China Journal of Accounting Research xxx (2017) xxx–xxx

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China Journal of Accounting Research

journal homepage: www.elsevier.com/locate/cjar

Peer effects in decision-making: Evidence from corporate investment

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ARTICLE INFO

Article history:
Received 19 September 2014
Accepted 25 November 2016
Available online xxxx

Keywords:
Peer effects
Corporate investment
Managerial learning

ABSTRACT

We show that peer effects influence corporate investment decisions. Using a sample of China's listed firms from 1999 to 2012, we show that a one standard deviation increase in peer firms' investments is associated with a 4% increase in firm *i*'s investments. We further identify the mechanisms, conditions and economic consequences of peer effects in firms' investment decisions. We find that peer effects are more pronounced when firms have information advantages and the information disclosure quality of peer firms is higher, or if they face more fierce competition. When firms are industry followers, are young or have financial constraints, they are highly sensitive to their peers firms. We also quantify the economic consequences generated by peer effects, which can increase firm performance in future periods.

1. Introduction

It is common for corporations to interact with peer firms in decision-making, such as signing strategic cooperating agreements and developing marketing strategies. Previous studies show that peer firms play an important role in shaping a variety of corporate policies, such as product pricing (Bertrand, 1883) and advertising (Stigler, 1968), but the effect of peer-firm behavior on corporate financial policy is often ignored in empirical research, or at most assumed to operate through an unmeasured effect on firm-specific determinants. Recent studies examine whether the characteristics or behavior of peer firms affect corporate capital structure (Leary and Roberts, 2014), mergers and acquisitions (Bizjak et al., 2009) and tax avoidance (Li et al., 2014).

☆ We acknowledge funding for project 71263034 and 71572087 from the National Natural Science Foundation of China.
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http://dx.doi.org/10.1016/j.cjar.2016.11.002
1755-3091/

Please cite this article in press as: Chen, S., Ma, H. Peer effects in decision-making: Evidence from corporate investment. China Journal of Accounting Research (2017), http://dx.doi.org/10.1016/j.cjar.2016.11.002

Investment decisions are important and determine corporate development. Most studies that examine peer effects in corporate investment suggest that managers can gain useful information from the stock price of peer firms. Edmans et al. (2012a, 2012b) and Bond et al. (2012) point out that stock prices include information that is helpful in guiding a firm's investment policy, such as industry growth opportunities, external environment, competitor strategy and consumer demands. Valuing the stock price of peer firms can therefore capture useful information to help reduce investment uncertainty. Ozoguz and Rebello (2013) find that firms' investment policy reacts appropriately to volatility in a peer firms' stock price. Using U.S. listed firms from 1996 to 2008, Foucault and Fresard (2014) find that the valuation of peers matters for a firm's investment: a one standard deviation increase in a peers' valuation is associated with a 5.9% increase in corporate investment. Fracassi (2012) and Dougal et al. (2012) provide similar empirical results. However, few studies investigate whether managers directly mimic the investment behavior of peer firms. In this study, we predict that firms' investment behavior is influenced by peer firms' investment decisions, and provide empirical evidence to support the prediction.

In the stock markets of developed counties, stock prices aggregate diverse corporate decisions and ultimately reflect an accurate assessment of firm value. However, China has only slowly developed a legal framework for its stock market, and has a weak law enforcement record. Consequently, the idiosyncratic information of firms is deficient, and stock prices are highly synchronous (Morck et al., 2000; Zhu et al., 2007). In this undeveloped stock market, stock prices are not the most useful source of information when real decisions are taken. Firms are more likely to directly mimic the strategies and decisions of their peers. Liu and Chen (2012) find that it is common for firms to imitate their peers' behavior in the industry cluster, and this imitation can increase the performance of both a firm and its peers. Focusing on corporate mergers and acquisitions, Chen and Lu (2013) argue that the acquisition premium is significantly affected by peer firms. This evidence shows that managers have strong incentives to learn from peer firms, enabling them to maximize firm value or avoid the potential risk of failure (Ren, 2002; Zhuang, 2003; Li et al., 2011).

We examine the effect of the investment policy of peer firms on a firm's investment. Information imperfection and investment uncertainty are the main reasons behind the learning behavior of a peer group (Lieberman and Asaba, 2006). Any investment decision involves risk and uncertainty. Managers may be unsure of the likelihood of possible outcomes, and may have fundamental difficulties recognizing cause and effect relationships and the full range of potential consequences (Milliken, 1987). In environments of uncertainty and ambiguity, managers are particularly likely to imitate the investment activities of peers. This imitation, though still highly imperfect, can significantly reduce the investment risk and the possibility of falling behind rivals. Peer firms therefore have a strong influence on managerial perceptions and beliefs. For example, Mongolia Yili Industrial Group Co., Ltd., a large dairy enterprise, produces "breakfast milk" and attaches importance to a nutritional breakfast. Mengniu Dairy, the biggest competitor of Yili, then actively rolls out "Mengniu breakfast milk." "JinDian (金典) milk" produced by Yili and "TeLunsu (特仑苏) milk" produced by Mengniu are also good examples of the learning effect in product development. While specific cases of firms learning from their peers can be identified, it is unclear whether the learning effect is widespread in investment policies.

The challenge in examining learning from a peer group is to identify the set of firms that can use the investment policies of peers to guide their own investment decisions. Generally, this group will include firms that have several similar characteristics (e.g., industry, size, diversification, business complexity and financing constraints), so the behavior of these firms is similar within the same market. The more similarities a firm has with its peers, the more likely it is to mimic their investment decisions to reduce the potential failure risk. Considering all these characteristics simultaneously is not practical, however, as peer groups may be made up of too few firms, which would be noisy when filtering external shocks. Following Albuquerque (2009) and Leary and Roberts (2014), we specify peer firms as those in the same industry and in upper and lower size quartiles (0.75 times to 1.25 times a firm's total assets) in relation to the firm. After specifying the peers of each firm, we examine whether peer firms influence the investment behavior of the firms, and find that they play an important role in shaping corporate investment decisions. Specifically, we find that a one standard deviation increase in peer firms' investment is associated with a 4% increase in firm *i*'s investment. Investment can generally be divided into two categories: (1) investment in property, plant and equipment (PPE) and (2) investment in intangible assets such as R&D, and we test the peer effect in these two types of investment. The results show that both types are sensitive to the investment policies of peer firms, while the peer effect is more pronounced in PPE

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investment. Specifically, a one standard deviation increase in PPE investment by peer firms leads to a 14.4% increase in the PPE investment of firm *i*.

To ensure the robustness of the empirical results, we specify peer firms according to different criteria and reexamine the peer effect in corporate investment policy. In robustness tests, we specify the firms in the same registering city and industry, and in the upper and lower size quartiles (0.75 times to 1.25 times a firm's total assets) to the firm as provincial-level peer firms. We define firms as national-level peer firms if their assets are in the range of 0.9–1.1 times the assets of the firm and in the same industry. The inferences are robust to these different measures. We replace the lagged control variables with contemporaneous controls to address the concern that investment policy affects firm-specific and peer firm characteristics with a lag. Again, we see little change in the results, suggesting that model misspecification in the control variables is unlikely to be behind our results.

Evidence is, however, insufficient to conclude that peer firms influence the firm's investments as the relation can covary, due to reflection problems (Manski, 1993; Shue, 2013). Reflection problems arise when a researcher observing the distribution of behavior in a population tries to infer whether the average behavior in a group influences the behavior of the individuals that comprise the group. In the current context, this problem is recreated by identifying peer firms in same industry. Firms from the same industry face similar institutional environments, investment opportunities and consumption demands, and are more likely to make similar investment decisions. The inability to accurately model the relevant factors influencing the firms' investment and its peers generates endogeneity bias. Identifying peer effects is therefore an empirical challenge. We use the following tests to further establish the causality of our findings.

First, specifying firms in the same industry but not in upper and lower size quartiles of that firm as non-peer firms, we examine the effect of the investment of a non-peer firm on the firm's investment. If our findings are driven by the macroeconomic environment, industry factors or market-level factors rather than by learning behavior, then we can predict there is a significant positive relationship between the investment of peer firms and that of the firm, as non-peer firms are still in the same industry. However, if we cannot observe a positive relationship, we can infer that the findings are not driven by the reflection problem. Second, we conduct an instrumental variable method to address the possible endogeneity bias, using our measures of peer firm equity shocks as instruments for peer firm investment policy. The peer firms return shocks are serially uncorrelated and serially cross-uncorrelated, and are less likely to be manipulated by managers when compared to other investment determinants, such as profitability and cash ratios. The instrument variable selected therefore meets the requirements for instrument relevance and exogeneity. Third, with the inclusion of firm fixed effects in the regression model, we reexamine whether peer firms influence the investment behavior of the firm. This specification addresses the concern that commonality in a firm's investment policy is due to time-invariant investment determinants over the business cycle.

The alternative explanation of the results is that a firm's investment policies are driven by a response to their peers' characteristics rather than investment behavior. Here, the peer effect in corporate investment arises when firms respond to changes in the characteristics of their peers' profitability, risk, etc. However, the response to their peers' characteristics is different from learning behavior. Thus, we provide additional analysis to investigate this distinction. To distinguish between these alternatives, we exploit heterogeneity in firms' investment responses to their peers' equity shocks after controlling for their peers' investment. The evidence shows that holding fixed the peer firm equity shock, the investments are strongly positively correlated with investments in the peer firms, but investments are unrelated to the peer firm equity shock, holding fixed the peer firm investments. Thus, firms only change their investment in response to a peer firm equity shock if it is accompanied by a change in peer firm investment, which provides additional support to our conclusion.

