

Spillover Effects of Options Listing

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Abstract

This paper shows that options listing adversely affects peer stocks in the same industry as the underlying stock. Investors and information intermediaries substitute their limited resources towards acquiring information on underlying stocks at the expense of the peer stocks. This resource substitution away from peer stocks leads to a decline in informational efficiency and market quality for these stocks. Lower informational efficiency negatively affects firm value and profitability for peer firms. Contrary to the extant literature, these findings highlight a negative externality generated by options listing on the stock market.

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1 Introduction

Extant literature shows that equity options listing improves overall quality of the underlying stocks and promotes shareholder interest. For instance, equity options listing is positively associated with information acquisition (e.g. analyst following, press releases), informational efficiency, trading volume, firm value and profitability among other stock and firm characteristics. Does this unambiguously imply that options listing improves welfare of the entire stock market? Or is this approach too narrow to answer this broad question as it focuses on the partial equilibrium effect on the underlying stocks? Options listing may create externalities in the stock market and affect other stocks. Since little is known about these externalities, the impact of options listing on the stock market as a whole remains unclear. Taking a step towards understanding this general equilibrium effect, I study a particular externality generated by options listing and investigate its impact on stocks in the same industry as the underlying stock.

Options listing may affect peer stocks in the same industry as the underlying stock for a few reasons. Options trading offers certain advantages over stock trading like higher leverage opportunities and mitigation of short sell constraints, which makes informed trading more profitable. As a result, options listing encourages information acquisition on underlying firms leading to higher informational efficiency of their stocks¹. If peer firms have common characteristics, and options listing leads to better reflection of information about these characteristics in the price of the underlying stock, then this incremental information also gets incorporated in prices of peer stocks as agents trade on it. Consistent with this argument, Cao (1999) predicts that options listing on one asset improves informational efficiency of other positively correlated assets. Thus, options listing may have a positive information spillover on peer stocks.

On the other hand, if investors and information intermediaries have limited resources (for example, limited time and attention)², they may shift their resources towards acquiring information on the underlying firm and away from peer firms following options listing, as marginal value of information increases for underlying firms. For example, if information intermediaries like analysts

¹Skinner (1990); Damodaran and Lim (1991); Ho (1993) among others show that information acquisition increases on underlying stocks following options listing. Jennings and Starks (1986); Anthony (1988); Mayhew et al. (1995); Amin and Lee (1997); Kumar et al. (1998); Pan and Poteshman (2006); Zhang et al. (2010) among others establish the positive association between options trading and informational efficiency for the underlying stock.

²Corwin and Coughenour (2008); Ramadorai (2013); Dong and Chenkai (2014); Kacperczyk et al. (2014) among others provide evidence that investors have limited resources

specialize in a particular industry and have limited resources, peer stocks may be substitutes from their point of view. And if options get listed on one of the peer stocks, analysts may optimally employ more resources on the listed stock at the expense of other stocks. This resource substitution towards underlying stocks and away from peer stocks may lead to a decline in informational efficiency of peer stocks. Along these lines, Peng (2005) presents a model where agents distribute their limited resources of time and attention to acquire information on different assets, and their optimal choice to allocate resources on one asset negatively affects informational efficiency of other assets. Therefore, options listing may also have a negative information spillover on peer stocks. Which of these opposing spillover effects dominates is an empirical question that this paper addresses.

To identify the causal effect of options listing on peer stock and firm characteristics, I use difference-in-differences methodology and instrumental variables approach for a matched sample. I start by identifying stocks for which options get listed for the first time between 1997 and 2010 (henceforth, listed stocks). For every listed firm, I find a close peer firm from firms in the same industry that *do not have options listed on them*, and hence don't offer the advantages of options trading to the investors. Further, I find a control firm for every listed and peer firm from firms in the same industry that *do have options listed* since prior to 1997. Since, these firms already offer the advantages associated with options trading, I expect them to be least affected by options listing on peer firms, if at all. I use options listing as 'treatment' in difference-in-differences framework, and assume that options listing on one stock is exogenous to the characteristics of the peer stock and provide evidence consistent with this assumption.

To further solidify identification, I use lagged idiosyncratic stock volatility of the listed firm as an instrument for 'peer-listing' in an instrumental variables approach. The OLS specification for the analysis entails regressing dependent variables for firm i on a dummy variable that takes a value of 1 in the years following first option listing on firm j (where i & j are peers). Since, the OLS regression suffers with omitted variable problem, I instrument option listing for firm j with lagged idiosyncratic stock volatility for stock j . The choice of the instrument is based on the fact that stocks for which options get listed tend to have higher stock volatility (Mayhew and Mihov (2004)). Consistent with the findings reported in Mayhew and Mihov (2004), I find that lagged idiosyncratic stock volatility is strongly associated with options listing. The likelihood of options listing increases by 9.3% for a unit increase in idiosyncratic stock volatility, thus supporting the relevance condition.

Further, the test for weak instruments yields an F-statistic of 13.42 which exceeds the threshold of $F = 10$ suggesting that the instrument is strong and unlikely to be biased towards the OLS estimates (Bound et al. (1995); Staiger and Stock (1997)). The exclusion restriction in this setting requires that lagged idiosyncratic volatility of listed stock affects peer firm characteristics only through its effect on the likelihood of options listing.

I first show that information acquisition increases for listed firms but declines for peer firms in the years following options listing. In other words, resources to acquire information are substituted towards listed stocks and away from peer stocks following options listing. To do this, I use four different measures of information acquisition used in the literature including media articles, internet searches, analyst coverage and analyst revisions. I find that annual change in the number of media articles written about the firm increases by 9 articles for listed firms but declines by 10 articles for peer firms, relative to control firms in the year of listing. Internet searches increase by 5.7% for listed firms but decline by 8.3% for peer firms relative to control firms in the year following listing. Further, analyst coverage increases by 1.5 analysts for listed firms but declines by 0.8 analysts for peer firms relative to control firms in the second year following listing. Instrumental variable coefficients show a decline of about 5 analysts in the years following listing. I further show that the number of analyst revisions increases for listed firms but declines for peer firms following options listing which suggests that analysts substitute their resources to process information about listed stocks at the expense of peer stocks. I also show that an average of 1.6 analysts that followed peer stocks before listing move to listed stocks and stop following peer stocks in the years following options listing.

Further, I show that resource substitution away from peer firms and towards listed firms leads to a decline in informational efficiency and market quality for peer stocks. I show that the amount of private information incorporated in stock price, as measured by non-synchronicity, declines for peer stocks in the years following options listing. Further, information asymmetry between traders, measured by probability of informed trading (PIN), increases for peer stocks but declines for listed stocks. This result supports the findings reported in Hu (2015) which documents a decline in PIN for listed stocks following options listing. I also document that stock volatility increases by 18.5% for peer stocks in the years following options listing, relative to mean volatility in the year prior to listing. Liquidity, as measured by Amihud illiquidity measure, declines for peer stocks, and trading

volume as a fraction of total stock market trades increases for listed firms but declines for peer firms following options listing.

Next, I turn my attention to the effect of options listing on firm value and profitability. Options listing can affect firm value through its effect on informational efficiency for two reasons. First, if prices become more informative for listed firms, corporate resources may be allocated more efficiently leading to an increase in firm value (Fishman and Hagerty (1992); 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. Consistent with this argument Roll et al. (2009) document a positive association between options trading volume and firm value of the underlying stock. In line with their results, I find that options listing leads to an increase in firm value of the listed firms, but a decline in firm value of the peer firms. Next, I document that both earnings and profitability of peer firms decline significantly in the years following options listing. This is consistent with the argument that lower informational efficiency of peer stocks following options listing leads to lower profitability for these firms.

Finally, I investigate the impact of options listing on managerial learning for peer firms. Managers learn valuable information from stock prices and incorporate this information in their investment decisions. Chen et al. (2007) show that managers learn more if stock prices are more informative. Further, Roll et al. (2009) show that managerial learning for listed firms increases as informational efficiency improves following options listing. In addition to their findings, I show that managerial learning, measured by investment sensitivity to stock price, declines for peer firms in the years following options listing.

This paper contributes to the long stream of literature that examines the impact of options trading on underlying stock and firm characteristics. Among them, several studies examine the effect of options trading on information acquisition for underlying firms. For example, Skinner (1990) and Ho (1993) show that analyst coverage and wall street journal's coverage is positively associated to options listing and trading respectively. A large number of studies also show that options listing and trading leads to higher informational efficiency and market quality for underlying firms (for example, Brennan and Cao (1996); Bollen (1998); Kumar et al. (1998); Cao (1999); Mayhew and Mihov (2004); Danielsen et al. (2007); Hu (2014, 2015) among others). Further, recent papers discuss the impact of options listing on firm characteristics which is mainly driven by its effect on

informational efficiency. For instance, Roll et al. (2009) document that options trading is positively associated to firm value and show evidence consistent with informational efficiency being the channel for this effect. Naiker et al. (2013) show that implied cost of equity capital declines as informational efficiency increases following options listing. While these studies investigate the impact of options listing on underlying stocks and firms, I contribute to this literature by showing a negative spillover effect of options listing on peer stocks in the same industry with no options trading. Understanding the impact of options listing on peer firms would be of interest to these firms and options market regulators.

This study also relates to the literature on limited investor resources and its impact on financial markets. The closest paper to this study in the ‘limited resources’ literature is Peng (2005) which presents a model where agents distribute their limited resources to acquire information about different assets. In her setting, agents choose to employ most resources on acquiring information about assets with high uncertainty which leads to an increase in price informativeness for these assets but a decline in informational efficiency for other assets. Van Nieuwerburgh and Veldkamp (2010) show that agents with limited resources choose to acquire information on assets that they expect to hold or trade, which leads to under-diversification. Peng and Xiong (2006) argue that investors with limited attention tend to process market wide information rather than firm specific information which leads to a decline in the amount of firm specific information incorporated in stock price. Corwin and Coughenour (2008) find that NYSE specialists allocate effort toward their most active stocks during periods of increased activity, resulting in less frequent price improvement and increased transaction costs for their remaining assigned stocks. I contribute to this literature by empirically showing that an exogenous increase in marginal value of information on one stock leads to resource substitution towards these stocks at the expense of peer stocks which adversely affects informational efficiency of peer stocks and has real implications for these firms.

Finally, this paper is related to the literature that studies the effect of informational efficiency of stock market on corporate investment and performance. Several studies in this literature show that higher stock price informativeness leads to more efficient allocation of resources resulting in higher profitability (Fishman and Hagerty (1992); Khanna et al. (1994); Dow and Gorton (1997)). Recent studies demonstrate that managers learn valuable information from stock prices and incorporate this information in their investment decisions (Dow and Gorton (1997); Subrahmanyam and

Titman (1999); Chen et al. (2007)). Chen et al. (2007) further show that managerial learning is positively associated with stock price informativeness. I contribute to this literature by showing that a decline in informational efficiency of peer stocks induced by options listing leads to a decline in firm performance and managerial learning.

The remainder of this paper is organized as follows. Section 2 discusses and develops the hypotheses. In section 3, I describe the empirical methodology used to identify the causal effect of options listing and discuss identifying assumptions. Section 4 describes the data sources and variables used in the study. In section 5, I present the results and provide further insights. Section 6 discusses robustness tests and section 7 concludes.

2 Hypotheses Development

Options markets offer certain advantages over stock markets that makes informed trading more profitable. For instance, options markets have higher leverage opportunities (Back (1993); Biais and Hillion (1994)), mitigate short sell constraints (Diamond and Verrecchia (1987)) and increase the opportunity set of trading strategies available to investors (Cao (1999)). This allows investors with private information to generate higher payoffs, thus increasing the marginal value of information. As a result, options markets encourage information acquisition on the underlying stock (Cao (1999)). A number of papers provide evidence consistent to this argument. For example, Skinner (1990) shows that the number of analysts following the firm increases considerably in the years following options listing. Damodaran and Lim (1991) show that institutional ownership increases for underlying stock following options listing. Ho (1993) finds that Wall Street Journal's coverage of firms with listed options is more than 50 percent higher than the coverage for firms without listed options. Higher information acquisition leads to an increase in informed trading in the options market, which improves informational efficiency of the underlying stock as information flows from options to stock market to eliminate potential arbitrage opportunities (Diamond and Verrecchia (1987); Roll et al. (2009)). In support, Easley, O'Hara and Paperman (1998) and Chakravarty et al. (2004) find that options order flows contain information about the future direction of the underlying stock price. Bali and Hovakimian (2009) and Cremers and Weinbaum (2010) find that changes in options prices or volatility can predict the underlying equity price movements. Chakravarty et al. (2004) find that

the options market provides an average of 17 percent of information discovery in equity prices³.

