

Online Social Networks, Media Supervision and Investment Efficiency: An Empirical Examination of Chinese Listed Firms

Yang, X., Cao, D., Andrikopoulos, P., Yang, Z. & Bass, T.

Author post-print (accepted) deposited by Coventry University's Repository

Original citation & hyperlink:

Yang, X, Cao, D, Andrikopoulos, P, Yang, Z & Bass, T 2020, 'Online Social Networks, Media Supervision and Investment Efficiency: An Empirical Examination of Chinese Listed Firms' *Technological Forecasting and Social Change*, vol. 154, 119969.
<https://dx.doi.org/10.1016/j.techfore.2020.119969>

DOI 10.1016/j.techfore.2020.119969
ISSN 0040-1625

Publisher: Elsevier

NOTICE: this is the author's version of a work that was accepted for publication in *Technological Forecasting and Social Change*. Changes resulting from the publishing process, such as peer review, editing, corrections, structural formatting, and other quality control mechanisms may not be reflected in this document. Changes may have been made to this work since it was submitted for publication. A definitive version was subsequently published in *Technological Forecasting and Social Change*, 154 (2020) DOI: 10.1016/j.techfore.2020.119969

© 2020, Elsevier. Licensed under the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International <http://creativecommons.org/licenses/by-nc-nd/4.0/>

Copyright © and Moral Rights are retained by the author(s) and/ or other copyright owners. A copy can be downloaded for personal non-commercial research or study, without prior permission or charge. This item cannot be reproduced or quoted extensively from without first obtaining permission in writing from the copyright holder(s). The content must not be changed in any way or sold commercially in any format or medium without the formal permission of the copyright holders.

This document is the author's post-print version, incorporating any revisions agreed during the peer-review process. Some differences between the published version and this version may remain and you are advised to consult the published version if you wish to cite from it.

Online social networks, media supervision and investment efficiency: An empirical examination of Chinese listed firms

Xiaoping Yang^a, Dongmei Cao^b, Panagiotis Andrikopoulos^b, Zonghan Yang^{cd}, Tina Bass^e

^a The School of International Business, the Centre for Digital Technology and Management Innovation, Zhejiang Yuexiu University of Foreign Language, No.428 Kuaiji Road, Yue Cheng District, Shaoxing 312000, China

^b Coventry Business School, Coventry University, Priory Street, Coventry CV1 5FB, UK

^c The Business School, University of Shanghai for Technology and Science, China

^d The School of Business Management, Guilin University of Aerospace Technology, No. 2, JinJi Road, QiXing District Guilin 541004, China

^e College of Business, Law and Social Sciences, University of Derby, Derby, DE22 1GB, UK

Abstract

Prior literature suggests that media reports acting as external supervision improve information transparency and corporate governance leading to increased investment efficiency. This study empirically tests this hypothesis in the context of online social networks by investigating the combined effects of online social networking and media reports on investment efficiency using a sample of Chinese listed firms. Our results show that the interaction of media reports and Tobin's q ratio is negatively related to corporate investment efficiency. However, the introduction of online social networks turns this relationship from a negative to a positive and statistically significant one. The combined factors significantly increase investment efficiency in non-SOEs (State Owned Enterprises) but not in SOEs. We provide evidence that online social networking effectively mitigates the negative effect of media supervision on investment efficiency, further advancing knowledge of the link of external supervision and corporate governance.

Keywords: Online social networks; media supervision; investment efficiency; China; Sina Weibo

JEL Classification: G30, G31, G34,

1. Introduction

Prior studies in corporate governance suggest that the efficiency of corporate investment is mainly affected by information asymmetry and agency problems (Myers and Majluf, 1984; Armstrong et al., 2011). Agency problems arise due to conflicts of interest between managers and shareholders as managers' investment behavior is often motivated by maximizing self-benefit rather than that of shareholders (Jensen, 1986; Cao et al., 2018). Under the presence of information asymmetry between corporate insiders and the capital market, investors have to compete over the acquisition of valuable information regarding firms' current performance and future potential, and the costs of such an activity are typically passed to the cost of equity capital; hence, introduce some degree of inefficiency in corporate investment (Armstrong et al., 2011; Akins et al., 2012; Lai et al., 2014).

Extant literature has investigated various factors explaining firms' investment efficiency. Empirical studies suggest that financial reporting quality explains the investment efficiency of both private firms (Chen et al., 2011a) and listed companies (Gomariz et al., 2014). Study of Chen et al. (2011b) supports the proposition that government intervention is significantly associated with investment efficiency and that there is a difference in the effect between state-owned and non-state-owned enterprises. Jin and Yu (2018) find that executive networks and government governance can improve investment efficiency. Another strand of the literature investigates the role that information disclosure plays in investment efficiency (Dutta and Nezlobin, 2017; Cheng et al., 2013). Studies suggest that firms with increased levels of disclosure reduce information asymmetry; restrain agency problems, and thus improve internal corporate governance mechanisms (Dyck et al., 2008; Johanson et al., 2000;

Zavyalova et al., 2012; Bednar, 2012; Chen et al., 2014). Consistent with the effect of disclosure on investment efficiency, a growing literature pays attention to the effect of media reports, termed media supervision, as media reports play a supervisory role in exposing business scandals (Zhang and Su, 2015). Zhang and Su (2015) suggest that media supervision, via an external corporate governance mechanism, can inhibit the level of corporate overinvestment to enhance the efficiency of corporate investment.