Next, we identify the possible channels through which peer firms influence a firm's investment. Lieberman and Asaba (2006) find that firms imitate to avoid falling behind their rivals, or because they believe that their rivals' actions convey information. According to information based theory, firms disclose large amounts of information, such as their business strategy, financial performance, expected future outlook, current and future investment outlays, material contracts and business risks, and this information has a strong spillover effect on the decision-making of others (Gigler, 1994; Kumar and Langberg, 2010). Managers then have an incentive to value information disclosed by peers, which will guide their real decisions. Empirical evidence demonstrates that a firm's disclosures can have positive externalities. For example, using a private firm

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context, Badertscher et al. (2013) examine the externalities of public firm presence on the investment decisions of private firms, and find that public firm presence reduces uncertainty in a specific industry and increases the investment efficiency of private firms in that industry. Beatty et al. (2013) find that peers react to high-profile fraudulent reports by increasing their investment expenditure during the fraud period, due to the spillover effect of fraudulent information. We therefore predict that information is an important channel through which peers matter to firms in their investment decisions. We test this prediction in two ways. First, following Houston et al. (2014), we use the distance between the registering city of the firm and the capital city Beijing to measure the informativeness of the firm, and then examine whether the peer effect in corporate investment policy varies with a firm's informativeness. Given that most policies in China are made at conferences in Beijing, it is possible for firms close to Beijing to identify potential industry policies and investment opportunities in advance, thus reducing the investment uncertainty and incentive to learn from peers. The results show that closer to Beijing a firm is the less sensitive and its investment policy is to peers. Second, we investigate whether the information quality of peers influences the learning effect. Institutional background and regulatory environment differences between mainland China and Hong Kong also lead to a difference in the quality of information disclosure of listed firms (Pistor and Xu, 2005; Ke et al., 2015). The information disclosed by AH share firms is therefore more reliable and valuable. We test this prediction by using AH share firms to measure information quality. We find that the learning effect is more pronounced when at least one AH share firm is in a peer group.

According to rival-based theory, firms' imitation is also a response designed to mitigate competitive rivalry or risk. Firms imitate others in an effort to maintain their relative position or to neutralize the aggressive actions of rivals. Imitation to mitigate rivalry is most common when firms with comparable resource endowments and market positions face one another. In a highly competitive environment, suffering from a high risk of bankruptcy, firms have strong incentives to learn from the strategies of their peer firms (Peress, 2010; Ozoguz and Rebello, 2013). Klemperer (1992) argues that learning from others can to some extent alleviate competitive pressure. Chen and Chang (2012) also provide evidence that firm's cash holdings respond more positively to peers when the product market is highly competitive. Thus, firms learn from each other in the introduction of new products and processes, in the adoption of managerial methods and organizational forms and in the entry of certain investments and the timing of the investment. Learning behavior therefore helps firms preserve the status quo among their close competitors, even in industries where strong rivalry is maintained. Similar to previous studies (Curry and George, 1983; Giroud and Mueller, 2011), we use the Herfindahl index and the number of firms in each two-digit industry to proxy for market competition, and then examine whether the peer effect in investment policy varies with product market competition. The results show that the learning effect in investment policy is more pronounced in a highly competitive market.

To better understand why peer firms affect investment policy, we further examine the heterogeneity in peer effects. First, industry leaders are more likely to have the ability to capture the investment opportunities and develop innovative products and techniques than non-industry leaders. Consequently, we predict that the peer effect is less pronounced in the investment policies of industry leader firms. Second, lacking sufficient market experience and available resources, young firms are more likely to mimic the investment behavior of peer firms, to reduce uncertainty and the risk of failure (Petersen and Rajan, 1994; Hadlock and Pierce, 2010). We predict that the investment of young firms is more sensitive to the investment of their peer firms. Third, financially constrained firms are less sensitive to the behavior of peer firms than unconstrained firms, as mimicking behavior is assumed to be more costly for financial constrained firms, given their high cost of financing. These inferences are supported by empirical results.

Finally, using ROA and Tobin-Q in the next one to three years to measure future corporate performance, we examine the economic consequences generated from this learning behavior in corporate investment policies. Learning behavior in investment is found to benefit corporate performance. Specifically, learning behavior increases corporate performance and firm value. The results reveal the importance of the learning effect in investment under an uncertain environment.

Our study contributes to the literature in two ways. First, previous studies suggest that a firm's investment policy is typically assumed to be determined as a function of its growth opportunities, financing constraints, marginal tax rate and external regulations. The role of peer firm behavior in affecting investment policy is often ignored. Following the research perspective of Ozoguz and Rebello (2013) and Foucault and Fresard

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(2014), this study's focus is on the role of a peer firm in shaping a firm's investment policy. Using a sample of Chinese listed firms from 1999 to 2013, we extend the literature by analyzing the direct relation between a firm's and its peers' investments, which differs from the studies by Ozoguz and Rebello (2013) and Foucault and Fresard (2014). We further address the reflection problem and endogeneity bias, identifying the potential channels and mechanisms behind the peer effect in investment, and finally confirm the economic consequences of these effects. The findings extend our understanding of investment determinants.

Second, peer effects have been mainly applied in psychology and sociology research (Valliant, 1995; Dishion et al., 1999; Katz et al., 2001). Many studies have examined the peer effect on corporate real decisions, such as corporate capital structure, merges and acquisitions and corporate governance (John and Kadyrzhanova, 2008; Chen and Chang, 2012; Leary and Roberts, 2014; Foucault and Fresard, 2014). We first examine the role of a peer firm in shaping a firm's investment decisions, which extends the literature on peer effects. Lieberman and Asaba (2006) argue that information needs and competition pressure are two channels through which peers influence the behavior of the firm. In this study, we empirically test these two predictions and provide evidence to support the theoretical prediction of Lieberman and Asaba (2006), which reveals the mechanism of the learning effect.

The remainder of this paper is as follows. Section 2 reviews the literature. Section 3 develops the hypothesis based on theoretical analysis. Section 4 introduces the sample selection and the variables, and develops the empirical model. Section 5 presents the summary statistics and main empirical results. Section 6 identifies the potential channels through which peer firms affect firms' investment policies. Section 7 examines the cross-sectional heterogeneity in the effects to better understand the economic mechanisms behind the peer effect. Section 8 presents the economic consequences of the peer effect in investment decisions. Section 9 concludes.

2. Literature review

In economic theory, it is argued that peer firms play an important role in shaping corporate decisions, such as through product pricing (Bertrand, 1883) and product advertising (Stigler, 1968). An increasing number of empirical studies examine the characteristics or behavior of peer firms and whether they affect a firm's behavior. Using a sample of U.S. listed firms, John and Kadyrzhanova (2008) investigate the peer effect in corporate governance. Studies also examine the effect of peer firms on corporate capital structure (Leary and Roberts, 2014), merges and acquisitions (Bizjak et al., 2009) and tax avoidance (Li et al., 2014). For example, Leary and Roberts (2014) present evidence that a one standard deviation increase in peer firms' leverage ratios is associated with a 10% increase in firm *i*'s leverage ratio, an effect greater than that of any other determinants. In corporate investment policies, the behavior of peer firms has a strong spillover effect on a firm's investment decisions (Foucault and Fresard, 2014), so the possibility of a significant effect cannot be ignored.

Information-based and rivals-based theories are typically used to explain learning behavior among peer firms (Benoit, 1984; Lieberman and Asaba, 2006). In information-based theories, information imperfection is viewed as the main cause of learning behavior. Managers can learn new information from peer firms' stock prices, which can then guide their real decisions. Managers do not have perfect information on every decision-relevant factor, so learning from peers can help them capture more useful information and reduce investment uncertainty. Conlisk (1980) finds that experience or experiment is more costly and time-consuming than imitation, so firms whose information is imperfect rationally imitate the strategies of others to reduce the possibility of failure. Under environmental uncertainty, it is difficult for managers to predict the consequences of a particular investment, as it raises the likelihood of undesirable outcomes and the risk of failure (Milliken, 1987). Firms with imperfect information when making investment decisions are therefore more likely to learn investment behavior from peer firms, to reduce investment risk (Foucault and Fresard, 2014), as they believe that peers' actions convey information about growth opportunities, investment opportunities and industry fluctuations.

Investment decisions also reflect managers' rationally formed expectations, and provide a signal of managers' abilities (Scharfstein and Jeremy, 1990). Although decision-makers can make optimal investment decisions by capturing and analyzing as many investment-relevant factors as possible, the risk of

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investment failure is still significant. Under an uncertain environment, managers are more likely to imitate the investment behavior of other managers, as from the perspective of managers concerned about their reputation in the labor market, this mimicking behavior is rational and costless (Palley, 1995; Scharfstein and Jeremy, 1990). It is better for the reputations of managers to fail conventionally than to succeed unconventionally.