An increase in price informativeness of underlying stock following options listing may have a positive information spillover on peer stocks. Related stocks in the same industry may have common underlying characteristics which get reflected in their stock prices in similar manner. If the additional information being incorporated into stock prices following options listing includes information on these common characteristics, it may increase informational efficiency of peer stocks as this incremental information gets incorporated in peers' stock price when agents trade on it. Consistent with this argument Cao (1999) predicts positive information spillover of options listing on stocks with positively correlated returns.

On the other hand, options listing may also have a negative information spillover on peer stocks. If more resources are employed in acquiring information about underlying firms following options listing, it raises a natural question "where are these resources coming from?" One possibility is that agents may have ample resources and optimally invest these resources before options listing such that the marginal benefit of private information is offset by the marginal cost of acquiring information. With options listing, the marginal benefit of possessing private information increases and agents optimally adjust by increasing resources employed in acquiring information on underlying firms. On the other hand, if agents are resource constraint (e.g. limited time and attention) before options listing, they optimally distribute their limited resources across stocks to maximize their payoff. An exogenous increase in marginal benefit of acquiring private information on one asset caused by options listing could change the optimal distribution of resources allocated across assets. In a similar vein, Peng (2005) presents a model where agents optimally allocate their limited resources of time and attention between assets to learn about their sources of uncertainties with an objective to minimize total uncertainty in their portfolio. The model concludes that agents employ more resources in gathering information about assets with greater uncertainty leading to a decline in resources allocated to, and price informativeness of other assets. Similarly, if agents are resource constraint, options listing on one stock could affect resource distribution between assets leading to a change in price informativeness of peer stocks. Specifically, if investors invest across different industries for diversification reasons and information intermediaries like analysts specialize in a

³Other studies that find a relation between options trading and stock price efficiency include Jennings and Starks (1986); Anthony (1988); Mayhew et al. (1995); Amin and Lee (1997); Kumar et al. (1998); Pan and Poteshman (2006); Zhang et al. (2010) etc.

particular industry, resources may be substituted away from peer stocks and towards listed stocks leading to a decline in informational efficiency of peer stocks.

This leads to first prediction of the paper:

Prediction 1a: *Following options listing, information acquisition on peer firms declines*

Prediction 1b: *Following options listing, informational efficiency of peer stocks declines as resources are substituted away from peer stocks*

Further, if peer stocks receive less resources in terms of investor time and attention, their market quality could decline as measured by stock volatility, liquidity and trading volume.

Prediction 2: *Following options listing, market quality declines for peer stocks i.e. stock volatility increases, and liquidity and trading volume declines*

Informational efficiency of stock price induced by options trading has been shown to have positive implications for firm value (Roll et al. (2009)). This can happen for three reasons. First, if prices are more informative, corporate resources may be allocated more efficiently leading to increased firm value (Fishman and Hagerty (1992); Khanna et al. (1994); Dow and Gorton (1997); Subrahmanyam and Titman (1999)). Second, increased price informativeness reduces the risk of investing in the underlying asset, which tends to raise the asset's price, thus increasing firm valuation (Roll et al. (2009)). Third, options help complete the markets, thus allowing traders to trade on more contingencies which may have a positive price effect (Conrad (1989)). If options trading induced informational efficiency of the underlying stock improves firm value of listed firms, I expect that a decline in informational efficiency of peer stocks should adversely affect the firm value of peer firms.

Prediction 3: *Following options listing, firm value of peer firms declines*

Roll et al. (2009) show that options trading volume is positively associated to firm profitability. They argue that options listing affects firm profitability through its effect on stock price informativeness. As stock prices become more informative, corporate resources are employed more efficiently which leads to an increase in profitability. It follows that a decline in price informativeness of peer stocks due to options listing may lead to a decline in profitability of peer firms.

Prediction 4: *Following options listing, profitability of peer firms declines*

If options listing affects price informativeness of peer stocks, it can affect the extent to which managers learn from stock price. Several papers have theoretically and empirically demonstrated that managers learn important information from stock price about their firm's prospects and incorporate this information in their investment decisions (Dow and Gorton (1997); Subrahmanyam and Titman (1999); Chen et al. (2007)). Further, Chen et al. (2007) show that managers learn more from stock prices when prices reflect more information. It follows that managers for underlying firms may be able to learn more from stock price as it becomes more informative following options listing. Consistent with this argument, Roll et al. (2009) show that options trading volume is positively associated to managerial learning as measured by investment sensitivity to stock price. Similarly, I expect a decline in managerial learning from stock price for peer firms following options listing.

Prediction 5: *Following options listing, investment sensitivity to stock price declines for peer firms*

3 Empirical Methodology

To test the predictions discussed, I use dynamic difference-in-differences and instrumental variables approach described in this section. I start by discussing the options listing process and definition of peer firms.

3.1 Options Listing

Unlike the stock market, where firms apply to be listed, decisions to list options are made within the exchanges. Currently, there are 14 different exchanges that offer standardized options on individual stocks and indices in the United States⁴. These option exchanges are 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, choice of stocks for option listings is made to maximize total trading volume (Mayhew and Mihov (2004)). In addition, these decisions may be influenced

⁴All option exchanges are members of Options Clearing Corporation which is the common clearinghouse shared by all option exchanges. List of these exchanges can be found on the Options Clearing Corporation website: <http://www.optionsclearing.com/clearing/clearing-services/exchanges.jsp>

by other institutional factors. 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).

Given these eligibility requirements, an exchange chooses those eligible stocks to list options for which it anticipates highest demand for option trading. Mayhew and Mihov (2004) show that exchanges tend to list options on stocks with high volatility, trading volume and market capitalization. They further show that the relative weight on trading volume has declined over the years and volatility has emerged as the most important factor in an exchange's choice of stocks to list options. Danielsen et al. (2007) show that liquidity also plays a vital role in this decision as exchanges prefer to list more liquid stocks. Thus, the decision to list options, though made outside of the firm, is not exogenous to firm characteristics.

3.2 Definition of Peer Firms

The focus of this paper is on peer firms which I define as related firms in the same industry that *do not have options listed on their stock*. Firms in the same industry are more likely to be substitutes from the investors' perspective. If investors invest in different industries for diversification reasons, they are more likely to substitute resources between stocks in the same industry rather than stocks in different industries. Moreover, information intermediaries like analysts specialize in specific industries, and if analysts decide to follow listed stocks following options listing, it is likely that they'll shift resources away from similar firms in the same industry. To choose firms that are close substitutes, I impose more restrictions on peer firms. Specifically, for every firm that gets option listed in my sample, I find a peer firm from firms in the same industry defined by 4-digit SIC code that *do not have options listed on their stock* and are closest to the listed firms in terms of market capitalization, trading volume, stock volatility, liquidity and profitability in the year prior to listing. These firms are more likely to be *substitutes* from investors' and information intermediaries' perspective. Firms in the same industry with similar size, profitability, trading volume, stock

volatility and liquidity are likely very similar to each other and an exogenous increase in benefit of informed trading in one firm is likely to attract investor resources towards that firm at the expense of the other firms. Moreover, these firms are similar to listed firms along observable dimensions that exchanges use to select stocks for options listing (according to Mayhew and Mihov (2004); Danielsen et al. (2007)), making them potential candidates for options listing themselves. However, since the exchange decided to list their peer firms, these became subject to spillover effects of options listing. Thus, this definition of peer firms allows me to compare very similar firms eligible for options listing where one firm got listed while other did not.

Though the main analysis uses above definition of peer firms, I show that results are not dependent on this particular definition and are robust to defining peer firms in different ways. For the same, I present results for a sample where where I find upto three peer firms for every listed firm from the group of firms in the same industry defined by 3-digit SIC code that *do not have options listed on their stock* and are closest to listed firms in terms of market capitalization and profitability.

3.3 Difference-in-Differences Methodology

I use dynamic difference-in-differences methodology for a matched sample where treatment is defined by options listing. Since the paper focuses on peer firms, I assume that the decision of the exchange to list options on listed stocks is plausibly exogenous to peer stock and firm characteristics, and show evidence consistent to this assumption. To the extent that this is true, I identify the causal effect of options listing on peer stock and firm characteristics by estimating the following model:

$$y_{i,t} = \sum_{s=-6}^{-2} \beta_s Pre - Listing(-s)_{i,t} + \sum_{s=0}^6 \beta_s Listing(s)_{i,t} + \sum_{s=-6}^{-2} \gamma_s Pre - PeerListing(-s)_{i,t} + \sum_{s=0}^6 \gamma_s PeerListing(s)_{i,t} + \delta_i + \delta_t + \epsilon_{i,t} \quad (1)$$

where $Pre - Listing(-s)$ ($Listing(s)$) is a dummy variable that takes a value one for firm i , ' s ' years before (after) options are listed on it's stock and zero otherwise. Similarly, $Pre - PeerListing(-s)$ ($PeerListing(s)$) is a dummy variable that takes a value one for the peer firm of firm i , ' s ' years before (after) options are listed on firm i 's stock and zero otherwise. Since there are firm-year observations more than six years before and after options listing, there is one dummy variable each

for multiple years at the two end points. That is, $Pre - Listing(-6)$ ($Listing(6)$) equals one for firm i , for all years greater than five years before (after) options are listed on firm i 's stock. Similarly, $Pre - PeerListing(-6)$ ($PeerListing(6)$) equals one for the peer firm of firm i , for all years greater than five years before (after) options are listed on firm i 's stock. δ_i and δ_t represent firm-fixed effects and year fixed effects respectively. The model is fully saturated with the year immediately before options listing as the excluded category. That is I don't include $Pre - Listing(-1)$ and $Pre - PeerListing(-1)$ in the specification. Therefore, the coefficients on $Pre - Listing(-s)$ ($Listing(s)$) and $Pre - PeerListing(-s)$ ($PeerListing(s)$) compare the level of the dependent variable 's' years before (after) options listing to the year before listing. For brevity, I present coefficient estimates on $Pre - PeerListing(-2)$ to $Pre - PeerListing(4)$ and $Pre - Listing(-2)$ to $Listing(4)$ in the tables.

The inclusion of firm fixed effects, δ_i , ensures that each indicator is estimated using only within firm variation in the dependent variable and the time dummies, δ_t , control for economy wide trends. The standard errors are corrected for heteroskedasticity and autocorrelation, and are clustered at firm-level.

Though the focus of the paper is to investigate the effect of options listing on peer stocks (i.e. γ 's in equation (1)), I include dummy variables for listing firms for the following reason. While testing predictions 1 & 2, I want to show that not only are resources taken away from the peer stocks following options listing but they are taken away from peer stocks and employed towards listed stocks. That is, resources to acquire information (e.g. investor attention) are being substituted from peer to listed stocks. Though the coefficients on dummy variables for listed firms don't give the causal estimate of the effect on the outcome variables for listed firms, they do provide the direction of the effect.

The sample consists of three types of firms - listed firms, peer firms and control firms. For every listed and peer firm, I find a control firm from firms that are in the same industry defined by 3-digit SIC code that *have options listed on their stock* since prior to 1997 and are closest to listed and peer firms in terms of size and profitability. The key difference between peer and control firms is that control firms have options listed on their stocks unlike the peer firms. Since, control firms already offer advantages of options trading to informed investors, I expect these firms to be least affected, if at all when options get listed on other stocks in the same industry.

Thus the γ coefficients in equation (1) captures the effect of options listing on peer firms that *don't have options listed on their stocks* relative to the effect on control firms that *already had options listed on their stocks*.

3.3.1 Identification

Identification in this setting requires two assumptions: (1) Peer and control firms follow parallel trends for different variables being investigated; and (2) The decision to list options on listed firms is exogenous to peer firms. To test the first assumption, I check for pre-trends between peer and control firms. For most of the variables, I show that there are no pre-trends between the two sets of firms. However, difference-in-differences methodology does not allow empirical validation for the non-existence of time varying unobservable characteristics that may affect both sets of firms differently. To the extent these characteristics don't drive the results, γ coefficients in equation (1) give the causal impact of options listings on peer firms.

A potential concern that violates the second assumption is that exchanges may compare firms that don't have options listed and pick the ones they believe will have certain characteristics relative to the other. For example, they may compare stock volatility of firms A and B in the same industry, and choose A because stock volatility for A is higher than B. To mitigate this concern, I perform three different steps. First, as described above, I choose peer firms by matching on observables that exchanges use to make listing choices. To a certain extent, this mitigates the concern that observed differences between listed and peer firms may be driving both the choice of listing and the results discussed in the paper. However, this doesn't mitigate the concern that exchange may be choosing one firm over the other because they anticipate one firm to have different characteristics relative to other firms in the future. The two remaining steps help address this concern. Second, I talk to exchanges to further explore the factors that affect the choice of stocks for option listing. These conversations suggest that exchanges do not compare firms in the same industry. There is no set criteria to list a particular number of stocks from an industry or to list a particular number of stocks overall, in a given year. Instead, the exchanges consider the universe of stocks that don't have options listed and choose stocks for listing on the basis of absolute values of characteristics like customer interest and stock volatility. Third, I perform a robustness check to show that the decision to list an option is not driven by either past or expected future peer firm characteristics.

