Do Managers Learn from Short Sellers?

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Abstract

This paper investigates whether short selling activities affect corporate decisions through an information channel. By exploiting a unique institutional feature in Hong Kong market that only stocks included in an official list are eligible for short sales, I show that non-shortable firms' investment is positively and significantly related to their shortable peers' stock prices: a one standard deviation decrease in shortable peers' stock prices is associated with a decrease in non-shortable firms' investment by around 10%. I verify that this relationship is not driven by shortable peers' firm characteristics other than short-sale eligibility. Moreover, this relationship becomes stronger in situations where non-shortable firms' managers are more likely to learn negative information from shortable peers' stock prices. These findings are consistent with my hypothesis that non-shortable firms' managers seek to learn short sellers' information on external conditions from shortable peers' stock prices and use this information in their corporate investment decisions.

Keywords: Short selling; corporate investment; managerial learning; peers

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1. Introduction

The informational role of stock prices in guiding real decisions has been recently addressed in finance research. The key idea is that managers can learn new information from stock prices and use this information in corporate decisions.[1] While a large number of studies provide evidence that managers learn useful information from stock prices, little attention has been paid to the source of this information: who has the information that is *ex ante* unknown to managers and trade on it? This paper tries to fill this gap by examining whether managers seek to learn short sellers' information from stock prices and use it in corporate decisions.

Short sellers are often believed to be sophisticated investors with private information in finance literature. Recent studies find that short sellers may have private information that is *ex ante* unknown to managers. Chu (2015) finds that short sellers have information about customers' preference that is new to managers. This information is transmitted to managers through short sellers' trading activities and further helps managers improve firms' product market performance. Massa et al. (2015) show that when the presence of short sellers improve stock price efficiency, managers become more likely to learn information from stock prices to guide long-term investment decisions.

These evidence suggest that when short sellers are active in the market, stock prices are likely to incorporate information from short sellers that is *ex ante* unknown to managers, thus managers may have incentives to learn short sellers' information from stock prices and use such information to make corporate decisions. If so, short selling activities can affect corporate decisions through an information channel.

However, to empirically identify whether managers learn short sellers' information from stock prices is challenging due to two reasons. First, there is no natural empirical proxy for the

[1] Several papers have documented empirical evidence that managers learn information from stock prices and use it to make investment decisions (Chen, Goldstein and Jiang, 2007, and Bakke and Whited, 2010), merger and acquisition decisions (Luo, 2005), and cash saving decisions (Fresard, 2012). For a detailed survey on this literature, see Bond, Edmans and Goldstein (2012).

information incorporated in stock prices from short sellers. Second, short selling activities can affect stock prices and managers' decisions simultaneously through channels other than the information channel. For instance, short selling activities can affect corporate decisions by influencing firms' financial constraints. Moreover, short sellers can affect managers' decisions by alleviating or aggravating agency problems. Therefore, even if information transmission from short sellers to managers via stock prices exists, it is difficult to identify the information channel empirically.

In this paper, I address these difficulties and study the information channel by exploring a unique feature in Hong Kong stock market. In Hong Kong market, whether a stock is eligible for short sales is determined by regulators when a stock meets certain requirements, and only stocks on an official list are allowed for short sales.[2] Based on whether the stocks are eligible for short sales, there are two groups of firms in the market, shortable firms and non-shortable firms. Since only shortable firms' stocks are eligible for short sales, information from short sellers is reflected only in shortable firms' stock prices.

Using this institutional feature, I study whether managers learn from short sellers by examining whether non-shortable firms' investment is influenced by the stock prices of their shortable peer firms in the same industry. On one hand, while managers, as insiders, have information advantage on firms' internal conditions, it is highly plausible that short sellers, as outsiders, have more information about firms' external conditions than managers.[3] Hence, managers may wish to learn from short sellers about additional information on external conditions. On the other hand, as a firm and its industry peers face a similar external environment, the information on external conditions reflected in its peers' stock prices is also relevant to the firm's managers.[4] Hence, when non-shortable firms' managers wish to learn short sellers' information on external

[2] For more details on the regulation of short sales in Hong Kong stock market, see Appendix 1.
[3] Edmans, Jayaraman and Schneemeier (2016) argue that outside investors are better informed about industry prospects, and hence managers may wish to learn outsiders' information from observing stock prices.
[4] See, for example, Foucault and Fresard (2014), Ozoguz and Rebello (2015), and Huang and Zeng (2015).

conditions, they have incentives to pay attention to their shortable peers' stock prices, which may provide them with incremental information about the common demand and productivity from short sellers.

Under the information channel, non-shortable firms' managers can learn short sellers' information on external conditions from shortable peers' stock prices and use it in their corporate decisions. Therefore, I expect to see that non-shortable firms' investment decisions are sensitive to their shortable peers' stock prices. This is the main hypothesis tested in this paper.

Furthermore, as non-shortable firms' own stocks are not affected by short selling activities directly, short sellers are unlikely to affect non-shortable firms' investment by influencing these firms' financing constraints or by influencing their managers' incentives. Thus, the observed sensitivity of non-shortable firms' investment to shortable peers' stock prices is unlikely to be driven by channels other than the information channel, which suggests that non-shortable firms' managers use information from shortable peers' stock prices to guide investment decisions.

In this paper, I empirically test my hypothesis using a sample of firms listed in Hong Kong market from 2002 to 2013. Consistent with my hypothesis, I find that non-shortable firms' investment is positively and significantly related to the stock prices of their shortable peers in the same two-digit SIC industry. However, such a relationship is not found between non-shortable firms' investment and the stock prices of their peers that are also non-shortable. These findings suggest that non-shortable firms' managers pay attention to the stock prices of shortable peers that may aggregate information from short sellers. In terms of economic significance, a one standard deviation decrease in the average stock prices of shortable peers is related to a decrease in non-shortable firms' average investment level by around 10%. Further analyses confirm that my findings are not driven by shortable peers' other firm characteristics besides short-sale eligibility. This relationship is also robust to alternative peer definitions and to a variety of additional tests.

Next, I support my hypothesis by looking at the cross-sectional variation of non-shortable firms' investment sensitivity to their shortable peers' stock prices in different situations. Specifically, I examine whether non-shortable firms' investment sensitivity to shortable peers' stock prices becomes stronger in situations where non-shortable firms' managers are more likely to learn short sellers' information from stock prices.

First, I predict that non-shortable firms' managers are less motivated to learn from shortable peers' stock prices when their own firms' stock prices incorporate a greater amount of negative information. This is due to two reasons. On one hand, when stock prices aggregate more negative information from outsider investors, managers are more likely to obtain negative information from their own firms' stock prices directly. On the other hand, managers can incorporate their private information into stock prices through insider trading, hence more negative information in stock prices may suggest that managers already have more negative private information. Using two measures that capture the amount of negative information in stock prices, I find that non-shortable firms' investment is more sensitive to their shortable peers' stock prices when their own firms' stock prices incorporate less negative information.

Second, I expect that non-shortable firms' investment sensitivity to shortable peers' stock prices is weaker when the information environment of these firms is richer and thus their managers can obtain negative information from other sources. I operationalize this intuition by looking at financial analysts: when analysts' opinion is less optimistically biased, managers are more likely to obtain negative information from analysts and thus are less motivated to learn from shortable peers' stock prices. Consistent with this prediction, I find that non-shortable firms' investment sensitivity to shortable peers' stock prices becomes weaker when these firms are covered by more analysts or when the analysts following these firms do not issue upward biased earnings forecasts.

Third, managers are more likely to learn negative information from shortable peers' stock prices when negative information is more valuable for investment decisions. Negative information is more valuable to managers if their firms will suffer more from future negative productivity shocks. Cooper (2006) argues that when hit by adverse productivity shocks, firms with a higher proportion of tangible assets or a higher degree of investment irreversibility tend to experience a larger loss in productivity efficiency and firm value. In line with this argument, I show that non-shortable firms' investment becomes more sensitive to shortable peers' stock prices when they have more tangible assets in place or when they face a higher level of investment irreversibility. I also find that this sensitivity becomes stronger when non-shortable firms have a higher level of business risk or uncertainty. This is consistent with the intuition that when firms operate in an environment with greater uncertainty, managers are more likely to learn new information from other sources, such as short sellers.

Finally, I examine whether my findings are driven by a primary market channel. That is, high shortable peers' stock prices are associated with a loosening of financial constraints for non-shortable firms due to industry hedging. If so, non-shortable firms' investment sensitivity to shortable peers' stock prices should be greater in financially constrained firms. However, my findings do not support the primary market channel.

Furthermore, if shortable peers' stock prices contain short sellers' information that is new to non-shortable firms' managers and hence help managers make better investment decisions, I expect that non-shortable firms' investment efficiency would be improved when their managers can learn more information from shortable peers' stock prices. Consistent with this prediction, I find that within an industry, when relatively more firms are shortable, the overall investment efficiency level of non-shortable firms becomes higher. Moreover, this improvement is more pronounced for non-shortable firms that might be overinvesting. These findings lend additional support to my hypothesis that non-shortable firms' managers learn information from shortable peers' stock prices and use it in corporate investment decisions.

In the final exploration, by employing a regulatory change (Regulation SHO) that relaxes short-sale constraints on a random sample of firms in U.S. stock market, I show that my previous findings in Hong Kong stock market also carry over to U.S. stock market.

This paper contributes to the literature in several ways. First, it contributes to a recent literature that shows managers learn information from stock prices when making corporate decisions. While a significant portion of this literature has shown evidence of managerial learning, this paper presents the first effort, to best of my knowledge, to identify a specific source of information learned by managers from stock prices. My findings suggest that managers learn short sellers' information from stock prices and use it in corporate investment decisions. In this regard, this paper also contributes to the studies on the information advantage of short sellers. A large body of literature has shown that short sellers have access to private information that is known to managers. My paper suggests that short sellers possess information on external conditions that is *ex ante* unknown to managers.

Finally, this paper contributes to the literature that studies the real effects of short selling activities on corporate decisions. Prior studies typically focus on the effects of short selling activities on firms' financing constraints or managers' incentives. This paper differs by showing that short selling activities can affect corporate decisions through an information channel. That is, short selling enhances the informational role of stock prices by revealing information that is new to managers, and then managers learn this information from stock prices and use it in corporate decisions.

The remainder of this paper is organized as follows. Section 2 discusses related literature. Section 3 describes data and empirical testing issues. Section 4 and Section 5 present main empirical results and cross-sectional analyses. Section 6 presents further analyses. Section 7 concludes.

2. **Related literature**

This paper is closely related to three strands of literature. First, it relates to the literature on the information feedback from stock prices to corporate decisions. The idea that managers can learn new information from stock prices to guide their corporate decisions has been studied theoretically by Dow and Gorton (1997) and Subrahmanyam and Titman (1999), among others. On empirical part, a growing literature has shown evidence that managers learn from stock prices when making corporate decisions. Chen, Goldstein and Jiang (2007) find that corporate investment decisions are more sensitive to stock prices when stock prices contain more private information, suggesting that managers learn information from stock prices and use it to guide corporate investment. Fresard (2012) shows that cash saving decisions are also more sensitive to stock prices when stock prices are more informative. Luo (2005) finds that managers use the information from stock returns around acquisition announcements to determine whether to consummate the deals later. Moreover, recent studies, such as Foucault and Fresard (2014), Ozoguz and Rebello (2015), and Huang and Zeng (2015), show theoretically and empirically that besides from their own firms' stock prices, managers also seek to learn from peer firms' stock prices to obtain additional information about common shocks when making corporate investment decisions.

Second, this paper is related to studies on the information advantage of short sellers. While a significant portion of extant literature shows that short sellers have access to private information that is also known to managers, a few recent studies suggest that short sellers possess valuable information that is new to managers.[5] Chu (2015) finds that short sellers have information about customers' preference that is *ex ante* unknown to managers. This information is transmitted to managers through short sellers' trading activities and further helps managers improve product market performance. Massa et al. (2015) find when the presence of short sellers improves stock price efficiency, managers become more likely to learn from stock prices to guide long-term

[5] See, for example, Christophe, Ferri and Angel (2004), and Massoud et al. (2011).

investment decisions. Their findings suggest that short sellers have information that managers wish to learn.