According to the rivals-based theory, learning behavior commonly acts to defuse rivals and stabilize relative positions in the market. Firms imitate each other in the introduction of new products and processes, the adoption of managerial methods and organizational forms, and the timing and types of investments, as learning behavior is helpful in gaining competitive advantage (Klemperer, 1992) and reducing investment uncertainty (Knickerbocker, 1973). Firms imitate others in an effort to maintain their relative positions or to neutralize the aggressive actions of rivals. Chen and Chang (2012) find that firms also tend to have sizeable cash reserves when their rivals hold high cash holdings. From the perspective of market competition, imitation to mitigate rivalry in important corporate decisions is most rational when firms with comparable resource endowments and market positions face each another.

3. Hypothesis development

Imitation processes are most interesting in environments characterized by uncertainty or ambiguity. Few decisions have outcomes that are fully predictable. Managers take actions, the consequences of which depend on the future state of the environment. Managers therefore actively and regularly imitate peers' behavior or actions to overcome information imperfection and protect and enhance managerial reputation. They may also believe that imitation is important in defusing rivalry and reducing risk for their firms. Chen and Chang (2012), for example, present evidence that the ratio of cash to total assets is significantly influenced by peer firms' average cash holdings. They argue that firms imitate others to reserve cash in an effort to maintain their relative position or to neutralize the aggressive actions of rivals. Chen and Lu (2013) find that peers' merger and acquisition programs are considered and referred to by a firm when preparing their own programs to maximize their merger and acquisition performance. Investment policy is important and determines corporate development. Promising investment not only establishes the direction for future development, but also allocates available resources more efficiently, enhancing corporate performance and market value. Firms may suffer enormous financial loss and even the risk of bankruptcy due to errors in vital investments. Consequently, firms within the same strategic group may adopt similar behavior to constrain competition and maintain competitive advantages.

In a developed stock market, a firm's stock price provides useful information such as growth opportunities, the state of the economy, the position of competitors and consumer demand. Decision-makers can learn from peer firms' stock price and use the information to guide their investment policy, thus reducing uncertainty and failure risk. Foucault and Fresard (2014) present evidence that the investment behavior of a firm is affected significantly by its peer firms' stock prices, as this informs managers about growth opportunities, thereby overcoming information imperfection and enabling them to make optimal investment decisions. However, the Chinese stock market's legal framework has developed slowly, and law enforcement is weak. Consequently, specific firm information is lacking, and stock prices are highly synchronous (Morck et al., 2000; Zhu et al., 2007). In emerging economies such as China, stock prices provide less useful information to managers making decisions than in developed countries. Learning directly from the real decisions of peer firms rather than from their stock prices is more efficient and prevalent, and the mechanism is different from that of developed countries. Liu and Chen (2012) find that the learning behavior of Chinese firms is common in an industry cluster, and significantly enhances productivity for both a firm and its peers. We can therefore infer that a firm has strong incentives to mimic the investment behavior of peer firms in China, thus reducing the failure risk of investment and mitigating competitive pressure as much as possible. We therefore conduct a statistics test of the following hypothesis:

H1. A firm's investment is significantly influenced by its peer firms.

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4. Research design, sample selection and summary statistics

4.1. Corporate investment model

Following Richardson (2006), we control for firm-level factors relevant to investment decisions and the corporate investment model is set as follows:

$$Inv_t = \beta_0 + \beta_1 Growth_{t-1} + \beta_2 Lev_{t-1} + \beta_3 Cash_{t-1} + \beta_4 Age_{t-1} + \beta_5 Size_{t-1} + \beta_6 Ret_{t-1} + \beta_7 Inv_{t-1} + Year\ fixed\ effect + Industry\ fixed\ effect + \varepsilon \quad (1)$$

where *Inv* is the measure of corporate investment policy, defined as the ratio of capital expenditure to the beginning-of-year book assets; *Growth* is the measure of growth opportunities, which is calculated as sales growth; *Lev* is the ratio of total debt over total assets; *Cash* is the balance of cash and short-term investments deflated by total assets measured at the beginning of the year; *Age* is the log of the number of years the firm has been listed on stock markets as of the start of the year; *Size* is the log of total assets measured at the start of the year; and *Ret* is the stock returns for the year prior to the investment year. *Year fixed effect* is a vector of indicator variables to capture year fixed effects. *Industry fixed effect* is a vector of indicator variables to capture industry fixed effects.

4.2. Baseline empirical model

To examine whether the investment policy of peer firms matters in a firm's investment decision, the average investment of peer firms is incorporated in the model (1). We also control for peer firms' characteristics in the model to mitigate omitted variable bias.

$$Inv_{ijt} = \alpha + \beta\ PInv_{-ijt} + \delta\ Firm\ Specific\ Factors_{ijt-1} + \gamma\ Peer\ Firms\ Factors_{-ijt-1} + Year\ fixed\ effect_t + Industry\ fixed\ effect_j + \varepsilon \quad (2)$$

where the indices ***i***, ***j*** and ***t*** correspond to firm, industry and year, respectively. The outcome variable Inv_{ijt} is the measure of investment. $PInv_{-ijt}$ denotes peer firms' average investment (excluding firm *i*). $Firm\ Specific\ Factor_{ijt-1}$ contains firm's sales growth, leverage, cash ratio, firm age, firm size, stock return and investment at year $t-1$. $Peer\ Firms\ Factors_{-ijt-1}$ contains peer firms' sales growth, leverage, cash ratio, firm age, firm size, stock return and investment at year $t-1$.

The challenge in examining how firms learn from their peer group is to identify the set of firms that can use the investment policy of peers to guide their own investment decisions. The group will typically include firms that have several characteristics in common (e.g., industry, size, diversification, business complexity and financing constraints), so the behavior of these firms is similar in the same market. Firms are more likely to mimic the investment decisions of their peers if they are similar, reducing potential failure risk. Yet considering all the characteristics simultaneously is not practical as it may result in a peer group consisting of too few firms, which would be noisy when filtering external shocks. Following Albuquerque (2009) and Leary and Roberts (2014), we specify firms in the same industry and with upper and lower size quartiles (0.75 times to 1.25 times a firm's total assets) as similar peer firms. Table 1 provides definitions of the specific variables.

4.3. Sample selection

We obtain financial data from the China Stock Market and Accounting Research Database (CSMAR) from 1999 to 2013. We drop (1) financial, insurance and utility firms, (2) firm-years that do not match other firms in the same industry and size quartiles, and (3) observations with missing data on any variables. The final sample contains 17,463 observations from 1999 to 2013. To avoid the effect of outliers, we winsorize the top and bottom 1% of the continuous variables. To correct this statistical problem, we use a "clustering" method to adjust the standard error of the estimated coefficient for each company (Petersen, 2009).

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Table 1
Variable definitions.

Variable	Definition
Inv	Firm's investment, measured as the ratio of capital expenditure over the total assets
PInv	Peer firms' average investment
Growth	Firm's (peer firms') sales growth
Lev	Firm's (peer firms') book leverage, measured as the ratio of total debt over total assets
Cash	Firm's (peer firms') cash ratio, measured as the ratio of cash balance over total assets
Age	Firm's (peer firms') age, log of the number of years the firm has been listed on stock markets
Size	Firm's (peer firms') size, log of total assets
Ret	Firm's (peer firms') annual stock return
Inv	Firm's (peer firms') investment in year $t-1$
Shock	Peer firm's average specific stock return calculated using a market model
Dis	Log of distance between the registering cities of firms to the capital city Beijing
AH	AH dummy variable. If there is at least one AH share firm among the peer group, it equals 1
HHI	Herfindahl index, $HHI = 1 - \Sigma Pi^2$, where Pi is sales share of the firm
Num	Log of the number of firms in an industry
Leader	Industry leader. If the sales share of the firm is in the upper third at each industry-year, it equals 1
Young	Young firm. If the age of the firm is in the upper third at each industry-year, it equals 1
WW	Financing constraints, measured as ww index, which states that the larger the number, the more severe the financing constraints faced

4.4. Descriptive statistics and correlation analysis

Table 2 presents the descriptive statistics. Variables are grouped into two distinct categories: peer firm averages and firm-specific factors. The mean (median) of the corporate investment is 0.062 (0.039), and means (medians) of PPE and R&D investment are 0.031 (0.012) and 0.005 (0.001), respectively. The mean (median) of sales growth is 0.184 (0.146). The average cash holding and leverage are 0.485 and 0.190, respectively. The means of firm size, age, stock return and lagged investment are 21.332, 8.148, 0.172 and 0.066. For peer firm averages, the mean (median) of the investment is 0.063 (0.040), and means (medians) of PPE and R&D investment are 0.043 (0.035) and 0.001 (0.005), respectively. The latter group includes variables constructed as firm i's value in year t. At this point, we simply note the similarities of many statistics to the former group.

In addition, we also report summary statistics for other variables. The peer firm average equity shock is 0.218, and the average log of distance from the registering city of the firms to Beijing is roughly 6.505. About 29.1% of firms have at least one AH-share peer firm in their peer group. The mean of MP is −0.160. The average HHI is 0.935 and 98 firms are in the two-digit industry code. Of the sample, about 35.8% of firms are industry leaders, and over 75% firms are young firms in the market. The average for WW index, which measures corporate financing constraints is −0.962.