In addition, I use an instrumental variable approach and find similar results, thus supporting the argument that results are not driven by endogenous decisions made by the exchanges.

3.4 Instrumental Variable Approach

To identify the causal effect of options listing for stock j , on characteristics of peer firm i using instrumental variable approach, requires an instrument that is correlated to the listing decision for firm j (relevance condition) but uncorrelated to firm i 's characteristics (exclusion restriction). To this end, I use lagged idiosyncratic stock volatility of firm j as the instrument for listing. Mayhew and Mihov (2004) show that stock volatility is one of the most important determinants of exchange's decision to list options which supports the relevance condition. Further, I assume that idiosyncratic stock volatility of firm j is not correlated to stock i 's characteristics, and affects firm i only through its effects on the listing decision. Thus, I estimate the following model:

$$Listing_{j,t} = \alpha + \beta IVol_{j,t-1} + \delta_{ind} + \delta_t + \epsilon_{j,t} \quad (2)$$

$$y_{i,t} = \psi + \gamma \widehat{Listing}_{j,t} + \delta_{ind} + \delta_t + e_{i,t} \quad (3)$$

where $Listing_{j,t}$ is a dummy variable that takes the value of 1 for firm j in the years following option listing and 0 otherwise. $IVol_{j,t-1}$ is the lagged idiosyncratic stock volatility of firm j and $y_{i,t}$ is the variable of interest for the peer firm i . $\widehat{Listing}_{j,t}$ is the fitted value of $Listing$ variable from equation (2). The model includes industry fixed effects (δ_{ind}) and year fixed effects (δ_t).

I define idiosyncratic stock volatility as the standard deviation of the residual values of the following equation, calculated over the year:

$$r_{j,t} - r_{f,t} = \alpha + \beta(r_{m,t} - r_{f,t}) + \gamma(r_{-j,t} - r_{f,t}) + \delta(r_{i,t} - r_{f,t}) + \epsilon_{i,t} \quad (4)$$

where all observations are at daily level, $r_{j,t}$ is the total return for stock j at time t , $r_{f,t}$ is the risk free rate at time t , $r_{m,t}$ is the market return at time t , $r_{-j,t}$ is the industry return excluding firm j 's return and $r_{i,t}$ is the return on stock i , i.e. the peer stock. By construction, any factor that affects both stock j and i gets absorbed into δ , thus lending support to the assumption that

idiosyncratic stock volatility for firm j is uncorrelated to firm i and plausibly affects firm i only through its effect on likelihood of listing.

4 Data & Summary Statistics

Data for the analysis comes from seven different sources, including Optionmetrics (Options listing data), Compustat (financial data), CRSP (stock price data), TAQ (trading data), IBES (analysts data), Factiva (business press data) and Google Trends (Google search data). As a first step, I identify the set of firms on which options got listed for the first time between 1997 and 2010 (i.e. listed firms) using OptionMetrics. This database contains information on trading activity of all listed options in the U.S. starting from 1996. I 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 1997.⁵ Then I merge this list with Compustat and CRSP databases which provide firm financials and stock market data respectively. I omit financials (SIC 6000 - 6999), utilities (SIC 4900 - 4999) and public administration/non-classifiable firms (SIC 9000 - 9999) from this sample. For every listed firm, I find a peer firm from firms in the same industry defined by 4-digit SIC code which *do not have options listed on their stock* by matching on market capitalization, trading volume, stock volatility, liquidity and profitability for the year immediately prior to listing. Next, I find a control firm for every listed and peer firm from firms in the same industry defined by 3-digit SIC code which *already had options listed on their stock* before 1997 by matching on market capitalization and profitability for the year immediately prior to listing. The first matching procedure matches without replacement while the second matches with replacement using mahalanobis distance methodology. I drop those listed firms which have missing data in Compustat and CRSP and for which a peer firm could not be found. This leaves 294 firms each in listed and peer categories. The final sample consists of over 11,000 firm-year observations.

⁵Since the database starts in 1996, I cannot distinguish between the firms that got options listed in 1996 from those that already had options listed before 1996. So, I start my sample from 1997 considering all firms appearing in the database in 1996 as firms having options listed before 1997.

4.1 Construction of Variables

To test prediction 1, I use four different measures of information acquisition (resources employed in information acquisition): the count of business articles on a firm, internet search volume, analyst coverage and analyst forecast revisions. The first measure of information acquisition is *Media Articles*, which is equal to the change in number of articles issued by business press for each firm-year relative to previous year. I hand-collect data on business press coverage from Factiva which provides media articles for public and private firms obtained from numerous sources across the world. Following the literature, I focus on press articles published in Dow Jones Newswire, Wall Street Journal, USA today, The New York Times and The Washington Post. The second measure used in the paper is *Internet Searches*, which represents google searches on a firm. I hand-collect data on google searches from the Google Trends application. Google Trends tracks the number of searches made for a particular search term in google search engine and reports normalized level of search volume during a week/month for the search term during the period between 2004 and current date. I use natural logarithm of 1 plus normalized level of google search to correct for skewness. The third measure used for information acquisition is *Analyst Coverage*, which represents the number of analysts following a firm in a year. Data on analyst coverage is obtained from IBES database which has information on all forecasts made by reporting analysts. Following Gomes et al. (2015), I identify an analyst as following a firm in a year if she makes at least one earnings forecast during the year and the forecast is made at most six months before the end of the forecast period and at least three months after the end of the previous forecast period. The last measure used for information acquisition is *Analyst Revisions*, which is the number of revisions made by analysts following a firm in a year. This variable is calculated using the IBES database and proxies for the amount of time and attention that analysts employ in processing information about a firm.

To test the effect of options listing on informational efficiency and market quality of peer stocks, I use five different measures used in the literature. First, I use *Non-synchronicity*, which measures the amount of firm-specific information in the stock price. The variation of a stock return can be decomposed into two components: market-related variation and firm-specific variation, the latter of which is captured by the non-synchronicity measure. Following this argument, the measure is given

by $1 - R^2$, where R^2 is the R-square from the following regression:

$$r_{i,t} = \beta_{i,0} + \beta_{i,m}r_{m,t} + \epsilon_{i,t}$$

where $r_{i,t}$ is the return of firm i at time t and $r_{m,t}$ is the market return at time t .

I use daily returns to calculate the non-synchronicity measure for each firm-year. This measure is based on a large body of theoretical and empirical literature. Roll (1988) was the first one to suggest that price non-synchronicity is correlated with private information. Later, Durnev et al. (2003) empirically showed that price non-synchronicity is highly correlated with stock prices' ability to predict firms' future earnings, supporting the argument that price non-synchronicity reflects private information⁶.

The second measure used for information asymmetry is the *PIN* measure which measures the probability of informed trading. This measure is based on the structural model of sequential trade developed in Easley and O'Hara (1992)⁷. There are four exogenous parameters of the model that define the measure including probability of information events (α), the probability of an information event being bad news (β), the arrival rate of uninformed trades (ϵ) and the arrival rate of informed trades (μ). There is no closed form solution for the model and maximum likelihood estimation (MLE) is often used to identify the parameters. Under the model specification, the likelihood function of a particular trading day is

$$L(\theta|B, S) = \alpha\beta e^{-(\mu+\epsilon)} \frac{(\mu+\epsilon)^B}{B!} e^{-\epsilon} \frac{\epsilon^S}{S!} + \alpha(1-\beta) e^{-\epsilon} \frac{\epsilon^B}{B!} e^{-(\mu+\epsilon)} \frac{(\mu+\epsilon)^S}{S!} + (1-\alpha) e^{-\epsilon} \frac{\epsilon^B}{B!} e^{-\epsilon} \frac{\epsilon^S}{S!}$$

where B and S denote the daily number of buyer-initiated and seller-initiated trades, respectively. Using intraday trading information obtained from TAQ and assuming cross-trading-day independence, I estimate the parameters of the model for each firm-year by maximizing the following likelihood function

$$L(\theta|B, S) = \prod_{j=1}^{j=n} L(\theta|B_j, S_j)$$

⁶Morck et al. (2000); Wurgler (2000); DeFond and Hung (2004); Durnev et al. (2004); Bris et al. (2007) and Chen et al. (2007) among others study and use non-synchronicity as a measure of private information.

⁷The PIN measure has been shown to proxy for information asymmetry in many studies including Easley et al. (1996, 1997); Easley, O'Hara and Paperman (1998); Easley, O'Hara and Srinivas (1998); Vega (2006); Chen et al. (2007) among others.

where j represents a particular day and n is the number of trading days over the year. Given this setup, the probability of informed trading (PIN) is given by

$$PIN = \frac{\alpha\mu}{\alpha\mu + 2\epsilon}$$

The third measure used for market quality is *stock volatility* which is measured as the standard deviation of daily returns over the year. The fourth measure used is the *Amihud illiquidity* measure which captures liquidity of the stock. Amihud measure is based on trading volume of the stock and captures the price impact of trade. The measure, introduced by Amihud (2002) 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 is the average of daily price impacts of one currency unit of volume traded over a given sample period. Higher value of the measure represents lower liquidity as the price impact of trade is higher and vice versa. The fifth measure used is the *trading volume* obtained from TAQ which measures the fraction of stock trading volume to total trading volume of the market. Normalizing by market trading volume controls for changes in aggregate trading behavior of the market.

4.2 Summary Statistics

Table 1 presents summary statistics for the variables used in the analysis. The table reports and compares these statistics for both listed and peer firms for three years prior to listing. The first set of variables reported include information acquisition measures: Media Articles, Internet Searches, Analyst Coverage and Analyst Revisions. Both listed and peer firms are not significantly different in terms of media articles and analyst attention during the three years prior to listing. However, internet searches on listed firms are significantly lower than peer firms before listing. The mean value of internet searches for listed firms is 17.44 compared to 27.01 for peer firms during this period.

Next, the table reports statistics for informational efficiency and market quality measures. Con-

sistent with the finding in Mayhew and Mihov (2004), I find that stock volatility is significantly higher for listed firms with mean value of 0.20 compared to mean value of 0.17 for peer firms. Non-synchronicity and PIN measures are not significantly different suggesting that informational efficiency is comparable for both types of firms before listing. Further, I cannot reject the null hypotheses that firms are similar in terms of amihud illiquidity measure and trading volume during three years prior to listing. The next set of variables include firm value and profitability. These statistics show that firms are significantly different in terms of MTB and profitability. Listed firms have lower MTB values and are less profitable than peer firms with mean values of 2.918 and -0.230 respectively, compared to mean values of 2.931 and -0.083 for peer firms. This observation is consistent with stock volatility being negatively associated to firm performance, i.e. listed firms have higher volatility and lower profitability during the years before listing. The last set of variables compare investment and financing policies for listed and peer firms before listing. These statistics report that listed firms invest more with mean values of 0.34, 0.42 and 0.46 for R&D investment, CapR&D and investment respectively, compared to mean values of 0.28, 0.36 and 0.38 for peer firms.

5 Results

5.1 Information Acquisition

In this section, I discuss results for estimating the effect of options listings on information acquisition. Table 2 presents estimates of difference-in-differences model presented in equation (1) with information acquisition measures as dependent variables. Column (1) reports results for media coverage for both listed and peer firms. The results show that the number of media articles increases at a higher rate for listed firms relative to control firms following options listing. This result is consistent with Ho (1993) which shows that wall street journal's coverage is higher for firms with options trading than firms without options trading. Coefficients reported in column (1) further show that the number of media articles about peer firms increases at a slower rate than control firms following listing. Specifically, the change in number of media articles increases by over 9 articles for listed firms and decreases by over 10 articles for peer firms compared to the same set of control firms in the year of options listing. The coefficients on year[-2] are not significant for either listed or peer

firms suggesting that pre-trends are absent for both types of firms. Column (2) investigates the effect of options listing on internet searches. Consistent with options listing encouraging information acquisition on listed firms and agents substituting resources away from peer firms and towards listed firms, I find that internet searches increase for listed firms while they decline for peer firms, compared to control firms, in the years following options listing. Panel A of figure 1 plots dynamic coefficients for the effect on internet searches over time. The blue dashed line plots coefficients for listed firms while red solid line plots them for peer firms. Coefficients for both listed and peer firms are not statistically different from zero for the years before listing implying that there were no pre-trends for both types of firms relative to control firms. Further, it also shows that trends for internet searches for both listed and peer firms are statistically indistinguishable during the years prior to listing. However, following options listing, internet searches significantly increase for listed firms and decline for peer firms, relative to the same sample of control firms.

