In Short Supply: Efficiency Implications of Rational Attention Allocation*

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Abstract

This paper examines the role of rational attention allocation in shaping private information acquisition, and its implications for price informativeness and real outcomes. Our setting exploits the listing of options on a stock as a source of variation in the relative value of acquiring information on its close industry peers. Consistent with the predictions of our theoretical model, we find that options listing is associated with a decline in attention, trading volume, and liquidity, and an increase in volatility for peer stocks. These peer firms further experience a decline in stock price informativeness, firm value, and profitability.

Keywords: attention allocation, information acquisition, efficiency, options listing.

JEL Classification: D82, G14, G12, G31

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1 Introduction

Efficient stock prices aggregate and reflect traders' private information (Hayek, 1945). A large literature has shown that this stock price efficiency can in turn promote real efficiency, e.g. by lowering information asymmetries (Stiglitz and Weiss, 1981) or by revealing decision-relevant information to firms (Bond et al., 2012). However, our understanding of the underlying mechanism that gives rise to traders' private information in the first place is somewhat limited because private information and its quality are inherently unobservable.

In this paper, our goal is to study whether rational attention allocation shapes traders' private information and whether this allocation has implications for stock prices and corporate outcomes. This question is important because the efficiency implications of corporate decisions or regulatory changes may critically depend on the traders' response and choice to acquire private information. For instance, stricter disclosure requirements could have a negative net impact on the firm's overall information environment, and thus overall efficiency, if they reduce traders' attention allocation incentives.[1]

We hypothesize that financial market participants allocate their scarce attention across firms based on a rational cost-benefit analysis as in the theoretical literature on rational attention allocation (see e.g., Peng and Xiong, 2006; van Nieuwerburgh and Veldkamp, 2010; Kacperczyk et al., 2016). Consequently, firms that receive more market-wide attention should benefit from more efficient prices and corporate decisions.[2] Testing our hypothesis poses significant empirical challenges because both the economic value of information and allocation of attention, along with the ensuing efficiency changes, are

[1]Consistent with this idea, Gao and Liang (2013) show theoretically that corporate disclosure can crowd-out traders' private information acquisition. Bond and Goldstein (2015) highlight a similar channel in the context of government intervention.

[2]In our setting, we consider attention as a resource required to acquire information with more attention being analogous to more/better information acquisition.

endogenous. For instance, we could use the cost of short-selling as a proxy for the net value of information (Diamond and Verrecchia, 1987) and examine its association with attention allocation and efficiency.[3] However, changes in this proxy directly affect the trading environment, which could confound the efficiency implications even outside attention allocation decisions.

Our empirical strategy circumvents these challenges by considering a plausible (negative) shock to the incentive to allocate attention towards a specific firm. This shock needs to satisfy the following two criteria. First, it should decrease the net value of information for this specific firm relative to similar firms. Second, it should not directly affect the firm's price and real efficiency such that efficiency implications would not be completely attributable to the attention allocation decisions.

We use a stylized trading model with endogenous information acquisition to demonstrate how the option listing of a firm's industry peer satisfies the above criteria and represents a negative shock to the value of information.[4] The model guides our empirical analysis and features two types of firms, options-listed and non-options-listed. We allow rational traders to allocate a fixed attention budget across these firms. Following the existing theoretical literature, we assume that traders' private signal precisions increase in the attention allocated towards a certain firm. Subsequently, they trade the firm's stock against uninformed noise traders based on these informative signals and render the stock price a noisy predictor of the firm's future value.

Our main focus is on the impact of a firm's transition from non-options-listed to options-listed. This listing event mitigates short-selling and leverage frictions for traders

[3]If it is more costly to sell short, learning negative information becomes less valuable and traders' attention should decrease.

[4]A large literature has shown that option listing has large positive effects on the value of information and hence information acquisition, price efficiency and firm value for the *underlying* stocks and firms (e.g., Skinner, 1990; Ho, 1993; Brennan and Cao, 1996; Cao, 1999; Chakravarty et al., 2004; Danielsen et al., 2007; Hu, 2014, 2018; Roll et al., 2009).

and allows them to trade more aggressively on their private information (Diamond and Verrecchia, 1987; Back, 1993; Biais and Hillion, 1994; Cao, 1999). Hence, it leads to an increase in the relative value of information for the newly-listed firm. Following this intuition, our model generates the following set of predictions: (i) the attention share of the newly-listed firm should increase; (ii) the attention shares of its industry peers should decrease with a stronger decline for non-options-listed peer firms; (iii) the decrease in attention should be accompanied by a decrease in trading volume, an increase in return volatility, and a decrease in price informativeness for peer firms.

While our first prediction is consistent with existing empirical work,[5] we test predictions (ii) and (iii) by evaluating the association between listing of new options and industry peer firms' outcomes using a difference-in-differences framework. We begin by identifying all listings of options for firms that experienced options listing for the first time between 1997 and 2013. For all such firms, we find a closely related industry peer firm that does not have options listed on their stocks. These non-options-listed industry peer firms constitute our treated group. Using propensity score matching, we find up to three similar control firms for every treated firm that belong to the same industry and importantly have options listed prior to our sample period (i.e. firms which had options listed before 1997). Hence, our setting examines the differential change in outcomes before and after listing of new options for industry peers with and without options listed on their stocks. This choice of treated and control groups allows us to evaluate our model predictions that non-options-listed peer firms within the same industry should be more affected relative to options-listed peer firms.[6]

Though options listing decisions are made entirely within exchanges and firms play

[5]For instance, Skinner (1990) and Ho (1993) show that analyst coverage is positively associated with options listing and trading, respectively. Hu (2018) shows that option listing increases informed trading by 12.4% for the underlying stocks.

[6]We also conduct robustness tests to ensure that our results are not driven by this particular choice of treated and control firms.

no role in them, such decisions are not random. Exchanges are more likely to list options on stocks that they expect will maximize their profits, e.g. stocks with high trading volume (Mayhew and Mihov, 2004). However, since we examine the listing of options on peer firms as our event, we are one degree removed from this potential endogeneity problem. Yet, it is plausible that these choices may bias our results for different reasons. For example, exchanges may actively choose to not list our treated firms because they expect them to perform poorly. We conduct a number of tests to rule out such and other endogeneity concerns as we describe later.

We use analyst coverage and revisions as main measures of attention. Analysts provide an ideal setting to evaluate attention allocation decisions required to acquire information for a couple of reasons. First, these decisions are likely to be of first-order importance for analysts because they are mainly involved in information acquisition and cater to traders' demand for information (Skinner, 1990). Second, to the extent that analysts specialize in a given industry, the relative value of acquiring information across firms within the same industry may drive their attention allocation decisions. We find that both analyst coverage and the number of analyst revisions decline significantly for treated firms relative to the control firms following listing of options on peer firms within the same industry. On average, coverage declines by 1.55 analysts which is economically large as it corresponds to over 20% relative to the sample mean coverage of 7.18 analysts. These findings complement Skinner (1990) who documents an increase of 3.64 analysts following the firm after options listing on their stock. Our estimates suggest that this increase at least partially occurs at the expense of peer firms who experience a decline in analyst coverage. Consistent with analysts paying less attention to peer firms even if they continue following them, we also find that forecast accuracy declines significantly for these firms. We further supplement these results by using institutional ownership and SEC filing downloads as other measures of attention and find similar results.

Consistent with our model predictions, trading volume and liquidity decline while volatility increases for treated stocks relative to the control group following listing of options on peer firms. Treated stocks also experience a relative decline in stock price informativeness. Our final set of results examines real outcomes where we find that investment-price sensitivities decrease for treated firms relative to the control group following options listing on peer stocks. This decrease is accompanied by a delayed relative decline in firm value beginning after two years following listing. Furthermore, firm value declines by 6.9% of the sample mean, which complements Roll et al. (2009) who show that a one standard deviation increase in options trading volume leads to an increase of 23% in value for the underlying firm. Finally, we find that profitability in our setting relatively declines by 6.67% of the standard deviation for treated firms following listing of options on peer firms.

To examine our proposed mechanism of attention reallocation, we track specific analysts and the firms that they follow. This allows us to directly examine the association between options listing on peer stocks and attention reallocation across peer firms. We find that 63% more analysts begin following newly listed firms at the *expense* of treated firms relative to the control firms after listing. Furthermore, peer firms that lose more analysts to the listed firms experience a greater decline in stock price informativeness and profitability. These results suggest that peer firms, without options listed on them, lose more analysts and that the re-allocation of analysts drives changes in stock price informativeness and profitability for these firms. We also examine competition within industries as an alternative channel. Specifically, if the listing of options offers any competitive advantage to the listed firms, their competitors may lose analysts and experience lower profitability owing to competition. However, we find no evidence supporting this channel in our setting.

A potential concern with our analysis is that exchanges may actively choose not to list options on our treated firms' stocks because they expect them to perform poorly.[7] This expected poor performance may lead to a decline in attention and other changes that we detect for our treated firms. However, exchanges evaluate the characteristics of stocks in the entire market while making listing decisions, instead of comparing peers within the same industry (Mayhew and Mihov, 2004). They are also not obligated to list stocks at any particular frequency, any given year or point in time. Hence, their decision to list is likely to be driven by the characteristics of stocks that get listed and likely not correlated to their peer firms' characteristics that we examine. Notwithstanding this argument, we conduct a number of robustness tests where we find that our observed effects are not statistically different for treated firms that the exchanges are more likely to have private information on or for those more likely to be expected to perform poorly. This finding suggests that negative expectations by exchanges likely do not drive our results.

Yet another concern is that our choice of treated and control groups based on the options listing status may bias our results. For example, differential trends across firms with and without options listed may contribute to our findings. Though matching on observables and absence of time-trends in the pre-period in our setting are inconsistent with such concerns, we conduct an analysis based on intensity of treatment to ensure that this choice does not explain our results. This analysis captures the differential response of industry peers to options listing based on how closely related they are to the listed firms regardless of their options listing status. We find that more similar peers experience a greater decline in analyst coverage and profitability, and a greater increase in variance ratio. This finding suggests that our specific choice of treated and control groups likely does not drive our results.

A related concern may be that even within our baseline treated group, early and later

[7]Exchanges may form such expectations either through public signals or by acquiring private information about firms.

treated firms may have differential time-trends, which can bias the estimates. To address this concern, we re-estimate our baseline results after controlling for treatment-cohort by time fixed effects, thereby allowing for differential trends across firms treated at different points in time. We find similar results to our baseline with this specification. Finally, to ensure that our effects are not confounded by other market factors like co-movement in stock volatility, we repeat our baseline analysis after controlling for lagged values of stock volatility, liquidity and trading volume, and find similar results.

Our paper relates to the recent literature that argues that different financial market participants are subject to attention capacity constraints. For instance, Kacperczyk et al. (2016) find evidence that mutual funds allocate their attention rationally over the business cycle. Kempf et al. (2017) and Schmidt (2019) show that institutional investors can be distracted by shocks to their portfolios.[8] Similarly, Fang et al. (2014) show that institutional investors are influenced by attention-grabbing mass media coverage supporting the notion that they have limited attention. Gargano and Rossi (2018) show that attention is positively related to the investment performance of individual investors. Peress and Schmidt (2020) identify events that distract noise traders and show that these events lead to lower volume, liquidity, and volatility. In line with these findings, Hirshleifer et al. (2009) show that price reaction to earnings is weaker if there are more announcements on the same day.

We contribute to this literature along two dimensions. First, we deviate from the existing literature with regards to the type of economic consequences that we analyze. To the best of our knowledge, we are the first to provide evidence that limited attention has a detrimental impact on the informational content of stock prices and real efficiency. In particular, our results are consistent with the notion that endogenous reallocation of attention changes the amount of *private* information aggregated in stock prices and has

[8] Ben-Rephael et al. (2017) propose Bloomberg search volume as proxy for institutional attention and show that it is highly correlated with institutional trading measures.

real implications for firms. Second, we consider a relatively *persistent* shock to the value of *private* information of an individual firm, while existing work has focused on transient shocks with a temporary distracting effect. We are thus able to gauge whether traders' limited attention and allocation decisions can have consequences lasting over multiple years.

Following Chen et al. (2007) and Bakke and Whited (2010), several recent papers have found empirical evidence for a feedback effect (Bond et al., 2012) from a firm's stock price to its real decisions. For instance, Edmans et al. (2017) show that insider trading regulations reduce the share of inside information and increase the share of outside information in price. They find that firms learn more from price after the implementation of these laws. Similarly, Brogaard et al. (2019), Kacperczyk et al. (2021), and Bennett et al. (2020) identify shocks to the informational content of prices and find evidence for spill-over effects to real decisions.[9] We contribute to this literature by identifying a novel (negative) shock to price efficiency which is caused by a drop in attention. Importantly, we show that the decline in price efficiency leads to less efficient firm decisions, which supports the aforementioned feedback hypothesis. Thus, our results indicate that traders' limited attention carries real economic costs and that policies aimed at alleviating these constraints may likely lead to more efficient real decisions.

Finally, our paper also contributes to the long stream of literature that examines the impact of options listing and trading on the underlying firm and its information environment. For example, Skinner (1990) and Ho (1993) show that analyst coverage is positively associated with options listing and trading, respectively. Moreover, a large number of papers show that options listing and trading leads to higher price efficiency for the underlying firms.[10] Other papers discuss the impact of options listing and trading on

[9]Bai et al. (2016) show that price efficiency has increased over time and that it has also become a better predictor of firm investment.

[10]See e.g., Brennan and Cao (1996); Cao (1999); Chakravarty et al. (2004); Danielsen et al. (2007); Hu (2014,

firm characteristics and show that the effect is mainly driven by increased informational efficiency. For instance, Roll et al. (2009) documents that options trading is positively associated with firm value, while Naiker et al. (2013) show that it decreases the firm's cost of equity capital.[11] While these studies investigate the impact of options on the underlying firm, we highlight a negative spillover effect of options listing on industry peers. Moreover, we show that a firm's options listing can have real effects on its industry peers by crowding out attention and reducing the informational content of prices. Our results suggest that caution is warranted in evaluating the overall benefits of options trading by only examining the listed firms as listing may have spillover effects on other firms.

2 Theoretical Framework

In this section, we use a simple trading model with endogenous information acquisition in the spirit of Kyle (1985) to develop our main hypotheses. We consider a market with a finite, discrete number of firms indexed by $j \in \{1, 2, \ldots, M\}$, which can be interpreted as an industry. There are two types of firms: the first $m_N \geq 1$ firms are of type N, while the last $m_L \geq 1$ firms are of type L, where $m_N + m_L = M$. Both types are publicly-listed but they differ in terms of their option-listing status: N-type firms are non-options-listed, while $L-$type firms are options listed.