In Table 3, we present the results of the correlation analysis of the variables. The correlation coefficient of PInv with *Inv* is 0.262 and is significant at a 5% level, showing that corporate investment is strongly positively correlated with the average investment of peer firms. Firm i's sales growth, leverage ratio, firm size, stock return and lagged investment are positively significant at a 5% level. However, its cash ratio and age are negatively correlated with investment. A peer firm's specific characteristics also affect a firm's investment decision. For example, peer firms' growth, size and lagged investment are significant at 5% level. The correlation coefficients of leverage ratio and firm age with firm i's investment are −0.046 and −0.031 respectively, and are significant at a 5% level.

5. The role and implications of the peer effect

5.1. Empirical results for baseline model

Table 4 shows the empirical results for the effects of peer firms on corporate investment. When controlling for only the year and the industry fixed effects in the model, the result is reported in column (1). The coefficient

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Table 2
Summary statistics.

Variable	*N*	Mean	SD	Min	Q1	Median	Q3	Max
Inv	17,463	0.062	0.064	0.000	0.011	0.039	0.090	0.227
PInv	17,463	0.063	0.040	0.000	0.035	0.058	0.086	0.153
Firm-specific characteristics								
PPE	17,463	0.031	0.071	−0.079	−0.011	0.012	0.062	0.210
RD	17,463	0.005	0.016	−0.015	−0.001	0.001	0.006	0.055
Growth	17,463	0.184	0.324	−0.366	−0.015	0.146	0.338	0.986
Cash	17,463	0.485	0.189	0.143	0.342	0.491	0.629	0.824
Lev	17,463	0.190	0.143	0.019	0.082	0.150	0.263	0.546
Size	17,463	21.332	1.001	19.720	20.584	21.203	21.975	23.445
Age	17,463	8.148	4.274	2.000	4.000	8.000	11.000	16.000
Ret	17,463	0.172	0.638	−0.456	−0.252	−0.036	0.339	2.059
Inv	17,463	0.066	0.069	0.000	0.012	0.042	0.097	0.245
Peer firm-specific characteristics								
PPE	17,463	0.040	0.043	−0.031	0.008	0.035	0.067	0.133
RD	17,463	0.007	0.010	−0.007	0.000	0.005	0.013	0.031
Growth	17,463	0.246	0.251	−0.079	0.087	0.195	0.324	0.987
Cash	17,463	0.198	0.090	0.043	0.138	0.185	0.242	0.411
Lev	17,463	0.480	0.113	0.243	0.409	0.487	0.558	0.686
Size	17,463	21.263	0.972	19.461	20.586	21.178	21.898	23.232
Age	17,463	7.892	2.880	3.000	5.632	7.773	9.958	13.421
Ret	17,463	0.202	0.656	−0.366	−0.192	0.000	0.307	2.362
Inv	17,463	0.067	0.042	0.000	0.038	0.062	0.094	0.159
Other variables								
Shock	13,667	0.218	0.728	−0.462	−0.233	0.001	0.213	2.144
Dis	17,463	6.505	1.628	0.693	6.448	6.950	7.318	7.635
AH	17,463	0.291	0.454	0.000	0.000	0.000	1.000	1.000
HHI	17,458	0.935	0.056	0.647	0.921	0.956	0.967	0.982
Num	17,458	4.584	0.706	2.833	4.127	4.522	5.100	6.188
Leader	17,463	0.358	0.479	0.000	0.000	0.000	1.000	1.000
Young	17,463	0.754	0.431	0.000	1.000	1.000	1.000	1.000
WW	17,307	−0.962	0.075	−1.146	−1.013	−0.963	−0.907	−0.786

Table 3
Correlation matrix.

		(1) Firm-specific characteristics						(2) Peer firm-specific characteristics						
	Inv	Growth	Cash	Lev	Size	Age	Ret	Inv	Growth	Cash	Lev	Size	Age	Ret	Inv
PInv	0.262*														
(1) Growth	0.154*	0.091*													
Cash	−0.171*	−0.051*	0.027*												
Lev	0.140*	0.028*	0.200*	−0.319*											
Size	0.123*	0.289*	0.133*	0.228*	0.040*										
Age	−0.189*	−0.041*	−0.057*	0.286*	−0.167*	0.237*									
Ret	0.053*	0.004	0.043*	0.042*	−0.029*	−0.033*	0.034*								
Inv	0.585*	0.249*	0.207*	−0.127*	0.134*	0.177*	−0.229*	−0.028*							
(2) Growth	0.036*	0.121*	0.112*	0.037*	0.043*	0.149*	0.061*	−0.045*	0.036*						
Cash	0.010	0.184*	0.064*	−0.115*	0.279*	0.060*	0.047*	−0.114*	0.012	0.262*					
Lev	−0.046*	0.002	0.025*	0.259*	−0.063*	0.268*	0.203*	0.070*	−0.045*	0.171*	−0.096*				
Size	0.181*	0.401*	0.142*	0.172*	0.069*	0.831*	0.213*	−0.010	0.187*	0.225*	0.199*	0.431*			
Age	−0.031*	0.026*	0.031*	0.176*	0.059*	0.333*	0.479*	0.046*	−0.043*	0.173*	0.159*	0.500*	0.470*		
Ret	0.004	0.029*	−0.027*	0.044*	−0.065*	−0.011*	0.039*	0.807*	−0.049*	−0.011	−0.105*	0.117*	0.002	0.083*	
Inv	0.246*	0.709*	0.089*	−0.053*	0.017*	0.291*	−0.068*	−0.083*	0.267*	0.164*	0.177*	0.010	0.418*	−0.020*	−0.076*

* Significant at a 5% level (two-tailed test).

Please cite this article in press as: Chen, S., Ma, H. Peer effects in decision-making: Evidence from corporate investment. China Journal of Accounting Research (2017), http://dx.doi.org/10.1016/j.cjar.2016.11.002

Table 4
Effect of peer firms on corporate investment.

	Dep: Inv					
	(1)		(2)		(3)	
	Coefficient	*t*-Value	Coefficient	*t*-Value	Coefficient	*t*-Value
PInv	**0.2205*****	**11.26**	**0.0906*****	**6.73**	**0.0618*****	**3.97**
Firm-specific characteristics						
$Growth_{t-1}$			0.0032**	2.40	0.0026**	2.00
$Cash_{t-1}$			−0.0270***	−10.57	−0.0262***	−10.02
Lev_{t-1}			0.0162***	4.49	0.0160***	4.32
$Size_{t-1}$			0.0013**	2.46	−0.0088***	−5.53
Age_{t-1}			−0.0008***	−6.67	−0.0009***	−6.70
Ret_{t-1}			0.0150***	11.85	0.0136***	10.62
Inv_{t-1}			0.4659***	51.88	0.4603***	50.59
Peer firm-specific characteristics						
$Growth_{t-1}$					0.0041**	2.47
$Cash_{t-1}$					−0.0369***	−5.93
Lev_{t-1}					−0.0242***	−4.81
$Size_{t-1}$					0.0156***	9.32
Age_{t-1}					−0.0009***	−3.37
Ret_{t-1}					0.0019	0.92
Inv_{t-1}					−0.0520***	−3.42
Constant	0.0249***	6.78	−0.0033	−0.31	−0.0903***	−8.10
Year		Controlled		Controlled		Controlled
Industry		Controlled		Controlled		Controlled
N		17,463		17,463		17,463
Adj. *R*-sq.		0.113		0.388		0.398
F		31.5252		201.4452		181.6136

Note: All coefficient estimates are adjusted using heteroskedasticity and company clustering to obtain robust standard errors. Adjusted *t*-statistics are provided in brackets.
*Significance at a 10% level (two-tailed test).
** Significance at a 5% level (two-tailed test).
*** Significance at a 1% level (two-tailed test).

of Pinv is 0.2205, significant at a 1% ($t = 11.26$) level, which indicates that firm *i*'s investment is significantly influenced by peer firms. Specifically, a one standard deviation increase in the average peer firm investment leads to a 14.2 percentage point increase in firm *i*'s investment. Following Richardson (2006), we add firm-specific characteristics such as sales growth $Growth_{t-1}$, cash ratio $Cash_{t-1}$, leverage ratio Lev_{t-1}, firm size $Size_{t-1}$, firm age Age_{t-1}, annual stock return Ret_{t-1} and lagged investment Inv_{t-1} as control variables to mitigate the effect of other factors. From the estimates in column (2) of Table 4, we see that the coefficient on the PInv in the regression is 0.0906 and significant at a 1% ($t = 6.73$) level, which is consistent with column (1). We also control for the peer firms' specific characteristics in the model to mitigate omitted variable bias (Leary and Roberts, 2014). Regarding omitted factors, we note the following in column (3) of Table 4. The adjusted R^2 is 0.398, and the control variables are statistically significant in the expected directions. The coefficient on the PInv is positive and significant at a 1% level, which indicates that a one standard deviation increase in the average peer firm investment leads to a 4% (calculation: (0.0618 × 0.040)/0.062) increase in firm *i*'s investment after controlling for firm-specific and peer firm-specific characteristics. This suggests that peer firms play an important role in shaping corporate investment policy, which may be a strategy used to reduce investment uncertainty and stabilize the competition position in the market. The above regression results provide evidence supporting our Hypothesis.