Last but not least, this paper is related to literature that studies how short selling activities affect managers' decisions. On one hand, prior studies suggest that short selling activities can affect corporate decisions by influencing firms' financial constraints. For example, Grullon, Michenaud and Weston (2015) find that upon the relaxation of short-sale constraints, increased short selling activities cause stock prices to fall, leading to a decrease in equity issuance and corporate investment for financially constrained firms. On the other hand, several papers show that short selling can affect managers' decisions by alleviating or aggravating agency problems. Massa, Zhang and Zhang (2015) and Chang, Lin and Ma (2014) find that short selling has a disciplining effect on managers' decisions by deterring earnings manipulation or empire building behavior. He and Tian (2014) find a positive relationship between short selling activities and innovation, suggesting that short selling induces managers to invest in long-term innovative projects. In contrast, Nezafat, Shen and Wang (2014) show that short selling activities cause overinvestment when managers have short-term incentives.

3. **Data and Methodology**

3.1. Sample construction

In this paper, I empirically test my hypothesis by exploring the institutional feature in Hong Kong stock market that only stocks on an official list are allowed for short sales. I use a panel of firms listed in Hong Kong market for empirical analysis. The empirical goal is to examine whether non-shortable firms' investment is sensitive to their shortable peers' stock prices. To start, I need to identify whether a firm's stock is allowed for short sales at any given time point.

Hong Kong Stock Exchange (hereafter, HKSE) publishes the most recent official list of stocks for short sales, as well as the announcement of each past revision to the list on its website.[6] To obtain the historical lists for short sales, I collect data on each list revision announcement and then deduct the historical official lists for short sales from the most recent one.[7] Finally, I obtain the historical lists of stocks for short sales in each year from 2002 to 2013.

According to the historical lists of stocks for short sales, for each year, I classify firms into two groups. For each year, firms who appear in the official lists for short sales are classified as shortable firms, and the remaining firms are called non-shortable firms.[8] Then I match these firms with Compustat Global database to obtain financial statement data and stock price data. I exclude firms in financial and banking industries (SIC code 6000-6999) and utility industries (SIC code 4900-4999). I also exclude firm-year observations with negative book value of total assets or equity, or with less than 30 days of trading activities in a year. After these adjustments, my final sample consists of 4,963 firm-year observations associated with 722 firms from 2002 to 2013.

[Insert Table 1 Here]

Table 1 summarizes the distribution of shortable firms and non-shortable firms across years in my sample. In the early years of my sample, around 10% of firms are shortable in Hong Kong stock market; however, this number almost doubles in the second half of my sample period.

[Insert Table 2 Here]

Table 2 presents the summary statistics for my sample. Panel B and C show that shortable firms have higher Tobin's Q than non-shortable firms. The average values of Q are 1.679 and 1.488 for

[6] See https://www.hkex.com.hk/eng/index.htm.
[7] My data cleaning process is similar to that used in Hwang, Liu and Xu (2015).
[8] In case that a firm is included into the official list in the middle of the year, this firm is defined as shortable if it is allowed for short sales for at least six months before its fiscal year end. This guarantees enough time for stock prices to incorporate information from short sellers. However, eliminating these observations does not qualitatively change my results.

shortable firms and non-shortable firms, respectively. In addition, shortable firms also have a higher level of investment and cash flows than non-shortable firms. These differences are mainly due to the fact that shortable firms are on average larger than non-shortable firms. According to the information revealed by HKSE, firms are required to meet a minimum level of market capitalization and trading turnover to become eligible for short sales. Hence, shortable firms have substantially larger market capitalization and higher trading turnover than non-shortable firms in my sample. The median market capitalization and trading turnover for shortable firms are HK$ 5,346 million and 0.514. This compares to a median market capitalization of HK$ 412 million and a median trading turnover of 0.264 for non-shortable firms.

3.2. Baseline model

To test the hypothesis that non-shortable firms' investment is sensitive to the stock prices of their shortable peers, I use the following specification:

$$\mathrm{Inv}_{ijt} = \delta_j + \eta_t + \beta_1 Q_{ijt-1} + \beta_2 \mathrm{Control}_{ijt} + \beta_3 Q^{\mathrm{Shortable}}_{jt-1,-i} + \beta_4 \mathrm{Control}^{\mathrm{Shortable}}_{jt,-i} + \beta_5 Q^{\mathrm{Non-shortable}}_{jt-1,-i} + \beta_6 \mathrm{Control}^{\mathrm{Non-shortable}}_{jt,-i} + \varepsilon_{ijt}$$

where the dependent variable Inv_{ijt} represents the investment of a non-shortable firm i in industry j at year t.[9] On the right-hand side of the model, following Chen, Goldstein and Jiang (2007) and Ozoguz and Rebello (2015), I first include firm i's own stock price measure Q_{ijt-1} as well as CF_{ijt} and $1/\mathrm{ASSET}_{ijt-1}$.

The main explanatory variable is a measure for the stock prices of firm i's shortable peers, $Q^{\mathrm{Shortable}}_{jt-1,-i}$. In this paper, I mainly use two-digit SIC code to define industry peers. That is, I define shortable peers of firm i as all shortable firms that belong to the same two-digit SIC industry as firm i at a given year. This choice aims to achieve a trade-off between obtaining a reasonable number of shortable peers for each firm and minimizing the possibility that a firm and

[9] Since I only look at the investment decisions of non-shortable firms, the final sample used in my main analysis consists of 4166 firm-year observations associated with 679 non-shortable firms.

its peers are in unrelated businesses. $Q_{jt-1,-i}^{Shortable}$ is calculated as the equally-weighted average value of Q across all shortable peers of firm i in industry j at year t-1.

In addition, I include a set of peer-level control variables constructed from firm i's shortable peers, $Control_{jt,-i}^{Shortable}$, in my specification. Prior studies show that firms' corporate decisions are influenced by their peer's decisions.[10] Since peers' investment decisions are correlated with peers' stock prices, a correlation between firms' investment and their peers' stock prices may be simply caused by the fact that firms are mimicking their peers' investment decisions. To address this concern, I add to the baseline model $Inv_{jt,-i}^{Shortable}$, which is calculated as the equally-weighted average capital expenditures of all shortable peers of firm i in industry j at year t. In addition, I include $CF_{jt,-i}^{Shortable}$, as measured by the equally-weighted average cash flows of all shortable peers, to control for product market characteristics (Foucault and Fresard, 2014).

Furthermore, I include the same set of peer-level variables constructed from firm i's non-shortable peers ($Q_{jt-1,-i}^{Non-shortable}$ and $Control_{jt,-i}^{Non-shortable}$). Finally, I include δ_j and η_t to control for industry and year fixed effects. The definitions of all variables are presented in Appendix 2.

4. **Empirical Results**

4.1. Baseline model tests

In this subsection, I test whether non-shortable firms' investment is sensitive to their shortable peers' stock prices. Before estimating the model, I normalize all stock price variables (Q_{ijt-1}, $Q_{jt-1,-i}^{Shortable}$ and $Q_{jt-1,-i}^{Non-shortable}$ in the model) to unit standard deviation. Hence, the estimated coefficient for each stock price variable represents the change in firm i's investment for a one standard deviation increase in the corresponding stock price variable.

[10] For example, Leary and Roberts (2014) show that firms mimic their peer firms' capital structures when making their own capital structure decisions.

[Insert Table 3 Here]

Table 3 summarizes the estimation results for the baseline model. Column (1) presents the results from estimating baseline model including only shortable peers' variables. The estimated coefficient for Q_{ijt-1} is positive and statically significant, consistent with prior findings that managers use information reflected in their firms' own stock prices to make investment decisions (e.g., Chen, Goldstein, and Jiang, 2007).

More importantly, the coefficient for $Q_{jt-1,-i}^{Shortable}$ is 0.0030 and significant at 10% level, indicating that non-shortable firms' investment is also sensitive to their shortable peers' stock prices. This result is consistent with my hypothesis that non-shortable firms' managers learn information from shortable peers' stock prices; when shortable peers' stock prices decline, non-shortable firms' managers perceive it as a negative signal relevant to them, and hence decrease their investment.[11]

Column (2) of Table 3 estimates the baseline model including only non-shortable peers' variables. If non-shortable firms' managers seek to learn short sellers' information from peers' stock prices, it would be unlikely for these managers to pay attention to the stock prices of their peers that are also non-shortable. Hence, non-shortable firms' investment should not be sensitive to their non-shortable peers' stock prices. Consistent with this prediction, I find that the coefficient for $Q_{jt-1,-i}^{Non-shortable}$ is small and insignificant, indicating that non-shortable firms' managers do not alter their investment decisions in response to a change in their non-shortable peers' stock prices.

Finally, Column (3) includes both shortable peers' variables and non-shortable peers' variables in the baseline model. I obtain similar results: the coefficient for $Q_{jt-1,-i}^{Shortable}$ is 0.0041 and significant at 5% level. In terms of economic significance, this means that a one stand deviation decrease in shortable peers' stock prices is associated with a decrease in non-shortable firms'

[11] For example, a decrease in peers' stock prices may reflect the declining product demand for the whole industry.

investment by 0.0041. Given that the mean value of non-shortable firms' investment is 0.0439, this implies a decrease in non-shortable firms' investment by around 10%.

In addition, the coefficient for $Q_{jt-1,-i}^{Non-shortable}$ remains small and statistically insignificant in Column (3). The null hypothesis that the estimated coefficients are equal for $Q_{jt-1,-i}^{Shortable}$ and $Q_{jt-1,-i}^{Non-shortable}$ is rejected at 5% level, suggesting that non-shortable firms' investment decisions respond differently to the stock prices of shortable peers and non-shortable peers.[12]

With respect to the control variables, consistent with findings in prior literature, Table 3 shows that firms' investment is positively and significantly related to their own stock prices as well as cash flows. In addition, the coefficients for $Inv_{jt,-i}^{Shortable}$ and $Inv_{jt,-i}^{Non-shortable}$ are negative, suggesting that firms lower their investment when their peers make more investment to expand production capacity. This finding is consistent with the intuition that managers take into account product market competition when they make investment decisions. Finally, the coefficients for $CF_{jt,-i}^{Shortable}$ and $CF_{jt,-i}^{Non-shortable}$ are positive, indicating that cash flows of both shortable and non-shortable peers are positively related to firms' investment. This result suggests that firms in more profitably industries tend to make more investment.

Overall, these findings are consistent with my hypothesis that non-shortable firms' managers seek to learn short sellers' information from shortable peers' stock prices and use it in their investment decisions.

4.2. Controlling for firm characteristics

In this subsection, I examine whether my findings are driven by firm characteristics rather than short selling activities. Leary and Roberts (2014) show that smaller firms tend to mimic the capital structure of their larger peers. In addition, Ozoguz and Rebello (2015) find that firms'

[12] Since the estimated coefficients for $Q_{jt-1,-i}^{Shortable}$ and $Q_{jt-1,-i}^{Non-shortable}$ have opposite signs, I also test whether the two coefficients are equal in absolute value. The null hypothesis $\left|Q_{jt-1,-i}^{Shortable}\right| = \left|Q_{jt-1,-i}^{Non-shortable}\right|$ is rejected at 10% level.

investment is more sensitive to the prices of peers with more liquid stocks. Hence, if whether a firm's stock is eligible for short sales is influenced by certain firm characteristics (e.g. firm size), then it is possible that my findings are influenced by these firm characteristics.

Indeed, whether a firm's stock is eligible for short sales is highly correlated with at least two firm characteristics. As shown in Appendix 1, HKSE requires firms to meet a minimum level of market capitalization and trading turnover to become eligible for short sales.[13] Table 2 shows that shortable firms have larger market capitalization and higher trading turnover than non-shortable firms. Therefore, my findings are plagued by the possibility that firms' investment decisions are more sensitive to the stock prices of their peers with larger market capitalization or higher trading turnover.