At $t = 2$, firm j's equity generates a random cash flow $v_j \in \{v^L, v^H\}$ with $v^H > v^L$ and equal probability. At $t = 1$, three types of risk-neutral traders trade claims to these payoffs in a secondary financial market. First, there is a unit mass of rational traders indexed by $i \in [0, 1]$ who can acquire informative signals about v_j. The signal precisions depend on the trader's attention choice. Second, there is a continuum of noise traders trading for reasons unrelated to information. Third, there is a competitive market maker setting the

2018), among others.

[11] Blanco and Wehrheim (2017) emphasize the positive effect of option trading on firm innovation.

equilibrium stock price p_j equal to the expected cash flow.

We assume that the firms' cash flows are independent of each other and *ex ante* unobserved by all traders.[12] Rational traders, however, can acquire informative signals about these cash flows. For simplicity, we assume each private signal either reveals the true value of the cash flow or no additional information: $s_{ij} \in \{v_j, \emptyset\}$, as in Goldstein and Guembel (2008) or Foucault and Fresard (2014), among others. The probability with which a private signal reveals novel information is equal to $\kappa_{ij} \equiv Pr\left(s_{ij} = v_j\right)$ and can be interpreted as the signal precision.

We follow the existing literature on rational attention allocation, such as Peng and Xiong (2006), Mondria (2010), or Kacperczyk et al. (2016), and let trader i choose $\{\kappa_{ij}\}$ at $t = 0$ subject to the following two constraints. The first constraint is the *information capacity constraint*: $\sum_{j=1}^{M} \kappa_{ij} \leq K$.[13] It states that the sum of the signal precisions for trader i cannot exceed the fixed capacity $K \in (0, 1]$. The second constraint is the *no-forgetting constraint*, $\kappa_{ij} \geq 0$, which ensures that the precisions are weakly positive.

At $t = 1$, rational traders submit market demands $\vec{x}_i \equiv [x_{i1}, \ldots, x_{iM}]'$ that maximize their expected trading profits given private signals and information choices:[14]

$$\max_{\vec{x}_i \in \mathcal{X}} \mathbb{E}\left[\vec{x}_i'\left(\vec{v} - \vec{p}\right)|\vec{s}_i, \vec{\kappa}_i\right]. \tag{1}$$

The traders' common investment opportunity set for each firm is captured by $\mathcal{X} \equiv [\mathcal{X}_1, \ldots, \mathcal{X}_M]'$ with $\mathcal{X}_j = [\underline{x}_j, \overline{x}_j]$ and $-\infty < \underline{x}_j < 0 < \overline{x}_j < \infty$ and $|\underline{x}_j| < \overline{x}_j$.[15] Noise trader demand is given by $\vec{z}$ with $z_j \sim U\left(\underline{x}_j, \overline{x}_j\right)$.[16] We therefore assume that noise traders face

[12]It would be straightforward to add a common component to the cash flow processes.

[13]Without loss of generality, we normalize the traders' attention budget to one. Hence, κ_{ij} can be interpreted as the attention *share* of trader i allocated to firm j.

[14]Throughout, we use the notation $\vec{y} \equiv [y_1, \ldots, y_M]'$ to indicate an $M \times 1$ vector for a generic variable y_j.

[15]The latter assumption captures the intuition that it is more difficult for traders to short an asset than to go long. It sharpens our predictions with regards to trading volume, but does not affect the other predictions.

[16]The assumption that z_j is drawn from a uniform distribution simplifies our solutions. We expect our results to be robust to a wide range of bounded distributions.

the same investment opportunities as rational traders. The key difference between both agents is that noise trader demand is orthogonal to v_j, while that of rational traders is positively correlated with v_j (if $\kappa_{ij} > 0$). As in Kyle (1985), the market maker observes the total order flow $X_j \equiv \int_0^1 x_{ij} di + z_j$ for each asset and sets the stock price to break even in expectation, i.e. $\vec{p} = \mathbb{E}\left[\vec{v}|\vec{X}\right]$.

A crucial assumption is that there are certain frictions in the financial market that limit the size of the traders' asset positions. Examples of these frictions are short-selling or leverage constraints. The existing theoretical literature has shown that the introduction of options can change the span of security payoffs in such incomplete markets (see e.g, Back, 1993; Biais and Hillion, 1994; Cao, 1999, among others). We build on these insights and increase the traders' investment opportunity set for an options-listed firm, instead of explicitly modelling the options market.[17] For simplicity, we assume a common investment opportunity set for all $N-$type and all L-type firms, respectively. Hence, we have $\mathcal{X}_j = \mathcal{X}_N$ for $j \in \{1, \ldots, m_N\}$ and $\mathcal{X}_j = \mathcal{X}_L$ for $j \in \{m_N + 1, \ldots, M\}$. We assume that options listing strictly increases the investment opportunities, such that $\underline{x}_L < \underline{x}_N$ and $\overline{x}_L > \overline{x}_N$. This assumption implies that an options-listed firm provides traders more opportunities to trade and increases their permissible set of asset demands. We will show below that this increase makes it more attractive to pay attention towards these firms.

We solve the model using backwards induction and defer all formal derivations to Appendix A.1. At $t = 1$, given information choices κ_{ij}, each trader optimally buys (sells) the stock in response to positive (negative) information, and does not trade after an uninformative signal. It follows that the equilibrium stock price p_j is an increasing step function of total order flow X_j.

We focus on symmetric equilibria in which all rational traders allocate attention κ_N

[17] This reduced-form approach allows us to solve for the traders' optimal attention allocation in closed-form.

to each non-listed firm and κ_L to each listed firm.[18] Because signals are conditionally independent, a fraction κ_j of traders observes $s_{ij} = v_j$, while a fraction $1 - \kappa_j$ observes $s_{ij} = \emptyset$ and does not trade. Thus, if more market-wide attention is allocated towards firm j, the share of traders with an informative signal about this firm increases. It follows that the informational content of total order flow X_j is positively related to the traders' attention choice.

The market maker observes X_j and sets the stock price p_j equal to the conditional expectation of the firm's terminal value. If total order flow is particularly high, the market maker knows that the underlying fundamental for this firm must have been high. As a result, the equilibrium stock price is equal to $p = v^H$ in this case. Similarly, if X_j is sufficiently low, the market maker infers that $v_j = v^L$ and sets $p = v^L$. For intermediate values of X_j the market maker remains uncertain about the firm's cash flow and sets the price equal to the unconditional expectation of v_j, $p_j = \frac{v^L+v^H}{2}$.

Next, we move back to $t = 0$ and solve for the traders' rational attention choices. To this end, we can use the expressions for the traders' optimal demands and the equilibrium stock prices to compute their expected trading profits. Simple algebra implies that trader i's aggregate trading profits are given by:

$$\Pi_i \equiv \mathbb{E}\left[\vec{x}_i' \left(\vec{v} - \vec{p}\right)\right] = \sum_j \frac{v^H + v^L}{4} \left(1 - \kappa_j\right) \kappa_{ij} \Delta_j, \tag{2}$$

where $\Delta_j \equiv \overline{x}_j - \underline{x}_j$. Hence, expected profits are increasing in the expected asset cash flow, the potential width of the traders' asset position, and the amount of attention trader i allocates to firm j. Importantly, expected profits are decreasing in the amount of attention all other traders allocate to firm j because more attention renders order flow more informative and allows the market maker to set a more informed price.

[18] For simplicity, we consider homogeneous firms that only differ in terms of their options-listing status and hence the implied investment sets $\mathcal{X}_j$.

In an interior attention allocation equilibrium with $\kappa_{ij} \in (0,1)$, all rational traders have to be indifferent between the two firm types. Hence the marginal benefit of allocating more attention towards firm j, $\frac{\partial \Pi_i}{\partial \kappa_{ij}}$, will be identical for all firms. In the following, we will focus on this case. We formally show in the Appendix, that the equilibrium attention choices are given by:[19]

$$\kappa_j = \begin{cases} \frac{\Delta_L - m_L(\Delta_L - \Delta_N)}{\Delta_L m_N + m_L \Delta_N} & \text{for } j \in \{1, \ldots, m_N\} \\ \frac{\Delta_N + m_N(\Delta_L - \Delta_N)}{\Delta_L m_N + m_L \Delta_N} & \text{for } j \in \{m_N + 1, \ldots, M\} \end{cases} \tag{3}$$

It follows that the traders' optimal attention allocation depends on the firm's options-listing status. Moreover, each firm's attention share κ_j depends on four parameters. The number of $N-$type and $L-$type firms and the widths of the firms' investment opportunity sets. Based on this equilibrium, we can derive the main hypotheses for our empirical analysis.

Hypothesis 1 (Main Hypotheses) *(i) Options-listed firms receive more attention; (ii) An increase in the number of listed firms decreases κ_N and κ_L, but the decline in κ_N is stronger.*

Intuitively, the option-listing of an individual firm j has two major implications. First, it increases the investment opportunity set for traders in firm j, which leads to an increase in attention allocated toward this firm. Second, in response to the increase in j's *relative* attractiveness, the attention share of the remaining firms declines. The drop in the attention share of a non-listed firm is greater than that of a listed firm because L's investment opportunity set (Δ_L) is greater.

Hypothesis 2 (Further Model Implications) *An increase in the number of listed firms has the following implications:*

[19]These results are derived under the assumption that m_L is sufficiently small, which ensures an interior solution.

1. *trading volume for non-listed firms decreases more than for listed firms;*
2. *return volatility for non-listed firms increases more than for listed firms;*
3. *price informativeness for non-listed firms decreases more than for listed firms.*

Our theoretical framework provides further implications regarding the effect of an increase in the number of option-listed firms on its industry peers. More specifically, it leads to a decline in trading volume, an increase in return volatility, and a decrease in price informativeness for all firms. These three implications are driven by the loss in attention. As traders pay less attention, they are less likely to receive an informative signal and more likely to stay passive, which in turn lowers trading volume and price informativeness. Furthermore, on average the price deviates more from the firm's fundamental value v_j, which increases return volatility. As before, these effects are more pronounced for non-options-listed firms.

3 Data and Empirical Approach

This section provides details on the institutional background and describes the methodology and sample used for the analysis.

3.1 Options Listing

Unlike the stock market, where firms apply to be listed, decisions to list options are made within the exchanges. There are 16 different exchanges that offer standardized options on individual stocks and indices in the United States.[20] These option exchanges are

[20] All option exchanges are members of Options Clearing Corporation which is the common clearinghouse shared by all option exchanges. A list of these exchanges can be found on the Options Clearing Corporation website: http://www.optionsclearing.com/clearing/clearing-services/exchanges.jsp.

member-owned self-regulating agencies that operate with the main objective of maximizing long-term profits. Since commission fee is an important source of revenue, the choice to list options is made to maximize such fees (Mayhew and Mihov, 2004). In addition, other institutional factors may influence these decisions. For instance, exchanges are subject to federal securities laws and regulated by the Securities and Exchange Commission (SEC). The SEC plays an important role in determining and revising the eligibility requirements for underlying securities to be selected for option listing. These eligibility requirements state that (1) the security must be listed on a national exchange; (2) the security must have at least seven million publicly held shares; (3) there must be at least two thousand shareholders; (4) the security must be traded for at least $3.00 per share; and (5) at least five days must have passed since its initial public offering (IPO).

Subject to these eligibility requirements, an exchange chooses stocks to list options for which it anticipates the highest commission fees. Consistent with this argument, Mayhew and Mihov (2004) document that exchanges tend to list options on stocks with high volatility, trading volume, and market capitalization. Similarly, Danielsen et al. (2007) find that exchanges prefer to list more liquid stocks. Hu (2018) documents that firms with higher institutional ownership, greater buying pressure, and more balanced order flows are more likely to be listed consistent with the notion that options exchanges prefer stocks with large hedging demand, high short selling costs, and low market-making costs. Thus, the decision to list options, though made outside of the firm, is not exogenous to underlying firm characteristics.

Yet such decisions are likely exogenous to industry peer firm characteristics. Exchanges evaluate the characteristics of stocks in the entire market while making listing decisions, instead of comparing peers within the same industry (Mayhew and Mihov, 2004). They are also not obligated to list stocks at any particular frequency, any given year or point in time. Hence, their decision to list is likely to be driven by the characteristics of stocks that get listed instead of those that do not.

To help support this argument, we define peer firms as similar firms in the same industry that do not have options listed on their stock. Specifically, for every firm that gets option listed during our sample period, we find a peer firm, within the same industry defined by 3-digit SIC code, that does not have listed stock options and is closest to the listed firm in terms of market capitalization, trading volume, and stock volatility in the year prior to listing. This choice of peer firms offers a distinct advantage. Since such firms are very similar to each other, an increase in the benefit of informed trading in one firm is likely to attract investor resources towards that firm at the expense of the other firms.

Notwithstanding the aforementioned argument, we discuss the plausibility that listing of options may be correlated with industry peer firms' (realized or expected) performance and characteristics, and conduct a number of tests to evaluate the importance of this concern for our results.

3.2 Empirical Specification

We evaluate the association between the listing of peer firm's options, and stock and firm outcomes using a difference-in-differences framework. The first difference comes from comparing treated and control firms where treated firms are firms whose peer firm gets options listed for the first time, and control firms are chosen as similar firms from the same industry that already had options listed on their stocks before our sample period. The choice of the treated and control firms allows us to evaluate our model's predictions and compare the differential response on other firms based on whether or not they have options listed on their stocks. Firms which already have options listed on them offer more trading opportunities, and hence a higher value for information, which makes them relatively less affected. The second difference comes from comparing the period before and after options listing on the peer firm. Specifically, we estimate the following model:

$$y_{i,j,t} = \beta \times PeerListing_i \times Post_t + \delta_i + \delta_t(\delta_{j,t}) + \epsilon_{i,j,t} \quad (4)$$

where y measures attention allocation, stock price characteristics, and firm outcomes for firm i operating in industry j during year t. $PeerListing_i$ is a dummy variable that takes a value of one for treated firms and $Post_t$ is a dummy variable that takes a value of one during the years following the listing of options on peer stocks. δ_i represents firm fixed effects that control for firm-level, time invariant characteristics. δ_t and $\delta_{j,t}$ are year and three-digit SIC industry-by-year fixed effects that control for overall economic conditions and time-varying industry-level characteristics, respectively. Robust standard errors are clustered at the firm level.

The identifying assumption is that of parallel trends. That is, to interpret the estimates as driven by the listing of options on peer stocks, one must assume that in the absence of options listing for peer stocks, the outcome variables for the treated and control firms would trend in a parallel manner after controlling for firm and industry-year fixed effects. While it is impossible to test this assumption in the period after listing of options on peer stocks, we can test it for the pre-listing period by examining the difference in trends in outcome variables between treated and control firms before the listing of options on peer stocks.

Our model predicts that firms in the same industry that do not have options listed on their stocks would be differentially more affected than those who have listed options. To help evaluate this prediction, for every peer firm, we choose up to three control firms from the same three-digit SIC industry that do not have listed options but are similar to the treated firm in terms of size and profitability (ROA) in the year immediately prior to listing of options on the peer stock. We use the Mahalanobis distance to identify the closest matches and match with replacement.