We then classify investment into tangible and intangible asset investment, and examine the peer effects in both investment types. The results are presented in Table 5. In column (1), the coefficient on PPE is 0.1401, and significant at a 1% level ($t = 7.09$), which indicates that firm *i*'s PPE investment increases 14.4% points

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Table 5
Peer effects on different investment types.

	(1) Dep: PPE investment		(2) Dep: R&D investment	
	Coefficient	*t*-Value	Coefficient	*t*-Value
PPE	**0.1041*****	**(7.09)**		
RD			**0.0277****	**(1.97)**
Firm-specific characteristics				
$Growth_{t-1}$	0.0043***	(2.68)	−0.0002	(−0.41)
$Cash_{t-1}$	−0.0167***	(−5.10)	−0.0008	(−1.00)
Lev_{t-1}	0.0401***	(9.72)	0.0037***	(3.83)
$Size_{t-1}$	−0.0145***	(−7.16)	−0.0025***	(−6.99)
Age_{t-1}	−0.0008***	(−5.28)	−0.0002***	(−6.59)
Ret_{t-1}	0.0117***	(7.88)	0.0019***	(4.88)
Inv_{t-1}	0.3730***	(36.87)	0.0236***	(10.10)
Peer firm-specific characteristics				
$Growth_{t-1}$	0.0049**	(2.39)	0.0003	(0.48)
$Cash_{t-1}$	−0.0567***	(−7.52)	−0.0033*	(−1.71)
Lev_{t-1}	−0.0210***	(−3.18)	−0.0015	(−0.99)
$Size_{t-1}$	0.0236***	(10.90)	0.0029***	(7.27)
Age_{t-1}	−0.0015***	(−4.57)	−0.0001*	(−1.81)
Ret_{t-1}	0.0001	(0.02)	0.0005	(0.92)
Inv_{t-1}	−0.0399**	(−2.23)	0.0013	(0.34)
Constant	−0.1535***	(−10.62)	−0.0020	(−0.60)
Year		Controlled		Controlled
Industry		Controlled		Controlled
N		17,463		17,463
Adj. *R*-sq.		0.263		0.056
F		98.5492		18.9477

Note: All coefficient estimates are adjusted using heteroskedasticity and company clustering to obtain robust standard errors. Adjusted *t*-statistics are provided in brackets.
* Significance at a 10% level (two-tailed test).
** Significance at a 5% level (two-tailed test).
*** Significance at a 1% level (two-tailed test).

with a one standard deviation increase in peer firms' PPE investment. Regarding R&D investment in column (2), we find that the coefficient is significantly positive, and that a one standard deviation increase in average peer firms R&D investment leads to a 5.54% increase in firm *i*'s R&D investment. In summary, firms have a strong incentive to mimic their peer firms' PPE and R&D investment, but the peer effect is more pronounced in tangible asset investment. Mimicking intangible asset investment policies requires more support, such as corresponding research teams and techniques, making this learning behavior more difficult in the short term.

5.2. Robustness tests

The above evidence shows that peer firms are important determinants for corporate investment. To avoid peer identification bias due to the current criteria, we specify peer firms using new criteria and then test our hypothesis. We not only consider industry and size in identifying peer firms, but also consider their registered province, based on spatial competition theory. We specify firms in the same registering city and industry, and in the upper and lower size quartiles (0.75 times to 1.25 times of a firm's total assets) to the firm as provincial-level peer firms. The results are reported in Panel A of Table 6. The coefficients on PInv are 0.0638 and 0.0918 in columns (1) and (2), respectively. The significantly positive coefficients are consistent with the above findings and provide further support for our hypothesis. Second, we replace provincial-level peer firms with national-level peers and re-examine the peer effect in corporate investment. We define firms whose assets are in the range of 0.9–1.1 times the assets of the firm and when the industry is the same as national-level peer firms. From the estimates in columns (3) and (4), we can see that the coefficients on Pinv measured by national

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Table 6
Robustness tests.

	Dep: Inv							
	Peer (Prov, 25%)				Peer (Nat, 10%)			
	(1)		(2)		(3)		(4)	
	Coefficient	*t*-Value	Coefficient	*t*-Value	Coefficient	*t*-Value	Coefficient	*t*-Value
Panel A Specifying peers using different criteria								
PInv	**0.0638*****	**4.30**	**0.0918*****	**5.09**	**0.0939*****	**7.68**	**0.1400*****	**10.03**
Firm-specific characteristics								
$Growth_{t-1}$	0.0062***	3.00	0.0054***	2.65	0.0038***	2.62	0.0016	1.17
$Cash_{t-1}$	−0.0282***	−7.62	−0.0270***	−7.28	−0.0266***	−9.53	−0.0234***	−8.48
Lev_{t-1}	0.0162***	3.25	0.0178***	3.61	0.0168***	4.48	0.0156***	4.19
$Size_{t-1}$	−0.0012	−1.45	−0.0119***	−4.00	−0.0003	−0.50	−0.0320***	−10.96
Age_{t-1}	−0.0007***	−3.99	−0.0007***	−3.86	−0.0007***	−5.09	−0.0007***	−4.91
Ret_{t-1}	0.0160***	8.81	0.0148***	7.86	0.0151***	11.11	0.0110***	8.10
Inv_{t-1}	0.4632***	36.28	0.4584***	35.79	0.4694***	50.51	0.4496***	48.63
Peer firm-specific characteristics								
$Growth_{t-1}$			0.0060**	2.04			0.0060***	3.40
$Cash_{t-1}$			−0.0153***	−2.58			−0.0075	−1.34
Lev_{t-1}			0.0051	1.18			0.0064	1.51
$Size_{t-1}$			0.0128***	3.54			0.0346***	11.02
Age_{t-1}			0.0001	0.55			0.0002	1.10
Ret_{t-1}			0.0032	1.18			0.0034	1.62
Inv_{t-1}			0.0035	0.22			−0.0180	−1.40
Constant	0.0494***	2.91	0.0028	0.12	0.0264**	2.19	−0.0372***	−2.73
Year		Controlled		Controlled		Controlled		Controlled
Industry		Controlled		Controlled		Controlled		Controlled
N		7634		7634		15,284		15,284
Adj. *R*-sq.		0.397		0.410		0.385		0.420
F		119.3529		105.5605		177.6010		153.9109

	Dep: Inv					
	(1) Peer (Prov, 25%)		(2) Peer (Nat, 25%)		(3) Peer (Nat, 10%)	
	Coefficient	*t*-Value	Coefficient	*t*-Value	Coefficient	*t*-Value
Panel B Replacing lagged with contemporaneous control variables						
PInv	**0.1015*****	**5.44**	**0.0870*****	**4.23**	**0.0744*****	**4.92**
Firm-specific characteristics						
Growth	0.0295***	18.46	0.0294***	12.53	0.0306***	17.37
Cash	−0.0238***	−6.14	−0.0261***	−4.87	−0.0224***	−5.39
Lev	0.0220***	3.98	0.0169**	2.29	0.0237***	4.07
Size	0.0139***	8.84	0.0110***	7.91	0.0103***	5.12
Age	−0.0031***	−15.51	−0.0033***	−12.72	−0.0031***	−14.92
Ret	0.0025*	1.92	0.0019	1.04	0.0027*	1.92
Peer firm-specific characteristics						
Growth	0.0022	1.17	−0.0036	−1.08	0.0012	0.57
Cash	0.0041	0.47	0.0015	0.17	−0.0079	−1.08
Lev	−0.0054	−0.84	0.0042	0.71	−0.0063	−1.22
Size	−0.0022	−1.41	0.0003	0.31	0.0027	1.49
Age	0.0001	0.32	−0.0001	−0.29	−0.0002	−0.88
Ret	−0.0056***	−2.94	−0.0019	−0.66	−0.0029	−1.36
Constant	−0.1858***	−10.96	−0.1822***	−7.31	−0.2112***	−11.36
Year		Controlled		Controlled		Controlled
Industry		Controlled		Controlled		Controlled

(*continued on next page*)

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Table 6 (*continued*)

	(1) Peer (Prov, 25%)		(2) Peer (Nat, 25%)		(3) Peer (Nat, 10%)	
	Coefficient	*t*-Value	Coefficient	*t*-Value	Coefficient	*t*-Value
N		17,463		7634		15,284
Adj. *R*-sq.		0.212		0.216		0.204
F		51.0907		30.9489		46.7047

Note: All coefficient estimates are adjusted using heteroskedasticity and company clustering to obtain robust standard errors. Adjusted *t*-statistics are provided in brackets.

* Significance at a 10% level (two-tailed test).

** Significance at a 5% level (two-tailed test).

*** Significance at a 1% level (two-tailed test).

peer firms' average investment are positive (0.0939 and 0.1400) and significant ($t = 7.86$; $t = 10.03$). The evidence shows that peer firms do influence a firm's investment decision-making. In summary, the inferences are robust to these different measures.

Furthermore, we replace the lagged control variables with contemporaneous controls to address the concern that investment policy affects firm-specific and peer firm characteristics with a lag. The results are tabulated and reported in Panel B of Table 6. As expected, the coefficients on explanatory variables are strongly positive. Again, we see little change in the results, suggesting that model misspecification in the control variables is unlikely to be behind our results. All the robustness tests are consistent with our main results, further strengthening the reasoning on peer effects in corporate investment decisions.