Column (3) reports results for the effect of options listing on analyst coverage. I find that the number of analysts following listed firms increases significantly relative to control firms following options listing. In the first and second year following listing, there is an average increase of 0.4 and 1.5 analysts, respectively, for listed firms relative to control firms. The magnitudes are economically significant and correspond to an increase of 8.69% and 32.60% relative to the year prior to listing and compared to control firms. This finding is consistent with Skinner (1990) which documents a significant increase in the number of analysts following the firm after options listing. Further, results show that the number of analysts following peer firms declines significantly relative to control firms following options listing. Coefficients suggest a decline of 0.36 and 0.8 analysts in the first and second year following listing. This corresponds to a decline of 7.82% and 17.39% relative to the year prior to listing and compared to control firms. Panel B of figure 1 plots dynamic coefficients for the effect on analyst coverage over time. The blue dashed and red solid lines represent coefficients for listed and peer firms respectively. The figure shows that trends for analyst coverage in the years prior to listing are not statistically different among the three sets of firms, i.e. listed, peer and control. But they diverge following options listing showing a significant increase in analyst coverage for listed firms and a significant decline for peer firms. Column (4) presents results on analyst revisions which proxies for analyst attention. Coefficients on $\text{year}[-2]$ are significant for both listed and peer firms suggesting that pre-trends exist between both listed and control firms, and peer

and control firms. The positive sign of these coefficients suggests that number of analyst revisions was increasing on both listed and peer firms relative to control firms in the years prior to listing. However, following listing it significantly declined for peer firms even though it kept on increasing for listed firms. The results suggest that analysts substitute resources away from peer firms and towards listed firms following options listing.

The results in columns (3) & (4) may also be driven by some analysts moving away from peer firms and other analysts moving towards listed firms instead of same analysts moving from peer to listed firms. To show that analysts move from peer to listed firms following options listing, I restrict my sample to only those analysts who were either following listed firms or peer firms or both before listing. I also confine the sample to only listed and peer firms and then estimate the single-difference coefficient to observe changes in distribution of these analysts between listed and peer firms. To further illustrate this point, consider an example of two firms - A (listed) & B (peer). Suppose that before options listing on firm A, four analysts follow A, three follow B and one follows both A & B. I investigate how the distribution of these eight analysts changes following options listing. For instance, if I observe that out of these eight analysts five follow A, two follow B and one follows both A & B after options listing, I can conclude that one analyst moved from firm B to A. The single difference estimates are reported in column (5). The negative coefficient on $year[-2]$ suggests that both types of firms attract new analysts between $year[-2]$ and $year[-1]$. However, following options listing the distribution of these analysts shifts towards listed firms as some analysts stop following peer firms and start following listed firms. Specifically, among analysts who follow either or both types of firms in $year[-1]$, 0.70 analysts stop following peer firms and 0.56 analysts start following listed firms in the $year[2]$.

Next, I discuss results from instrumental variables approach. Panel A of table 3 reports estimates for the first stage regression presented in equation (2). First stage regresses the instrumented variable, $Listing_{j,t}$ on the instrumenting variable $IVol_{j,t-1}$, which is the lagged idiosyncratic volatility for firm j . The coefficient on $IVol_{j,t-1}$ is positive and significant suggesting that firms that get listed have higher stock volatility in the year prior to listing. A unit increase in idiosyncratic volatility leads to an increase of 9.3% in the likelihood of options being listed on the stock in the following year. This is consistent with the findings in Mayhew and Mihov (2004) and supports the relevance condition. Moreover, the F-statistics equals 13.42 and exceeds the threshold of $F = 10$ which sug-

gests that the instrument is strong and unlikely to be biased towards the OLS estimates (Bound et al. (1995); Staiger and Stock (1997)).

Panel B of table 3 reports second stage estimates for the effect of options listing on information acquisition for peer firms. The results are statistically significant for all information acquisition measures except media articles. Column (1) reports results for media articles and shows that the change in number of media articles drops by 27 articles for peer firms in the years following options listing. Column (2) presents results for internet searches and shows that internet searches decline significantly for peer firms in the years following options listing. The impact of options listing on analyst coverage for peer firms is reported in column (3) which shows a decline of 5 analysts following listing. The IV estimate is larger in magnitude than the results reported for difference-in-differences methodology. This is because the difference-in-differences coefficient estimates the differential change in analyst coverage for peer firms relative to control firms whereas the IV estimate gives the absolute change in the analyst coverage owing to options listing. This suggests that analyst coverage also goes down for control firms (i.e. firms which have options listed) but the effect is significantly stronger for peer firms (i.e. firms without options listing). Column (4) investigates the effect of options listing on the number of analyst revisions for peer firms. It shows a decline of 28.95 revisions for peer firms following options listing. This provides support to the result presented for difference-in-differences methodology where pre-trends existed for analyst revisions of peer firms. Finally, column (5) presents the distribution of those analysts between listed and peer firms which followed either or both firms in the year prior to listing. It suggests that 1.6 analysts among analysts following either or both firms in year[-1] stopped following the peer firms in the year following options listing.

Overall, the results in tables 2 and 3 suggest that information acquisition on listed firms increases and peer firms declines following options listing as resources get substituted away from peer firms and towards listed firms.

5.2 Informational Efficiency & Market Quality

In this section, I discuss the results on informational efficiency and market quality. If the distribution of investor resources between listed and peer firms changes following options listing, it should lead to a change in informational efficiency and market quality for both firms. To study the effect

of options listing on informational efficiency, I use two measures. Non-synchronicity measure that captures the amount of firm specific information reflected in stock price and PIN measure that captures information asymmetry between traders. Columns (1) and (2) in table 4 report difference-in-differences estimates for the impact of options listing on non-synchronicity and PIN. I find that non-synchronicity increases for listed firms but declines for peer firms relative to control firms following options listing suggesting that the amount of private information incorporated in stock price increases for listed firms but declines for peer firms following listing. Non-synchronicity increases by 0.003 for listed firms and decreases by 0.006 for peer firms in the year of listing. These magnitudes correspond to an increase of 3.05% and a decline of 6.11% relative to the mean value in the year prior to listing. Neither coefficients on year[-2] are significant suggesting that pre-trends are absent for both listed and peer firms. Panel B of figure (2) plots the dynamic coefficients over time where the blue dashed line presents the estimates for listed firms and the red solid line presents the estimates for peer firms. The figure shows that there are no pre-trends for both listed and peer firms. Further, there is no statistical difference in trends between listed and peer firms before listing. However, following listing the trends diverge with the trend for listed firms moving upwards and peer firms moving downwards. As more information gets incorporated in stock price for listed firms after options listing, I expect information asymmetry between traders to reduce. Consistent with this expectation, results reported in column (2) show that PIN reduces for listed firms following options listing. PIN reduces by more than 2.5% for listed firms relative to control firms in the year immediately following options listing. This result is consistent to the findings reported in Hu (2015). However, PIN significantly increases for peer firms in the years following listing which suggests that information asymmetry between traders increases for peer firms. PIN increases by more than 2.8% for peer firms relative to control firms in the second year following options listing. Panel B in figure (2) plots the dynamic coefficients for both listed and peer firms. The figure illustrates that pre-trends are absent for both types of firms and the trends diverge in the years following listing.

In the remaining three columns in table 4, I present results on market quality variables for listed and peer firms. Column (3) reports the effect of options listing on stock volatility for both listed and peer firms. Coefficients show that stock volatility declines for listed firms while it increases for peer firms following options listing. Options listing leads to a decline of 0.032 units in standard deviation of listed stocks and an increase of 0.019 units in standard deviation of peer stocks, relative

to control stocks in the year immediately following listing. This corresponds to a decline of 16.24% and an increase of 9.64% relative to the mean standard deviation in the year prior to listing. Neither coefficients on year[-2] are significant suggesting that pre-trends are absent between both listed and control firms, and peer and control firms. Column (4) reports results on the effect of options listing on amihud illiquidity measure. Consistent with findings reported in Danielsen et al. (2007), I find no significant change in liquidity for both listed and peer stocks following options listing, as measured by amihud illiquidity measure. Finally, I present results on the effects of options listing on trading volume in column (5). Trading volume increases for listed firms but declines for peer firms which is consistent with resource substitution between listed and peer firms. Coefficients show that trading volume increases by 11.16% for listed firms but declines by 5.83% for peer firms relative to control firms as compared to the mean trading volume in the year prior to listing. Though pre-trends exist between listed and control firms, they are absent between peer and control firms.

In table 5, I present results for instrumental variables approach. Columns (1) reports results for Non-synchronicity measure. Consistent with the difference-in-differences estimates, results show that non-synchronicity declines for peer stocks in the years following listing. However, contrary to difference-in-differences estimates, the estimate for PIN measure reported in column (2) shows insignificant results. Column (3) reports results for stock volatility of peer stocks and shows that it increases in the years following options listing. The magnitude suggests that this increase is economically large. Contrary to difference-in-differences estimates, results reported in column (4) show that liquidity declines for peer firms following options listing. Specifically, liquidity declines by 10% for peer firms compared to the mean in the year before listing. Finally, consistent with difference-in-differences estimates, column (5) reports a decline of 2.66% in trading volume of peer firms following options listing, relative to the mean in the year prior to listing.

Overall, results in tables 4 and 5 suggest that informational efficiency and market quality improve for listed firms but decline for peer firms in the years following options listing.

5.3 Firm Value & Profitability

This section discusses results for predictions 3 and 4 which predict a decline in firm value and profitability for peer firms following options listing. Table 6 presents difference-in-differences estimates of the effect of options listing on firm value and profitability. Column (1) presents results for MTB

and show that it increases for listed firms while declines for peer firms in the years following options listing. Listed firms experience an increase of 32.08% while peer firms experience a decline of 21.76% in the year immediately following listing relative to the mean value of MTB in the year prior to listing. Neither coefficients on year[-2] are significant suggesting that pre-trends are absent for both listed and peer firms. Results for firm value reported in column (2) are consistent with MTB and show that firm value increases for listed firms but declines for peer firms in the years following options listing. Firm value of listed firms increases by 33.21% in the year following listing. This result is consistent with the findings reported in Roll et al. (2009) which shows that options trading is positively associated to firm value. The magnitudes are also in the same range as their estimates suggest that an increase in one standard deviation in options trading volume leads to an increase of 23% in firm value for sample of firms with positive trading volume. Further, firm value declines by 0.88 for peer firms in the year following listing which corresponds to a decline of 27.13% relative to mean value in the year prior to listing. Both coefficients on year[-2] are insignificant suggesting that pre-trends are absent between both listed and control firms, and peer and control firms. Panel A of figure 3 plots the dynamic coefficients on firm values over time. The blue dashed line plots these estimates for listed firms while the red solid line plots them for peer firms. The figure shows that all three types of firms (i.e. listed, peer and control firms) have similar trends of firm value in the years prior to listing. However, following options listing, they diverge with the trend for listed firms moving upwards while the trend for peer firms moving downwards. The results on MTB and firm value suggest that options listing has an economically significant effect on both listed and peer firms with the effect being positive for listed firms and negative for peer firms.

In the last two columns of table 6, I present results on earnings and ROA. Column (3) shows that earnings increases for listed firms in the years following listing. This may be a result of more efficient allocation of resources owing to increased price informativeness or could be driven by lower equity cost of capital resulting from options trading (Naiker et al. (2013)). The magnitude of increase in earnings is significant as it corresponds to an increase of 15.9%. Results in column (3) further show a significant decline in earnings for peer firms in the years following listing. The magnitude for the impact in the second year after listing corresponds to a decline of 16.8%. Neither coefficients on year[-2] are significant suggesting an absence of pre-trends for both listed and peer firms. Finally, column (4) reports results for ROA and shows a significant increase in ROA for listed firms but a

significant decline for peer firms following options listing. ROA increases by 26% for listed firms and declines by 10% for peer firms in the second year following options listing. The estimates on year[-2] suggest that pre-trends are absent between both listed and control firms, and peer and control firms. Panel B of figure 3 plots dynamic coefficients for ROA. The blue dashed line reports coefficient estimates for listed firms and red solid line reports them for peer firms. Both lines are not statistically different from zero during the years before listing which suggests that pre-trends are absent for both listed and peer firms. Further, they are also not different from each other suggesting that both types of firms had similar trends before listing. However, the trends diverge following options listing with the blue dashed line moving upwards while red solid line moving downwards in the years following listing.

Table 7 presents results for instrumental variables approach. The coefficients are consistent with difference-in-differences estimates. The results presented in columns (1) and (2) show that MTB and Tobin's Q decline for peer firms in the years following options listing. The magnitudes of the coefficients suggest that this effect is economically large. Column (3) reports results for earnings and shows that earnings for peer firms declines by 37.4% in the years following options listing. Finally, column (4) shows a decline of 26% in ROA for peer firms.

Overall, the results in tables 6 and 7 show that firm value and profitability increase for listed firms but decline for peer firms in the years following options listing.