3.3 Data Sources and Sample Construction

Data for the analysis comes from a number of different sources including Optionmetrics (options listing data), Compustat (financial data), CRSP (stock price data), and IBES (analysts data). We begin by identifying the set of firms on which options got listed for the first time between 1997 and 2013 using OptionMetrics. This database contains information on trading activity of all listed options in the U.S. starting from 1996. We identify the date of options listing on a firm's stock as the first date when its 6-digit CUSIP appears in the OptionMetrics database beginning in 1997. Since the database starts in 1996, we cannot distinguish the firms that got options listed in 1996 from those that already had options listed before 1996. Hence, we focus our attention on listings from 1997 onwards.

We then merge financial information on these firms from Compustat and omit financials (SIC 6000 - 6999), utilities (SIC 4900 - 4999), and public administration/non-classifiable firms (SIC 9000 - 9999). Figure 1 plots the distribution of the number of options listings that satisfy these criteria through time. Other than the peak in 1997, the number of listings seem to be staggered, occurring in every year of our sample period.

For each of these newly listed firms that satisfy the above criteria, we find a peer firm from firms in the same industry defined by 3-digit SIC code which do not have options listed on their stock by matching on market capitalization, trading volume, and stock volatility for the year immediately prior to listing. These non-options-listed industry peer firms constitute our treated group. Using propensity score matching, we find up to three control firms for every treated firm that belong to the same industry based on 3-digit SIC code, have similar levels of market capitalization and profitability in the year prior to listing, and importantly have options-listed since the beginning of our sample period. This results in a sample of 1,806 unique firms, which is summarized in Table 1.

4 Results

This section describes our main results where we examine the association between listing of options on peer stocks and attention allocation, stock characteristics, and real outcomes.

4.1 Attention Allocation

We begin by estimating the association between options listing on peer stocks and different attention measures. If listing of options increases the marginal value of acquiring private information on the underlying stocks, then information intermediaries, like analysts, may allocate more attention towards these firms and acquire more information about them. To the extent these agents have limited attention/resources and specialize in a given industry, they may be substituting this increase in attention by reallocating their attention away from similar peer stocks within the same industry. In our setting, we consider attention as a resource to acquire information on the stocks, without particularly distinguishing it from information acquisition itself.

Table 2 reports results for our baseline difference-in-differences regressions that estimate the differential response of options listing on attention measures for peer firms in the same industry that do not have options listed on their stocks to control firms within the same industry that already have options listed on their stocks. In Panel A, Columns (1)-(3) control for firm and year fixed effects while Columns (4)-(6) control for firm and industry-by-year fixed effects. Columns (1) and (4) report estimates where the outcome variable is the total number of analysts following the firm. Across both specifications, we find that analyst following declines significantly for treated firms relative to the control firms following listing of options on peer firms within the same industry. On average, coverage declines by 1.55 analysts which is economically large as it corresponds to over

20% of the sample mean coverage of 7.18 analysts. This finding complements Skinner (1990) which documents a significant increase in the number of analysts following the firm after options listing on their stock. Our estimates suggest that this increase at least partially occurs at the expense of peer firms who experience a decline in analyst coverage.

Our next set of outcomes examines the intensive margin of attention allocation, i.e. analysts may keep following the peer firm but may pay less attention towards it. Columns (2) and (4) report estimates on the number of analyst revisions which proxies for analyst resources allocated to different stocks. With the specification that controls for time varying industry-level changes, we find that the number of analyst revisions, on average, declines by 3.21 revisions for treated firms relative to control firms following listing of options on peer stocks. This estimate corresponds to about 22% of the sample mean which is economically large. Columns (3) and (6) report results on forecast accuracy by analysts who continue to follow the firm. We define this error as the negative mean absolute error in individual forecasts and find that forecast accuracy declines significantly for peer firms following options listing relative to control firms. These results suggest that even those analysts who continue to follow the peer firm allocate less resources towards those firms.

The observed differential post-listing trends do not reflect a pre-existing differential trend between treated and control firms. Rather, treated firms only begin experiencing lower analyst coverage after the listing of options on peer stocks. This is shown in Figure 2 where, instead of a dummy variable for all years post listing, we include a set of dummy variables that identify the years relative to the year of options listing and plot the coefficient estimates with analyst coverage as the outcome variable. The sample includes our treated firms and the matched control firms. The horizontal axis represents years relative to the listing year and the vertical axis measures the magnitude of the coefficient estimates. We present the coefficient estimates around the year of listing (which is denoted by year 0) from a fully-saturated model where we set the base year as the year immediately before the listing by omitting the dummy variable for that year from the estimation. The vertical bars represent confidence intervals at the 90% level. We find that none of the coefficient estimates for the pre-listing period are statistically significant and that the decrease in analyst coverage begins only in the year after listing of options on peer stocks and continues to decline for at least three years afterward.

We supplement our main attention measures with institutional ownership and SEC traffic. The existing literature has shown that both proxies are positively related to information production and price efficiency (see e.g., Boehmer and Kelley, 2009; Gao and Huang, 2020). Institutional ownership captures the percentage of stock owned by institutional investors while SEC traffic captures the number of times SEC filings associated with the given firm-year are downloaded from the SEC website (in 100,000s). Panel B of Table 2 reports estimates with these measures as outcome variables. In Column (3), we find that institutional ownership declines by 3 percentage points more for treated firms relative to the control group. This corresponds to 8.1% of the sample mean of 0.37. Similarly, Column (4) finds that SEC traffic declines by 55k downloads more for the treated firms which corresponds to 23.1% of the sample mean.

Overall, the results support the predictions of our model and suggest that attention reallocation occurs post listing of options on peer stocks that takes away attention from closely-related firms.

4.2 Stock Price Characteristics and Informativeness

We next examine the association between peer firms' options listing and several stock price characteristics. We begin this analysis by examining trading volume as the outcome variable. Columns (1) and (5) of Table 3 report these estimates where we find a relative decline in trading volume for treated firms following options listing on peer stocks. The estimates suggest that trading volume declines by 0.02-0.03 percentage points following listing which corresponds to about 2%-3% of the sample mean. These findings support our main hypothesis that investors pay less attention to the stock, which, in turn, leads to less precise private signals. As a result, these investors expect to earn lower trading profits and are less willing to trade in the firm's stock following the options listing of the peer firm.

Columns (2) and (4) use the Amihud measure, which is based on trading volume of the stock and captures the price impact of trade. As in Amihud (2002) it is given as

$$Amihud_{i,y} = \frac{1}{D_{i,y}} \sum_{t=1}^{D_{i,y}} \frac{|r_{i,t}|}{Dvol_{i,t}}$$

where $Amihud_{i,y}$ is the Amihud measure of firm i estimated in year y, $r_{i,t}$ and $Dvol_{i,t}$ are daily return and daily dollar trading volume for stock i on day t; $D_{i,y}$ is the number of days with available ratio in year y. The measure reflects the average of daily price impacts of one currency unit of volume traded over a given sample period. Higher values of the measure represent lower liquidity as the price impact of trade is higher and vice versa. Hence, it is commonly referred to as an "illiquidity" measure. Our estimates suggest that illiquidity increases by 2-3 percentage points for treated firms relative to the control firms following listing of options on peer firms.

Our theoretical model predicts that lower attention leads to higher return volatility because the stock price is more heavily influenced by noise and less by payoff-relevant information for treated firms. This prediction is consistent with recent work by Dávila and Parlatore (2019) who find a negative association between price informativeness and volatility for most firms. We test and find support for this prediction in Columns (3) and (7) where the estimates show a relative increase in volatility of 6.67% compared to the sample mean.

Next, we evaluate the association between peer option listing and price informativeness using variance ratio as a proxy (see e.g., Lo and MacKinlay, 1988; Kacperczyk et al., 2021, among others). The intuition behind variance ratio follows from a random walk process which implies that the ratio of long- to short-term return variances should equal one. Any deviation from one reflects less informative prices. We follow Kacperczyk et al. (2021) and calculate the variance ratio as $|1 - VR(n,m)|$ where $VR(n,m)$ is the ratio of the return variance over m days to the return variance over n days, divided by the period length. We use 1 and 5 days for n and m respectively and report results in Columns (4) and (8). Across both specifications, we find that variance ratio increases for treated firms by 2 percentage points relative to the control firms following listing of options on peer stocks thus suggesting a relative decline in stock price informativeness for treated firms. This coefficient is economically meaningful as it corresponds to 2.7% of the sample mean. Figure 3 plots coefficients for the dynamic analysis where, instead of a dummy variable for all years post listing, we include a set of dummy variables that identify the years relative to the year of options listing. As before, we do not find any statistically different trends across treated and control groups during the pre-listing period. However, the variance ratio increases significantly more for treated firms in the period following listing.

To complement the previous analysis, we follow Bai et al. (2016) and Kacperczyk et al. (2021), and use the correlation between current market prices and future earnings as another measure of stock price informativeness. We examine how the association between current market prices and future earnings changes for treated firms relative to control firms following listing of options on peer stocks. Specifically, we run regressions of the following form:

$$\frac{E_{i,t+h}}{A_{i,t}} = \beta_{1,h} \log\left(\frac{M}{A}\right)_{i,t} \times PeerListing_i \times Post_t + \beta_{2,h} \log\left(\frac{M}{A}\right)_{i,t} \times PeerListing_i + \beta_{3,h} \log\left(\frac{M}{A}\right)_{i,t} \times Post_t + \beta_{4,h} PeerListing_i \times Post_t + \beta_{5,h} \log\left(\frac{M}{A}\right)_{i,t} + \delta_i + \delta_t(\delta_{j,t}) + \epsilon_{i,t+h} \quad (5)$$

where $E_{i,t+h}$ represents earnings for firm i at time $t+h$, M represents market value of equity, and A represents book value of assets while other variables are same as defined before. The main coefficient of interest, $\beta_{1,h}$, captures the change in correlation between future earnings and current stock price for treated firms relative to control firms in the period after listing of options on peer firms.

Table 4 reports estimates for this analysis. As before, Columns (1) through (3) control for firm and year fixed effects while others control for firm and industry-by-year fixed effects. Columns (1) and (4) examine how the correlation between earnings at time $t+1$ and market to book value at time t changes for treated firms following listing of options on peer stocks. We find that this correlation weakens more for treated firms relative to the control group following options listing on peer firms. This suggests that current stock prices have less information about future earnings for treated firms following treatment. In Columns (2) and (5) we use earnings at time $t+3$ instead of earnings at time $t+1$ and find similar results. However, the other two columns use earnings at time $t+5$ and do not find statistical difference in price informativeness suggesting that the declines occur in stock price's capacity to reflect short-term information. We note that power issues may also be responsible for the lack of statistical significance for these estimates.

To ensure that these changes in price informativeness are not driven by pre-existing trends between treated and control firms, we repeat our analysis where, instead of using a dummy variable for all years post listing, we include a set of dummy variables that identify the years relative to the year of options listing. Figure 4 plots these estimates where we do not find any statistical difference in trends across treated and control groups during the pre-listing period. However, stock price informativeness declines significantly more for treated firms in the period following listing.

Overall, consistent with our model predictions, these results suggest that price informativeness declines for treated firms following listing of options on peer stocks.

4.3 Investment-Q Sensitivity, Firm value, and Profitability

A large literature in finance shows that managers learn new information from stock prices and use this information for making investment decisions.[21] If stock price informativeness declines, the plausibility to learn from prices and incorporate this new information into investment decisions may decline as well. To evaluate this hypothesis, we follow Chen et al. (2007) and examine how sensitivity of investment to lagged value of Tobin's Q ratio changes for treated firms following listing of options on peer stocks relative to control firms. Specifically, we estimate a triple interactions model by interacting our difference-in-differences measure with lagged Q as follows:

$$y_{i,j,t} = \beta_1 \times PeerListing_i \times Post_t \times Q_{t-1} + \beta_2 \times PeerListing_i \times Post_t + \beta_3 \times PeerListing_i \times Q_{t-1} + \beta_4 \times Post_t \times Q_{t-1} + \beta_5 Q_{t-1} + \delta_i + \delta_t(\delta_{j,t}) + \epsilon_{i,j,t} \quad (6)$$

where Q is the Tobin's Q ratio of the firm in a given year, y measures different types of investments (e.g. capital expenditures, research and development, etc.), and the remaining variables are the same as before. The coefficient of interest, β_1, captures the change in sensitivity of investment to Q ratio for treated firms relative to control firms following the listing of options on peer firms. Panel A of Table 5 reports results for this estimation. In Columns (1) and (5), we find that the sensitivity of capital investment (CapEx) to Q declines significantly for treated firms relative to control firms following options listing on peer firms. This suggests that managers learn and impound less information from stock prices while making CapEx decisions. However, we do not find any change in sensitivity for other types of investment.

We next evaluate whether changes in managerial learning following listing of options on peer firms are transitory or more permanent. To that end, we re-estimate the model

[21] See e.g. Chen et al. (2007), Edmans et al. (2017), and Dessaint et al. (2019) for recent empirical evidence.

in Equation (6) by splitting the post variable into two dummy variables, Post I and Post II, that identify the first three years following options listing on peer stocks, including the listing year, and all years following the first three years respectively. Panel B of Table 5 reports these estimates where we find that investment sensitivity to Q declines for all types of investments for the first three years following listing. Thus managerial learning from stock prices declines for all types of investment during this period.

Lower price informativeness and managerial learning may in turn affect firm value and profitability for a couple of reasons. First, if prices become more informative for listed firms, corporate resources may be allocated more efficiently leading to an increase in firm value (e.g., Fishman and Hagerty, 1992; Boot and Thakor, 1993; Khanna et al., 1994; Dow and Gorton, 1997; Subrahmanyam and Titman, 1999). Second, more informative prices reduce the risk of investing in the underlying asset, which tends to raise the asset's price, thus increasing firm valuation (Roll et al., 2009). We evaluate this plausibility and examine the association between listing of options on peer stocks, and firm value and profitability in Table 6. Panel A reports our baseline regressions with firm and year fixed effects in Columns (1) through (3) and with firm and industry-by-year fixed effects in Columns (4) through (6).

We use Tobin's Q as our measure for firm value, and return on assets (ROA) and earnings as our measures for profitability. Surprisingly, across all columns and specifications in Panel A, we find no statistical difference in the outcome variable between treated and control firms in the period following listing of options on peer stocks. To the extent that profitability and firm value respond to changes in investment decisions and outcomes, there may be a delayed reaction to the listing of options on peer firms. Earlier results show that investment is less sensitive to stock prices in the first three years following options listing (including the year of listing), and the outcomes for these investment changes may take time to materialize. This may hinder us to detect changes in our baseline specification that compares mean values of outcome variables for all years following options listing including the year of listing to the mean value of the outcome for years before. We evaluate this plausibility in Panel B of Table 6 where we split our main difference-in-differences variable into two dummy variables PeerListing x Post I and PeerListing x Post II. The first takes a value of one for treated firms for the year of listing and two years following listing of options on peer stocks while the second takes a value of one for treated firms for all years beginning from three years following options listing on peer stocks.