5.3. Reflection problem and endogeneity bias

The above evidence is, however, insufficient to establish a causal relationship between the investment of peer firms and a firm's investment, as the correlation may be driven by a reflection problem. This problem is due to how peer firms are identified, in this case as peers in the same industry. Firms from the same industry face similar institutional environments, investment opportunities and consumption demands, so are more likely to make similar investment decisions. Our next challenge is therefore to identify the causality and mitigate the disturbance of the reflection problem (Manski, 1993; Shue, 2013). Specifying firms in the same industry but not in the upper and lower size quartiles as the firm as non-peers, we then examine whether these non-peer firms can influence corporate investment policies. The test is reasonable and valuable as these non-peer firms are still in the same industry and the same regulatory environment, so they can filter the effects of their macro-economy, industry policy and market development on investment synchronicity. If our findings are driven by these common factors rather than by a learning incentive, then we can predict that there will still be a significantly positive relation between non-peers' investment and a firm's own investment. However, the results from column (1) of Table 7 show that the coefficient on NPInv is negative (−0.0048) and insignificant ($t = -0.19$), which violates the expectation based on the reflection problem. The evidence that non-peers in the same industry do not affect corporate investment suppresses reflection problem concerns but supports the causality of the peer effect in investment decisions.

To alleviate endogeneity bias, we follow the method of Leary and Roberts (2014) and use peer firm equity shocks to instrument for peer firm investment policy. Foucault and Fresard (2014) find that stock prices react to corporate investment policy, which shows that equity shock, correlated with investment decisions, meets the requirement of instrumental relevance. The peer firms return shocks are serially uncorrelated and cross-uncorrelated, and are less likely to be manipulated by managers compared to other investment determinants, such as profitability and cash ratios. This measure is available for a broad panel of firms and thus mitigates the statistical power and external validity concerns, when comparing CEO sudden death. While these features do not guarantee exogeneity, they are reassuring as they suggest that peer firm return shocks contain little common variation. Regression results using instrumental variables are reported in column (2) of Table 7. When using average peer firm investment as the dependent variable in the first stage, instrumental variable is positive

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Table 7
Reflection problem and endogeneity bias.

	Dep: Inv					
	(1) OLS		(2) 2SLS		(3) FE	
	Coefficient	*t*-Value	Coefficient	*t*-Value	Coefficient	*t*-Value
NPInv	**−0.0048**	**−0.19**				
PInv			**0.6666***	**1.86**	**0.0847*****	**5.24**
Firm-specific characteristics						
$Growth_{t-1}$	−0.0002	−0.14	0.0008	0.62	0.0035***	2.64
$Cash_{t-1}$	0.0110***	2.59	−0.0352***	−7.90	−0.0290***	−11.38
Lev_{t-1}	−0.0181***	−6.09	0.0601***	12.93	0.0155***	4.29
$Size_{t-1}$	−0.0582***	−13.40	−0.0269***	−13.44	0.0023***	4.76
Age_{t-1}	−0.0005***	−3.41	−0.0008	−0.83	−0.0009***	−7.19
Ret_{t-1}	0.0066***	4.61	0.0099***	8.05	0.0153***	11.94
Inv_{t-1}	0.4488***	29.80	0.2699***	26.47	0.4720***	53.01
Peer firm-specific characteristics						
$Growth_{t-1}$	0.0045*	1.79	0.0029*	1.67	0.0005	0.82
$Cash_{t-1}$	−0.0205**	−2.47	−0.0261***	−3.54	−0.0168	−1.59
Lev_{t-1}	0.0149	0.98	−0.0207***	−3.53	−0.0279***	−3.22
$Size_{t-1}$	0.0596***	21.13	0.0197***	9.88	−0.0004**	−2.05
Age_{t-1}	0.0006*	1.82	−0.0005	−1.46	−0.0007	−1.41
Ret_{t-1}	−0.0015	−0.22	0.0015	0.76	0.0044	1.13
Inv_{t-1}	−0.2360	−1.27	−0.0312**	−2.00	0.0847***	3.30
Constant	−0.0252	−0.68	0.2080***	7.93	0.0061	0.49
First stage in 2SLS regression						
Shock			0.0052***	4.66		
Year		Controlled		Controlled		Controlled
Industry		Controlled		Controlled		—
Firm		—		—		Controlled
N		17,463		13,667		17,463
Adj. *R*-sq.		0.385		0.397		0.185
F		182.0175		184.9233		41.1082

Note: All coefficient estimates are adjusted using heteroskedasticity and company clustering to obtain robust standard errors. Adjusted *t*-statistics are provided in brackets.
* Significance at a 10% level (two-tailed test).
** Significance at a 5% level (two-tailed test).
*** Significance at a 1% level (two-tailed test).

and significant at a 1% level. In the second stage, the coefficient on PInv is still significantly positive, which is consistent with the main results.

Finally, with the inclusion of firm fixed effects in the regression model, we reexamine whether peer firms influence the investment behavior of a firm. As shown in column (3), the coefficient on Pinv is 0.0824 and significant at a 1% level ($t = 5.24$). The evidence indicates that commonalities among firm's investment policy are time-invariant investment determinants over the business cycle, but this does not influence the conclusion. All tests confirm the findings are robust after removing the reflection problem and mitigating endogeneity bias.

While our results establish the presence of significant peer effects, they are subject to limitations. We cannot distinguish between the characteristics and behavior of peer firms that affect a firm's investment policy. To exclude the alternative explanation, we exploit heterogeneity in a firm's investment change responses to their peers' equity shock, by performing a double sort of the data, based on quintiles of our peer firm average equity shocks and peer firm investment changes. Within each quintile combination, we calculate the average changes in investment for firm *i* and *t*-statistics of whether this change is significantly different from zero.

The results are presented in Table 8, where quintile 1 represents the lowest 20% of the distribution and quintile 5 the highest. For example, the average change in investment among firms in the lowest peer firm

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Table 8
Removal of alternative explanation.

Peer Return Shock	PInv					
	1 (low)	2	3	4	5 (high)	5-1
1 (low)	0.0407*** (22.26)	0.0474*** (18.96)	0.0495*** (17.81)	0.0652*** (22.98)	0.0859*** (30.78)	0.0452*** (14.15)
2	0.0285*** (12.65)	0.0489*** (20.43)	0.0530*** (24.32)	0.0618*** (23.52)	0.0839*** (26.74)	0.0554*** (13.23)
3	0.0337*** (13.99)	0.0455*** (22.32)	0.0495*** (27.17)	0.0653*** (27.57)	0.0798*** (27.48)	0.0462*** (11.88)
4	0.0323*** (12.23)	0.0446*** (20.53)	0.0519*** (21.74)	0.0613*** (24.59)	0.0838*** (27.25)	0.0515*** (11.67)
5 (high)	0.0420*** (19.64)	0.0489*** (19.96)	0.0511*** (20.17)	0.0603*** (21.08)	0.0842*** (27.38)	0.0422*** (11.61)
5-1	0.0013 (0.46)	0.0014 (0.39)	0.0016 (0.41)	−0.0048 (−1.19)	−0.0018** (−0.42)	

* Significance at a 10% level (two-tailed test).
** Significance at a 5% level (two-tailed test).
*** Significance at a 1% level (two-tailed test).

equity shock quintile and the highest peer firm leverage change quintile is 0.0859 with a *t*-statistic of 30.78. We note a monotonic increase in the average investment change across each row. Holding fixed the peer firm equity shock, investment changes are strongly positively correlated with changes in peer firm investment. The converse is not true. Average investment changes are largely uncorrelated with the peer firm equity shock, holding fixed peer firms' average investment change. In fact, in the last row (5-1), where the difference of average peer firm investment changes between rows 1 and 5 is indistinguishable from zero, the cell averages are all economically small and two are statistically insignificant. Thus, firms only change their investment in response to a peer firm equity shock if it is accompanied by a change in peer firm investment. These findings reinforce the implication of the regression results and suggest that a firm's investment is more likely a response to peer firm financial policies, as opposed to characteristics.

6. Channels of identification

Lieberman and Asaba (2006) found that information imperfection and market competition are the two main causes of imitation among the peer group. Thus, we empirically examine the channels through which peer effects operate. Based on information theory, firms actively learn from peers' decisions as they have imperfect information on decision-making and they believe that peers' actions convey some useful information to guide their real decisions. If firms are able to capture information about macroeconomic or industry policy in advance, or if they can identify the profitable investment opportunities, then we can predict that the firms have the advantage in collecting and analyzing information, and thus have less incentive to mimic the investment decisions of peer firms. Investment is critical to further development, and firms usually take some time to select projects, survey consumer demand, analyze viability and finalize projects. The peer group faces similar institutional environments, investment opportunities and consumption demands, and is likely to make similar investment decisions. As such, a firm is eager to notice and value the information of peer firms so they can overcome information imperfection and reduce uncertainty. Thus, we predict that the information quality of peer firms also influences the peer effect in investment. We test these two predictions in two ways.

First, following Houston et al. (2014), we use the distance between the registering city of the firm and the capital city Beijing to measure the informational advantage of the firm. Most relevant investment policies are made at conferences in Beijing, and firms near the city are more likely to identify profitable investment opportunities in advance, so we predict that the investment of firms far from Beijing is more sensitive to that of their peers. As shown in column (1) of Table 9, the coefficient on the interaction term PInv × Dis is 0.0135, and significant at a 10% level ($t = 1.93$), demonstrating that investment is more sensitive to peer firms far from Beijing. The evidence for our prediction is strong.