First, I check whether my previous results are driven by firms' market capitalization. To do so, for each year in the sample, I match each shortable firm with a non-shortable firm closest in market capitalization and from the same two-digital SIC industry. The firm with closest market capitalization is chosen by the smallest ratio of market capitalization (MV), which is defined as $\max(\mathrm{MV}_{\mathrm{shortable}}, \mathrm{MV}_{\mathrm{non-shortable}})/\min(\mathrm{MV}_{\mathrm{shortable}}, \mathrm{MV}_{\mathrm{non-shortable}})$. I require that the ratio of market capitalization is less than two and perform one-to-one matching without replacement. I plot the distribution of logarithm of market capitalization for shortable and non-shortable firms at the top of Figure 1. The two distributions become nearly identical after matching.

Then, I re-calculate peer-level variables using firm i's shortable and non-shortable peers from this matched sample. Hence, $\mathrm{Q}_{\mathrm{jt-1,-i}}^{\mathrm{Shortable}}$ and $\mathrm{Q}_{\mathrm{jt-1,-i}}^{\mathrm{Non-shortable}}$ are constructed using firm i's shortable and non-shortable peers with close market capitalization, respectively. I re-estimate the baseline model and the results are reported in Column (1) of Table 4.

[Insert Table 4 here]

[13] Though the selection of shortable stocks is mainly driven by market capitalization and trading turnover, not all stocks that meet the criteria are include into the list immediately. The delay is mainly due to the regulatory capacity constraint (Gao et al., 2011).

If my findings are driven by market capitalization rather than short selling activities, I should expect to see that non-shortable firms' investment is sensitive to the stock prices of both shortable and non-shortable (large) peers. However, this is not the case. Column (1) shows that the coefficient for $Q_{jt-1,-i}^{Shortable}$ is positive and significant at 5% level, while the coefficient for $Q_{jt-1,-i}^{Non-shortable}$ remains small and insignificant. In addition, the null hypothesis that the coefficients are equal for $Q_{jt-1,-i}^{Shortable}$ and $Q_{jt-1,-i}^{Non-shortable}$ is rejected at 5% level.

Second, I repeat the same analysis but using a sample of shortable and non-shortable firms matched on trading turnover. The bottom graphs in Figure 1 show that matching produces almost perfectly overlapped trading turnover distributions. Column (2) of Table 4 shows that my results remain qualitatively unchanged: the estimated coefficient for $Q_{jt-1,-i}^{Shortable}$ is 0.0049 and significant at 5% level, while the coefficient for $Q_{jt-1,-i}^{Non-shortable}$ remains insignificant. Moreover, the null hypothesis that the coefficients are equal for $Q_{jt-1,-i}^{Shortable}$ and $Q_{jt-1,-i}^{Non-shortable}$ is rejected at 5% level. Therefore, these results indicate that my findings are unlikely to be driven by market capitalization or trading turnover.[14]

In addition, Ozoguz and Rebello (2015) find that when managers seek to learn from peers' stock prices, they pay more attention to peers whose stock prices contain a greater amount of information, such as peers with higher stock price non-synchronicity (1-R2) or with higher Amihud (2002) ratio. Hence, it is possible that my results are driven by the likelihood that shortable peers' stock prices are on average more informative than non-shortable peers' stock prices.

[14] In unreported analysis, I employ another method to address this concern. Specifically, I interact firm i's market capitalization with $Q_{jt-1,-i}^{Shortable}$ in the baseline model. If relative market capitalization matters, I should observe that non-shortable firms' investment sensitivity to shortable peers' stock prices decreases with firms' market capitalization. However, the coefficient for the interaction term is insignificant. I also interact firm i's trading turnover with $Q_{jt-1,-i}^{Shortable}$ and find no significant results.

To address this concern, I repeat the previous analysis by using a sample of shortable and non-shortable firms matched on stock price non-synchronicity and Amihud ratio to construct peer-level variables in Column (3) and (4), respectively. In both columns, the estimated coefficient for $Q^{Shortable}_{jt-1,-i}$ is positive and statistically significant, while the coefficient for $Q^{Non-shortable}_{jt-1,-i}$ remains insignificant. These findings indicate that even when the stock prices of shortable and non-shortable peers contain a similar amount of information, non-shortable firms' managers still seek to learn from shortable peers' stock prices, which are more likely to incorporate information from short sellers.

Finally, I examine whether my findings are affected by peers' unobservable time-invariant firm characteristics. For example, when making investment decisions, a firm's manager may look at the stock prices of "bellwether" peers as a barometer for market or industry future performance, no matter these peers' stocks are shortable or not. To address this possibility, I exploit the dynamic change of stocks' eligibility for short sales and examine whether non-shortable firms' investment is sensitive to the stock prices of a certain group of peer firms when these peers are shortable or non-shortable at different time points. Specifically, I identify a sample of peer firms that experienced (at least one) change of short-sale eligibility during my sample period, and re-calculate peer-level variables using peers from this sample. Thus, $Q^{Shortable}_{jt-1,-i}$ and $Q^{Non-shortable}_{jt-1,-i}$ are calculated using the same group of peers when they are shortable and non-shortable, respectively.

The estimation results are reported in Column (5) and (6) of Table 4. Consistent with my previous findings, non-shortable firms' investment are sensitive to these peers' stock prices when these peers are shortable: in Column (5), the coefficient for $Q^{Shortable}_{jt-1,-i}$ is positive and significant at 5% level. However, when the same peers become non-shortable, non-shortable firms' investment is no longer sensitive to these peers' stock prices: in Column (6), the coefficient for $Q^{Non-shortable}_{jt-1,-i}$ is close to zero and statistically insignificant. These findings suggest that non-shortable firms' investment is sensitive to the stock prices of their peers, only when these peers' stocks are shortable.

Overall, these results provide additional support to my hypothesis that non-shortable firms' managers learn short sellers' information from their shortable peers' stock prices.

4.3. Alternative peer definitions

In this subsection, I test whether my findings are sensitive to the way peers are defined. In previous analysis, I define peers of firm i as all other firms that belong to the same two-digit SIC industry as firm i at a given year. Using a relatively coarse peer definition allows me to obtain a reasonable number of (shortable and non-shortable) peers for each firm, but bears the risk that firms and their peers might be in unrelated businesses.

To alleviate this concern, I re-estimate the baseline model using three-digit SIC code to define peers. Switching to a narrower industry classification lowers the possibility that firms and their peers are in unrelated businesses.[15]

[Insert Table 5 Here]

The estimation results in Column (1) of Table 5 show that my findings are essentially unchanged when switching to this narrower classification of industry peers: the estimated coefficient for $Q_{jt-1,-i}^{Shortable}$ is 0.0037 and significant at 5% level. In addition, the coefficient for $Q_{jt-1,-i}^{Non-shortable}$ remains both statistically and economically insignificant.

Furthermore, I examine the robustness of my findings by using another scheme of industry classification, Global Industry Classifications Standard (hereafter, GICS), to define peers. Compared to SIC that uses production and technology based framework to organize industry groups, GICS categorizes firms on the basis of their primary business activity. Bhojraj, Lee and

[15] However, switching to three-digit SIC code reduces my sample size by around 40%. Since the results remain unaffected by switching to this narrower industry classification as shown in this subsection, I mainly use two-digit SIC code to define peers throughout this paper.

Oler (2003) find that GICS performs better than SIC in identifying and grouping firms based on future sales growth. If the future sales growth of firms and their peers are closely correlated, the information about future demand reflected in their peers' stock prices should be useful to the firms' managers in making investment decisions.[16]

Column (2) of Table 5 shows the estimation results of baseline model using four-digit GIC code to define industry peers. The main result remains virtually unchanged: the estimated coefficient for $Q_{jt-1,-i}^{Shortable}$ is positive and statistically significant, while the coefficient for $Q_{jt-1,-i}^{Non-shortable}$ remains small and insignificant. In addition, I obtain similar results when using six-digit GIC code to define peers in Column (3).[17] Therefore, I conclude that my findings are not affected by the choice of peer definitions.

In the last column of Table 5, I perform a falsification test. One premise for non-shortable firms' managers to learn from shortable peers' stock prices is that information incorporated in shortable peers' stock prices is relevant for non-shortable firms. I therefore check this premise by examining whether non-shortable firms' investment is sensitive to the stock prices of shortable firms that are unlikely to contain relevant information.

Specifically, at a given year, for each firm i in the sample, I select a set of pseudo peers by drawing a random sample of shortable and non-shortable firms from other industries, and then construct peer-level variables using these pseudo peers. Since these pseudo peers are not in the same industry as firm i, the information in pseudo shortable peers' stock prices is not relevant to firm i. Therefore, I expect that firm i's investment decisions should be not sensitive to these pseudo shortable peers' stock prices.

Column (5) shows that the estimated coefficient for $Q_{jt-1,-i}^{Shortable}$ is statistically insignificant. This evidence suggests that non-shortable firms' investment is not related to stock prices of shortable

[16] This is consistent with the model setup used by Foucault and Fresard (2014).

[17] According to Bhojraj, Lee and Oler (2003), four-digit (six-digit) GIC code is at the similar level to SIC two-digit (three-digit) code.

firms from different industries, that is, when these shortable firms' stock prices are unlikely to contain relevant information for non-shortable firms.

4.4. Additional robustness tests

This subsection discusses several additional robustness checks.

[Insert Table 6 Here]

First of all, I re-estimate the baseline model by replacing industry fixed effects with firm fixed effects to control for unobserved time-invariant firm characteristics. Column (1) of Table 6 shows that the main result remains unchanged: the coefficient for $Q^{Shortable}_{jt-1,-i}$ is 0.0026 and significant at 10% level after the inclusion of firm fixed effects.

Second, I re-estimate the baseline specification using the Fama-MacBeth approach as an alternative way to tackle with potential cross-sectional error correlation. In Column (2), I also obtain a positive and significant coefficient for $Q^{Shortable}_{jt-1,-i}$.

Third, I check whether my findings are robust to the way investment is defined. In Column (3), I re-estimate the baseline model by defining investment as the sum of capital expenditures and research and development (R&D) expenses scaled by book value of beginning-of-year total assets. The result is essentially identical. This finding suggests that non-shortable firms' managers also use the incremental negative information from their shortable peers' stock prices in long-term investment decisions.

In addition, while the finding that the non-shortable firms' investment is sensitive to shortable peers' stock prices is consistent with my hypothesis, it would be also driven by the fact that the investment opportunities of firms and their peers are correlated. To address this concern, I re-estimate the baseline model by replacing stock price variables with non-price based measures of investment opportunities. If my finding is driven by correlated investment opportunities rather than managers learning information from peers' stock prices, I should observe similar results when using non-price based measures. Otherwise, I expect to see that non-shortable firms' investment is not related to shortable peers' non-price based measures of investment opportunities. In Column (4) of Table 6, I use one-year sales growth as the non-price based measures of investment opportunities. The results show a weak and insignificant relationship between non-shortable firms' investment and their shortable peers' average sales growth.

Moreover, besides the information channel, another mechanism that links firms' investment to stock prices is market timing theory, which argues that firms invest more when their stock prices are overvalued (e.g. Baker, Wurgler and Stein, 2003). Thus, my findings might be driven by the correlation between firms' investment and a market-level or industry-level overvaluation component that is contained in peers' stock prices. To address this concern, I include firms' future returns ($\mathrm{CumRet}_{ij,t+3}$) as an additional control for stock mispricing in my specification. Baker and Wurgler (2002) argue that because stock mispricing is a transient phenomenon, overvalued stocks will experience negative returns in the future when mispricing is corrected. Following their argument, my proxy for stock mispricing is calculated as cumulative market-adjusted returns over a time period of three years subsequent to the measurement of firms' investment. The estimation results in Column (5) show that my findings are not affected after controlling for mispricing.