We find that both firm value and profitability decline for treated firms relative to the control group for the period three years after listing of options on peer stocks. For instance, Column (1) suggests that Tobins Q for the treated firm declines by 17 percentage points beginning from three years following options listing on peer stocks relative to the control group. This is economically meaningful as it corresponds to a decline of 6.9% of the sample mean. This magnitude seems reasonable when compared to the findings reported in Roll et al. (2009) who show that options trading is positively associated to firm value for the underlying firm and one standard deviation increase in options trading volume leads to an increase of 23% in firm value. In contrast, our results suggest that firm value declines by less than a third of that for the peer firms following listing of options.[22]

Similarly, we find that return on assets (ROA) and earnings decline significantly for treated firms three years after options listing on peer firms. Column (2) shows that ROA declines by 6.67% of the standard deviation in the sample. The estimate seems extremely large relative to the mean because there are many firms with negative ROA in our sample that lead to a small sample mean. Hence, comparing the estimate to standard deviation gives a more accurate sense of economic magnitude. For instance, in the extreme case if

[22]It is worth noting that Roll et al. (2009) examine the association between option trading volume and value of the underlying firm. The extensive margin where firms move from no options trading to options getting listed may lead to an even larger effect on the underlying firm value. This would imply that our effects might be even less than a third of the effect of options listing on the value of the underlying firm.

the sample mean were zero owing to negative values in the sample, it would not allow for a viable comparison of estimates to the mean. In a similar vein, the estimate for earnings in Column (3) shows a substantial decline of 11.4% of the sample standard deviation for the treated firms relative to the control group.

These observed differences in trends post-listing may be driven by differential pre-existing trends. We evaluate this in Figure 5 where, instead of two dummy variables for years post listing, we include a set of dummy variables that identify the years relative to the year of options listing and plot the coefficient estimates with ROA as the outcome variable. As before, the horizontal axis represents years relative to the listing year and the vertical axis measures the magnitude of the coefficient estimates. We present the coefficient estimates around the year of listing (which is denoted by year 0) from a fully-saturated model where we set the base year as the year immediately before the listing by omitting the dummy variable for that year from the estimation. The vertical bars represent confidence intervals at the 90% level. We find that none of the coefficient estimates for the pre-listing period are statistically significant and that the decrease in ROA begins from the second year after listing of options on peer stocks.

Overall, these results suggest that listing of options has implications for firm value and profitability of peer firms within the same industry.

5 Mechanism

In this section, we evaluate whether attention reallocation drives the observed results. Our data allows us to track analysts and directly examine whether they start following the listed firm post options listing while at the same time stop following peer firms. This measure captures directly whether analysts are substituting attention towards the listed firms at the expense of peer firms. The results for this analysis are reported in Panel A of

Table 7. The outcome variable is defined as the number of analysts that move from either the peer or the control firm to the listed firm in a given year, i.e. the number of analysts that start following the listed firm and stop following the peer or control firm in a given year. With the specification that includes firm and year fixed effects, we find that 0.1 more analysts move away from the peer firm towards the listed firm relative to the control firm following listing. The estimate declines to 0.07 analysts when we include industry × year fixed effects in the specification. These values are economically large as they correspond to 90% and 63% of the sample mean, respectively.

If the changes in other outcome variables that we detect are driven by re-allocation of attention, one would expect to find a stronger association between listing of options on peer firms and firm outcomes for those treated firms that lose more analysts to the listed firms following listing. We test this conjecture in Panel B of Table 7 by interacting our baseline difference-in-differences variable with the number of analysts that the firm loses to the listing firm following listing. Consistent with the prediction, the estimates suggest that peer firms that lose more analysts to the listed firms experience a greater decline in stock price informativeness and profitability during the first three years and all years after three years following listing, respectively. Overall, these results suggest that peer firms without options listed on them lose more analysts and re-allocation of attention drives changes in stock price informativeness and profitability for peer firms.

Another plausibility is that competition within industries may drive our results. Specifically, if the listing of options offers any competitive advantage to the listed firms, their competitors may lose analysts and experience lower profitability owing to competition. We argue that both treated and control firms in our setting belong to the same industry as the listed firm, and so any effect of industry competition should likely be absorbed by this comparison. However, to the extent that the effect of competition is differential across both sets of firms, it may still drive our results. We evaluate this plausibility by examining the differential response of listing of options on firm outcomes based on the degree of competition within industries that different peer firms belong to. Panels A and B in Table 8 report results for this analysis where we use the Herfindahl-Hirschman Index (HHI) and sales margin to measure competition respectively. Panel A examines this relation by comparing all periods before and after options listing while Panel B splits the post period into first three years following options listing (including the year of listing) and all years after that. Across all panels and specifications, we do not find any significant differential response of peer firms based on the degree of competition within their industry.[23] These estimates suggest that competition likely does not drive the results in our setting.

6 Robustness

6.1 Expectations by Exchanges

A potential concern with our analysis is that exchanges may actively choose not to list options on our treated firms' stocks because they expect them to perform poorly. This expected poor performance may be correlated with the decline in attention we detect. As we have discussed earlier, exchanges evaluate the characteristics of stocks in the entire market while making listing decisions and are not obligated to list stocks at any particular frequency. This renders them less likely to base their listing decisions on industry peer firms' expected characteristics.

Notwithstanding this argument, we conduct a number of robustness checks to evaluate the merits of this concern in our setting. If exchanges decide not to list our treated stocks owing to expected poor performance and such expectations are responsible for the decline in attention and other changes that we detect, one would expect our effects

[23]Note that the significant coefficients in Columns (1) and (5) of Panel B are in the opposite direction as higher HHI values reflect less competition.

to be stronger when the exchanges are more likely to have private information about the treated stocks. We evaluate this plausibility by using distance as a proxy for more private information. A large literature documents that distance acts as a friction and creates information asymmetries in different settings.[24] Hence, exchanges are more likely to have private information for firms that are physically closer to them and closer firms should react more to listing of options on peer firms if such private information leads the treated firms not to get listed. We test this heterogeneity in Table A.3.1 where we do not find any systematic incremental effects on treated firms that are closer to the exchanges relative to those that are farther away. Though we find significant coefficients in a couple of columns, they do not paint a consistent picture as they seem to be sensitive to the specification employed and their timing does not match our baseline results. Hence, our results are less likely to be driven by the exchange's expectations prior to listing.

Next, we exploit analyst forecast during the quarter previous to listing to proxy for market expectations about our treated firms. If our results are driven by negative expectations about performance of treated firms, we would expect to find a stronger association between listing of peer firms and our main outcome variables for firms with more negative analyst forecasts. We test this in Table A.3.2 by examining the differential response to listing of peer options on firms with different levels of average earnings forecasts in the quarter prior to listing.[25] With the more stringent specification in Columns (4) and (6) of Panel A, we do not find a significant differential association of listing of peer options on analyst coverage and ROA for treated firms with different levels of earnings forecasts prior to listing. Column (5) reports a significant association for variance ratio which goes

[24] Among others, Giroud (2013) shows the role that distance plays in information asymmetry within firms, Petersen and Rajan (2002) document its role in lending, and Gopalan et al. (2018) show its importance in regulation.

[25] Note that $Post \times Forecast$ and $Forecast$ get absorbed by time and firm fixed effects respectively because the forecast variable that represents average earnings forecast in the quarter prior to listing remains constant for a firm through time.

in the opposite direction, i.e. estimates suggest that price informativeness declines more for firms expected to have better performance.

Overall, these results suggest that negative expectations by exchanges likely do not drive our results.

6.2 Choice of Treated and Control Firms

Another potential concern is that our choice of treated and control groups based on the options listing status may bias our results. For example, differential trends across firms with- and without-options listed may contribute to our findings. Though matching on observables and absence of time-trends in the pre-period in our baseline setting are inconsistent with such concerns, we conduct an analysis based on intensity of treatment to ensure that this choice does not explain our results. In this analysis, we consider the response of the industry peers to options listing regardless of their own listing status. Instead, we capture the differential response across industry peers based on how closely related they are to the listed firms. On the margin, information intermediaries may be more likely to substitute their resources away from more similar firms if information acquisition on one of the industry firms becomes more attractive. We test this conjecture by estimating the following equation:

$$y_{i,j,t} = \beta \times PScore_i \times Post_t + \delta_i + \delta_t(\delta_{j,t}) + \epsilon_{i,j,t} \tag{7}$$

where $PScore$ reflects the propensity score between the peer firm i and the listed firm in the year prior to listing. As before, this propensity score is based on observables including market cap, stock volatility and trading volume. All other equation variables are the same as described in section 3.2.

Table 9 reports these results where we find that more similar peers experience a greater decline in analyst coverage and profitability, and a greater increase in variance ratio. This suggests that our specific choice of treated and control groups likely doesn't drive our results.

6.3 Other Robustness

A related concern may be that even within our baseline treated group, early and late treated firms may have differential time-trends which can bias the estimates. As before, the absence of time-trends in the pre-period helps alleviate this concern. To further ensure that this does not drive our results, we re-estimate our baseline results after controlling for treatment cohort x time fixed effects. This ensures that our coefficients are estimated by comparing treated firms to their matched control firms and that differential time trends across different groups do not affect the estimates. Table A.3.3 reports these estimates where we find similar results.

To further ensure that treatment in any particular year is not responsible for our findings, we re-estimate our analysis for the main outcome variables dropping firms associated with one listing year at a time. Tables A.3.4 and A.3.5 report t-stats for these regressions where we find significant results consistently across all specifications.

Finally, to ensure that our effects are not confounded by other market factors like co-movement in stock volatility, we repeat our baseline analysis after controlling for lagged values of stock volatility, liquidity and trading volume. Table A.3.6 reports results for this estimation where we find results similar to our baseline.

7 Conclusion

This paper examines the role of rational attention allocation in shaping private information acquisition, and its implications for price informativeness and real outcomes. We build a stylized model which shows that the option-listing on peer stocks represents a negative shock to firms' relative value of information. Consistent with our model predictions, we find that following the listing of options on peer stocks firms lose attention from several market participants, including analysts and institutional investors. Moreover, this reduction in attention affects both the firms' stock prices and real decisions.

Overall, these results suggest that even relatively sophisticated traders have to manage their scarce attention budget and that this constraint has real economic ramifications that go beyond financial markets and even affect firm profitability. From a policy perspective, it is thus important to carefully gauge the "attention burden" of public announcements or regulations, as unnecessary reductions in traders' attention capacity might lead to negative unintended consequences. Furthermore, our results also highlight that caution is warranted in evaluating the benefits of options trading by only examining the listed firms as listing may have spillover effects on other firms.

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Figure 1:
Distribution of Options Listing
This figure presents the distribution of total number of options listings associated with our sample across different years over the sample period between 1997-2013.

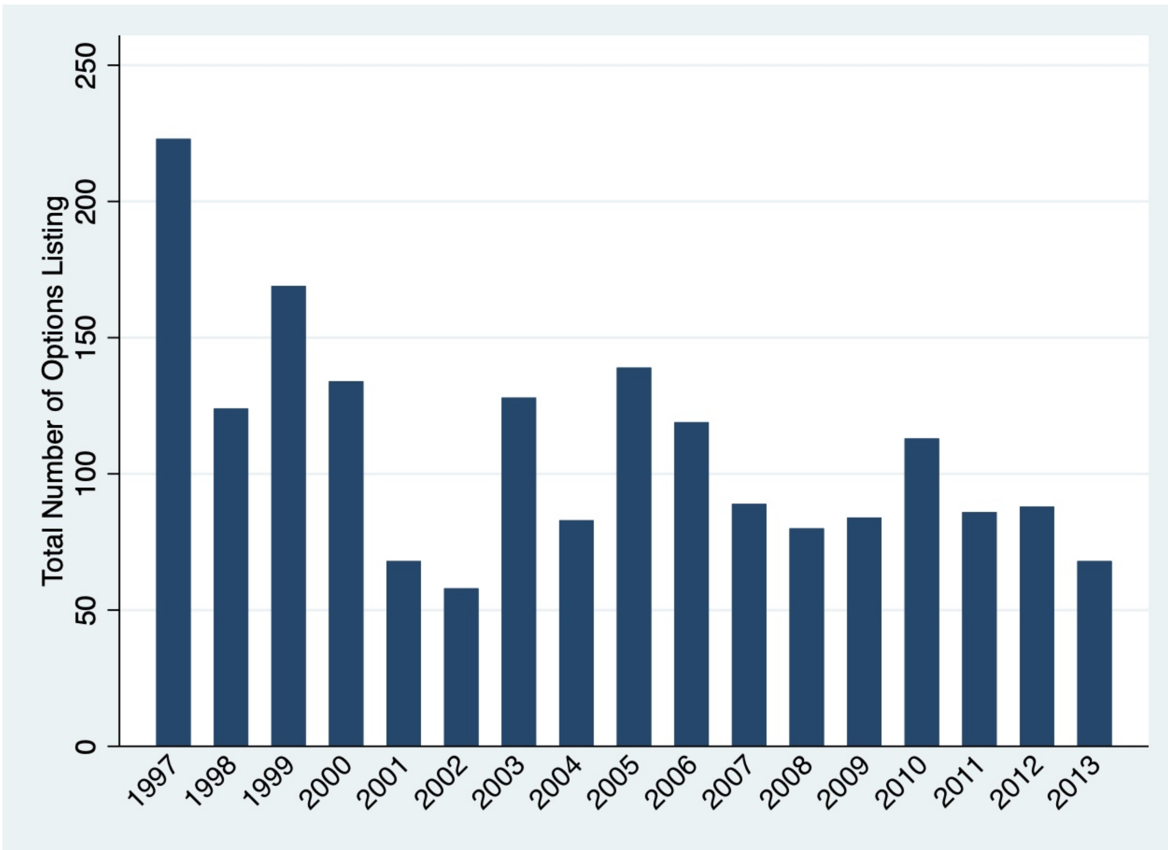

Figure 2:
Attention Allocation
This figure plots the coefficients for the dynamic difference-in-differences regressions that estimate the association between listing of options on peer firms and analyst coverage, defined as the number of analysts following the firm. The horizontal axis represents time in years relative to treatment while the vertical axis represents the estimates. Each point on the plot corresponds to the difference in outcome variable for treated firms between the given year and the mean during the year preceding options listing relative to the same difference for control firms. Vertical bars represent confidence intervals at 90% level.