5.4 Investment Sensitivity to Stock Price

In this section, I discuss the impact of options listing on managerial learning for peer firms. Extant literature has shown that managers learn important information from stock price which they incorporate in their investment decisions. Further, Chen et al. (2007) show that managers learn more when stock prices are more informative. It follows that managerial learning should decline for peer firms following options listing as informational efficiency goes down for their stocks. To test this prediction, I follow the methodology employed by Chen et al. (2007) and include the interaction terms between tobins Q and options listing dummies in the baseline specification shown in equation

(1). Thus, I estimate the following model:

$$\begin{aligned}
y_{i,t} = & \sum_{s=-6}^{-2} \alpha_s \text{Pre-Listing}(-s) * Q_{i,t-1} + \sum_{s=0}^6 \alpha_s \text{Listing}(s) * Q_{i,t-1} + \sum_{s=-6}^{-2} \mu_s \text{Pre-PeerListing}(-s) * Q_{i,t-1} \\
& + \sum_{s=0}^6 \mu_s \text{PeerListing}(s) * Q_{i,t-1} + \sum_{s=-6}^{-2} \beta_s \text{Pre-Listing}(-s) + \sum_{s=0}^6 \beta_s \text{Listing}(s) + \sum_{s=-6}^{-2} \gamma_s \text{Pre-PeerListing}(-s) \\
& + \sum_{s=0}^6 \gamma_s \text{PeerListing}(s) + Q_{i,t-1} + \delta_i + \delta_t + \epsilon_{i,t} \quad (5)
\end{aligned}$$

where $\text{Pre-Listing}(-s)$ ($\text{Listing}(s)$) is a dummy variable that takes a value one for firm i , ' s ' years before (after) options are listed on firm i 's stock and zero otherwise. Similarly, $\text{Pre-PeerListing}(-s)$ ($\text{PeerListing}(s)$) is a dummy variable that takes a value one for the peer firm to firm i , ' s ' years before (after) options are listed on the firm i 's stock and zero otherwise. Since there are few firm-year observations more than six years before and after options listing, there is one dummy variable each for multiple years at the two end points. That is, $\text{Pre-Listing}(-6)$ ($\text{Listing}(6)$) equals one for firm i , for all years greater than five years before (after) options are listed on firm i 's stock. Similarly, $\text{Pre-PeerListing}(-6)$ ($\text{PeerListing}(6)$) equals one for the peer firm to firm i , for all years greater than five years before (after) options are listed on firm i 's stock. $Q_{i,t-1}$ is tobins Q for firm i in the year $t-1$. δ_i and δ_t represent firm-fixed effects and year fixed effects respectively.

The coefficients of interest are μ_s . If managerial learning declines for peer firms following options listing, μ_s coefficients should be negative and significant for years following options listing. Table 8 reports estimates for equation (5). For brevity, I show coefficients on $\text{Pre-PeerListing}(-2) * Q$ to $\text{Pre-PeerListing}(4) * Q$. Column (1) reports results with capital expenditures as the dependent variable. Investment sensitivity for investments in capital expenditures declines significantly for years following options listing. The magnitudes correspond to a decline of 4.07% and 4.32% in the two years following listing. Columns (2) & (3) reports results with $R\&D$ and $CapR\&D$ as dependent variables respectively. Both results suggest that investment sensitivity for peer firms declines in the years following options listing. Finally in column (4), I show these results for *Investment* variable which includes investments made in capital expenditures, research and development, and acquisitions. The results in column (4) also show a significant decline in investment sensitivity for peer firms in the years following listing. Specifically, investment sensitivity declines by 2.11% and

1.94% in second and third years following listing.

Overall, results in table 8 provide support for prediction 5 and show that investment sensitivity for peer firms declines following options listing.

6 Heterogenous Effects by Stock Return Correlation

The findings discussed so far suggest that options listing leads to negative spillover effects on peer stocks in the same industry as the underlying stock. Further, this effect is driven by resource substitution towards listed stocks and away from peer stocks following options listing. If resource substitution between closely related stocks drives the spillover effect, it should be stronger for more closely related stocks that may be better substitutes for investors and information intermediaries. To investigate if the negative spillover effects are stronger for stocks that are potentially closer substitutes, I compare the effects of options listing on stocks with highly correlated stock returns to the underlying stocks and the effects on stocks whose returns are not correlated to underlying stocks. The peer stocks with highly correlated stock returns are plausibly close substitutes to the underlying stocks. To the extent that this is true, I expect that the spillover effects would be stronger for these stocks.

To test this expected heterogenous effect, I split the sample into two subsamples based on whether the stock correlation between listed and peer stock is higher (or lower) than the median correlation. Then, I perform IV analysis for both subsamples separately. Table 9 reports results for this analysis. All results consistently show that the negative spillover effects are stronger for the subsample of stocks with higher correlation with the underlying stocks. For the subsample with below median correlation, none of the spillover effects are statistically significant. These results support the argument that resource substitution is higher for stocks that are potentially closer substitutes to the underlying stocks.

7 Robustness

7.1 Selection of Options

As discussed in section 3.3.1, the difference-in-differences coefficients may be biased if exchanges choose stocks to list options based on peer firms characteristics. To mitigate this concern, I show that the decision to list options on a stock does not depend on peer firm characteristics and is determined solely by the properties of chosen stocks. As discussed earlier, anecdotal evidence in the form of conversations with the exchanges suggests that the choice of stocks is not driven by industries or peer firm characteristics. Specifically, the exchanges look at the universe of unlisted stocks and choose stocks with highest investor interest to list options. To support this argument, I empirically show that the likelihood of listing is not associated with observable peer firm characteristics. I accomplish this by estimating a logit model where the dependent variable is a dummy that takes a value of one if the firm gets chosen for options listing and zero otherwise. I use different independent variables for listed and peer firms and show that peer firm characteristics are not associated with the dependent variable. Specifically, I estimate the following model:

$$Listing_{j,t} = \alpha + \beta_1 X_{j,t-1} + \beta_2 X_{j,t} + \beta_3 E[X_{j,t+1}] + \beta_4 E[X_{j,t+2}] + \gamma_1 X_{i,t-1} + \gamma_2 X_{i,t} + \gamma_3 E[X_{i,t+1}] + \gamma_4 E[X_{i,t+2}] + \epsilon_{i,t} \quad (6)$$

where $Listing_{j,t}$ is a dummy variable that takes a value of one if firm j gets listed at time t and zero otherwise, $E[X_{i,t+k}]$ is the expected value for the variable of interest for firm i at time $t+k$ that the exchange may anticipate at time t and $E[X_{j,t+k}]$ is the expected value of the variable of interest for firm j at time $t+k$ that the exchange may anticipate at time t . I assume that exchanges have perfect information and are able to accurately predict future values of various characteristics. Thus I use realized values of variables to proxy for expected values. I restrict the estimation to the sample of listed firms and run a panel regression with characteristics of both listed and peer firms.

Table 10 reports results on estimates of equation (6). Columns represent different X variables used and rows represent whether the variables are lead, lag or contemporaneous and whether the variables are for listed firms or peer firms. Columns (1) and (2) test if the decision to list options depends on stock volatility of listed and peer firms. Hence, the X variable in the first two columns is stock volatility. Column (1) includes lagged stock volatility of listed and peer firms as independent

variables. Coefficients suggest that the likelihood of options listing increases with lagged stock volatility of the chosen firm but is not associated with lagged volatility of the peer firm. Column (2) adds contemporaneous and lead values to this model. Coefficients suggest that the choice of listing depends only on lagged stock volatility of the underlying stock and is independent of contemporaneous and expected stock volatility of both listed and peer firms. Columns (3) and (4) estimate equation (6) with Amihud illiquidity measure as the X variable. As before, column (3) reports estimates for the model with only lagged values of amihud measure while column (4) includes contemporaneous and lead values to the model. Coefficients suggest that the likelihood of options listing is not associated with liquidity of chosen and peer stocks. However, coefficient on the lead value of amihud measure for peer firms suggests that likelihood of options listing increases when the exchanges expect peer stocks to be more liquid in the future. But this is contrary to the findings reported earlier. The IV estimates show that liquidity declines for peer stocks following options listing. This suggests that the results are not driven by the exchange's expectation of higher liquidity on the peer stocks.

Columns (5) and (6) report estimates for equation (6) with trading volume as the X variable. Results suggest that the choice of listing is not associated with peer firms' trading volume. However, results reported in column (7) suggest that likelihood of options listing increases if the exchanges expect peer firms to have higher firm values in the year following listing. But this is contrary to the findings reported earlier. The estimates in the main analysis show that firm value of peer firms declines significantly following options listing suggesting that these estimates are not driven by exchanges' expectation of higher firm value of peer firms. Finally, column (8) reports estimates of equation (6) with ROA as the X variable. Coefficient estimates suggest that the choice of listing option does not depend on ROA values of peer firms.

Overall, the results in table 11 are consistent with the argument that the decision to list options on a stock is plausibly exogenous to peer firm characteristics.

7.2 Peer Firm Definition

In this section, I show that results discussed in the paper are robust to alternative definitions of peer firms. The main sample uses a restrictive definition for peer firms, thus making these firms close substitutes to listed firms. Though these firms should be subject to strongest spillover effects

because of higher substitution effect, other related firms in the same industry who do not offer the benefits of options trading should also be affected. To test this prediction, I choose upto 3 peer firms for every listed firm from firms in the same industry defined by 3-digit SIC code that are closest to listed firms in terms of size and profitability. I repeat the entire analysis for these firms and find similar results. For brevity, I report results on six variables investigated in this study but find similar results for most variables. Table 11 presents IV estimates for these variables. Columns (1) and (2) show that analysts reduce resources employed in acquiring information on peer firms following options listing. Specifically, analyst coverage and analyst revisions decline for peer firms in the years following options listing. The estimates reported in columns (3) and (4) respectively show that stock volatility increases and trading volumes declines for peer stocks in the years following options listing. Finally, results reported in last two columns of the table confirm that both firm value and profitability decline for peer firms in the years following options listing.

Overall these results suggest that results discussed in the paper are robust to alternative definitions of peer firms.

8 Conclusion

Extant literature concludes that options listing improves overall market quality for the underlying stocks. I contribute to this literature by highlighting a negative externality generated by options listing on peer firms in the same industry as underlying firms. I show that options listing leads to an increase in information acquisition of underlying stocks at the expense of peer stocks as agents substitute resources away from peer stocks and towards listed stocks following listing. This resource substitution away from peer firms leads to a decline in informational efficiency and market quality for their stocks. Lower informational efficiency adversely affects firm value and profitability for these firms. Further, corporate investment for these firms becomes less sensitive to stock price following options listing. These negative spillover effects of options listing are stronger for peer stocks with highly correlated returns to the underlying stocks suggesting that resource substitution is higher for potentially closer substitutes. Overall, the results suggest that the benefits of options trading on the stock market may not necessarily be positive and are less than what is conceived from the extant literature.

The findings in the paper have important implications for options market regulators. The findings in this paper support the regulators' decisions of relaxing eligibility requirements on stocks for options listing over the years and encourage them to continue relaxing these requirements. These results also have implications for peer firms who may take actions to mitigate this negative spillover of options listing. For example, they may enhance disclosure quality to improve information environment during the years following options listing. It would be interesting to explore firms' reactions to options listing on peer stocks.

