019	0.018	0.019	0.019	0.018

Table 8. The effect of investor attention: Friday or non-Friday announcements

All announcements are first sorted into two groups by whether the announcement date is a Friday or not. Panel A shows the results for events associated with the patent application announcement occurring on Friday. Panel B presents the results for the events associated with the patent application announcement occurring on a non-Friday. Table A1 summarizes the variable definitions and data sources. T-statistics are reported in parentheses and standard errors clustered at the firm level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

AnnRet						
Panel A: Friday						
xi_nominal1	0.0022***					
	(5.07)					
xi_nominal1×op130d	0.0002					
	(1.06)					
xi_real1		0.0024***				
		-4.84				
xi_real1×op130d		0.0002				
		(0.99)				
cites1			0.0001			
			(0.43)			
cites1×op130d			0.0001			
			(0.51)			
xi_nominal2				0.0019***		
				(4.93)		
xi_nominal2×op130d				0.0002		
				(1.28)		
xi_real2					0.0020***	
					(4.60)	
xi_nominal2×op130d					0.0002	
					(1.11)	
cites2						0.0001
						(0.42)
cites2×op130d						0.0001
						(0.61)
op130d	-0.0005	-0.0004	-0.0001	-0.0006	-0.0005	-0.0002
	(-1.23)	(-1.18)	(-0.46)	(-1.49)	(-1.34)	(-0.58)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm
N	267,910	267,910	267,910	267,910	267,910	267,910
adj. R ²	0.026	0.026	0.025	0.026	0.026	0.025

Table 8. The effect of investor attention: Friday or non-Friday announcements (continued)

AnnRet						
Panel B: Non-Friday						
xi_nominal1	0.0019*** (5.91)					
xi_nominal1×op130d	0.0004*** (3.41)					
xi_real1		0.0019*** (5.67)				
xi_real1×op130d		0.0005*** (3.29)				
cites1			-0.0002 (-0.96)			
cites1×op130d			0.0004** (2.25)			
xi_nominal2				0.0015*** (5.55)		
xi_nominal2×op130d				0.0004*** (3.34)		
xi_real2					0.0016*** (5.24)	
xi_nominal2×op130d					0.0004*** (3.20)	
cites2						-0.0002 (-1.08)
cites2×op130d						0.0004** (2.12)
op130d	-0.0008*** (-3.13)	-0.0006*** (-2.96)	-0.0004* (-1.77)	-0.0008*** (-3.12)	-0.0006*** (-2.94)	-0.0008*** (-3.12)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm
N	922,557	922,557	922,557	922,557	922,557	922,557
adj. R^2	0.019	0.018	0.018	0.019	0.018	0.019

Table 9. The effect of innovation efficiency and option trading activity on firm performance and expenses

In this table, we examine how firm performance and expenses in the post-grant period are affected by innovation efficiency, contingent upon option trading activity, at the time of patent application. The main sample and explanatory variables are the same as those in Table 3. In Panel A, the dependent variable is firm performance, measured using Tobin's Q. In Panel B, the dependent variable is selling, general, and administrative (SG&A) expenses. Both Tobin's Q and SG&A are measured in year y+1, where y is the grant announcement year. Table A1 provides variable definitions and data sources. T-statistics are reported in parentheses, with standard errors clustered at the firm level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Firm performance						
Panel A: Tobin's Q						
xi_nominal1	0.1231***					
	(5.52)					
xi_nominal1×op130d	0.0187***					
	(3.43)					
xi_real1	0.1363***					
	(5.50)					
xi_real1×op130d	0.0230***					
	(3.25)					
cites1			0.0024			
			(0.16)			
cites1×op130d			0.0156			
			(1.55)			
xi_nominal2				0.1003***		
				(5.29)		
xi_nominal2×op130d				0.0200***		
				(3.66)		
xi_real2					0.1120***	
					(5.24)	
xi_nominal2×op130d					0.0236***	
					(3.39)	
cites2						-0.0001
						(-0.01)
cites2×op130d						0.0158
						(1.63)
op130d	-0.0394***	-0.0344***	-0.0154	-0.0441***	-0.0373***	-0.0167
	(-2.92)	(-2.74)	(-1.01)	(-3.24)	(-2.97)	(-1.10)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm
N	1,181,046	1,181,046	1,181,046	1,181,046	1,181,046	1,181,046
adj. R ²	0.839	0.840	0.829	0.837	0.840	0.829

Table 9. The effect of innovation efficiency and option trading activity on firm performance and expenses (continued)

Expenses						
Panel B: SG&A						
xi_nominal1	-0.0350***					
	(-2.84)					
xi_nominal1×op130d	-0.0075					
	(-1.45)					
xi_real1	-0.0364***					
	(-2.73)					
xi_real1×op130d	-0.0107					
	(-1.59)					
cites1	-0.0052					
	(-0.52)					
cites1×op130d	-0.0133**					
	(-2.56)					
xi_nominal2	-0.0286**					
	(-2.58)					
xi_nominal2×op130d	-0.0075					
	(-1.43)					
xi_real2	-0.0296**					
	(-2.44)					
xi_nominal2×op130d	-0.0103					
	(-1.55)					
cites2	-0.0047					
	(-0.56)					
cites2×op130d	-0.0123**					
	(-2.35)					
op130d	0.0162	0.0165	0.0180**	0.0168	0.0166	0.0173**
	(1.51)	(1.64)	(2.30)	(1.52)	(1.64)	(2.13)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm	Ind×Yr,Firm
N	1,135,229	1,135,229	1,135,229	1,135,229	1,135,229	1,135,229
adj. R^2	0.964	0.964	0.963	0.964	0.964	0.963