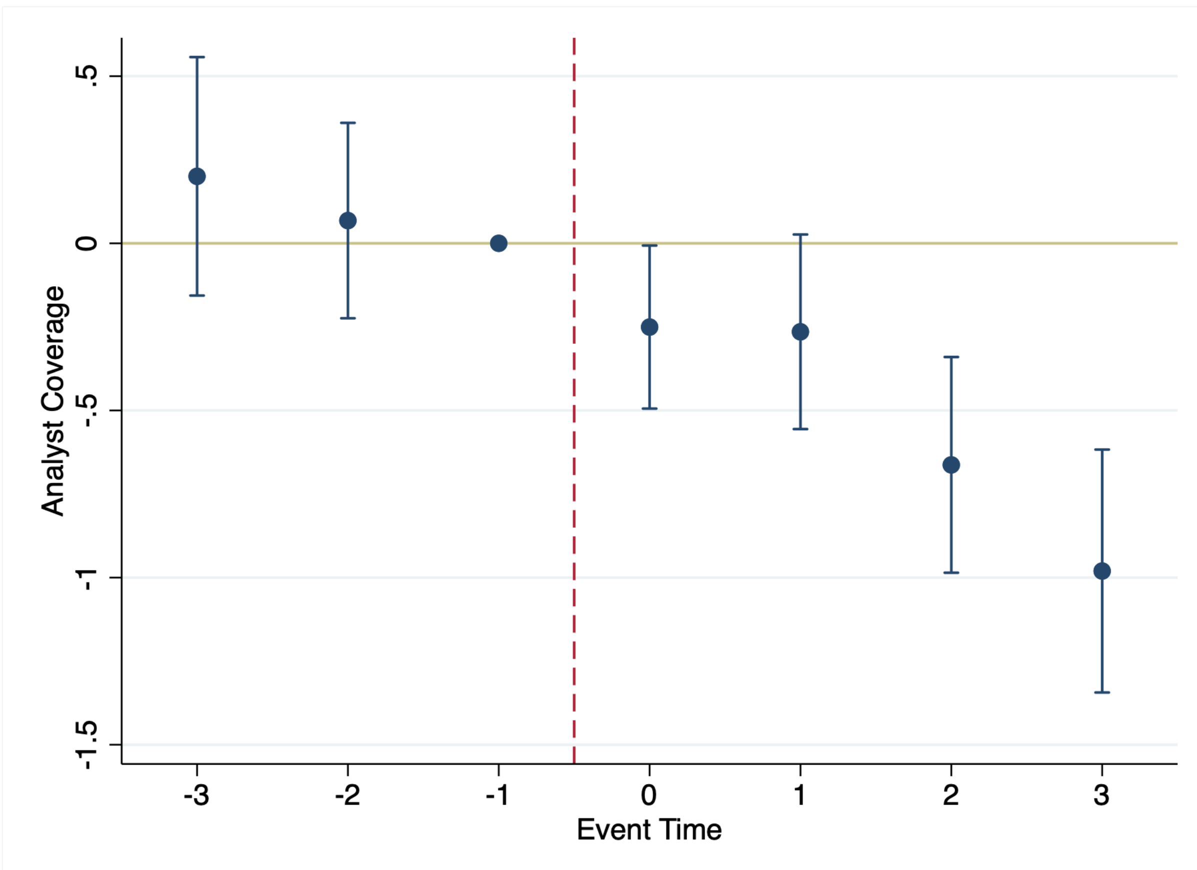

Figure 3:
Stock Price Characteristics
This figure plots the coefficients for the dynamic difference-in-differences regressions that estimate the association between listing of options on peer firms and variance ratio. The horizontal axis represents time in years relative to treatment while the vertical axis represents the estimates. Each point on the plot corresponds to the difference in outcome variable for treated firms between the given year and the mean during the year preceding options listing relative to the same difference for control firms. Vertical bars represent confidence intervals at 90% level.

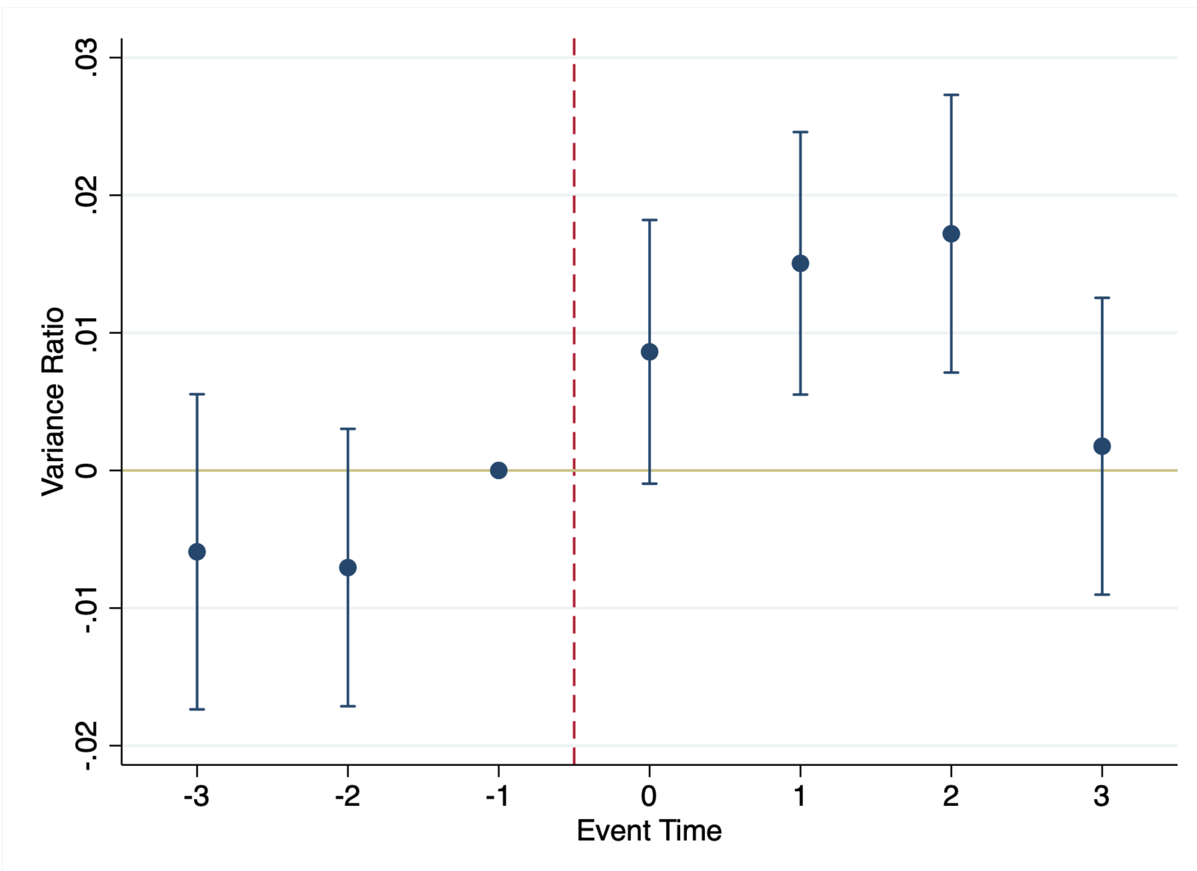

Figure 4:
Stock Price Informativeness
This figure plots the coefficients for the dynamic triple interaction regressions that estimate the association between listing of options on peer firms and stock price informativeness measured by the sensitivity of stock prices to future earnings (PI measure). The horizontal axis represents time in years relative to treatment while the vertical axis represents the estimates. Each point on the plot corresponds to the difference in outcome variable for treated firms between the given year and the mean during the year preceding options listing relative to the same difference for control firms. Vertical bars represent confidence intervals at 90% level.

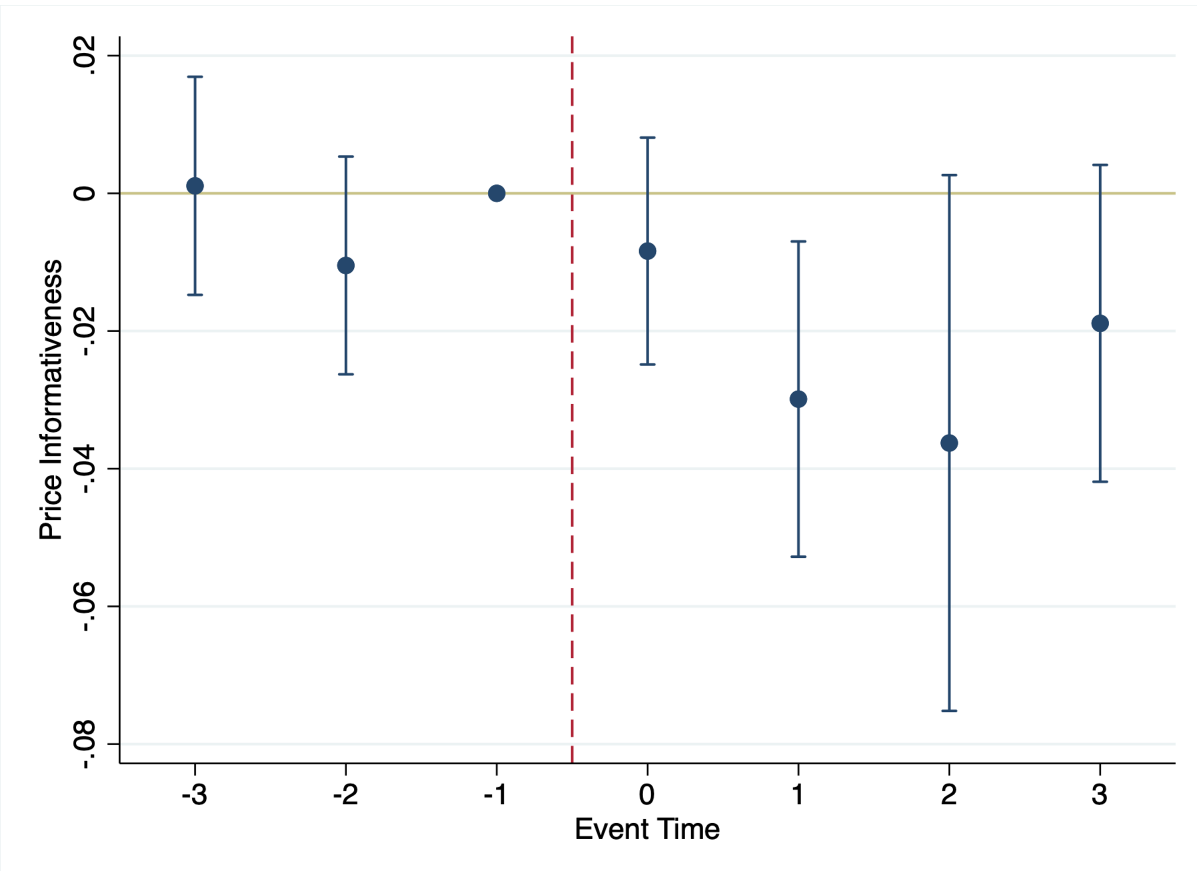

Figure 5:
Firm Profitability
This figure plots the coefficients for the dynamic difference-in-differences regressions that estimate the association between listing of options on peer firms and firm profitability. The horizontal axis represents time in years relative to treatment while the vertical axis represents the estimates. Each point on the plot corresponds to the difference in outcome variable for treated firms between the given year and the mean during the year preceding options listing relative to the same difference for control firms. Vertical bars represent confidence intervals at 90% level.

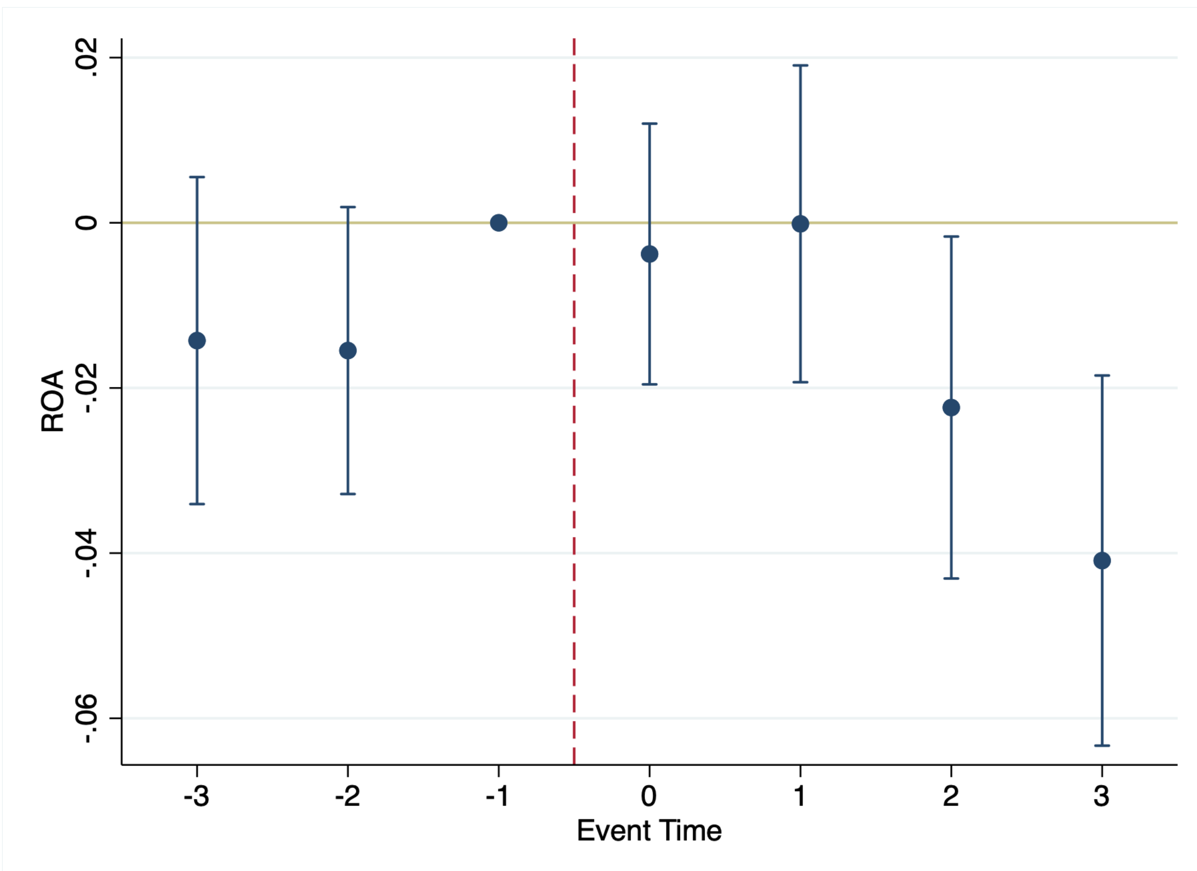

Table 1:
Descriptive Statistics
This table reports summary statistics for our sample that comprises 1,805 firms over 1996-2014. Variable definitions are in Appendix A.2.