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Appendix: Variable Definitions

- Above: Dummy variable that takes value of 1 for firms with market capitalization greater than median for all firms in the year before treatment (listing or peer-listing)
- Amihud: See Section 4.1
- Analyst Coverage: Number of analysts following the firm.
- Analyst Revisions: Number of revisions made by analyst following the firm.
- Below: Dummy variable that takes value of 1 for firms with market capitalization smaller than median for all firms in the year before treatment (listing or peer-listing)
- 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 (*CapEx + R&D*)
- Cash: Cash holdings of the firm scaled by lagged value of total assets (*Compustat items: che/l1.at*)
- Debt Issuance: Sum of total long-term debt plus total debt in current liabilities for the contemporaneous year minus the sum of total long-term debt plus total debt in current liabilities in the previous year scaled by lagged value of total assets (*Compustat items: (dltt + dlc - l1.dltt - l1.dlc)/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*)
- Equity Issuance: Difference between equity issuance minus equity repurchases scaled by lagged value of total assets (*Compustat items: (stkc - prstk)/l1.at*)
- Internet Searches: Search interest index reported by google trends app

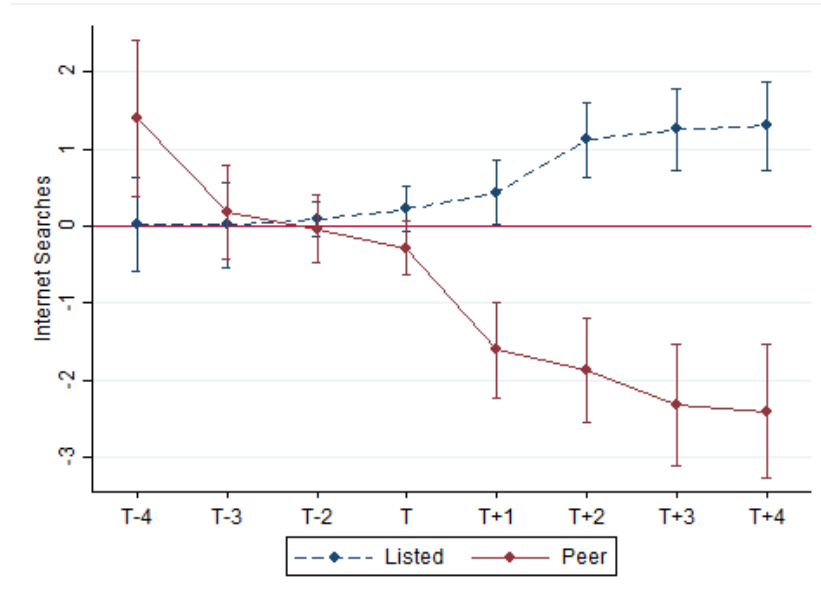
- Investment: Total annual investment made by the firm in capital, R&D and acquisitions scaled by lagged value of total assets (*Compustat items: (capx + aqc + xrd)/l1.at*)
- Leverage: The ratio of the sum of total long-term debt plus total debt in current liabilities (*Compustat items: dlts + dlc*) scaled by market value of total assets (*Compustat items: prcc_f * cshpri + dlc + dlts + pstkl - txditc*)
- Listing(i): Dummy variable that takes value of 1 for listing firms i years after options listing
- MarketCap: Average of daily market capitalization taken over the year.
- Media Articles: Total number of articles on the firm appearing on Dow Jones Newswires, Wall Street Journal, The New York Times, USA Today and Washington Post (*Collected from Factiva*)
- MTB: Ratio of market value of assets to book value of assets (*Compustat items: (prcc_f * cshpri + at - ceq)/at*)
- Non-Synchronicity: $1 - R^2$ of CAPM for every firm-year
- PeerListing(i): Dummy variable that takes value of 1 for peer firms i years after options listing
- PIN: Probability of Informed Trading described in Section 4
- Pre-PeerListing(-i): Dummy variable that takes value of 1 for peer firms i years before options listing
- Pre-Listing(-i): Dummy variable that takes value of 1 for listing firms i years before 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*)
- Repurchase: Annual purchase of common stock computed as a difference of total purchase of both common and preferred stocks and total purchase of preferred stocks (*Compustat items: (prstk - pstkrv)/l1.at*)
- ROA: Earnings before interest, taxes, depreciation and amortization (EBITA) scaled by lagged value of total assets (*Compustat items: oibdp/l1.at*)

- Q/TobinsQ: Ratio of market value of the firm to book value of assets (*Compustat items:*
 $(prcc_f * csho + at - che)/at$)
- Trading Vol: Total number of stocks traded in the year.
- Volatility: Standard deviation of daily stock returns calculated at yearly level

Figure 1: Information Acquisition - Dynamics

The figures present coefficients from a fully saturated difference-in-differences model for listed and peer firms relative to control firms for the time period relative to the year of options listing. The excluded category is one year before listing and the data point corresponding to year 't' can be interpreted as the impact of listing on Y variable in year 't' relative to control firms and to one year before listing. The dashed blue line represents the coefficients for listed firms while the solid red line represent coefficients for peer firms.

(a) Internet Searches



(b) Analysts Coverage

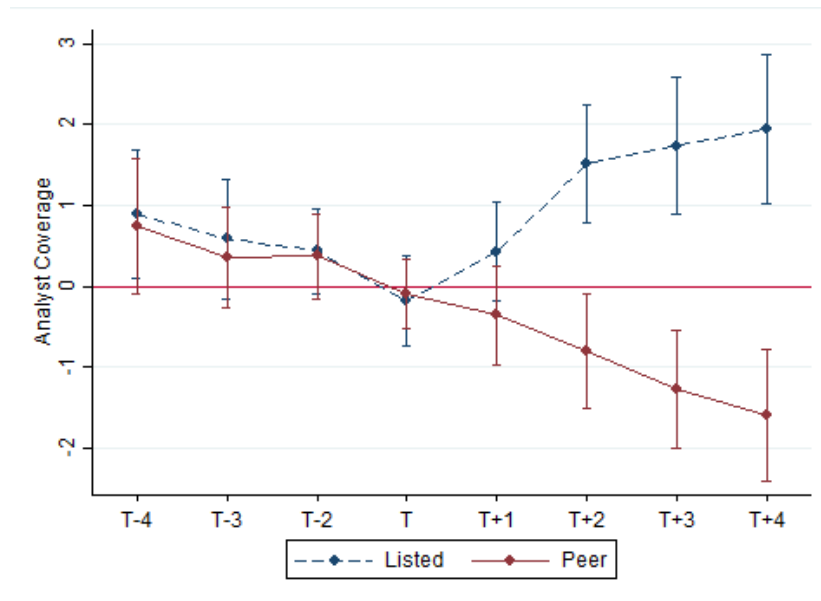
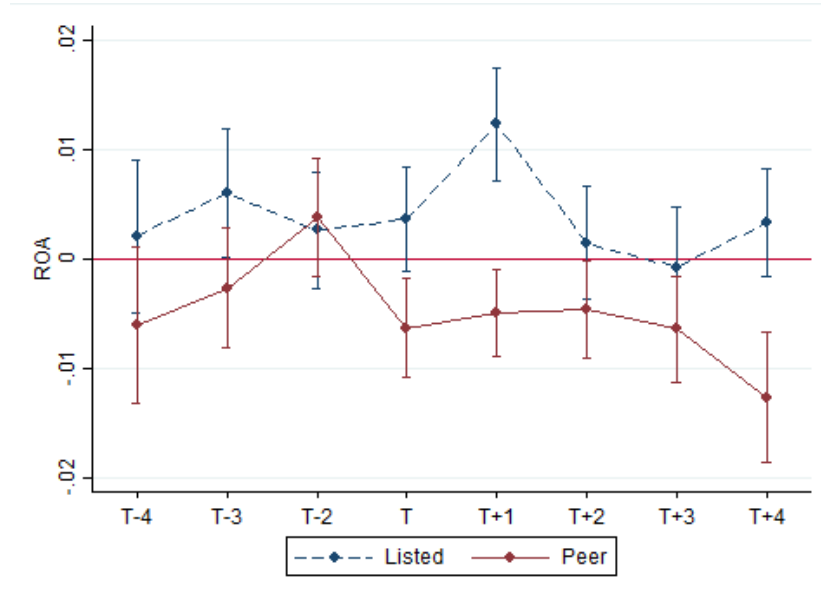


Figure 2: Stock Price Informativeness - Dynamics

The figures present coefficients from a fully saturated difference-in-differences model for listed and peer firms relative to control firms for the time period relative to the year of options listing. The excluded category is one year before listing and the data point corresponding to year 't' can be interpreted as the impact of listing on Y variable in year 't' relative to control firms and to one year before listing. The dashed blue line represents the coefficients for listed firms while the solid red line represent coefficients for peer firms.

(a) Non-Synchronicity



(b) PIN

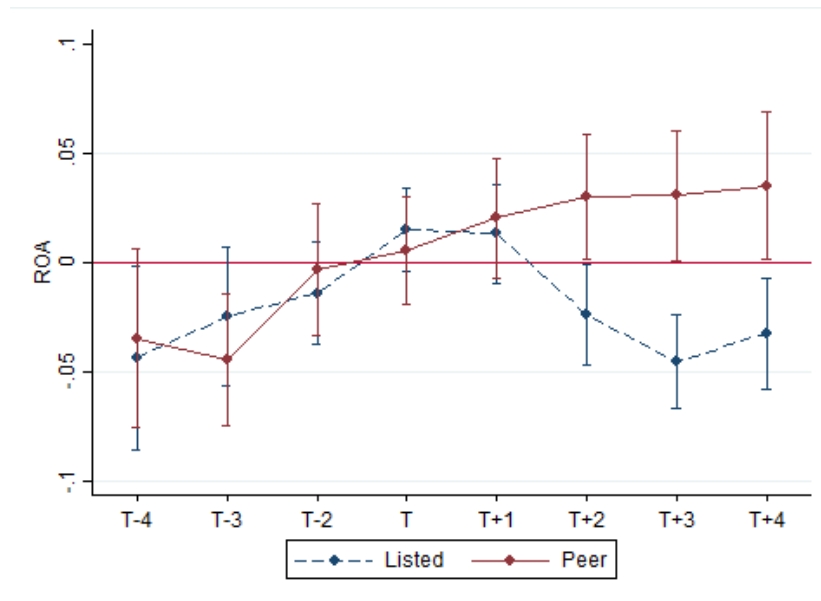
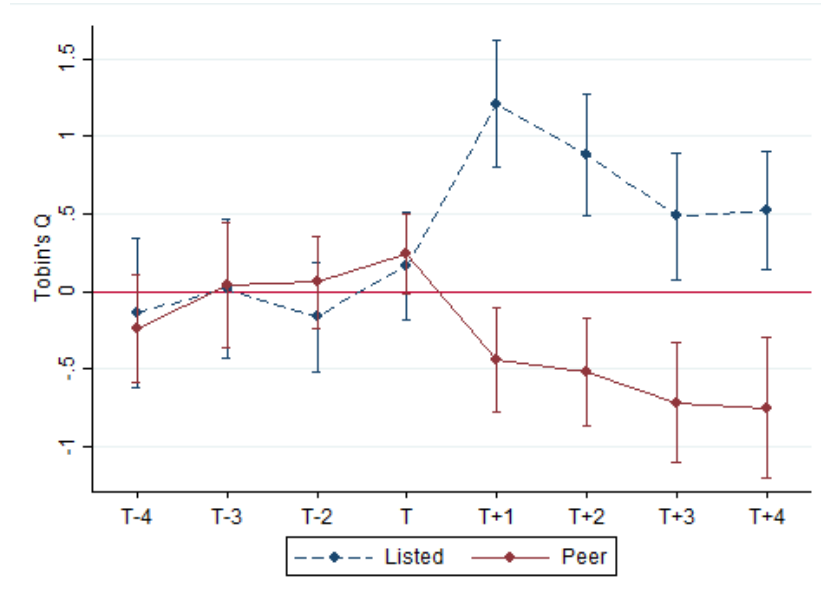


Figure 3: Firm Value & ROA - Dynamics

The figures present coefficients from a fully saturated difference-in-differences model for listed and peer firms relative to control firms for the time period relative to the year of options listing. The excluded category is one year before listing and the data point corresponding to year 't' can be interpreted as the impact of listing on Y variable in year 't' relative to control firms and to one year before listing. The dashed blue line represents the coefficients for listed firms while the solid red line represent coefficients for peer firms.

(a) *Tobin's Q*



(b) *ROA*

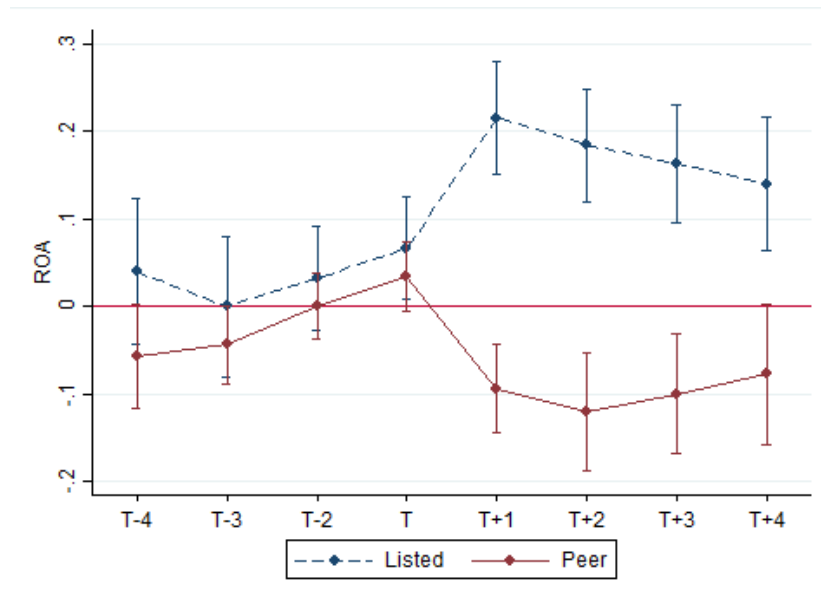


Table 1: Summary Statistics

This table reports descriptive statistics for listed and peer firms in the three years before listing along with the difference between the two sets of firms. All variables are defined in the appendix.