From another perspective, my findings are also unlikely to be explained by market timing theory. Prior studies argue that stocks are likely to be overvalued in the presence of short-sale constraints. Using the same institutional feature in Hong Kong market, Chang, Cheng and Yu (2007) find that stocks experience negative cumulative returns after becoming eligible for short sales, suggesting that shortable firms' stocks are less likely to be overvalued than non-shortable firms' stocks. Therefore, if market timing theory matters, I should observe that firms' investment is related to non-shortable peers' stock prices rather than to shortable peers' stock prices. However, this is opposite to my findings.

Finally, I discuss the possibility of reverse causality that firms' investment may directly affect their peers' stock prices. This might happen in two ways. On one hand, when firms' investment is high, it might be perceived as a signal of good growth opportunities for the industry and lead to an increase in peers' stock prices. However, in this scenario, I should find that that firms' investment is related to the stock prices of both shortable and non-shortable peers. On the other hand, if firms and their peers are competing in product market, an expansion of firms' productive ability by increasing investment may cause a loss of market share for their peers and result in a decrease in peers' stock prices. If so, I should observe a negative relationship between non-shortable firms' investment and their shortable peers' stock prices. Therefore, I conclude that my findings are unlikely to be driven by reverse causality.

5. Cross-sectional analyses

In this section, I take a closer look at the cross-sectional variation on the sensitivity of non-shortable firms' investment to their shortable peers' stock prices. I expect that this sensitivity should become stronger in situations where non-shortable firms' managers are more likely to learn negative information from short sellers.

I first examine how this sensitivity varies with the amount of negative information incorporated in non-shortable firms' own stock prices. When there is a greater amount of negative information in non-shortable firms' stock prices, their managers are less likely to learn from shortable peers' stock prices due to two reasons.

On one hand, when stock prices incorporate more negative information from outsider investors, managers are more likely to obtain negative information from their own stock prices directly. On the other hand, managers can incorporate their private information into stock prices through insider trading, hence more negative information in stock prices may suggest that managers already have more negative private information. In both cases, managers are less likely to learn from shortable peers' stock prices. In both cases, managers are less motivated to learn from shortable peers' stock prices.

Therefore, I expect that when non-shortable firms' own stock prices reflect less negative information, their investment becomes more sensitive to shortable peers' stock prices.

To test this prediction, I employ two measures to capture the amount of negative information in stock prices. The first measure is downside-minus-upside R2 from Bris, Goetzmann and Zhu (2007). This measures is derived from Roll (1988)'s idea that more firm-specific information incorporated into stock prices results in lower R2 (stock price synchronicity). Bris, Goetzmann and Zhu (2007) further decompose R2 into downside R2 and upside R2, and argue that the difference between downside and upside R2 measures the asymmetry of stock prices in incorporating positive and negative information. Hence, downside-minus-upside R2 measures the extent to which negative information is incorporated into stock prices; the higher downside-minus-upside R2, the less negative information in stock prices.

I follow Bris, Goetzmann and Zhu (2007) to calculate downside-minus-upside R2 and then define a dummy variable, $\text{High\_R2Diff}_{\text{ijt}-1}$, that takes value of one if firm i's downside-minus-upside R2 is higher than the industry median at year t-1, and zero otherwise. I extend the baseline model by including $\text{High\_R2Diff}_{\text{ijt}-1}$ and an interaction term of $\text{High\_R2Diff}_{\text{ijt}-1}$ with $Q_{\text{jt}-1,-\text{i}}^{\text{Shortable}}$ as additional independent variables.

[Insert Table 7 Here]

The estimation results are reported in Column (1) of Table 7, Panel A. The coefficient for the interaction term, $\text{High\_R2Diff}_{\text{ijt}-1} * Q_{\text{jt}-1,-\text{i}}^{\text{Shortable}}$, is 0.0052 and significant at 10% level, indicating that non-shortable firms' investment becomes more sensitive to their shortable peers' stock prices, when their own stock prices reflect less negative information.

The second measure is equity market-to-book ratio. Figlewski (1981) argues that short-sale constraints prevent negative information from being incorporated into stock prices and lead to overvaluation. Therefore, the stock prices of non-shortable firms with a higher equity market-to-book ratio are more likely to be overvalued, and hence reflect less negative information. I create a dummy variable, $\mathrm{High\_M/B_{ijt-1}}$, that equals to one if firm i's equity market-to-book is higher than the industry median at year t-1, and zero otherwise, and then interact the dummy variable, $\mathrm{High\_M/B_{ijt-1}}$, with $\mathrm{Q_{jt-1,-i}^{Shortable}}$.

In Column (2) of Table 7, Panel A, the coefficient for the interaction term is positive and statistically significant, suggesting that non-shortable firms' investment responds more strongly to shortable peers' stock prices when their own stocks are more likely to be overvalued.

In addition, I expect that non-shortable firms' investment sensitivity to shortable peers' stock prices is weaker when the information environment of these firms is richer and thus managers are more likely to obtain negative information from other sources. Financial analysts, as an important source of information in financial industry, are assumed to produce information about firms' future prospects. However, prior studies point out that analysts' opinion might be optimistically biased.[18] If analysts' opinion is optimistically biased, non-shortable firms' managers are unlikely to obtain negative information from analysts but may have to learn from shortable peers' stock prices.

I test this prediction in two ways. First, I look at analyst coverage. Hong and Kacperczyk (2010) find that higher analyst coverage leads to less optimistically biased opinion from analysts. Hence, I expect that when firms are covered by more analysts, negative information is more likely to be revealed to managers, resulting in a weaker relationship between non-shortable firms' investment and shortable peers' stock prices.

[18] For example, Hong and Kacperczyk (2010) argue that analysts' earnings forecasts can be excessively optimistic due to interest conflicts between firms and analysts.

To test this prediction, I define a dummy variable, $\text{High\_Coverage}_{\text{ijt}-1}$, equal to one if the number of analysts following firm i is above the industry median at year t-1, and zero otherwise, and interact it with $Q^{\text{Shortable}}_{\text{jt}-1,-\text{i}}$ in the baseline model. Consistent with my prediction, Column (1) of Table 7, Panel B shows that the estimated coefficient for the interaction term, $\text{High\_Coverage}_{\text{ijt}-1} * Q^{\text{Shortable}}_{\text{jt}-1,-\text{i}}$, is negative and significant at 10% level.

Second, I look at the upward bias of analyst forecasts. I predict that non-shortable firms' investment sensitivity to their shortable peers' stock prices becomes stronger when the analysts following them issue upward biased earnings forecasts. To test this prediction, I create a dummy variable, $\text{High\_Bias}_{\text{ijt}-1}$, that equals to one if firm i's mean forecasted earnings is higher than the actual earnings and zero otherwise. I include the interaction term between $\text{High\_Bias}_{\text{ijt}-1}$ and $Q^{\text{Shortable}}_{\text{jt}-1,-\text{i}}$ in the baseline model to test my prediction.

Column (2) of Table 7, Panel B shows that non-shortable firms' managers rely more on their shortable peers' stock prices when analysts' earnings forecasts are upward biased: the coefficient for the interaction term of $\text{High\_Bias}_{\text{ijt}-1}$ with $Q^{\text{Shortable}}_{\text{jt}-1,-\text{i}}$ is 0.0053 but only significant at 20% level.[19]

Furthermore, I examine whether non-shortable firms' managers become more likely to learn from shortable peers' stock prices when negative information is more valuable for investment decisions, that is, when their firms will suffer more from future negative productivity shocks. Cooper (2006) argues that when hit by adverse productivity shocks, firms with a higher proportion of tangible assets in place will have more redundant productive ability and hence suffer a larger loss in productivity efficiency and firm value. Moreover, this dampening effect becomes pronounced when firms' investment in these assets is largely irreversible. Therefore, I expect that non-shortable firms' investment becomes more sensitive to shortable peers' stock

[19] The p-value for the interaction term of $\text{High\_Bias}_{\text{ijt}-1}$ with $Q^{\text{Shortable}}_{\text{jt}-1,-\text{i}}$ in Column (2) of Table 7, Panel B is 0.176. One explanation for this weak result is the reduced sample size due to missing analyst data on I/B/E/S.

prices when they have more tangible assets in place or when they face a higher level of investment irreversibility.

I define asset tangibility as the ratio of property, plants and equipment to total assets, and then create a dummy variable, $\text{High\_Tangibility}_{ijt-1}$, that takes value of one if firm i's asset tangibility is higher than the industry median at year t-1, and zero otherwise. In Column (1) of Table 7, Panel C, the coefficient for the interaction term of $\text{High\_Tangibility}_{ijt-1}$ with $Q^{\text{Shortable}}_{jt-1,-i}$ is positive and significant at 10% level.

Chirinko and Schaller (2009) argue that when selling excess assets is costly, firms can only reduce their assets through depreciation. Hence, firms in the industries with higher depreciation rates face a lower level of investment irreversibility. Therefore, non-shortable firms' investment sensitivity to shortable peers' stock prices should be weaker when they are in the industries with higher depreciation rates.

I measure the depreciation rate as the ratio of depreciation of tangible capital assets to property, plants and equipment and compute the average at two-digit SIC industry level. Then, I define a dummy variable, $\text{High\_Depreciation}_{ijt-1}$, equal to one if the average depreciation rate of industry j that firm i belongs to is above the median depreciation rate of all industries in the sample, and zero otherwise. Consistent with my prediction, the coefficient for the interaction term of $\text{High\_Depreciation}_{ijt-1}$ with $Q^{\text{Shortable}}_{jt-1,-i}$ is -0.0091 and statistically significant in Column (2) of Table 7, Panel C.

In the last column of Panel C, I examine whether non-shortable firms' investment sensitivity to shortable peers' stock prices becomes greater when these firms have a higher level of business risk or uncertainty. The intuition is that when firms operate in an environment with greater uncertainty, managers are more likely to learn information from other sources, such as short sellers, to guide their corporate decisions.

I measure business risk by operating income volatility, which is calculated as the standard deviation of quarterly operating income before depreciation divided by quarterly book value of total assets over a period of past eight quarters. Then I define a dummy variable, $\text{High\_IncVol}_{\text{ijt}-1}$, equal to one if firm i's income volatility is higher than the sample median at year t-1, and zero otherwise, and interact it with $Q^{\text{Shortable}}_{\text{jt}-1,-\text{i}}$ in the baseline model. Consistent with my prediction, Column (3) of Table 7, Panel C shows that the coefficient for the interaction term, $\text{High\_IncVol}_{\text{ijt}-1} * Q^{\text{Shortable}}_{\text{jt}-1,-\text{i}}$, is positive and significant at 10% level.

Finally, I investigate how non-shortable firms' investment sensitivity to shortable peers' stock prices varies with financing constraints. According to my hypothesis, shortable peers' stock prices affect non-shortable firms' investment through a secondary market channel: the shortable peers' stock prices contain short sellers' information that is new to non-shortable firms' managers.

An alternative explanation is through a primary market channel: high shortable peers' stock prices are associated with a loosening of financial constraints for non-shortable firms due to industry hedging. Specifically, when shortable peers' stock prices are high, an arbitrageur who shorts these stocks may purchase non-shortable firms' stocks to hedge industry risk, which leads to an increase in non-shortable firms' stock prices. As a result, non-shortable firms' investments might increase due to a decline in cost of capital and a relaxation of financial constraints. Therefore, if my findings are due to the primary market channel, the non-shortable firms' investment sensitivity to shortable peers' stock prices should be stronger in firms that are more financially constrained.

I use two measures of financial constraints to test this prediction.[20] The first is firm size as measured by the logarithm of total assets. Bakke and Whited (2010) argue that larger firms tend to be less financially constrained. I define a dummy variable, $\text{High\_Size}_{\text{ijt}-1}$, equal to one if firm

[20] I use the same measures of financial constraints as used by Edmans, Jayaraman and Schneemeier (2016).

i's size is larger than the industry median at year t-1, and zero otherwise, and further interact it with $Q_{jt-1,-i}^{Shortable}$ in the baseline model. Column (1) of Table 7, Panel D shows that the estimated coefficient for the interaction term is close to zero and statistically insignificant, inconsistent with the primary market channel.