	Mean	Median	SD	Min	Max
Attention Measures					
Analyst Coverage	7.18	5.00	6.77	1.00	31
Analyst Revision	14.36	6.00	19.54	1.00	109
Analyst Substitution	0.11	0.00	0.44	0.00	12
Institution Ownership	0.37	0.32	0.30	0.00	0.99
SEC Search Volume (in 100,000s)	2.38	0.49	5.05	1	27.25
Price Informativeness					
Trading Volume	0.01	0.00	0.00	0.00	0.01
Illiquidity	0.03	0.00	0.13	0.00	1.02
Volatility	0.15	0.12	0.10	0.03	0.57
Variance Ratio	0.74	0.76	0.10	0.30	0.87
PI Measure					
E_{t+1}/A_t	-0.03	0.03	0.21	-1.06	0.33
E_{t+3}/A_t	-0.01	0.03	0.24	-1.30	0.51
E_{t+5}/A_t	0.01	0.04	0.27	-1.56	0.66
$\text{Log}(M/A)_t$	6.70	6.83	1.21	1.96	9.19
Firm Value and Profitability					
Tobin's Q	2.43	1.84	1.86	0.84	12.52
Earnings	-0.08	0.03	0.35	-2.15	0.30
ROA	0.03	0.10	0.30	-1.70	0.42
Firm Policies					
CapEx	0.07	0.04	0.09	0.00	0.55
R&D	0.13	0.05	0.21	0.00	1.29
CapR&D	0.19	0.11	0.23	0.00	1.54
Investment	0.21	0.13	0.26	0.00	1.74

Table 2:
Attention Allocation
This table reports results from difference-in-differences regressions that evaluate the association between listing of options on peer stocks and attention measures. First half of the Columns report results with firm and year fixed effects, while the second half report results with firm and industry × year fixed effects. Standard errors are robust and clustered at firm level. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. t-statistics are reported in parentheses.

Panel A						
	(1) Analyst Coverage	(2) Analyst Revision	(3) Forecast Accuracy	(4) Analyst Coverage	(5) Analyst Revision	(6) Forecast Accuracy
PeerListing ×Post	-1.70***	-4.18***	-0.15***	-1.55***	-3.21***	-0.13**
	(-10.07)	(-6.92)	(-2.59)	(-7.08)	(-5.09)	(-2.15)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	No	No	No
Ind×Year FE	No	No	No	Yes	Yes	Yes
Obs.	14,688	15,623	13,487	14,027	14,979	12,743
R2	0.72	0.49	0.68	0.76	0.54	0.77

Panel B				
	(1) Institution Ownership	(2) SEC Traffic	(3) Institution Ownership	(4) SEC Traffic
PeerListing ×Post	-0.03***	-0.55***	-0.03***	-0.69***
	(-4.73)	(-5.02)	(-4.06)	(-4.75)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	No	No
Ind×Year FE	No	No	Yes	Yes
Obs.	20,962	6,431	20,494	6,005
R2	0.79	0.65	0.80	0.66

Table 3:
Stock Price Characteristics
This table reports results from difference-in-differences regressions that estimate the association between listing of options for peer firms and stock price characteristics. Columns (1)-(4) report results with firm and year fixed effects while Columns (5)-(8) report results with firm and industry × year fixed effects. Standard errors are robust and clustered at firm level. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. t-statistics are reported in parentheses.

	(1) Trading Volume	(2) Amihud	(3) Volatility	(4) Variance Ratio	(5) Trading Volume	(6) Amihud	(7) Volatility	(8) Variance Ratio
PeerListing×Post	-0.0003***	0.03***	0.01**	0.02***	-0.0002***	0.02***	0.01***	0.02***
	(-5.85)	(4.94)	(2.47)	(4.42)	(-3.76)	(4.08)	(3.08)	(4.24)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	No	No	No	No
Ind ×Year FE	No	No	No	No	Yes	Yes	Yes	Yes
Obs.	17,612	17,611	22,354	19,952	17,196	17,195	21,891	19,477
R2	0.79	0.34	0.46	0.29	0.80	0.34	0.47	0.29

Table 4:
Stock Price Informativeness
This table reports results from triple interaction regressions that estimate the association between listing of options for peer firms and stock price informativeness measured as the sensitivity of market prices to future earnings. The outcome variable is earnings measured at time t+1, t+3 and t+5 scaled by assets at time t. On the right hand side, we interact our difference-in-differences coefficient with market to book value of assets. Columns (1)-(3) report results with firm and year fixed effects while Columns (4)-(6) report results with firm and industry × year fixed effects. Standard errors are robust and clustered at firm level. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. t-statistics are reported in parentheses.

	(1)	(2)	(3)	(4)	(5)	(6)
	$E_{i,t+1}/A_{i,t}$	$E_{i,t+3}/A_{i,t}$	$E_{i,t+5}/A_{i,t}$	$E_{i,t+1}/A_{i,t}$	$E_{i,t+3}/A_{i,t}$	$E_{i,t+5}/A_{i,t}$
PeerListing×Post×Log(M/A)$_{i,t}$	-0.02**	-0.02*	-0.04	-0.02**	-0.03*	-0.04
	(-2.02)	(-1.83)	(-1.36)	(-2.02)	(-1.90)	(-1.18)
PeerListing×Post	0.06	0.10	0.22	0.08	0.14	0.25
	(1.39)	(1.47)	(1.31)	(1.52)	(1.62)	(1.13)
PeerListing×Log(M/A)$_{i,t}$	-0.04***	-0.03	-0.03	-0.03**	-0.03	-0.05
	(-2.93)	(-1.59)	(-0.77)	(-2.54)	(-1.36)	(-0.91)
Post×Log(M/A)$_{i,t}$	0.002*	0.0001	0.0001	0.002	0.001	-0.00004
	(1.95)	(0.09)	(0.05)	(1.63)	(0.51)	(-0.02)
Log(M/A)$_{i,t}$	0.03***	0.004	-0.02	0.03***	0.003	-0.02
	(5.57)	(0.50)	(-1.11)	(3.53)	(0.22)	(-0.83)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	No	No	No
Ind ×Year FE	No	No	No	Yes	Yes	Yes
Obs.	15,753	12,311	9,528	15,333	11,862	9,073
R2	0.62	0.47	0.41	0.64	0.51	0.46

Table 5:

Investment-Q Sensitivity

This table reports results from triple interaction regressions that estimate the association between listing of options for peer firms and investment sensitivity to Q. Panel A examines this relation by comparing all periods before and after options listing while Panel B splits the post period into first three years following options listing (including the year of listing) and all years after that. Investment variables include CapEx (annual capital expenditure), R&D, CapEx+R&D, and Total Investment. Columns (1)-(4) report results with firm and year fixed effects while Columns (5)-(8) report results with firm and industry × year fixed effects. Standard errors are robust and clustered at firm level. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. t-statistics are reported in parentheses.

Panel A

	(1) CapEx	(2) R&D	(3) CapR&D	(4) Investment	(5) CapEx	(6) R&D	(7) CapR&D	(8) Investment
PeerListing×Post × Q	-0.003*	-0.002	-0.003	-0.001	-0.003**	-0.002	-0.003	-0.002
	(-1.86)	(-0.41)	(-0.42)	(-0.18)	(-2.11)	(-0.37)	(-0.45)	(-0.27)
PeerListing×Post	0.008**	0.004	0.006	-0.010	0.009**	0.002	0.006	-0.012
	(2.26)	(0.36)	(0.52)	(-0.73)	(2.48)	(0.20)	(0.44)	(-0.75)
Post × Q	-0.001*	0.001	0.000	0.002	-0.002**	0.003	0.001	0.002
	(-1.93)	(0.51)	(0.08)	(0.51)	(-2.26)	(1.00)	(0.42)	(0.72)
PeerListing×Q	-0.002	0.001	-0.001	0.000	-0.001	0.000	-0.001	-0.001
	(-1.11)	(0.26)	(-0.19)	(0.05)	(-0.53)	(0.03)	(-0.20)	(-0.09)
Q	0.010***	0.021***	0.032***	0.033***	0.009***	0.023***	0.033***	0.035***
	(10.09)	(7.65)	(10.78)	(9.44)	(8.78)	(7.62)	(10.16)	(9.41)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	No	No	No	No
Ind ×Year FE	No	No	No	No	Yes	Yes	Yes	Yes
Obs.	13,083	13,156	13,083	13,156	12,485	12,558	12,485	12,558
R2	0.51	0.74	0.68	0.52	0.58	0.75	0.70	0.57

Panel B

	(1) CapEx	(2) R&D	(3) CapR&D	(4) Investment	(5) CapEx	(6) R&D	(7) CapR&D	(8) Investment
PeerListing×Post I × Q	-0.003**	-0.010**	-0.012**	-0.011	-0.004***	-0.011**	-0.013**	-0.013*
	(-2.50)	(-2.05)	(-1.98)	(-1.59)	(-2.59)	(-2.01)	(-1.96)	(-1.66)
PeerListing×Post II × Q	-0.002	0.008	0.009	0.011	-0.002	0.009	0.009	0.011
	(-0.98)	(1.20)	(1.10)	(1.25)	(-1.29)	(1.20)	(1.04)	(1.15)
PeerListing×Post I	0.009**	0.011	0.017	0.006	0.009***	0.012	0.019	0.006
	(2.56)	(1.30)	(1.51)	(0.44)	(2.75)	(1.18)	(1.45)	(0.41)
PeerListing× Post II	0.007*	-0.011	-0.011	-0.031*	0.009*	-0.013	-0.012	-0.035*
	(1.66)	(-0.89)	(-0.72)	(-1.86)	(1.88)	(-0.93)	(-0.70)	(-1.84)
Post I × Q	-0.001	0.004	0.003	0.003	-0.002**	0.006**	0.004	0.005
	(-1.60)	(1.64)	(1.05)	(1.00)	(-2.04)	(2.07)	(1.34)	(1.31)
Post II × Q	-0.001	-0.002	-0.003	-0.000	-0.002*	-0.001	-0.002	-0.000
	(-1.61)	(-0.70)	(-0.82)	(-0.03)	(-1.76)	(-0.33)	(-0.53)	(-0.01)
PeerListing×Q	-0.002	0.001	-0.001	0.000	-0.001	-0.000	-0.001	-0.001
	(-1.10)	(0.22)	(-0.23)	(0.01)	(-0.52)	(-0.02)	(-0.24)	(-0.15)
Q	0.009***	0.021***	0.032***	0.033***	0.009***	0.023***	0.033***	0.035***
	(10.04)	(7.61)	(10.71)	(9.37)	(8.70)	(7.54)	(10.05)	(9.32)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	No	No	No	No
Ind ×Year FE	No	No	No	No	Yes	Yes	Yes	Yes
Obs.	13,083	13,156	13,083	13,156	12,485	12,558	12,485	12,558
R2	0.51	0.74	0.68	0.52	0.58	0.75	0.70	0.57

Table 6:
Firm Value and Profitability
This table reports results from difference-in-differences regressions that estimate the association between listing of options for peer firms and firm value and profitability. Panel A examines this relation by comparing all periods before and after options listing while Panel B splits the post period into first three years following options listing (including the year of listing) and all years after that. Columns (1)-(3) report results with firm and year fixed effects while Columns (4)-(6) report results with firm and industry × year fixed effects. Standard errors are robust and clustered at firm level. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. t-statistics are reported in parentheses.

	(1) TobinsQ	(2) ROA	(3) Earnings	(4) TobinsQ	(5) ROA	(6) Earnings
Panel A						
PeerListing × Post	-0.05	-0.00	-0.01	-0.01	0.00	-0.00
	(-0.90)	(-0.13)	(-0.66)	(-0.23)	(0.03)	(-0.24)
Firm	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	No	No	No
Ind×Year	No	No	No	Yes	Yes	Yes
Obs.	24,140	25,211	25,279	23,710	24,802	24,867
R2	0.44	0.61	0.50	0.43	0.59	0.47
Panel B						
PeerListing × Post I	0.038	-0.01	0.00	0.03	-0.01	0.00
	(0.68)	(-0.73)	(0.08)	(0.42)	(-0.81)	(0.15)
PeerListing × Post II	-0.17**	-0.02**	-0.04***	-0.07	-0.02*	-0.04***
	(-2.33)	(-2.13)	(-3.93)	(-0.81)	(-1.95)	(-3.43)
Firm	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	No	No	No
Ind×Year	No	No	No	Yes	Yes	Yes
Obs.	24,111	24,111	24,111	23,680	23,680	23,680
R2	0.49	0.65	0.54	0.54	0.68	0.58

Table 7:
Analyst Substitution
This table reports results from regressions that estimate the association between listing of options for peer firms and analyst substitution in Panel A, and the heterogeneity in association between listing of options for peer firms and our main outcomes by total analyst substitution in the years after listing. Outcome variables include analyst substitution in Panel A, and variance ratio and ROA in Panel B. First half of the columns report results with firm and year fixed effects while the latter half report results with firm and industry × year fixed effects. Standard errors are robust and clustered at firm level. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. t-statistics are reported in parentheses.

Panel A

	(1) Analyst Substitution	(2) Analyst Substitution
PeerListing×Post	0.106***	0.0712***
	(4.98)	(2.91)
Firm FE	Yes	Yes
Year FE	Yes	No
Ind×Year FE	No	Yes
Obs.	14,688	14,027
R2	0.177	0.312

Panel B

	(1) Variance Ratio	(2) ROA	(3) Variance Ratio	(4) ROA
PeerListing×Post I × Substitution	0.0080**	-0.0059	0.0083**	-0.0062
	(2.35)	(-1.05)	(2.15)	(-0.97)
PeerListing×Post II × Substitution	0.00671*	-0.0124*	0.00526	-0.0136*
	(1.77)	(-1.75)	(1.26)	(-1.67)
PeerListing×Post I	0.0182***	-0.0138*	0.0168***	-0.0145
	(4.05)	(-1.77)	(3.68)	(-1.61)
PeerListing× Post II	0.0044	-0.0328***	0.0053	-0.0314***
	(0.84)	(-3.69)	(0.98)	(-2.94)
Post I × Substitution	-0.0025***	0.0062**	-0.0030***	0.0056*
	(-2.81)	(2.39)	(-2.76)	(1.82)
Post II × Substitution	-0.0004	0.0096**	-0.0002	0.0103**
	(-0.40)	(2.13)	(-0.14)	(2.12)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	No	No
Ind×Year FE	No	No	Yes	Yes
Obs.	19,814	19,814	19,331	19,331
R2	0.36	0.70	0.45	0.73

Table 8:

Heterogeneity by Competition

This table reports results from triple interaction regressions that estimate the heterogeneity in association between listing of options for peer firms and our main outcomes by the degree of competition in the industry measured by HHI. Outcome variables include analyst coverage, variance ratio and ROA. Panel A examines this relation by comparing all periods before and after options listing while Panel B splits the post period into first three years following options listing (including the year of listing) and all years after that. Columns (1)-(3) report results with firm and year fixed effects while Columns (4)-(6) report results with firm and industry × year fixed effects. Standard errors are robust and clustered at firm level. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. t-statistics are reported in parentheses.