	Listed Firms			Peer Firms			Difference
	Mean	Median	SD	Mean	Median	SD	
Information Acquisition Measures							
Media Articles	23.640	8.000	77.373	24.699	5.000	62.022	-1.058
Internet Searches	17.443	0.000	25.569	27.013	26.228	24.144	-9.570***
Analyst Coverage	3.047	2.000	2.338	2.928	2.000	3.306	0.119
Analyst Revisions	25.175	12.000	37.106	22.113	9.000	48.773	3.062
Stock Price Informativeness							
Non-Synchronicity	0.980	0.988	0.021	0.983	0.989	0.019	-0.002
PIN	0.761	0.768	0.133	0.769	0.769	0.136	-0.007
Stock Volatility	0.204	0.172	0.131	0.173	0.145	0.124	0.030***
Amihud	3.343	0.223	25.424	2.589	0.244	11.967	0.753
Trading Volume	0.963	0.558	1.190	1.119	0.315	3.952	-0.156
Firm Value							
Market Cap	2.354	1.024	6.285	4.418	1.114	19.380	-2.063
MTB	2.918	2.061	2.745	2.931	1.835	3.228	-0.012**
TobinsQ1	2.656	1.769	2.677	2.627	1.566	3.124	0.029
TobinsQ2	3.371	2.470	2.896	3.307	2.239	3.214	0.064
Earnings	-0.335	-0.071	0.656	-0.172	-0.007	0.445	-0.164***
ROA	-0.230	0.018	0.584	-0.083	0.066	0.425	-0.147***
Firm Policies							
CapEx	0.088	0.049	0.109	0.084	0.047	0.102	0.004
R&D	0.340	0.166	0.426	0.278	0.132	0.379	0.062***
CapR&D	0.423	0.236	0.479	0.357	0.205	0.429	0.066**
Investment	0.465	0.267	0.524	0.383	0.218	0.460	0.082**
Leverage	0.127	0.029	0.195	0.129	0.046	0.188	-0.002
Equity Issuance	0.214	0.010	0.369	0.182	0.005	0.343	0.032
Debt Issuance	0.009	0.000	0.158	0.013	0.000	0.147	-0.004
Cash	0.362	0.298	0.306	0.321	0.213	0.301	0.041
Dividend	0.003	0.000	0.011	0.004	0.000	0.014	-0.002
Repurchase	-0.198	0.000	0.577	-0.196	0.000	0.578	-0.002

Table 2: Information Acquisition

This table reports results from regressions estimating the effect of options listing on information acquisition on underlying and peer stock. I estimate the following regression equation for different dependent variables ($y_{i,t}$):

$$y_{i,t} = \sum_{s=-6}^{-2} \beta_s \text{Pre-Listing}(-s) + \sum_{s=0}^6 \beta_s \text{Listing}(s) + \sum_{s=-6}^{-2} \gamma_s \text{Pre-PeerListing}(-s) + \sum_{s=0}^6 \gamma_s \text{PeerListing}(s) + \delta_i + \delta_t + \epsilon_{i,t}$$

Pre-Listing(-s) (*Listing(s)*) is a dummy variable that takes a value of one 's' years before (after) option gets listed on the firm, *Pre-PeerListing(-s)* (*PeerListing(s)*) is a dummy variable that takes a value of one 's' years before (after) option gets listed on the peer firm and zero otherwise. The coefficients on Listing ($t = -2$) to Listing ($t = 5$) and PeerListing($t = -2$) to PeerListing($t = 5$) are reported. The model is fully saturated with the year immediately before options listing as the base category. The specification includes firm and year fixed effects. Standard errors are corrected for heteroscedasticity and clustered at firm level. * indicates significance at less than 10% level, ** indicates significance at less than 5% level and *** indicates significance at less than 1% level. t-statistics are reported in parentheses.

	Media Articles (1)	Internet Searches (2)	Analyst Coverage (3)	Analyst Revisions (4)	Analyst Substitution (5)
Pre-Listing(-2)	3.210 (0.95)	0.0834 (0.74)	0.438 (1.64)	2.528* (1.86)	-0.361* (-1.77)
Listing(0)	9.082* (1.71)	0.435** (2.05)	-0.101 (-0.36)	-1.968 (-1.46)	-0.728*** (-2.93)
Listing(1)	17.26*** (2.66)	1.116*** (4.57)	0.430 (1.37)	5.007*** (3.46)	0.251 (0.92)
Listing(2)	2.736 (0.54)	1.254*** (4.65)	1.514*** (4.13)	8.190*** (4.44)	0.563* (1.84)
Listing(3)	4.210 (0.75)	1.302*** (4.45)	1.737*** (4.02)	8.331*** (4.15)	0.701** (1.98)
Listing(4)	12.86 (1.45)	1.377*** (4.32)	1.946*** (4.16)	8.823*** (3.84)	0.698* (1.72)
Pre-PeerListing(-2)	-6.520 (-1.12)	-0.0391 (-0.18)	0.373 (1.40)	2.498* (1.84)	-0.686*** (-2.87)
PeerListing(0)	-10.43* (-1.84)	-0.285 (-1.61)	-0.0876 (-0.40)	-0.0149 (-0.02)	-0.467** (-2.08)
PeerListing(1)	4.533 (0.57)	-1.610*** (-5.14)	-0.358 (-1.14)	-0.332 (-0.25)	-0.571 (-1.41)
PeerListing(2)	-9.920 (-1.06)	-1.879*** (-5.45)	-0.802** (-2.21)	-2.956* (-1.86)	-0.705 (-1.42)
PeerListing(3)	-0.309 (-0.04)	-2.333*** (-5.84)	-1.268*** (-3.42)	-4.294*** (-2.66)	-0.885* (-1.77)
PeerListing(4)	-4.966 (-0.65)	-2.404*** (-5.48)	-1.587*** (-3.81)	-4.153** (-2.37)	-1.071** (-2.11)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	7514	1547	6935	7678	3462
R-squared	0.104	0.869	0.735	0.724	0.643

Table 3: Information Acquisition - Instrumental Variable Approach

This table reports results from 2SLS model estimating the effect of options listing on information acquisition of peer stock. I estimate the following model for different dependent variables ($y_{i,t}$):

$$Listing_{j,t} = \alpha + \beta IVol_{j,t-1} + \delta_{ind} + \delta_t + \epsilon_{j,t}$$

$$y_{i,t} = \psi + \gamma \widehat{Listing}_{j,t} + \delta_{ind} + \delta_t + e_{i,t}$$

$Listing_{j,t}$ is a dummy variable that takes a value of one if option on stock j gets listed for the first time, $IVol_{j,t-1}$ is the lagged idiosyncratic volatility for firm j . The specification includes industry fixed effects and year fixed effects. Standard errors are corrected for heteroscedasticity and clustered at year level. * indicates significance at less than 10% level, ** indicates significance at less than 5% level and *** indicates significance at less than 1% level. t-statistics are reported in parentheses.

Panel A: First Stage

Listing	
$\widehat{Listing}$	0.093*** (3.66)
Observations	2705
F-Statistics	13.42

Panel B: Information Acquisition

	Media Articles (1)	Internet Searches (2)	Analyst Coverage (3)	Analyst Revisions (4)	Analyst Substitution (5)
$\widehat{Listing}$	27.87 (0.89)	-3.134* (-1.73)	-5.025** (-1.97)	-28.95*** (-2.47)	-1.612* (-1.76)
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	2651	528	2443	2705	2368
R-squared	0.074	0.629	0.041	-0.043	0.103

Table 4: Informational Efficiency & Market Quality

This table reports results from regressions estimating the effect of options listing on stock price informativeness and market quality of underlying and peer stock. I estimate the following regression equation for different dependent variables ($y_{i,t}$):

$$y_{i,t} = \sum_{s=-6}^{-2} \beta_s \text{Pre-Listing}(-s) + \sum_{s=0}^6 \beta_s \text{Listing}(s) + \sum_{s=-6}^{-2} \gamma_s \text{Pre-PeerListing}(-s) + \sum_{s=0}^6 \gamma_s \text{PeerListing}(s) + \delta_i + \delta_t + \epsilon_{i,t}$$

$\text{Pre-Listing}(-s)$ ($\text{Listing}(s)$) is a dummy variable that takes a value of one 's' years before (after) option gets listed on the firm, $\text{Pre-PeerListing}(-s)$ ($\text{PeerListing}(s)$) is a dummy variable that takes a value of one 's' years before (after) option gets listed on the peer firm and zero otherwise. The coefficients on Listing ($t = -2$) to Listing ($t = 5$) and PeerListing($t = -2$) to PeerListing($t = 5$) are reported. The model is fully saturated with the year immediately before options listing as the base category. The specification includes firm and year fixed effects. Standard errors are corrected for heteroscedasticity and clustered at firm level. * indicates significance at less than 10% level, ** indicates significance at less than 5% level and *** indicates significance at less than 1% level. t-statistics are reported in parentheses.

	Non-Synchronicity (1)	PIN (2)	Volatility (3)	Amihud (4)	Trading Vol (5)
Pre-Listing(-2)	0.00145 (0.61)	0.0162 (1.26)	-0.0160 (-1.32)	0.716 (1.01)	0.00033** (2.36)
Listing(0)	0.00296* (1.69)	-0.0162 (-1.49)	-0.0169 (-1.63)	0.258 (0.59)	0.00005 (0.48)
Listing(1)	0.000780* (1.69)	-0.0258** (2.08)	-0.0319* (1.89)	0.966 (0.93)	0.00067*** (2.61)
Listing(2)	-0.00172 (-0.68)	-0.0436*** (3.62)	-0.0229** (-1.98)	1.083 (0.93)	0.00064** (2.20)
Listing(3)	0.00230 (0.32)	-0.0266* (1.91)	-0.0105 (-0.56)	1.039 (0.92)	0.00050 (1.38)
Listing(4)	0.00374 (1.62)	-0.0384*** (3.03)	-0.0178 (-1.41)	0.939 (0.91)	0.00081 (1.55)
Pre-PeerListing(-2)	-0.00373 (-1.37)	-0.00120 (-0.08)	0.0138 (1.17)	0.524 (0.97)	0.00023 (1.35)
PeerListing(0)	-0.00630*** (-2.76)	0.00332 (0.25)	0.00785 (0.88)	0.370 (0.79)	-0.00011 (-0.90)
PeerListing(1)	-0.00500** (-2.49)	0.0157 (-1.08)	0.0193** (2.04)	0.810 (0.92)	-0.00035* (-1.69)
PeerListing(2)	-0.00460** (-2.05)	0.0286* (-1.88)	0.0193* (1.82)	0.819 (0.93)	-0.00056** (-2.00)
PeerListing(3)	-0.00640*** (-2.59)	0.0242* (-1.71)	0.0283** (2.28)	1.210 (1.01)	-0.00067** (-1.98)
PeerListing(4)	-0.0127*** (-4.19)	0.0395** (-2.14)	0.0336** (2.39)	0.924 (0.95)	-0.00075* (-1.85)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	8328	8016	9851	8170	8171
R-squared	0.150	0.364	0.410	0.169	0.761

Table 5: Informational Efficiency & Market Quality- Instrumental Variable Approach

This table reports results from 2SLS model estimating the effect of options listing on stock price informativeness and market quality of peer stock. I estimate the following model for different dependent variables ($y_{i,t}$):

$$Listing_{j,t} = \alpha + \beta IVol_{j,t-1} + \delta_{ind} + \delta_t + \epsilon_{j,t}$$

$$y_{i,t} = \psi + \gamma \widehat{Listing}_{j,t} + \delta_{ind} + \delta_t + e_{i,t}$$

$Listing_{j,t}$ is a dummy variable that takes a value of one if option on stock j gets listed for the first time, $IVol_{j,t-1}$ is the lagged idiosyncratic volatility for firm j . The specification includes industry fixed effects and year fixed effects. Standard errors are corrected for heteroscedasticity and clustered at year level. * indicates significance at less than 10% level, ** indicates significance at less than 5% level and *** indicates significance at less than 1% level. t-statistics are reported in parentheses.

	Non-Synchronicity (1)	PIN (2)	Volatility (3)	Amihud (4)	Trading Vol (5)
$\widehat{Listing}$	-0.0128* (1.69)	0.0381 (0.12)	0.602*** (2.80)	0.260** (1.98)	-0.00516* (-1.73)
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	2965	2574	3647	3129	3130
R-squared	-0.055	0.292	-3.336	-0.120	0.001

Table 6: Firm Value & Profitability

This table reports results from regressions estimating the effect of options listing on firm value and profitability of underlying and peer firm. I estimate the following regression equation for different dependent variables ($y_{i,t}$):

$$y_{i,t} = \sum_{s=-6}^{-2} \beta_s Pre - Listing(-s) + \sum_{s=0}^6 \beta_s Listing(s) + \sum_{s=-6}^{-2} \gamma_s Pre - PeerListing(-s) + \sum_{s=0}^6 \gamma_s PeerListing(s) + \delta_i + \delta_t + \epsilon_{i,t}$$

$Pre - Listing(-s)$ ($Listing(s)$) is a dummy variable that takes a value of one 's' years before (after) option gets listed on the firm, $Pre - PeerListing(-s)$ ($PeerListing(s)$) is a dummy variable that takes a value of one 's' years before (after) option gets listed on the peer firm and zero otherwise. The coefficients on Listing ($t = -2$) to Listing ($t = 5$) and PeerListing($t = -2$) to PeerListing($t = 5$) are reported. The model is fully saturated with the year immediately before options listing as the base category. The specification includes firm and year fixed effects. Standard errors are corrected for heteroscedasticity and clustered at firm level. * indicates significance at less than 10% level, ** indicates significance at less than 5% level and *** indicates significance at less than 1% level. t-statistics are reported in parentheses.