The second measure is external financing used by Rajan and Zingales (1998). External financing is calculated at the industry-level as the difference between capital expenditures and cash flows scaled by capital expenditures. A higher value indicates greater external financing and thus lower financing constraints. Then I define a dummy variable, $High\_EF_{ijt-1}$, equal to one if the external financing of industry j that firm i belongs to is above the median external financing of all industries, and zero otherwise. In Column (2) of Table 7, Panel D, the coefficient for the interaction term of $High\_EF_{ijt-1}$ with $Q_{jt-1,-i}^{Shortable}$ is positive and statistically significant, indicating that non-shortable firms' investment is more sensitive to shortable peers' stock prices when they are less financially constrained. This finding is opposite to the prediction of the primary market channel.

In summary, the overall evidence is consistent with my hypothesis that non-shortable firms' managers learn short sellers' information from shortable peers' stock prices and use it in investment decisions.

7. **Further Analyses**

7.1. Learning from shortable peers' stock prices and corporate investment efficiency

In this paper, I argue that non-shortable firms' managers seek to learn information from shortable peers' stock prices, because shortable peers' stock prices incorporate information from short sellers that is *ex ante* unknown to managers. If so, I expect that non-shortable firms' investment should become more efficient, when their managers can learn a greater amount of information from shortable peers' stock prices to guide their investment decisions. In this subsection, I test this prediction in an industry-year panel.

Following Durnev, Morck and Yeung (2004), I measure the investment efficiency at industry level by the deviation of marginal q (hereafter, $\dot{q}$) from one; the smaller the deviation, the higher the investment efficiency level for the industry. For each two-digit SIC industry j at year t, I estimate $\dot{q}_{jt}$ by running the following regression using a subsample of all non-shortable firms in industry j:

$$\Delta EV_{it} = \lambda_0 + \dot{q}\Delta NFA_{it} + \lambda_1 D_{it} + \lambda_2 EV_{i,t-1} + u_{it}$$

where ΔEV_{it} is the change in market value of firm i, ΔNFA_{it} is the change in fixed assets, D_{it} is the cash flow distributed to investors and u_{it} is an error term.[21] Therefore, the estimated $\dot{q}_{jt}$ measures the overall investment efficiency level of all non-shortable firms in industry j at year t.

Since there is no natural empirical proxy for the amount of information that managers can learn from shortable peers' stock prices, I look at the relative number of shortable firms within an industry. Under the two-factor framework in Huang and Zeng (2015), each firm's stock price is a noisy but informative signal for common shocks. Thus, I expect that the joint observation of more shortable peers' stock prices within the industry provides a greater amount of information on industry-level shocks from short sellers.[22]

I form an industry-year panel and estimate the following regression to test my prediction:

[21] I follow the method used by Ferreira and Laux (2007) to estimate $\dot{q}$. Ferreira and Laux (2007) modify Durnev, Morck and Yeung (2004)'s method to allow for estimating $\dot{q}$ for each industry-year. Moreover, I drop firms whose absolute change in firm value is more than 300% and require at least 10 non-shortable firms in each industry-year to estimate $\dot{q}$. Finally, I drop industry-years with estimated $\dot{q}$ of more than five in absolute value.

[22] Another interpretation is that the joint observation of more peers' stock prices provides more precise information on industry-level shocks. This is compatible with my prediction in this subsection; managers make better decisions when they can obtain more precise information from peers' stock prices.

$$|\dot{q}-1|_{jt} = \delta_j + \eta_t + \alpha_1 \text{Shortable ratio}_{j,t-1} + \alpha_2 \overline{\text{Leverage}}_{j,t-1} + \alpha_3 \overline{\text{Q}}_{j,t-1} + \alpha_4 \overline{\text{Market Cap}}_{j,t-1} + \alpha_5 \text{Total number of firms}_{j,t-1} + \varepsilon_{jt}$$

where $\text{Shortable ratio}_{j,t-1}$ is the percentage of shortable firms in industry j at year t-1. I control for the industry average of all non-shortable firms' leverage, Q and market capitalization, as well as the total number of firms in industry j. I also include industry and year fixed effects in my specification.

[Insert Table 8 Here]

The estimation results are presented in Column (1) of Table 8. The coefficient for $\text{Shortable ratio}_{j,t-1}$ is negative and significant at 10% level, indicating that that the overall investment efficiency level of non-shortable firms becomes higher, when their managers can obtain a greater amount of information from shortable peers' stock prices.

Furthermore, I split the sample into two subsamples based on whether the estimated $\dot{q}$ is above or below one. Durnev, Morck and Yeung (2004) state that $\dot{q} > 1$ implies underinvestment and $\dot{q} < 1$ implies overinvestment. Miller (1977) points out that, in the presence of short-sale constraints, once managers make investment decisions based on their own firms' stock prices, an overinvestment problem may occur. Thus, if non-shortable firms' investment efficiency improves because their managers learn additional information from shortable peers' stock prices and use it in their investment decisions, I expect that this improvement is more pronounced for the subsample where $\dot{q} < 1$, that is, firms that might be overinvesting.

Column (2) and (3) of Table 8 report the estimation results using the subsample where $\dot{q} > 1$ and where $\dot{q} < 1$, respectively. Though the coefficient for $\text{Shortable ratio}_{j,t-1}$ is negative in both columns, this coefficient is larger in magnitude and more statistically significant in Column (3). These findings suggest that the information from shortable peers' stock prices helps non-shortable firms' managers mitigate overinvestment and thus improve investment efficiency.

7.2. U.S. evidence

In previous parts, I find evidence from Hong Kong market that non-shortable firms' managers seek to learn information from shortable peers' stock prices. In this subsection, I examine whether this finding also applies to U.S. stock market. However, in U.S. market, there is no such institutional feature as in Hong Kong market that I can employ to conduct previous analysis. Thus, I rely on a regulatory change that relaxes short-sale constraints on a random sample of firms to perform my analysis.

On July 28, 2004, SEC announced a pilot program of Regulation SHO. Under this pilot program, a random sample of firms selected from Russell 3000 index (hereafter, pilot firms) were suspended from the uptick rule from 2005, while the remaining firms in Russell 3000 index (hereafter, control firms) were still subjected to the uptick rule for short sales.[23] Upon the relaxation of short-sale constraints on pilot firms, Reg SHO leads to increased short selling activities in pilot firms, compared to control firms (Grullon, Michenaud, and Weston, 2015).

In this context, I expect that when firms' managers seek to learn information from short sellers, they pay attention to the stock prices of pilot peers that are subject to a relatively higher level of short selling activities.

To test this prediction, I look at the investment decisions of U.S. firms that are not included in Russell 3000 index (hereafter, non-Russell firms) from 2004 to 2007 and employ a specification similar to the baseline model used in previous analysis:[24]

$$\begin{aligned}\mathrm{Inv}_{\mathrm{ijt}} = \delta_{\mathrm{j}} + \eta_{\mathrm{t}} + \beta_1 \mathrm{Q}_{\mathrm{ijt-1}} + \beta_2 \mathrm{Control}_{\mathrm{ijt}} + \beta_3 \mathrm{Q}^{\mathrm{Pilot}}_{\mathrm{jt-1,-i}} + \beta_4 \mathrm{Control}^{\mathrm{Pilot}}_{\mathrm{jt,-i}} + \beta_5 \mathrm{Q}^{\mathrm{Control}}_{\mathrm{jt-1,-i}} \\ + \beta_6 \mathrm{Control}^{\mathrm{Control}}_{\mathrm{jt,-i}} + \varepsilon_{\mathrm{ijt}}\end{aligned}$$

[23] See Grullon, Michenaud, and Weston (2015) for more details on Regulation SHO and the uptick rule.
[24] The sample ends at 2007, because SEC repealed the uptick rule to all firms on August 2007.

where Inv_{ijt} is the investment of a non-Russell firm i in industry j at year t. On the right-hand side of the model, I calculate peers-level variables using firm i's peers that are pilot and control firms in Russell 3000 index, respectively.

[Insert Table 9 Here]

Column (1) of Table 9 estimates the model including only pilot peers' variables. The coefficient for $Q_{jt-1,-i}^{Pilot}$ is positive and significant at 5% level. This finding is consistent with my expectation that non-Russell firms' managers learn information from pilot peers' stock prices and use it in investment decisions.

In Column (2) where only control peers' variables are included, the coefficient for $Q_{jt-1,-i}^{Control}$ is small and insignificant, indicating that non-Russell firms' investment is not sensitive to the prices of control peers' stocks that are subject to the same degree of short-sale constraints as their own firms' stocks. Since $Q_{jt-1,-i}^{Pilot}$ and $Q_{jt-1,-i}^{Control}$ are constructed using two groups of peers that are both included in Russell 3000 index and have similar firm characteristics, this finding alleviates the concern that the result in Column (1) is driven by Russell 3000 index inclusion or other firm characteristics.[25]

Finally, Column (3) of Table 9 presents the estimation results from the model including both pilot and control peers' variables. The coefficient for $Q_{jt-1,-i}^{Pilot}$ remains positive and statistically significant, while the coefficient for $Q_{jt-1,-i}^{Control}$ is still insignificant.

Furthermore, to confirm that the above results are driven by the increased short selling activities in pilot peers, I check whether similar results can be obtained in the period before Reg SHO. Specifically, I use a sample from 2001 to 2003 and re-estimate the model to see whether non-Russell firms' investment is sensitive to pilot peers' stock prices even during the pre-Reg SHO period.

[25] Grullon, Michenaud, and Weston (2015) find no significant differences in firm characteristics between pilot and control firms, such as market capitalization or stock trading volume.

Column (4) of Table 9 shows that the coefficients for $Q_{jt-1,-i}^{Pilot}$ is smaller and statistically insignificant in the pre-Reg SHO period. This finding suggests that non-Russell firms' investment only responds to the stock prices of pilot peers when these pilot peers' short-sale constraints are relaxed.

8. Conclusion

This paper investigates whether short selling activities affect corporate decisions through an information channel. It is challenging to empirically identify this channel due to two reasons. First, there is no natural empirical proxy for the information incorporated in stock prices from short sellers. Second, short selling activities can affect stock prices and managers' decisions simultaneously through channels other than the information channel. To overcome these empirical difficulties, I exploit a unique institutional feature in Hong Kong stock market that only stocks included in an official list are allowed for short sales.

I find robust empirical evidence that non-shortable firms' investment is positively and significantly related to their shortable peers' stock prices. However, such a relationship is not found between non-shortable firms' investment and the stock prices of their peers that are also non-shortable. These findings suggest that non-shortable firms' managers pay attention to the stock prices of shortable peers that may aggregate information from short sellers. Further analyses confirm that my findings are not driven by shortable peers' other firm characteristics and are robust to alternative peer definitions and to a variety of additional tests. In addition, the cross-sectional analyses show that non-shortable firms' investment becomes more sensitive to shortable peers' stock prices when (1) their own firms' stock prices reflect less negative information; (2) their managers are less likely to obtain negative information from financial analysts; and (3) negative information is more valuable for their corporate investment decisions. Taken together, these results are consistent with my hypothesis that non-shortable firms' managers seek to learn short sellers' information on external conditions from shortable peers' stock prices and use this information in their corporate investment decisions.