AH companies are Chinese firms that have A-shares listed in mainland China and H-shares listed in Hong Kong. They are under the supervision of the Chinese Securities Regulatory Commission (CSRC), and also four Hong Kong regulatory agencies: (1) the Hong Kong Securities and Futures Commission (HKSFC), (2) the Hong Kong Stock Exchange (HKSE), (3) the Hong Kong Institute of Certified Public Accountants (HKICPA) and (4) the Independent Commission against Corruption. The Hong Kong media, analysts and

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Table 9
Information-based theory.

	Dep: Inv			
	(1)		(2)	
	Coefficient	*t*-Value	Coefficient	*t*-Value
PInv	−0.0240	−0.51	0.0442***	2.66
Dis	−0.0003	−0.58		
PInv × Dis	**0.0135***	**1.93**		
AH			−0.0070***	−3.36
PInv × AH			**0.1103*****	**3.53**
Firm-specific characteristics				
$Growth_{t-1}$	0.0026**	2.00	0.0026**	2.02
$Cash_{t-1}$	0.0161***	4.37	0.0160***	4.30
Lev_{t-1}	−0.0264***	−10.06	−0.0264***	−10.06
$Size_{t-1}$	−0.0088***	−5.50	−0.0090***	−5.65
Age_{t-1}	−0.0009***	−6.79	−0.0009***	−6.72
Ret_{t-1}	0.0136***	10.61	0.0136***	10.57
Inv_{t-1}	0.4595***	50.54	0.4597***	50.49
Peer firm-specific characteristics				
$Growth_{t-1}$	0.0042**	2.49	0.0043**	2.56
$Cash_{t-1}$	−0.0375***	−6.02	−0.0360***	−5.76
Lev_{t-1}	−0.0239***	−4.73	−0.0241***	−4.76
$Size_{t-1}$	0.0156***	9.37	0.0158***	9.45
Age_{t-1}	−0.0009***	−3.46	−0.0009***	−3.24
Ret_{t-1}	0.0019	0.92	0.0018	0.90
Inv_{t-1}	−0.0523***	−3.44	−0.0545***	−3.58
Constant	−0.0905***	−7.48	−0.0903***	−7.93
Year		Controlled		Controlled
Industry		Controlled		Controlled
N		17,463		17,463
Adj. *R*-sq.		0.398		0.398
F		175.1240		175.4697

Note: All coefficient estimates are adjusted using heteroskedasticity and company clustering to obtain robust standard errors. Adjusted *t*-statistics are provided in brackets.
* Significance at a 10% level (two-tailed test).
** Significance at a 5% level (two-tailed test).
*** Significance at a 1% level (two-tailed test).

institutional investors also play an important role in enforcement. However, China has only recently developed a legal framework for the stock market, and has a weak law enforcement record (Pistor and Xu, 2005). The legal environment has improved in recent years, but it still lags behind Hong Kong in terms of the protection afforded to minority investors. The market for financial analysts is not well developed and institutional ownership is low (Chen et al., 2013). Institutional investors and brokerage firms are often affiliated with the government, so may lack incentives to protect private shareholders. Finally, the media in China are less active than their counterparts in Hong Kong in terms of investigating and publicizing accounting scandals. Government control of the media can prevent full disclosure, as stories are affected by political interests. Consequently, the information disclosed by an AH share firm is more reliable and valuable (Ke et al., 2015). We define a dummy variable AH to measure the information quality of peer firms. Specifically, if at least one AH share firm is in the peer group, then AH equals one, otherwise zero. The results are presented in column (2) of Table 9. The coefficient on the interaction term PInv × AH is 0.1103, and significant at a 1% ($t = 3.53$) level, which indicates that the peer effect on corporate investment is more pronounced when the peer group includes at least one AH share firm. The above evidence provides solid support that sensitivity to peer firms' investment varies with the informativeness of both a firm and its peers.

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Avoiding falling behind rivals is an important incentive for firms to imitate each other. Imitation to moderate rivalry is most common when firms with comparable resource endowments and market positions face one another. Under a highly competitive market, firms are exposed to a higher risk of bankruptcy and continuous operating is uncertain, which leads to severe financing constraints (Povel and Raith, 2004). They also pay more attention to resource allocation behavior as they compete for limited resources such as consumers in the highly competitive market (Valta, 2012). Chen and Chang (2012) find that the ratio of cash to total assets is significantly influenced by peer firms' average cash holdings. They argue that firms imitate others to reserve cash in an effort to maintain their relative position or to neutralize the aggressive actions of rivals. We next examine whether market competition influences the peer effect in corporate investment policy. Similar to previous studies (Curry and George, 1983; Giroud and Mueller, 2011), we use the Herfindahl index and the number of firms in each two-digit industry to proxy for market competition. From the estimates in Table 10, we find that the coefficients on the interaction terms are both positive and significant, which supports our prediction. In summary, the evidence demonstrates that when competitors take similar action, there is less chance that any firm will succeed or fail relative to others. Imitation therefore helps preserve the status quo among competitors that follow each other. In a competitive market, these firms have strong incentives to learn from the behavior of peer firms.

Table 10
Rival-based theory.

	Dep: Inv			
	(1) HHI		(2) Num	
	Coefficient	*t*-Value	Coefficient	*t*-Value
PInv	−0.0901*	−1.86	−0.1272***	−2.85
HHI	0.0092	0.48		
PInv × HHI	**0.1402*** **	**3.25**		
Num			−0.0028	−1.09
PInv × Num			**0.0362*** **	**4.53**
Firm-specific characteristics				
$Growth_{t-1}$	0.0026**	1.96	0.0026**	1.98
$Cash_{t-1}$	−0.0263***	−10.05	−0.0263***	−10.00
Lev_{t-1}	0.0161***	4.32	0.0159***	4.28
$Size_{t-1}$	−0.0093***	−5.78	−0.0094***	−5.81
Age_{t-1}	−0.0009***	−6.73	−0.0009***	−6.76
Ret_{t-1}	0.0136***	10.66	0.0136***	10.61
Inv_{t-1}	0.4602***	50.63	0.4596***	50.61
Peer firm-specific characteristics				
$Growth_{t-1}$	0.0038**	2.24	0.0039**	2.32
$Cash_{t-1}$	−0.0355***	−5.67	−0.0357***	−5.69
Lev_{t-1}	−0.0259***	−5.11	−0.0255***	−5.02
$Size_{t-1}$	0.0162***	9.60	0.0162***	9.57
Age_{t-1}	−0.0009***	−3.57	−0.0009***	−3.42
Ret_{t-1}	0.0016	0.78	0.0015	0.75
Inv_{t-1}	−0.0474***	−3.09	−0.0453***	−2.95
Constant	−0.1003***	−4.69	−0.0780***	−5.01
Year		Controlled		Controlled
Industry		Controlled		Controlled
N		17,458		17,458
Adj. *R*-sq.		0.399		0.399
F		174.8980		176.4205

Note: All coefficient estimates are adjusted using heteroskedasticity and company clustering to obtain robust standard errors. Adjusted *t*-statistics are provided in brackets.

* Significance at a 10% level (two-tailed test).

** Significance at a 5% level (two-tailed test).

*** Significance at a 1% level (two-tailed test).

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7. Heterogeneity in peer effect

Given the importance of peer firm behavior for firms' investment policy, we now turn to why firms mimic one another. In this section, we focus on firm specific characteristics such as industry leader position, firm age and corporate financing constraints, and then examine whether some firms within the industry are more or less sensitive to their peers' investment policy.

First, we examine whether an industry leader is less sensitive to peer firms' investment behavior. In general, industry leaders are more likely to have the ability to identify potentially profitable investment opportunities and innovate on new products, thus making the imitation to peer firms less valuable for industry leader. Leary and Roberts (2014) present evidence showing that industry leaders' financial policy is less sensitive to its peers' financial policy, though peer firms play an important role in shaping corporate capital structure. They argue that small firms have stronger incentive to mimic their peers' investment behavior, to reduce investment uncertainty. We categorize firms within each industry-year into two groups, industry leaders and followers. We define these by sorting firms within each industry-year into three groups according to their sales share.

Table 11
Heterogeneity in peer effect.