	MTB	TobinsQ	Earnings	ROA
	(1)	(2)	(3)	(4)
Pre-Listing(-2)	-0.180 (-1.03)	-0.158 (-0.88)	0.0313 (1.03)	0.0301 (0.83)
Listing(0)	0.150 (0.72)	0.144 (0.70)	0.0664** (2.20)	0.0808** (2.20)
Listing(1)	0.926*** (4.02)	1.184*** (4.74)	0.159*** (5.24)	0.189*** (5.12)
Listing(2)	1.065*** (4.33)	1.073*** (4.33)	0.215*** (6.59)	0.260*** (6.75)
Listing(3)	0.478** (2.08)	0.403* (1.72)	0.184*** (5.58)	0.189*** (4.73)
Listing(4)	0.130 (0.62)	0.558** (2.27)	0.163*** (4.73)	0.186*** (4.52)
Pre-PeerListing(-2)	-0.127 (-0.63)	-0.103 (-0.51)	-0.0263 (-0.96)	-0.0129 (-0.56)
PeerListing(0)	-0.188 (-1.00)	-0.183 (-0.99)	0.0280 (0.98)	0.0261 (1.06)
PeerListing(1)	-0.628*** (-2.92)	-0.880*** (-4.24)	-0.0130 (-0.42)	-0.00664* (1.67)
PeerListing(2)	-0.409* (-1.81)	-0.868*** (-3.91)	-0.168*** (-3.27)	-0.102*** (-2.94)
PeerListing(3)	-0.554** (-1.97)	-0.905*** (-3.29)	-0.115*** (-2.79)	-0.0690** (-2.08)
PeerListing(4)	-0.320 (-1.10)	-0.743** (-2.57)	-0.0636 (-1.32)	-0.0347 (-0.89)
Firm Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	10700	10687	11424	11441
R-squared	0.459	0.449	0.579	0.494

Table 7: Firm Value & Profitability - Instrumental Variable Approach

This table reports results from 2SLS model estimating the effect of options listing on firm value and profitability of peer stock. I estimate the following model for different dependent variables ($y_{i,t}$):

$$Listing_{j,t} = \alpha + \beta IVol_{j,t-1} + \delta_{ind} + \delta_t + \epsilon_{j,t}$$

$$y_{i,t} = \psi + \gamma \widehat{Listing}_{j,t} + \delta_{ind} + \delta_t + e_{i,t}$$

$Listing_{j,t}$ is a dummy variable that takes a value of one if option on stock j gets listed for the first time, $IVol_{j,t-1}$ is the lagged idiosyncratic volatility for firm j . The specification includes industry fixed effects and year fixed effects. Standard errors are corrected for heteroscedasticity and clustered at year level. * indicates significance at less than 10% level, ** indicates significance at less than 5% level and *** indicates significance at less than 1% level. t-statistics are reported in parentheses.

	MTB	TobinsQ	Earnings	ROA
	(1)	(2)	(3)	(4)
$\widehat{Listing}$	-4.518* (1.97)	-3.460* (1.83)	-2.259*** (-2.76)	-2.061*** (-2.85)
Industry Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	3809	3809	3820	3817
R-squared	-0.402	-0.172	-3.322	-3.812

Table 8: Investment Sensitivity to Stock Price

This table reports results from regressions estimating the effect of options listing on investment sensitivity to stock price for peer firms. I estimate the following regression equation for different dependent variables ($y_{i,t}$):

$$y_{i,t} = \sum_{s=-6}^{-2} \beta_s Pre - Listing(-s) * Q + \sum_{s=0}^6 \beta_s Listing(s) * Q + \sum_{s=-6}^{-2} \gamma_s Pre - PeerListing(-s) * Q + \sum_{s=0}^6 \gamma_s PeerListing(s) * Q$$

$$+ \sum_{s=-6}^{-2} \beta_s Pre - Listing(-s) + \sum_{s=0}^6 \beta_s Listing(s) + \sum_{s=-6}^{-2} \gamma_s Pre - PeerListing(-s) + \sum_{s=0}^6 \gamma_s PeerListing(s) + Q + \delta_i + \delta_t + \epsilon_{i,t}$$

$Pre - Listing(-s)$ ($Listing(s)$) is a dummy variable that takes a value of one 's' years before (after) option gets listed on the firm, $Pre - PeerListing(-s)$ ($PeerListing(s)$) is a dummy variable that takes a value of one 's' years before (after) option gets listed on the peer firm and zero otherwise. The coefficients on $PeerListing(t = -2)$ to $PeerListing(t = 5)$ are reported. The model is fully saturated with the year immediately before options listing as the base category. The specification includes firm and year fixed effects. Standard errors are corrected for heteroscedasticity and clustered at firm level. * indicates significance at less than 10% level, ** indicates significance at less than 5% level and *** indicates significance at less than 1% level. t-statistics are reported in parentheses.

	CapEx	R&D	CapR&D	Investment
	(1)	(2)	(3)	(4)
Pre-PeerListing(-2)*Q	-0.00316* (-1.92)	-0.00441 (-0.59)	-0.00776 (-1.01)	-0.00891 (-1.17)
PeerListing(0)*Q	-0.00222 (-1.26)	-0.0000151 (-0.00)	0.00170 (0.14)	-0.00132 (-0.10)
Post-PeerListing(1)*Q	-0.00407** (-2.22)	0.00909 (0.42)	0.00884 (0.34)	0.0104 (0.37)
Post-PeerListing(2)*Q	-0.00432*** (-2.80)	-0.0178** (-2.56)	-0.0228*** (-3.17)	-0.0211*** (-2.78)
Post-PeerListing(3)*Q	-0.00511*** (-2.94)	-0.0178* (-1.72)	-0.0221* (-1.67)	-0.0194* (-1.75)
Post-PeerListing(4)*Q	-0.00567*** (-2.73)	-0.0326*** (-4.19)	-0.0387*** (-4.37)	-0.0381*** (-3.91)
Firm Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	7342	7342	7671	7342
R-squared	0.419	0.545	0.487	0.416

Table 9: Heterogeneous Effects By Stock Return Correlation

This table reports results from 2SLS model estimating the heterogeneous effect of options listing on peer stocks based on stock return correlation. I estimate the following model for different dependent variables ($y_{i,t}$):

$$Listing_{j,t} = \alpha + \beta IVol_{j,t-1} + \delta_{ind} + \delta_t + \epsilon_{j,t}$$

$$y_{i,t} = \psi + \gamma \widehat{Listing}_{j,t} + \delta_{ind} + \delta_t + e_{i,t}$$

$Listing_{j,t}$ is a dummy variable that takes a value of one if option on stock j gets listed for the first time, $IVol_{j,t-1}$ is the lagged idiosyncratic volatility for firm j . The specification includes industry fixed effects and year fixed effects. Standard errors are corrected for heteroscedasticity and clustered at year level. * indicates significance at less than 10% level, ** indicates significance at less than 5% level and *** indicates significance at less than 1% level. t-statistics are reported in parentheses.

	Analyst Coverage (1)	Analyst Revisions (2)	Stock Volatility (3)	Trading Volume (4)	TobinsQ (5)	ROA (6)
Below Median						
$\widehat{Listing}$	77.29 (0.29)	185.8 (0.40)	-27.59 (-0.04)	-0.0673 (-0.44)	-19.35 (-0.25)	14.51 (0.13)
Observations	561	631	963	865	977	978
R-squared	-50.669	-13.268	-8578.061	-18.330	-14.256	-244.767
Above Median						
$\widehat{Listing}$	-11.89* (-1.80)	-50.65*** (-3.19)	0.231*** (3.53)	-0.0178*** (-3.33)	-2.005** (2.23)	-0.703*** (-4.23)
Observations	667	736	962	861	973	972
R-squared	0.028	-0.003	-0.325	-0.066	0.069	-0.417

Table 10: Robustness: Selection of Stocks

This table reports results from regressions that investigate whether the choice of options listing is associated to listed and peer firm characteristics. I estimate the following regression equation for different independent variables (X):

$$Listing_{i,t} = \alpha + \beta_1 X_{i,t-1} + \beta_2 X_{i,t} + \beta_3 E[X_{i,t+1}] + \beta_4 E[X_{i,t+2}] + \gamma_1 X_{j,t-1} + \gamma_2 X_{j,t} + \gamma_3 E[X_{j,t+1}] + \gamma_4 E[X_{j,t+2}] + \epsilon_{i,t}$$

$Listing_{i,t}$ is a dummy variable that takes a value of one if firm i gets listed at time t and zero otherwise, $E[X_{i,t+k}]$ is the expected value for the variable of interest for firm i at time $t+k$ that the exchange may anticipate at time t and $E[X_{j,t+k}]$ is the expected value of the variable of interest for firm j at time $t+k$ that the exchange may anticipate at time t . I assume that exchanges have perfect information and are able to accurately predict future values of various characteristics, and use realized values of characteristics to proxy for expected values. I restrict the estimation to the sample of listed firms and run a panel regression with characteristics of both listed and peer firms. * indicates significance at less than 10% level, ** indicates significance at less than 5% level and *** indicates significance at less than 1% level. t-statistics are reported in parentheses.

	Volatility	Volatility	Amihud	Amihud	Trading Vol	Trading Vol	TobinsQ	ROA
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Listed</i> _{T-1}	0.883* (1.77)	0.709* (1.68)	0.420 (0.95)	0.302 (0.66)	-0.001 (-1.36)	-0.0006 (-1.34)	0.00446 (0.10)	-0.239** (-2.25)
<i>Peer</i> _{T-1}	-0.298 (-0.34)	0.126 (0.13)	-1.743 (-1.29)	-0.362 (-0.29)	0.0006 (0.57)	0.0002 (1.39)	-0.0874 (-1.55)	-0.146 (-0.90)
<i>Listed</i> _T		-0.311 (-0.41)		-0.797 (-0.44)		-0.0002 (-0.72)	-0.100* (-1.83)	-0.290 (-1.22)
<i>Peer</i> _T		1.589 (1.59)		-0.404 (-0.27)		-0.0004 (-1.22)	0.0155 (0.27)	-0.0562 (-0.16)
<i>Listed</i> _{T+1}		0.782 (1.48)		0.377 (0.41)		-0.0003* (-1.66)	0.0380 (0.80)	-0.128 (-0.44)
<i>Peer</i> _{T+1}		-2.052* (-1.70)		-7.046** (-2.08)		0.0001 (0.60)	0.102* (1.79)	0.333 (0.86)
<i>Listed</i> _{T+2}							0.138*** (3.37)	0.664** (1.98)
<i>Peer</i> _{T+2}							-0.0674 (-1.09)	0.0340 (0.11)
Observations	1242	844	1149	759	1149	759	808	1080
Pseudo R-squared	0.004	0.013	0.007	0.032	0.062	0.072	0.038	0.015

Table 11: Robustness: Peer Definition

This table reports results from 2SLS model estimating the effect of options listing on various characteristics of peer firm and stock. I estimate the following model for different dependent variables ($y_{i,t}$):

$$Listing_{j,t} = \alpha + \beta IVol_{j,t-1} + \delta_{ind} + \delta_t + \epsilon_{j,t}$$

$$y_{i,t} = \psi + \gamma \widehat{Listing}_{j,t} + \delta_{ind} + \delta_t + e_{i,t}$$

$Listing_{j,t}$ is a dummy variable that takes a value of one if option on stock j gets listed for the first time, $IVol_{j,t-1}$ is the lagged idiosyncratic volatility for firm j . The specification includes industry fixed effects and year fixed effects. Standard errors are corrected for heteroscedasticity and clustered at year level. * indicates significance at less than 10% level, ** indicates significance at less than 5% level and *** indicates significance at less than 1% level. t-statistics are reported in parentheses.

	Analyst Coverage (1)	Analyst Revisions (2)	Stock Volatility (3)	Trading Volume (4)	TobinsQ (5)	ROA (6)
PeerListing(4)	-4.816** (-2.11)	-21.03*** (-2.58)	0.73*** (3.11)	-0.003* (-1.69)	-1.48*** (-2.6)	-2.061*** (-2.85)
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10301	10006	10845	11879	16004	17307
R-squared	0.867	0.757	0.818	0.369	0.481	0.607