Appendix 1: Short-sale constraints in Hong Kong stock market

Short sales are not permitted in Hong Kong stock market until 1994. In January 1994, Hong Kong Stock Exchange (HKSE) introduced a pilot scheme for regulated short sales to keep in line with the reform of securities borrowing and lending in Hong Kong stock market. Under this pilot scheme, 17 securities that are included in an official list are allowed for short sales. Further, in March 1996, this pilot scheme was revised to include more securities into the official list. Nowadays, the official list for short sales is revised in a quarterly basis by HKSE.[26]

According to the information revealed by HKSE on its website in December 2014, securities that are selected in the official list for short sales need to satisfy at least one of the following criteria:[27]

1. All constituent stocks of indices which are the underlying indices of equity index products traded on the Exchange;

2. All constituent stocks of indices which are the underlying indices of equity index products traded on Hong Kong Futures Exchange (hereafter, HKFE);

3. All underlying stocks of stock options traded on the Exchange;

4. All underlying stocks of Stock Futures Contracts (as defined in the rules, regulations and procedures of HKFE) traded on HKFE;

5. Stocks eligible for structured product issuance pursuant to Rule 15A.35 of the Main Board Listing Rules or underlying stocks of Structured Product traded on the Exchange;

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[26] Before 2001, the official list for short sales was not revised in a quarterly basis. Considering the changing market conditions, HKSE, at its discretion, revises the list in a yearly or semi-yearly basis. In addition, during my sample period, occasional revisions also exist between quarterly revisions.

[27] See "Regulated Short Selling" on the website of Hong Kong Exchanges and Clearing Limited (https://www.hkex.com.hk/eng/market/sec_tradinfo/regshortsell.htm).

6. Stocks with market capitalization of not less than HK$3 billion and an aggregate turnover during the preceding 12 months to market capitalization ratio of not less than 50%;[28]

7. Exchange Traded Funds approved by the Board in consultation with the Commission;

8. All securities traded under the Pilot Program;

9. Stocks that have been listed on the Exchange for not more than 60 trading days, with a public float capitalization of not less than HK$10 billion for a period of 20 consecutive trading days commencing from the date of their listing on the Exchange and an aggregate turnover of not less than HK$200 million during such period;

10. All underlying stocks of Structured Product which is based on one single class of shares traded on the Exchange; and

11. Applicable Market Making Securities approved by the Board in consultation with the Commission.

At the end of 2014, a total number of 797 securities are included in the official list and eligible for short sales. According to the statistics reports published by HKSE, in 2014, short sale activities are estimated to make up around 10% of the trading volume in Hong Kong stock market.[29]

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[28] The criterion related to market capitalization and aggregate turnover is not constant but subject to changes. For example, in May 2012, HKSE tightened this criterion by increasing market capitalization requirement from $1 billion to $3 billion and turnover requirement from 40 percent to 50 percent. See http://www.hkex.com.hk/eng/newsconsul/hkexnews/2012/120510news.htm.

[29] This is calculated based on the statistics from HKEx Fact Book 2014. See http://www.hkex.com.hk/eng/stat/statrpt/factbook/factbook2014/fb2014.htm.

Appendix 2: Variable definitions

Variable	Definition
Inv	Capital expenditures scaled by book value of beginning-of-year total assets
Q	Market value of equity plus book value of assets minus book value of equity, scaled by book value of total assets
CF	Sum of net income before extraordinary depreciation and amortization expenses, scaled by beginning-of-year total assets
1/ASSET	The inverse of total assets
$Q_{-i}^{Shortable}$ ($Q_{-i}^{Non-shortable}$)	The equally-weighted average value of Q across all shortable (non-shortable) peers of firm i in same industry at a given year, excluding firm i itself
$Inv_{-i}^{Shortable}$ ($Inv_{-i}^{Non-shortable}$)	The equally-weighted average value of Inv across all shortable (non-shortable) peers of firm i in same industry at a given year, excluding firm i itself
$CF_{-i}^{Shortable}$ ($CF_{-i}^{Non-shortable}$)	The equally-weighted average value of CF across all shortable (non-shortable) peers of firm i in same industry at a given year, excluding firm i itself
MV	Stock price times the number of total shares outstanding (in HK$ millions)
Turnover	The ratio of yearly aggregate trading volume (in HK$) to market capitalization
1-R2	One minus R2 from regressing weekly returns on market and industry returns over year t
Amihud	Average daily ratio of a stock absolute return by dollar trading volume
SGR	Sales growth, defined as one-year growth in total revenues
$SGR_{-i}^{Shortable}$ ($SGR_{-i}^{Non-shortable}$)	The equally-weighted average value of SGR across all shortable (non-shortable) peers of firm i in same industry at a given year, excluding firm i itself
CumRet	Cumulative market-adjusted returns over a time period of three years subsequent to the measurement of firms' investment
R2Diff	Downside R2 minus upside R2. Downside R2 (upside R2) is the R2 computed from a market model regression using only negative (positive) market returns
M/B	The ratio of market value of equity to book value of equity
Coverage	The number of analysts that issue one-year forward forecasts on earnings per share for the firm
Tangibility	The ratio of property, plants and equipment to total assets
Depreciation	The ratio of depreciation of tangible capital assets to property, plants and equipment and compute the average at two-digit SIC industry level across years

IncVol	Standard deviation of quarterly operating income before depreciation divided by quarterly book value of total assets over a period of past eight quarters
Size	The logarithm of total assets
EF	The difference between capital expenditures and cash flows scaled by capital expenditures, calculated at two-digit SIC industry level

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Figure 1: Market capitalization and trading turnover distribution of shortable and non-shortable firms

The top graphs show the market capitalization of shortable and non-shortable firms in full sample and matched sample. The bottom graphs show the trading turnover of shortable and non-shortable firms in full sample and matched sample. I plot the Epanechnikov kernel densities of the natural logarithm of market capitalization and trading turnover.

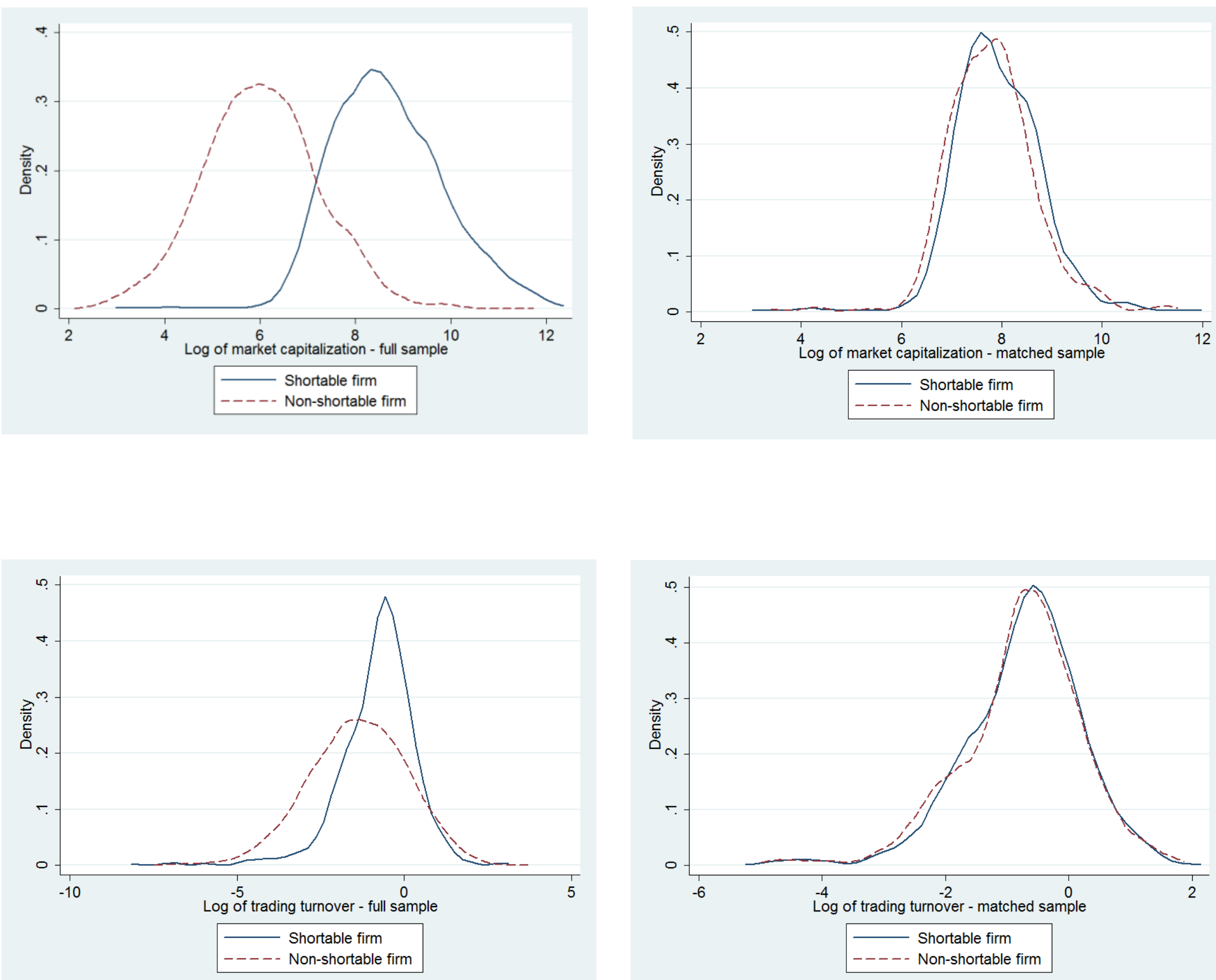

Table 1: Number of shortable and non-shortable firms

This table presents the yearly distribution of shortable and non-shortable firms for the sample from 2002 to 2013. I exclude firms in the financial and banking industries (SIC code 6000-6999) and utility industries (SIC code 4900-4999). I also exclude firm-year observations with negative book value of total assets or equity, or with less than 30 days of trading activities in a year.

Year	# of shortable firms	# of non-shortable firms	# of total firms	% of shortable firms
2002	25	131	156	16%
2003	31	257	288	11%
2004	29	264	293	10%
2005	46	363	409	11%
2006	67	380	447	15%
2007	49	367	416	12%
2008	100	405	505	20%
2009	72	375	447	16%
2010	49	374	423	12%
2011	117	412	529	22%
2012	117	415	532	22%
2013	95	423	518	18%

Table 2: Summary statistics

This table presents the summary statistics for the sample. The sample consists of 4963 firm-year observations associated with 722 firms from 2002 to 2013. Detailed variable definitions are in Appendix 2. All unbounded variables are winsorized at 1% and 99% levels for each panel year. Panel A presents the summary statistics for all firms, while Panel B (Panel C) presents the summary statistics for only shortable (non-shortable) firms. In this paper, I mainly use the sample of non-shortable firms (in Panel C) for empirical analysis.

Variables	# Obs	Mean	Std Dev	Q1	Median	Q3
			Panel A: All firms			
Inv	4963	0.0453	0.0665	0.0066	0.0225	0.0549
Q	4963	1.5190	1.7181	0.7545	1.0149	1.5649
CF	4963	0.0153	0.2326	-0.0270	0.0532	0.1165
ASSET (in HK$ millions)	4963	3767.61	12061.15	387.18	1017.60	2760.77
MV (in HK$ millions)	4963	2796.75	9738.50	215.06	549.90	1668.50
Turnover	4963	0.6978	1.4070	0.1115	0.3116	0.7621
			Panel B: Shortable firms			
Inv	797	0.0527	0.0584	0.0144	0.0370	0.0685
Q	797	1.6792	1.2173	0.9260	1.2995	1.9913
CF	797	0.0929	0.1184	0.0404	0.0916	0.1546
ASSET (in HK$ millions)	797	14774.94	26692.46	2935.00	6093.63	15037.48
MV (in HK$ millions)	797	12043.47	20619.79	2548.74	5346.24	12171.02
Turnover	797	0.7515	1.1571	0.2566	0.5135	0.8492
			Panel C: Non-shortable firms			
Inv	4166	0.0439	0.0679	0.0060	0.0203	0.0513
Q	4166	1.4883	1.7966	0.7351	0.9702	1.4801
CF	4166	0.0005	0.2458	-0.0459	0.0444	0.1067
ASSET (in HK$ millions)	4166	1661.78	3085.40	318.46	786.40	1785.04
MV (in HK$ millions)	4166	1027.75	3498.12	185.54	412.40	916.36
Turnover	4166	0.6875	1.4498	0.0964	0.2642	0.7256