	Dep: Inv					
	(1) Industry Leader		(2) Firm Age		(3) Financing Constraints	
	Coefficient	*t*-Value	Coefficient	*t*-Value	Coefficient	*t*-Value
PInv	0.1241***	7.69	0.0285	1.24	−0.0687*	−1.73
Leader	0.0097***	5.60				
PInv × Leader	**−0.0450****	**−2.31**				
Young			−0.0025	−1.60		
PInv × Young			**0.0375***	**1.80**		
WW					−0.2297***	−20.65
PInv × WW					**−0.1082*****	**−3.39**
Firm-specific characteristics						
$Growth_{t-1}$	0.0021	1.56	0.0026**	2.01	0.0014	1.08
$Cash_{t-1}$	−0.0290***	−11.18	−0.0264***	−10.09	−0.0156***	−6.04
Lev_{t-1}	0.0121***	3.26	0.0160***	4.32	0.0070*	1.93
$Size_{t-1}$	−0.0103***	−6.33	−0.0088***	−5.48	−0.0194***	−14.55
Age_{t-1}	−0.0009***	−6.72	−0.0009***	−6.09	−0.0006***	−4.33
Ret_{t-1}	0.0132***	10.21	0.0136***	10.61	0.0097***	7.81
Inv_{t-1}	0.4722***	52.95	0.4599***	50.31	0.4400***	49.48
Peer firm-specific characteristics						
$Growth_{t-1}$	0.0032*	1.88	0.0041**	2.45	0.0042**	2.51
$Cash_{t-1}$	−0.0552***	−9.12	−0.0360***	−5.73	−0.0297***	−5.00
Lev_{t-1}	−0.0318***	−6.55	−0.0244***	−4.85	−0.0228***	−4.65
$Size_{t-1}$	0.0147***	8.77	0.0156***	9.30	0.0112***	8.10
Age_{t-1}	−0.0010***	−4.45	−0.0009***	−3.34	−0.0004	−1.58
Ret_{t-1}	0.0019	0.97	0.0018	0.90	0.0032	1.62
Inv_{t-1}	0.0005	0.88	−0.0518***	−3.41	−0.0329**	−2.20
Constant	−0.0433***	−3.43	−0.0899***	−8.05	0.0005	0.04
Year		Controlled		Controlled		Controlled
Industry		Controlled		Controlled		Controlled
N		17,463		17,463		17,307
Adj. *R*-sq.		0.394		0.398		0.424
F		223.1080		174.9855		197.7103

Note: All coefficient estimates are adjusted using heteroskedasticity and company clustering to obtain robust standard errors. Adjusted *t*-statistics are provided in brackets.

* Significance at a 10% level (two-tailed test).

** Significance at a 5% level (two-tailed test).

*** Significance at a 1% level (two-tailed test).

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Industry leaders are those firms in the top third of the distribution. From the results in column (1) of Table 11, we find that the coefficient on the interaction term is negative and significant at a 5% level, which indicates that industry leaders' investment policy is less influenced by their peers compared to followers' investment behavior. The inference is consistent with Leary and Roberts (2014).

Second, previous evidence shows that young firms are different from mature firms in many aspects, such as unfamiliarity with the regulatory environment, a poor ability to capture valuable information, and higher capital costs of financing, and that young firms lack sufficient operating experience and sufficient available resource to compete with rivals (Petersen and Rajan, 1994; Hadlock and Pierce, 2010). Relative to mature firms, young firms are therefore exposed to higher risk of bankruptcy (Dune et al., 1989), and "follow-the-leader" behavior is the result of risk minimization. If rivals match each other, none become relatively better or worse off. This strategy guarantees that their competitive capabilities remain roughly in balance. We therefore predict that the investment of young firms is more sensitive to that of peer firms. We also categorize firms within each industry-year into two groups, young firms and mature firms. We define these by sorting firms within each industry-year into three groups according to their age in the listed year. Young firms are those in the bottom third of the distribution. The results show that the interaction term is significantly positive, which is consistent with our prediction.

Firms are defined as more financially constrained by Whited-Wu's (2006) index. The empirical results are reported in column (3) of Table 11. The coefficient on PInv × WW is −0.1082, and is significant at a 1% level. The finding suggests that financing constraints moderate the learning effect in corporate investment decisions, as mimicking behavior is expected to be more costly for financially constrained firms, given their high cost of financing. This evidence indicates that industry leaders, mature firms and financially constrained firms are less sensitive to their peers' investment policy.

Table 12
Economic consequences of peer effect.

	(1) $T+1$		(2) $T+2$		(3) $T+3$	
	Dep: ROA	Dep: Tobin-Q	Dep: ROA	Dep: Tobin-Q	Dep: ROA	Dep: Tobin-Q
Inv	0.1030***	−1.4310***	0.0628***	−0.5086**	0.0514***	−0.5299**
	4.87	−4.21	3.86	−2.42	2.98	−2.45
Pinv	−0.0503	−3.0759***	−0.0634***	−1.1022***	−0.0808***	−1.1882***
	−1.61	−6.17	−2.78	−3.87	−3.19	−3.97
Inv × Pinv	**0.3825**	**22.1938*** **	**0.4517***	**9.1425*** **	**0.4958***	**9.2450*** **
	1.22	**4.71**	**1.85**	**3.00**	**1.86**	**2.96**
Growth	0.0432***	0.0338	0.0265***	0.0332*	0.0226***	0.0273
	18.48	1.32	17.84	1.96	15.10	1.54
Lev	−0.1223***	−0.2243**	−0.0809***	−0.3277***	−0.0704***	−0.3221***
	−22.96	−2.23	−19.69	−5.37	−15.48	−4.99
Size	0.0114***	−0.4312***	0.0075***	−0.3395***	0.0075***	−0.3408***
	12.40	−21.72	9.50	−29.92	8.29	−27.79
Age	−0.0003	0.0200***	−0.0003	0.0144***	−0.0003	0.0126***
	−1.12	4.50	−1.31	4.97	−1.14	3.39
Constant	−0.1562***	11.1052***	−0.0955***	9.0714***	−0.1027***	8.8939***
	−8.43	28.46	−5.95	39.07	−5.61	35.53
Year	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
Industry	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
N	15,366	14,820	13,610	12,641	12,035	10,712
Adj. *R*-sq.	0.175	0.387	0.182	0.448	0.158	0.447
F	53.4831	82.8870	57.8204	174.4153	41.3233	128.7491

Note: All coefficient estimates are adjusted using heteroskedasticity and company clustering to obtain robust standard errors. Adjusted *t*-statistics are provided in brackets.

* Significance at a 10% level (two-tailed test).

** Significance at a 5% level (two-tailed test).

*** Significance at a 1% level (two-tailed test).

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8. Economic consequences of peer effect

Finally, using ROA and Tobin-Q to measure corporate performance in the next one to three years, we examine the economic consequences generated from learning behavior. From the estimates in Table 12, we find that the coefficients on the interaction term Inv × Pinv are significantly positive, which indicates learning behavior in investment benefit corporate performance. Specifically, learning behavior can increase corporate performance and firm value. The results reveal the importance of the learning effect under an uncertain environment .

9. Conclusion

It is common for corporations to interact with peer firms in decision-making, through actions such as signing strategic cooperating agreements and developing marketing strategies. Recent studies examine whether the characteristics or behavior of peer firms affects corporate capital structure (Leary and Roberts, 2014), mergers and acquisitions (Bizjak et al., 2009) and tax avoidance (Li et al., 2014). Investment decisions are important and determine corporate development. Most studies examining the peer effect in corporate investment hold that managers can gain useful information from the stock price of peer firms. Edmans et al. (2012a, 2012b) and Bond et al. (2012) point out that stock prices contain useful information that is helpful in guiding a firm's investment policy, such as industry growth opportunities, external environment, strategy of competitors and consumer demands. Valuing the stock price of peer firms can capture useful information, which can reduce investment uncertainty. However, few studies examine the direct effect of peer firms' investment behavior on the firm's investment policy. The aim of this study was therefore to identify whether, how, and why peer firm behavior matters for corporate investment policies.

Using a sample of China's listed firms from 1999 to 2012 and following Albuquerque (2009) to define peer firms, we indicate that a one standard deviation increase in peer firms' investment is associated with a 4% increase in firm *i*'s investment. Classifying investment into tangible asset investment and intangible asset investment, we then examine the peer effect in these different types. We find that both are significantly influenced by the investment behavior of peer firms, while the peer effect is more pronounced in tangible asset investment. To establish the causal relationship between a firm's investment and peer firms' investment policy, we address the reflection problem and endogeneity bias as much as possible. We use the following tests to address these concerns. First, specifying firms that are in the same industry but are not in the upper and lower size quartiles as the firm as a non-peer group, we examine the effect of the behavior of non-peer firms have on the firm's investment policy. Second, we use the instrumental variable method to address the possible endogeneity bias, and predict that the learning effect is still significant by using two stage least squared regression. Third, we incorporate the year fixed effect and firm fixed effect into the model, and reexamine the peer effect on investment. The results change little and are consistent with the main findings of the study.

Next, we identify the possible channels through which peer firms influence corporate investment policy. We find that peer effects are more pronounced when firms have information advantages and when the information disclosure quality of peer firms is higher or if they face more fierce competition. To reveal the potential mechanisms behind peer effects in investment policy, we further explore heterogeneity in the peer effect. When firms are industry followers, are young or have financial constraints, they are highly sensitive to their peers firms. We also quantify the economic consequences generated by peer effects, which can increase firm performance in future periods.

Acknowledgments

This study is the result of research supported by the National Natural Science Foundation of China (71263034, 71572087). We acknowledge the executive editor and the anonymous reviewer for their useful comments and suggestions.

Please cite this article in press as: Chen, S., Ma, H. Peer effects in decision-making: Evidence from corporate investment. China Journal of Accounting Research (2017), http://dx.doi.org/10.1016/j.cjar.2016.11.002

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Please cite this article in press as: Chen, S., Ma, H. Peer effects in decision-making: Evidence from corporate investment. China Journal of Accounting Research (2017), http://dx.doi.org/10.1016/j.cjar.2016.11.002

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