Panel A

	(1) Analyst Coverage	(2) Variance Ratio	(3) ROA	(4) Analyst Coverage	(5) Variance Ratio	(6) ROA
PeerListing × Post × HHI	-1.3450**	0.0081	-0.0017	0.3710	0.0117	-0.0074
	(-2.16)	(0.46)	(-0.06)	(0.38)	(0.64)	(-0.23)
PeerListing × Post	-1.3250***	0.0144*	-0.0071	-1.9600***	0.0122	-0.0094
	(-5.15)	(1.85)	(-0.51)	(-4.26)	(1.51)	(-0.58)
Post × HHI	0.2870	-0.0091	-0.0121	0.8260	-0.0140*	-0.0011
	(0.61)	(-1.51)	(-0.90)	(1.41)	(-1.71)	(-0.05)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	No	No	No
Ind ×Year FE	No	No	No	Yes	Yes	Yes
Obs.	12,219	16,888	21,500	11,488	16,257	20,958
R2	0.72	0.30	0.61	0.76	0.30	0.59

Panel B

	(1) Analyst Coverage	(2) Variance Ratio	(3) ROA	(4) Analyst Coverage	(5) Variance Ratio	(6) ROA
PeerListing×Post I × HHI	-0.9160	0.0182	0.0181	0.3400	0.0321*	0.0167
	(-1.48)	(1.00)	(0.64)	(0.40)	(1.77)	(0.50)
PeerListing×Post II × HHI	-1.3720*	0.0062	-0.0098	0.6550	-0.0051	-0.0230
	(-1.76)	(0.29)	(-0.25)	(0.47)	(-0.23)	(-0.45)
PeerListing×Post I	-0.6700***	0.0181**	-0.0088	-1.0620***	0.0132	-0.0140
	(-2.87)	(2.23)	(-0.62)	(-2.88)	(1.57)	(-0.85)
PeerListing× Post II	-2.2020***	0.0062	-0.0118	-3.1210***	0.0081	-0.0105
	(-6.67)	(0.68)	(-0.62)	(-4.88)	(0.84)	(-0.46)
Post I×HHI	-0.3060	-0.0146**	-0.0116	-0.0521	-0.0238***	0.0039
	(-0.69)	(-2.45)	(-0.97)	(-0.09)	(-2.83)	(0.23)
Post II ×HHI	0.712	-0.0112	-0.0233	1.6630*	-0.0127	-0.0243
	(1.12)	(-1.51)	(-1.27)	(1.94)	(-1.20)	(-0.80)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	No	No	No
Ind×Year FE	No	No	No	Yes	Yes	Yes
Obs.	12,219	16,888	21,500	11,488	16,257	20,958
R2	0.720	0.303	0.610	0.757	0.298	0.587

Table 9:

Intensity of Treatment

This table reports results from regressions of the form in Equation 7 that estimate the differential response of industry peers to options listing based on how closely related they are to listed firms. Panel A examines this relation by comparing all periods before and after options listing while Panel B splits the post period into first three years following options listing (including the year of listing) and all years after that. Columns (1)-(3) report results with firm and year fixed effects while Columns (4)-(6) report results with firm and industry × year fixed effects. Standard errors are robust and clustered at firm level. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. t-statistics are reported in parentheses.

	(1) Analyst Coverage	(2) Variance Ratio	(3) ROA	(4) Analyst Coverage	(5) Variance Ratio	(6) ROA
Panel A						
PScore x Post	-0.026***	0.001***	-0.003***	-0.028***	0.001***	-0.003***
	(-3.42)	(4.97)	(-2.86)	(-3.41)	(3.53)	(-3.09)
PScore	-0.001	-0.000	0.000	-0.002	-0.000	0.000
	(-1.19)	(-0.76)	(0.60)	(-1.19)	(-0.49)	(0.39)
Post	0.560***	0.011***	0.060***	0.500***	0.012***	0.063***
	(6.33)	(5.98)	(8.39)	(4.99)	(5.83)	(7.31)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	No	No	No
Ind×Year FE	No	No	No	Yes	Yes	Yes
Observations	29286	50631	64389	28328	49968	63813
R^2	0.685	0.433	0.497	0.749	0.490	0.514
Panel B						
PScore x Post I	-0.089***	0.001***	-0.002**	-0.109***	0.001***	-0.003***
	(-3.11)	(4.60)	(-2.53)	(-4.58)	(3.13)	(-2.65)
PScore x Post II	-0.012*	0.001	-0.008**	-0.016**	0.001**	-0.009***
	(-1.79)	(1.49)	(-2.44)	(-2.02)	(2.55)	(-2.66)
PScore	-0.002*	-0.000	0.000	-0.002	-0.000	0.000
	(-1.83)	(-0.77)	(0.51)	(-1.58)	(-0.47)	(0.32)
Post I	0.377***	0.014***	0.063***	0.331***	0.015***	0.067***
	(4.45)	(7.53)	(8.63)	(3.45)	(7.26)	(7.53)
Post II	1.910***	-0.003	0.023**	1.693***	-0.001	0.020*
	(13.37)	(-1.26)	(2.30)	(10.63)	(-0.18)	(1.67)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	No	No	No
Ind×Year FE	No	No	No	Yes	Yes	Yes
Observations	29286	50631	64389	28328	49968	63813
R^2	0.693	0.434	0.497	0.754	0.491	0.515

A Internet Appendix

A.1 Model Solution and Proofs

First, we conjecture that traders buy (sell) the asset after a high (low) signal and do not trade otherwise. Then, we solve for the equilibrium stock price and confirm the conjecture.

If $v_j = v^H$, a fraction κ_j observes the firm's payoff and demands $\overline{x}_j$. The remaining mass of rational traders does not observe information about the firm and chooses not to trade. Thus, total order flow is given by $X_j = \kappa_j \overline{x}_j + z_j$. If $v_j = v^L$, a fraction κ_j observes the firm's payoff and demands $\underline{x}_j$. The remaining mass of rational traders does not observe information about the firm and chooses not to trade. Thus, total order flow is given by $X_j = \kappa_j \underline{x}_j + z_j$. It follows that the market maker learns $v_j = v^H$ if $X_j > \kappa_j \underline{x}_j + \overline{x}_j$ and $v_j = v^L$ if $X_j < \underline{x}_j + \kappa_j \overline{x}_j$. Otherwise, he remains uninformed and sets the price equal to $\mathbb{E}[v_j]$.

Next, we derive the trading profits for rational trader i. First, we focus on the case $s_{ij} = v^H$. Traders know that with probability κ_j, the stock price is equal to v^H and with probability $1 - \kappa_j$ it is equal to $\frac{v^H + v^L}{2}$. If trader i demands $\overline{x}_j$ units, his expected profits are: $\overline{x}_j (1 - \kappa_j) \frac{1}{2} \left(v^H - v^L\right) > 0$. If trader i demands $\underline{x}_j$, his expected profits are: $\underline{x}_j (1 - \kappa_j) \frac{1}{2} \left(v^H - v^L\right) < 0$. If he does not trade, his expected profits are zero. Hence, the trader's optimal demand given $s_{ij} = v^H$ is $\overline{x}_j$.

If $s_{ij} = v^L$, traders know that with probability κ_j, the stock price is equal to v^L and with probability $1 - \kappa_j$ it is equal to $\frac{v^H + v^L}{2}$. If trader i demands $\overline{x}_j$ units, his expected profits are: $-\overline{x}_j (1 - \kappa_j) \frac{1}{2} \left(v^H - v^L\right) < 0$. If trader i demands $\underline{x}_j$, his expected profits are: $-\underline{x}_j (1 - \kappa_j) \frac{1}{2} \left(v^H - v^L\right) > 0$. If he does not trade, his expected profits are zero. Hence, the trader's optimal demand given $s_{ij} = v^L$ is $\underline{x}_j$.

If $s_{ij} = \emptyset$, traders know that the stock price is equal to v^H or v^L with probability $\frac{1}{2} k_j$ and equal to $\frac{v^H + v^L}{2}$ otherwise. If trader i demands $\overline{x}_j$ units, his expected profits are:

$\overline{x}_j(1-\kappa_j)\left(\frac{v^H}{2} - \frac{v^H+v^L}{2} + \frac{v^L}{2} - \frac{v^H+v^L}{2}\right) = 0$. If trader i demands $\underline{x}_j$, his expected profits are: $\underline{x}_j(1-\kappa_j)\left(\frac{v^H}{2} - \frac{v^H+v^L}{2} + \frac{v^L}{2} - \frac{v^H+v^L}{2}\right) = 0$. If he does not trade, his expected profits are zero. Hence, the trader's optimal demand given $s_{ij} = \emptyset$ is 0.

To solve for the firms' attention shares, we equate the traders' expected marginal profits: $\frac{v^H+v^L}{4}(1-\kappa_j)\Delta_j$, which leads to the condition: $(1-\kappa_L)\Delta_L = (1-\kappa_N)\Delta_N$. Finally, we can use the capacity constraint to solve for κ_N and κ_L given in the main text. To remain in the interior region $\kappa_j \in (0,1)$, we need to impose the restriction that $m_L < \frac{\Delta_L}{\Delta_L - \Delta_U}$.

Main Hypotheses. It follows from the optimal attention shares, that:

$$\kappa_L - \kappa_N = -\frac{(m_L + m_N - 1)(\Delta_L - \Delta_N)}{\Delta_L m_N + m_L \Delta_N} < 0.$$

Similarly, we obtain:

$$\begin{aligned} \frac{\partial \kappa_L}{\partial m_L} &= -\frac{\Delta_N (m_N (\Delta_L - \Delta_N) + \Delta_N)}{(\Delta_L m_N + m_L \Delta_N)^2} < 0 \\ \frac{\partial \kappa_N}{\partial m_L} &= -\frac{\Delta_L (m_N (\Delta_L - \Delta_N) + \Delta_N)}{(\Delta_L m_N + m_L \Delta_N)^2} < 0 \\ \frac{\partial (\kappa_L - \kappa_N)}{\partial m_L} &= -\frac{(\Delta_L - \Delta_N)(m_N (\Delta_L - \Delta_N) + \Delta_N)}{(\Delta_L m_N + m_L \Delta_N)^2} < 0. \end{aligned}$$

Further predictions. We define expected trading volume as $Vol_j \equiv \mathbb{E}[X_j]$, the return volatility as $\sigma_j \equiv \sqrt{\text{Var}\left(v_j - p_j\right)}$, and price informativeness as the probability with which firm j's stock price reveals v_j: $PI_j \equiv \mathbb{P}\left(p_j \in \{v^H, v^L\}\right)$. It then follows that: $Vol_j = \frac{1}{2}\left(\Delta_j + \left(\overline{x}_j + \underline{x}_j\right)\kappa_j\right)$; $\sigma_j = \sqrt{1-\kappa_j}\sigma_v$; and $PI_j = \kappa_j$. Using the equilibrium expression for κ_j, it follows that: $\frac{\partial Vol_N}{\partial m_L} < \frac{\partial Vol_L}{\partial m_L}$, $\frac{\partial \sigma_N}{\partial m_L} > \frac{\partial \sigma_L}{\partial m_L}$, and that $\frac{\partial PI_N}{\partial m_L} < \frac{\partial PI_L}{\partial m_L}$.

A.2 Definition of variables

- *Amihud*: A proxy for the degree of illiquidity of stocks. Average ratio of returns over trading volume. (See Section 4.2 for more details)

- *Analyst Coverage*: Number of analysts following the firm.

- *Analyst substitution*: Number of analyst that move from the given firm to the listed firm, i.e. the number of analysts that stop following the given firm and start following the listed firm.

- *CapEx*: Annual capital expenditure scaled by lagged value of total assets (Compustat items: capx/l1.at)

- *CapR&D*: Annual investment of the firm in capital and R&D scaled by lagged value of total assets.

- *Cash*: Cash holdings of the firm scaled by lagged value of total assets (Compustat items: che/l1.at)

- *Dividends*: Total dividends paid scaled by lagged value of total assets (Compustat items: dvc/l1.at)

- *Earnings*: Annual income before extra ordinary items scaled by lagged value of total assets (Compustat items: ib/l1.at)

- *Institution Ownership*: Total institutional ownership as the percentage of shares outstanding.

- *Investment*: Total annual investment made by the firm in capital, R&D and acquisitions scaled by lagged value of total assets (Compustat items: (capx + aqc + xrd)/l1.at)

- *Leverage*: The ratio of the sum of total long-term debt plus total debt in current liabilities (Compustat items: $dltt + dlc$) scaled by market value of total assets (Compustat items: $prcc_f \times cshpri + dlc + dltt + pstkl - txditcs$)

- *MarketCap*: Average of daily market capitalization taken over the year.

- *MTB*: Ratio of market value of assets to book value of assets (Compustat items: $(prcc_f \times cshpri + at - ceq)/at$)

- *PeerListing*: Dummy variable that takes value of 1 for industry peer firms that do not have options listed on their stocks.

- *Post*: Dummy variable that takes value of 1 for years after options listing.

- *R&D*: Annual research and development expense made by the firm scaled by lagged value of total assets (Compustat items: $xrd/l1.at$)

- *ROA*: Earnings before interest, taxes, depreciation and amortization (EBITDA) scaled by lagged value of total assets (Compustat items: oibdp/l1.at)

- *SEC Traffic*: Total annual number of downloads of SEC filings associated with a given firm-year.

- *TobinsQ*: Ratio of market value of assets to replacement value (proxied by book value of total assets) (Compustat items: $(prcc_f \times csho + at - che)/at$)

- *Trading Vol*: Total number of stock shares traded for the firm during the year normalized by the total trading volume of the market.

- *Variance Ratio*: Absolute value of one minus the ratio of daily over weekly return variance. (See Section 4.2 for more details)

- *Volatility*: Standard deviation of daily stock returns calculated at yearly level.

A.3 Additional Tables

Table A.3.1:

Heterogeneity by Distance from Exchange

This table reports results from triple interaction regressions that estimate the heterogeneity in association between listing of options for peer firms and our main outcomes by distance from options exchange. Outcome variables include analyst coverage, variance ratio and ROA. Panel A examines this relation by comparing all periods before and after options listing while Panel B splits the post period into first three years following options listing (including the year of listing) and all years after that. Columns (1)-(3) report results with firm and year fixed effects while Columns (4)-(6) report results with firm and industry × year fixed effects. Standard errors are robust and clustered at firm level. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. t-statistics are reported in parentheses.