Table 3: Baseline model results

This table presents the coefficient estimates of baseline model. The dependent variable is the investment of non-shortable firms. In Column (1), I include only shortable peers' variables, while in Column (2) I include only non-shortable peers' variables. In Column (3), I include both shortable and non-shortable peers' variables. Detailed variable definitions are in Appendix 2. The sample period is from 2002 to 2013. The estimations correct the error term structure for heteroskedasticity and within-firm clustering. The t-statistics are in parentheses. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

	Dependent variable = Inv_i					
	(1)		(2)		(3)	
Q_i	0.0103	***	0.0098	***	0.0099	***
	(4.45)		(4.28)		(4.32)	
CF_i	0.0389	***	0.0392	***	0.0392	***
	(4.76)		(4.83)		(4.84)	
1/ASSET	-0.0900		-0.0230		-0.0459	
	(-0.34)		(-0.09)		(-0.18)	
$Q_{-i}^{Shortable}$	0.0030	*			0.0041	**
	(1.95)				(2.58)	
$Inv_{-i}^{Shortable}$	-0.0238				-0.0267	
	(-0.73)				(-0.84)	
$CF_{-i}^{Shortable}$	0.0247	*			0.0394	***
	(1.74)				(2.74)	
$Q_{-i}^{Non-shortable}$			-0.0012		-0.0009	
			(-0.95)		(-0.79)	
$Inv_{-i}^{Non-shortable}$			-0.2237	***	-0.2469	***
			(-4.49)		(-4.80)	
$CF_{-i}^{Non-shortable}$			0.0097		0.0098	
			(0.93)		(0.94)	
Year FE	Yes		Yes		Yes	
Industry FE	Yes		Yes		Yes	
Adj-R2	0.092		0.100		0.102	
N	4166		4166		4166	

Table 4: Controlling for firm characteristics

This table presents the coefficient estimates of baseline model, using different groups of firms to calculate peer-level variables. The dependent variable is the investment of non-shortable firms. In Column (1), (2), (3) and (4), I calculate peer-level variables using a group of shortable and non-shortable firms matched on market capitalization, trading turnover, stock price non-synchronicity and Amihud ratio, respectively. In Column (5) and (6), I use a group of firms that experienced (at least one) change of short-sale eligibility during the sample period and calculate peer-level variables using these peers when they are shortable and non-shortable, respectively. Detailed variable definitions are in Appendix 2. The sample period is from 2002 to 2013. The estimations correct the error term structure for heteroskedasticity and within-firm clustering. The t-statistics are in parentheses. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

	Dependent variable = Inv_i											
	(1)		(2)		(3)		(4)		(5)		(6)	
Q_i	0.0083	***	0.0101	***	0.0095	***	0.0089	***	0.0086	***	0.0084	***
	(3.11)		(4.19)		(4.27)		(3.48)		(3.57)		(3.54)	
CF_i	0.0351	***	0.0385	***	0.0386	***	0.0426	***	0.0358	***	0.0358	***
	(3.61)		(4.56)		(4.61)		(4.47)		(4.24)		(4.25)	
1/ASSET	0.1861		-0.0337		-0.0231		0.0800		0.1031		0.1315	
	(0.62)		(-0.12)		(-0.08)		(0.31)		(0.38)		(0.48)	
$Q_{-i}^{Shortable}$	0.0035	**	0.0049	**	0.0036	**	0.0021	*	0.0034	**		
	(2.09)		(2.30)		(2.22)		(1.70)		(2.05)			
$Inv_{-i}^{Shortable}$	-0.0051		-0.0225		-0.0166		0.0698		-0.0099			
	(-0.17)		(-0.67)		(-0.48)		(1.56)		(-0.28)			
$CF_{-i}^{Shortable}$	0.0086		0.0256		0.0275	*	0.0302	*	0.0242			
	(0.65)		(1.63)		(1.85)		(1.81)		(1.49)			
$Q_{-i}^{Non-shortable}$	-0.0015		-0.0011		-0.0008		0.0014				0.0005	
	(-1.54)		(-1.06)		(-1.18)		(0.90)				(0.38)	
$Inv_{-i}^{Non-shortable}$	-0.0563	***	-0.1000	***	-0.1023	***	-0.0220				-0.0745	**
	(-2.97)		(-3.30)		(-3.44)		(-1.52)				(-2.56)	
$CF_{-i}^{Non-shortable}$	-0.0011		-0.0017		0.0029		0.0137	**			-0.0025	
	(-0.51)		(-0.53)		(0.50)		(2.10)				(-0.45)	
Year FE	Yes		Yes		Yes		Yes		Yes		Yes	
Industry FE	Yes		Yes		Yes		Yes		Yes		Yes	
Adj-R2	0.070		0.095		0.092		0.080		0.078		0.078	
N	3335		4007		4050		2911		3709		3709	

Table 5: Alternative peer definitions

This table presents the coefficient estimates of baseline specification, using alternative peer definitions. The dependent variable is the investment of non-shortable firms. In Column (1), I define a firm's peers as all other firms that belong to the same three-digit SIC industry as the firm. In Column (2) I use four-digit GICS code to define peers. In Column (3), I use six-digit GICS code to define peers. Finally, in Column (4), I select a set of pseudo peers by drawing a random sample of firms from other industries. Detailed variable definitions are in Appendix 2. The sample period is from 2002 to 2013. The estimations correct the error term structure for heteroskedasticity and within-firm clustering. The t-statistics are in parentheses. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

	Dependent variable = Inv_i							
	(1)		(2)		(3)		(4)	
Q_i	0.0072	**	0.0085	***	0.0115	***	0.0088	***
	(2.35)		(4.10)		(4.48)		(4.28)	
CF_i	0.0355	***	0.0371	***	0.0338	***	0.0276	***
	(2.81)		(4.81)		(4.43)		(3.43)	
1/ASSET	0.2527		0.1600		-0.0514		0.0532	
	(0.86)		(0.62)		(-0.17)		(0.25)	
$Q_{-i}^{Shortable}$	0.0037	**	0.0034	**	0.0042	**	-0.0005	
	(2.28)		(2.05)		(2.00)		(-0.51)	
$Inv_{-i}^{Shortable}$	-0.0619	*	0.1371	***	0.0620	**	0.0315	
	(-1.68)		(3.00)		(2.16)		(0.73)	
$CF_{-i}^{Shortable}$	0.0457	***	-0.0054		-0.0213		0.0000	
	(2.96)		(-0.29)		(-1.45)		(0.00)	
$Q_{-i}^{Non-shortable}$	-0.0007		0.0011		-0.0003		0.0003	
	(-0.39)		(1.13)		(-0.33)		(0.44)	
$Inv_{-i}^{Non-shortable}$	-0.2956	***	-0.1065	*	-0.1940	***	-0.0378	
	(-4.73)		(-1.76)		(-3.29)		(-1.31)	
$CF_{-i}^{Non-shortable}$	0.0023		0.0281	**	0.0159		-0.0012	
	(0.14)		(2.30)		(1.17)		(-0.42)	
Year FE	Yes		Yes		Yes		Yes	
Industry FE	Yes		Yes		Yes		Yes	
Adj-R2	0.105		0.078		0.084		0.077	
N	2563		4690		3767		3838	

Table 6: Additional robustness tests

This table presents the coefficient estimates for several additional robustness tests. The dependent variable is the investment of non-shortable firms. In Column (1), I re-estimate the baseline model by replacing industry fixed effects with firm fixed effects. In Column (2), I use the Fama-MacBeth method to estimate the baseline model. In Column (3), I alter the dependent variable to the sum of capital expenditures and R&D expenses scaled by beginning-of-year total assets. In Column (4), I replace stock price variable with non-price based measure of investment opportunity, SGR, for firm i and its shortable and non-shortable peers. Finally, in Column (5) I include CumRet to control for stock mispricing. Detailed variable definitions are in Appendix 2. The sample period is from 2002 to 2013. The estimations correct the error term structure for heteroskedasticity and within-firm clustering. The t-statistics are in parentheses. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

Table 6: Additional robustness tests (cont.)

	Dependent variable = Inv_i									
	(1)		(2)		(3)		(4)		(5)	
Q_i	0.0099	***	0.0099	***	0.0103	***			0.0106	***
	(4.03)		(5.33)		(4.13)				(4.17)	
CF_i	0.0276	***	0.0569	***	0.0414	***	0.0365	***	0.0415	***
	(2.75)		(5.13)		(4.78)		(4.35)		(4.75)	
1/ASSET	-0.1992		0.1724		0.8137	**	0.5827	**	-0.0588	
	(-0.54)		(0.78)		(2.50)		(2.48)		(-0.21)	
$Q_{-i}^{Shortable}$	0.0026	*	0.0053	*	0.0038	**			0.0042	**
	(1.85)		(2.15)		(2.42)				(2.45)	
$Inv_{-i}^{Shortable}$	-0.0087		0.0714		0.0053		-0.0377		-0.0299	
	(-0.28)		(0.74)		(0.16)		(-1.13)		(-0.89)	
$CF_{-i}^{Shortable}$	0.0234	*	0.0482		0.0370	**	0.0340	**	0.0418	**
	(1.65)		(1.24)		(2.47)		(2.43)		(2.49)	
$Q_{-i}^{Non-shortable}$	0.0009		0.0005		-0.0014				-0.0005	
	(0.81)		(0.19)		(-1.17)				(-0.34)	
$Inv_{-i}^{Non-shortable}$	-0.1084	***	-0.4488	**	-0.2872	***	-0.2582	***	-0.2879	***
	(-3.29)		(-3.08)		(-5.43)		(-4.98)		(-5.50)	
$CF_{-i}^{Non-shortable}$	0.0066		0.0798	*	0.0106		0.0120		0.0104	
	(0.65)		(2.12)		(0.97)		(1.18)		(0.98)	
CumRet									0.0005	
									(0.44)	
SGR							0.0025	*		
							(1.84)			
$SGR_{-i}^{Shortable}$							-0.0000			
							(-0.02)			
$SGR_{-i}^{Non-shortable}$							-0.0002			
							(-0.48)			
Year FE	Yes		Yes		Yes		Yes		Yes	
Industry FE	No		Yes		Yes		Yes		Yes	
Firm FE	Yes		No		No		No		No	
Adj-R2	0.056		0.153		0.110		0.090		0.108	
N	4166		4166		4166		4040		3704	

Table 7: Cross-sectional analyses - Panel A

This table presents the results of the cross-sectional variation in non-shortable firms' investment sensitivity to shortable peers' stock prices. In Column (1), I interact $Q_{-i}^{Shortable}$ with $High\_R2Diff_{ijt-1}$, which equals to one if firm i's downside-minus-upside R2 is higher than the industry median at year t-1, and zero otherwise. In Column (2), I interact $Q_{-i}^{Shortable}$ with $High\_M/B_{ijt-1}$, which equals to one if firm i's equity market-to-book is higher than the industry median at year t-1, and zero otherwise. Detailed variable definitions are in Appendix 2. The sample period is from 2002 to 2013. The estimations correct the error term structure for heteroskedasticity and within-firm clustering. The t-statistics are in parentheses. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

Table 7: Cross-sectional analyses - Panel A (cont.)