Panel A

	(1) Analyst Coverage	(2) Variance Ratio	(3) ROA	(4) Analyst Coverage	(5) Variance Ratio	(6) ROA
PeerListing × Post × Distance	-0.0001	-0.0000^{*}	0.0000	0.0000	-0.0000	0.0000^{*}
	(-0.59)	(-1.70)	(1.59)	(0.41)	(-0.39)	(1.78)
PeerListing × Post	-1.6530^{***}	0.0211^{***}	-0.0041	-1.6200^{***}	0.0166^{***}	-0.0059
	(-8.41)	(4.23)	(-0.44)	(-5.93)	(3.32)	(-0.56)
PeerListing × Distance	0.0000	0.0000^{*}	-0.0000	-0.0000	0.0000	-0.0000^{*}
	(0.57)	(1.80)	(-1.56)	(-0.42)	(0.52)	(-1.74)
Post × Distance	0.0001	-0.0000	-0.0000	0.0000	-0.0000^{*}	-0.0000
	(0.84)	(-1.60)	(-1.33)	(0.02)	(-1.85)	(-1.65)
Distance	-0.0000	0.0000	0.0000	-0.0000	0.0000^{*}	0.0000
	(-0.84)	(1.61)	(1.32)	(-0.02)	(1.86)	(1.62)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	No	No	No
Ind×Year FE	No	No	No	Yes	Yes	Yes
Obs.	13,767	18,952	23,822	13,005	18,372	23,298
R2	0.73	0.30	0.60	0.77	0.31	0.58

Panel B

	(1) Analyst Coverage	(2) Variance Ratio	(3) ROA	(4) Analyst Coverage	(5) Variance Ratio	(6) ROA
PeerListing×Post I × Distance	0.0001	-0.0000	0.0000	0.0002	0.0000	0.0000
	(0.76)	(-0.75)	(1.12)	(1.05)	(0.42)	(0.88)
PeerListing×Post II × Distance	-0.0002	-0.0000**	0.0000	-0.0001	-0.0000	0.0000**
	(-1.32)	(-2.36)	(1.60)	(-0.66)	(-1.14)	(2.16)
PeerListing×Post I	-0.9710***	0.0243***	0.0034	-0.9970***	0.0189***	0.0047
	(-5.69)	(4.71)	(0.35)	(-4.51)	(3.63)	(0.43)
PeerListing× Post II	-2.3600***	0.0154**	-0.0146	-2.3220***	0.0119*	-0.0224
	(-9.17)	(2.54)	(-1.17)	(-6.18)	(1.92)	(-1.56)
Post I × Distance	-0.0001	-0.0000*	-0.0000	-0.0002**	-0.0000**	-0.0000
	(-1.41)	(-1.87)	(-1.28)	(-2.30)	(-2.15)	(-1.08)
Post II × Distance	0.0002*	-0.0000	-0.0000	0.0002	-0.0000*	-0.0000**
	(1.85)	(-1.61)	(-1.24)	(1.32)	(-1.68)	(-2.02)
PeerListing×Distance	0.0000	0.0000	-0.0000	-0.0000	0.0000	-0.0000*
	(0.55)	(1.58)	(-1.57)	(-0.46)	(0.34)	(-1.73)
Distance	-0.0000	0.0000**	0.0000	0.0000	0.0000**	0.00000172*
	(-0.67)	(2.01)	(1.44)	(0.07)	(2.18)	(1.73)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	No	No	No
Ind×Year FE	No	No	No	Yes	Yes	Yes
Obs.	13,767	18,952	23,822	13,005	18,372	23,298
R2	0.73	0.30	0.60	0.77	0.31	0.58

Table A.3.2:

Heterogeneity by Analyst Forecasts

This table reports results from triple interaction regressions that estimate the heterogeneity in association between listing of options for peer firms and our main outcomes by mean analyst forecasts in the quarter before listing. Outcome variables include analyst coverage, variance ratio and ROA. Panel A examines this relation by comparing all periods before and after options listing while Panel B splits the post period into first three years following options listing (including the year of listing) and all years after that. Columns (1)-(3) report results with firm and year fixed effects while Columns (4)-(6) report results with firm and industry × year fixed effects. Standard errors are robust and clustered at firm level. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. t-statistics are reported in parentheses.

Panel A

	(1) Analyst Coverage	(2) Variance Ratio	(3) ROA	(4) Analyst Coverage	(5) Variance Ratio	(6) ROA
PeerListing × Post × Forecast	0.0288	0.0009*	-0.0023	0.0526	0.0010*	-0.0024
	(0.96)	(1.88)	(-1.61)	(1.50)	(1.66)	(-1.36)
PeerListing × Post	-1.6980***	0.0190***	-0.0018	-1.5620***	0.0193***	0.0000
	(-10.02)	(5.24)	(-0.23)	(-7.28)	(5.16)	(0.00)
PeerListing × Forecast	-0.0442*	-0.0011**	-0.0004	-0.0640**	-0.0010*	-0.0009
	(-1.80)	(-2.47)	(-0.97)	(-2.39)	(-1.95)	(-1.24)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	No	No	No
Ind ×Year FE	No	No	No	Yes	Yes	Yes
Obs.	14,685	19,727	24,933	14,119	19,428	24,713
R2	0.75	0.35	0.64	0.82	0.45	0.66

Panel B

	(1) Analyst Coverage	(2) Variance Ratio	(3) ROA	(4) Analyst Coverage	(5) Variance Ratio	(6) ROA
PeerListing×Post I × Forecast	0.0345	0.0007	-0.0036**	0.0595	0.0008	-0.0035*
	(1.14)	(1.42)	(-2.07)	(1.54)	(1.18)	(-1.74)
PeerListing×Post II × Forecast	0.0203	0.0012***	-0.0004	0.0401	0.0014**	-0.0008
	(0.69)	(2.70)	(-0.44)	(1.21)	(2.49)	(-0.41)
PeerListing×Post I	-1.1050***	0.0255***	0.0035	-0.9880***	0.0254***	0.0046
	(-7.42)	(6.86)	(0.46)	(-5.58)	(6.52)	(0.53)
PeerListing× Post II	-2.467***	0.0093**	-0.0091	-2.3350***	0.0096**	-0.0067
	(-11.37)	(2.06)	(-0.85)	(-7.88)	(2.08)	(-0.56)
PeerListing×Forecast	-0.0439*	-0.0011**	-0.0003	-0.0623**	-0.0011**	-0.0009
	(-1.72)	(-2.57)	(-0.94)	(-2.16)	(-2.01)	(-1.23)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	No	No	No
Ind×Year FE	No	No	No	Yes	Yes	Yes
Obs.	14,685	19,727	24,933	14,119	19,428	24,713
R2	0.72	0.29	0.61	0.76	0.29	0.59

Table A.3.3:
Controlling for cohort × time fixed effects
This table reports results from difference-in-differences regressions that estimate the association between listing of options for peer firms and our main outcomes. Panel A examines this relation by comparing all periods before and after options listing while Panel B splits the post period into first three years following options listing (including the year of listing) and all years after that. Columns (1)-(3) report results with firm and cohort × year fixed effects while Columns (4)-(6) report results with firm, cohort × year, and industry × year fixed effects. Standard errors are robust and clustered at firm level. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. t-statistics are reported in parentheses.

	(1) Analyst Coverage	(2) Variance Ratio	(3) ROA	(4) Analyst Coverage	(5) Variance Ratio	(6) ROA
Panel A						
PeerListing×Post	-1.925***	0.012*	-0.015	-1.443***	0.013**	-0.012
	(-6.77)	(1.93)	(-1.26)	(-3.73)	(1.97)	(-0.86)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Cohort x Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry x Year FE	No	No	No	Yes	Yes	Yes
Observations	12411	14195	17679	11696	13494	17110
R^2	0.730	0.335	0.613	0.816	0.456	0.651
Panel B						
PeerListing×Post I	-1.248***	0.016***	-0.008	-0.780**	0.016***	-0.006
	(-4.61)	(2.42)	(-0.60)	(-2.49)	(2.43)	(-0.43)
PeerListing×Post II	-2.678***	0.006	-0.025*	-2.173***	0.007	-0.020*
	(-7.85)	(0.91)	(-1.80)	(-4.18)	(0.94)	(-1.71)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Cohort x Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry x Year FE	No	No	No	Yes	Yes	Yes
Observations	12,411	14,195	17,679	11,696	13,494	17110
R^2	0.731	0.335	0.613	0.817	0.456	0.651

Table A.3.4:
Robustness to dropping different listing years I
This table reports t-stats from difference-in-differences regressions that estimate the association between listing of options on peer firms and our main outcome variables dropping firms associated with one listing year at a time.

	Analyst Coverage (1)	Variance Ratio (2)	ROA (3)
Excluding 1997	-6.93	4.32	-0.91
Excluding 1998	-6.78	4.58	-0.63
Excluding 1999	-7.17	4.45	-1.05
Excluding 2000	-6.95	4.45	-1.33
Excluding 2001	-7.00	4.49	-1.58
Excluding 2002	-6.92	4.36	-1.78
Excluding 2003	-7.20	4.20	-1.45
Excluding 2004	-6.29	4.75	-0.95
Excluding 2005	-7.21	4.46	-1.70
Excluding 2006	-7.19	4.41	-1.33
Excluding 2007	-7.34	4.07	-1.25
Excluding 2008	-7.02	4.99	-1.35
Excluding 2009	-7.57	4.24	-1.00
Excluding 2010	-7.26	4.75	-1.32
Excluding 2011	-7.33	4.53	-1.10
Excluding 2012	-6.98	4.69	-1.40
Excluding 2013	-7.34	4.61	-1.32

Table A.3.5:
Robustness to dropping different listing years II
This table reports t-stats from difference-in-differences regressions that estimate the association between listing of options on peer firms and our main outcome variables dropping firms associated with one listing year at a time. The main difference-in-differences variable has been split into two - zero to two years post listing and all years after two years.

		Analyst Coverage (1)	Variance Ratio (2)	ROA (3)
Excluding 1997	PeerListing x Post I	-7.24	5.15	-0.17
	PeerListing x Post II	-10.72	1.94	-1.92
Excluding 1998	PeerListing x Post I	-7.15	5.46	-0.54
	PeerListing x Post II	-10.98	1.96	-1.62
Excluding 1999	PeerListing x Post I	-7.12	4.88	-0.52
	PeerListing x Post II	-10.79	1.38	-1.69
Excluding 2000	PeerListing x Post I	-7.46	5.55	-1.02
	PeerListing x Post II	-11.04	1.84	-1.78
Excluding 2001	PeerListing x Post I	-7.74	5.72	-1.07
	PeerListing x Post II	-11.24	1.72	-2.06
Excluding 2002	PeerListing x Post I	-7.33	5.55	-1.00
	PeerListing x Post II	-10.71	1.33	-1.79
Excluding 2003	PeerListing x Post I	-7.45	5.13	-1.18
	PeerListing x Post II	-10.99	1.53	-1.94
Excluding 2004	PeerListing x Post I	-6.70	5.58	-0.59
	PeerListing x Post II	-10.56	1.69	-2.02
Excluding 2005	PeerListing x Post I	-7.00	5.39	-1.07
	PeerListing x Post II	-10.63	1.68	-2.14
Excluding 2006	PeerListing x Post I	-7.25	5.09	-0.65
	PeerListing x Post II	-10.79	1.69	-2.10
Excluding 2007	PeerListing x Post I	-7.85	5.63	-0.74
	PeerListing x Post II	-11.34	1.61	-1.98
Excluding 2008	PeerListing x Post I	-7.63	5.83	-0.86
	PeerListing x Post II	-11.49	1.80	-1.73
Excluding 2009	PeerListing x Post I	-7.30	5.64	-0.33
	PeerListing x Post II	-11.08	1.82	-1.69
Excluding 2010	PeerListing x Post I	-7.37	5.66	-0.63
	PeerListing x Post II	-11.05	2.28	-1.79
Excluding 2011	PeerListing x Post I	-7.39	5.35	-0.80
	PeerListing x Post II	-11.34	1.71	-1.96
Excluding 2012	PeerListing x Post I	-7.44	5.59	-0.77
	PeerListing x Post II	-11.20	1.61	-2.15
Excluding 2013	PeerListing x Post I	-7.53	5.70	-0.84
	PeerListing x Post II	-11.21	2.11	-1.94

Table A.3.6:
Robustness to adding linear controls
This table reports results from difference-in-differences regressions that estimate the association between listing of options for peer firms and our main outcomes. Panel A examines this relation by comparing all periods before and after options listing while Panel B splits the post period into first three years following options listing (including the year of listing) and all years after that. Columns (1)-(3) report results with firm and year fixed effects while Columns (4)-(6) report results with firm and industry × year fixed effects. All columns control for lagged volatility, Amihud illiquidity measure and trading volume. Standard errors are robust and clustered at firm level. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. t-statistics are reported in parentheses.

	(1) Analyst Coverage	(2) Variance Ratio	(3) ROA	(4) Analyst Coverage	(5) Variance Ratio	(6) ROA
Panel A						
PeerListing×Post	-2.001***	0.016***	-0.004	-1.798***	0.016***	-0.003
	(-10.05)	(3.63)	(-0.54)	(-6.20)	(3.39)	(-0.36)
LagVolatility	-0.878	-0.026**	0.026	-1.285*	-0.028**	0.013
	(-1.55)	(-2.37)	(0.95)	(-1.92)	(-2.28)	(0.41)
LagAmihud	0.267	0.018	0.030**	0.020	0.017	0.034**
	(0.84)	(1.55)	(2.21)	(0.04)	(1.37)	(2.14)
LagTradingVol	-116.800***	-0.463	-1.772	-80.770	-0.420	-1.398
	(-2.21)	(-0.97)	(-1.52)	(-1.37)	(-0.67)	(-0.96)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry x Year FE	No	No	No	Yes	Yes	Yes
Observations	9,673	13,737	15,961	8,743	13,009	15,303
R^2	0.720	0.293	0.615	0.749	0.283	0.581
Panel B						
PeerListing×Post I	-1.227***	0.017***	-0.006	-1.021***	0.015***	-0.010
	(-6.96)	(3.88)	(-0.86)	(-4.54)	(3.28)	(-1.16)
PeerListing×Post II	-2.681***	0.009*	-0.023**	-2.438***	0.009*	-0.029***
	(-10.94)	(1.91)	(-2.56)	(-7.27)	(1.72)	(-2.73)
LagVolatility	0.703	-0.009	0.032	0.498	0.003	0.042
	(1.29)	(-0.84)	(1.33)	(0.78)	(0.27)	(1.44)
LagAmihud	0.213	0.004	0.019	0.157	0.000	0.021
	(0.89)	(0.36)	(1.28)	(0.42)	(0.00)	(1.22)
LagTradingVol	-87.570*	0.173	-2.072	-73.900	0.478	-1.765
	(-1.70)	(0.32)	(-1.31)	(-1.40)	(0.74)	(-1.03)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry x Year FE	No	No	No	Yes	Yes	Yes
Observations	9,986	14,253	16,016	9,079	13,527	15,357
R^2	0.722	0.305	0.645	0.755	0.299	0.615