	Dependent variable = Inv_i			
	(1)		(2)	
Q_i	0.0103	***	0.0069	***
	(4.22)		(3.04)	
CF_i	0.0400	***	0.0382	***
	(4.74)		(4.76)	
1/ASSET	-0.0537		-0.1312	
	(-0.19)		(-0.50)	
$Q_{-i}^{Shortable}$	0.0014		0.0015	
	(1.13)		(1.28)	
$Q_{-i}^{Shortable}$ * High_R2Diff	0.0052	*		
	(1.95)			
High_R2Diff	0.0004			
	(1.13)			
$Q_{-i}^{Shortable}$ * High_M/B			0.0049	*
			(1.89)	
High_M/B			0.0150	***
			(5.89)	
$Inv_{-i}^{Shortable}$	-0.0398		-0.0296	
	(-1.17)		(-0.96)	
$CF_{-i}^{Shortable}$	0.0449	***	0.0426	***
	(2.86)		(2.94)	
$Q_{-i}^{Non-shortable}$	-0.0007		0.0000	
	(-0.46)		(0.02)	
$Inv_{-i}^{Non-shortable}$	-0.2569	***	-0.2445	***
	(-4.93)		(-4.76)	
$CF_{-i}^{Non-shortable}$	0.0104		0.0106	
	(0.90)		(1.01)	
Year FE	Yes		Yes	
Industry FE	Yes		Yes	
Adj-R2	0.103		0.113	
N	3850		4166	

Table 7: Cross-sectional analyses - Panel B

This table presents the results of the cross-sectional variation in non-shortable firms' investment sensitivity to shortable peers' stock prices. In Column (1), I interact $Q_{-i}^{Shortable}$ with $High\_Coverage_{ijt-1}$, which equals to one if the number of analysts following firm i is above the industry median at year t-1, and zero otherwise. In Column (2), I interact $Q_{-i}^{Shortable}$ with $High\_Bias_{ijt-1}$, which equals to one if firm i's mean forecasted earnings is higher than the actual earnings and zero otherwise. Detailed variable definitions are in Appendix 2. The sample period is from 2002 to 2013. The estimations correct the error term structure for heteroskedasticity and within-firm clustering. The t-statistics are in parentheses. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

Table 7: Cross-sectional analyses - Panel B (cont.)

	Dependent variable = Inv_i			
	(1)		(2)	
Q_i	0.0105	***	0.0094	***
	(3.92)		(3.19)	
CF_i	0.0587	***	0.0666	***
	(4.11)		(4.72)	
1/ASSET	-2.1669	**	-1.4959	
	(-2.39)		(-1.56)	
$Q_{-i}^{Shortable}$	0.0372	*	-0.0010	
	(1.93)		(-0.33)	
$Q_{-i}^{Shortable}$ * High_Coverage	-0.0362	*		
	(-1.96)			
High_Coverage	-0.0009			
	(-0.15)			
$Q_{-i}^{Shortable}$ * High_Bias			0.0053	
			(1.36)	
High_Bias			-0.0059	
			(-1.39)	
$Inv_{-i}^{Shortable}$	0.1043		0.0453	
	(1.08)		(0.53)	
$CF_{-i}^{Shortable}$	0.0072		0.0269	
	(0.29)		(0.87)	
$Q_{-i}^{Non-shortable}$	-0.0007		-0.0011	
	(-0.45)		(-0.48)	
$Inv_{-i}^{Non-shortable}$	-0.2729	***	-0.2944	***
	(-2.92)		(-3.29)	
$CF_{-i}^{Non-shortable}$	-0.0145		-0.0119	
	(-0.82)		(-0.59)	
Year FE	Yes		Yes	
Industry FE	Yes		Yes	
Adj-R2	0.227		0.225	
N	973		940	

Table 7: Cross-sectional analyses - Panel C

This table presents the results of the cross-sectional variation in non-shortable firms' investment sensitivity to shortable peers' stock prices. In Column (1), I interact $Q_{-i}^{Shortable}$ with $High\_Tangibility_{ijt-1}$, which equals to one if firm i's asset tangibility is higher than the industry median at year t-1, and zero otherwise. In Column (2), I interact $Q_{-i}^{Shortable}$ with $High\_Depreciation_{ijt-1}$, which equals to one if the average depreciation rate of industry j that firm i belongs to is above the median depreciation rate of all industries in the sample, and zero otherwise. In Column (3), I interact $Q_{-i}^{Shortable}$ with $High\_IncVol_{ijt-1}$, which equals to one if firm i's income volatility is higher than the sample median at year t-1, and zero otherwise. Detailed variable definitions are in Appendix 2. The sample period is from 2002 to 2013. The estimations correct the error term structure for heteroskedasticity and within-firm clustering. The t-statistics are in parentheses. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

Table 7: Cross-sectional analyses - Panel C (cont.)

	Dependent variable = Inv_i					
	(1)		(2)		(3)	
Q_i	0.0103	***	0.0099	***	0.0087	***
	(4.55)		(4.32)		(3.21)	
CF_i	0.0366	***	0.0392	***	0.0368	***
	(4.56)		(4.84)		(4.04)	
1/ASSET	0.0798		-0.0372		0.1306	
	(0.33)		(-0.14)		(0.38)	
$Q_{-i}^{Shortable}$	0.0018		0.0126	**	0.0005	
	(1.26)		(2.49)		(0.40)	
$Q_{-i}^{Shortable}$ * High_Tangibility	0.0046	*				
	(1.74)					
High_Tangibility	0.0227	***				
	(8.94)					
$Q_{-i}^{Shortable}$ * High_Depreciation			-0.0091	*		
			(-1.77)			
High_Depreciation			0.0068			
			(0.37)			
$Q_{-i}^{Shortable}$ * High_IncVol					0.0034	*
					(1.72)	
High_IncVol					0.0045	
					(1.59)	
$Inv_{-i}^{Shortable}$	-0.0295		-0.0351		-0.0973	***
	(-0.95)		(-1.11)		(-3.00)	
$CF_{-i}^{Shortable}$	0.0405	***	0.0387	**	0.0366	**
	(2.79)		(2.57)		(2.22)	
$Q_{-i}^{Non-shortable}$	-0.0006		-0.0004		-0.0012	
	(-0.45)		(-0.26)		(-0.75)	
$Inv_{-i}^{Non-shortable}$	-0.2414	***	-0.2577	***	-0.2400	***
	(-4.76)		(-4.94)		(-3.77)	
$CF_{-i}^{Non-shortable}$	0.0094		0.0107		0.0094	
	(0.90)		(1.01)		(0.71)	
Year FE	Yes		Yes		Yes	
Industry FE	Yes		Yes		Yes	
Adj-R2	0.131		0.103		0.103	
N	4166		4166		2917	

Table 7: Cross-sectional analyses - Panel D

This table presents the results of the cross-sectional variation in non-shortable firms' investment sensitivity to shortable peers' stock prices. In Column (1), I interact $Q_{-i}^{Shortable}$ with $High\_Size_{ijt-1}$, which equals to one if firm i's size is larger than the industry median at year t-1, and zero otherwise. In Column (2), I interact $Q_{-i}^{Shortable}$ with $High\_EF_{ijt-1}$, which equals to one if the external financing of industry j that firm i belongs to is above the median external financing of all industries in the sample, and zero otherwise. Detailed variable definitions are in Appendix 2. The sample period is from 2002 to 2013. The estimations correct the error term structure for heteroskedasticity and within-firm clustering. The t-statistics are in parentheses. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

Table 7: Cross-sectional analyses - Panel D (cont.)

	Dependent variable = Inv_i			
	(1)		(2)	
Q_i	0.0100	***	0.0097	***
	(4.35)		(4.24)	
CF_i	0.0389	***	0.0390	***
	(4.78)		(4.84)	
1/ASSET	0.0024		-0.0487	
	(0.01)		(-0.19)	
$Q_{-i}^{Shortable}$	0.0041	**	0.0037	**
	(1.98)		(2.28)	
$Q_{-i}^{Shortable}$ * High_Size	0.0000			
	(0.02)			
High_Size	0.0019			
	(0.464)			
$Q_{-i}^{Shortable}$ * High_EF			0.0165	**
			(2.59)	
High_EF			-0.0098	
			(-0.54)	
$Inv_{-i}^{Shortable}$	-0.0298		-0.0233	
	(-0.93)		(-0.73)	
$CF_{-i}^{Shortable}$	0.0423	***	0.0345	**
	(2.87)		(2.26)	
$Q_{-i}^{Non-shortable}$	-0.0005		-0.0012	
	(-0.33)		(-0.88)	
$Inv_{-i}^{Non-shortable}$	-0.2556	***	-0.2699	***
	(-4.98)		(-5.08)	
$CF_{-i}^{Non-shortable}$	0.0105		0.0079	
	(0.98)		(0.74)	
YearFE	Yes		Yes	
IndustryFE	Yes		Yes	
Adj-R2	0.102		0.104	
N	4166		4166	

Table 8: Learning from shortable peers' stock prices and corporate investment efficiency

This table presents the results for the relationship, at two-digit SIC industry level, between non-shortable firms' overall investment efficiency level and the relative number of shortable firms in an industry. The dependent variable is $|\dot{q} - 1|$, for which $\dot{q}$ is estimated using a subsample of all non-shortable firms in the industry at a given year. The independent variable of interest is the percentage of shortable firms in the industry. In Column (1), I use the full sample. In Column (2), I use a subsample where $\dot{q} > 1$. Finally, in Column (3), I use a subsample where $\dot{q} < 1$. The sample period is from 2002 to 2013. The estimations correct the error term structure for heteroskedasticity and within-industry clustering. The t-statistics are in parentheses. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

	Dependent variable = $|\dot{q} - 1|$					
	(1)		(2)		(3)	
Shortable ratio	-1.7655	*	-0.5100		-2.8426	**
	(-1.71)		(-0.23)		(-1.99)	
$\overline{\text{Leverage}}$	3.2384		3.0467		0.4621	
	(0.92)		(0.44)		(0.10)	
$\overline{\text{Q}}$	-0.0345		0.3733	**	-0.0631	
	(-0.47)		(2.16)		(-0.63)	
$\overline{\text{Market Cap}}$	0.0312		0.3771		0.1201	
	(0.10)		(0.66)		(0.28)	
Total number of firms	-0.0304		-0.0196		-0.0283	
	(-1.24)		(-0.38)		(-0.96)	
Year FE	Yes		Yes		Yes	
Industry FE	Yes		Yes		Yes	
Adj-R2	0.086		0.212		0.154	
N	194		64		130	

Table 9: U.S. evidence

This table presents the coefficient estimates of baseline model using a sample firms in U.S. stock market from 2004 to 2007. I rely on a regulatory change (Reg SHO) that relaxes short-sale constraints on a random sample of firms in Russell 3000 index to perform my analysis. The dependent variable is the investment of a non-Russell firm i. The independent variables, $Q^{Pilot}_{jt-1,-i}$ and $Q^{Control}_{jt-1,-i}$, are calculated using firm i's peers that are pilot and control firms in Russell 3000 index, respectively. In Column (1), I include only pilot peers' variables, while in Column (2) I include only control peers' variables. In Column (3), I include both pilot and control peers' variables. Finally, in Column (4), I repeat the same analysis as in Column (3) but using a sample of firms in the period before Reg SHO (from 2001 to 2003). The estimations correct the error term structure for heteroskedasticity and within-firm clustering. The t-statistics are in parentheses. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

	Dependent variable = Inv_i							
	(1)		(2)		(3)		(4)	
Q_i	0.0127	***	0.0126	***	0.0126	***	0.0116	***
	(6.61)		(6.59)		(6.59)		(5.73)	
CF_i	0.0313	***	0.0313	***	0.0312	***	0.0309	***
	(3.95)		(3.95)		(3.94)		(4.36)	
1/ASSET	-0.1145	*	-0.1141	*	-0.1157	*	0.0306	
	(-1.84)		(-1.82)		(-1.85)		(0.91)	
Q^{Pilot}_{-i}	0.0056	**			0.0054	*	0.0014	
	(2.10)				(1.93)		(0.70)	
Inv^{Pilot}_{-i}	0.1764				0.1832		-0.1350	
	(0.66)				(0.66)		(-1.52)	
CF^{Pilot}_{-i}	-0.0255				-0.0208		0.0153	
	(-0.47)				(-0.38)		(0.54)	
$Q^{Control}_{-i}$			-0.0004		-0.0034		-0.0020	
			(-0.07)		(-0.57)		(-0.96)	
$Inv^{Control}_{-i}$			0.2448		0.2290		0.1355	
			(1.37)		(1.28)		(1.48)	
$CF^{Control}_{-i}$			-0.0156		-0.0247		0.0192	
			(-0.34)		(-0.52)		(0.41)	
Year FE	Yes		Yes		Yes		Yes	
Industry FE	Yes		Yes		Yes		Yes	
Adj-R2	0.367		0.367		0.367		0.277	
N	3489		3489		3489		3782	