With the development of internet technology, online social networks (or ‘social media’) such as Weibo, WeChat, Twitter, Facebook, provide significant advantages regarding the efficient disclosure of information to the wider public in terms of both cost and convenience (Babutsidze, 2018). Blankespoor et al. (2014) show that if companies disclose information simultaneously in traditional media (or ‘media’) channels such as TV and newspaper and on Twitter, it reduces the stock price difference significantly; alleviating information asymmetry and improving stock liquidity. In addition to the dissemination of important information, online social media sites play an increasingly critical role in socialisation and networking, which is different from the functions of the traditional media (Neti et al., 2011; Kizgin et al., 2018; Munzel et al., 2018). Can corporations make the best out of this unique function of online social networking, in particular for the enhancement of investment efficiency? There is no documented research addressing this question. Thus, this study aims to fill in the research gap. In detail, we seek to understand the effects of combined online social networking and media supervision of traditional media (hereafter, media supervision) on investment efficiency; as well as to understand the impact of big data analysis and technological innovations, i.e. use of online media platforms, on driving financial efficiency and strategic

development within business. To do so, we use a sample of Chinese listed companies for the period 2011 to 2016 and analyze their financial data, the mainstream financial media reports, and the corporate Sina Weibo data.

In China, Sina Weibo, Tencent Weibo, WeChat, QQ, and Momo constitute the main platforms in online social networking. In particular, Sina Weibo and Tencent Weibo are the main platforms for corporates to release public information, playing an increasingly important role in alleviating information asymmetry, and improving governance efficiency. For instance, the headlines of the *New York Times*, the *Wall Street Journal* and the *Associated Press* reported a suspected scandal of the CEO of JD.com in the United States on the 2nd of September 2018. JD.com posted on its official Weibo account later on the same day, quoting ‘...Mr. Liu Qiangdong has experienced false accusation during his business trip in the United States, and the police have found no misconduct in the follow-up investigation’. JD.com’s official Weibo further responded to public concerns on the 3rd of September 2018.¹ The above two posts received significant attention. By the 6th of October 2018, the two statements were directly forwarded 24,000 times and 39,000 times respectively; while, the number of public comments in support of the JD.com’s CEO was 3,266 and the number of thumbs up, an indication of satisfaction, was 30,000 and 124,000 respectively.^{2,3} On September the 4th,

¹The statement on JD.COM’s official Weibo account reads, ‘Mr. Liu Qiangdong has been wronged of untrue accusation during his business trip in the United States, and the police have found no misconduct in the follow-up investigation. He will continue his trip as planned. We will take the necessary legal action against false reports or rumors’. Source from JD.COM’s official Weibo account: <https://m.microblog.cn/p/1005052839378595>.

²The ‘0’ reply to the statement on the official Weibo account on September 3 is a profound demonstration of the Weibo followers’ ‘wordless’ support for Mr. Liu Qiangdong, the CEO of JD.COM.

³The number of retweets, replies and thumb up does not include the number of screenshots and link retweets from Tencent, WeChat, QQ and other social media sites, which in fact are more frequently used by Chinese netizens.

Citigroup placed JD.com in the list of ‘Negative Catalyst Watch’,⁴ causing its share price to fall sharply on that day, but without any impact on its business and sales in the Chinese region. This is because JD.com had successfully used online social networks as a means to reduce the negative impact of the traditional media reports and effectively alleviate the problem of information asymmetry that could have caused panic to its investors. The example from JD.com is not unusual in China in the digital era. Such digital environments provide a range of evidence which forms the basis for this study.

Our contribution to the literature is twofold. Firstly, we advance knowledge on the effect of media supervision on investment efficiency with the empirical analysis of the latest data available. Secondly, by assessing the effect of online social networks when combined with media supervision on investment efficiency, we enhance understanding of the effect of media supervision on investment efficiency in the light of the social media context.

The remainder of the study is structured as follows: Section 2 reviews the literature and presents our testable hypotheses; Section 3 articulates our sampling procedure, data, and econometric methodology; Section 4 reports our findings. This is followed by a discussion of the findings in section 5. Section 6 concludes the paper.

2. Literature review and development of hypotheses

2.1. Media supervision and investment efficiency

Many studies indicate that the better corporate governance is, the higher the investment efficiency will be (Richardson et al., 2006; Chen et al., 2011b). Media reports revealing the

⁴Source: CAIJING.COM.CN [reference date 2018-09-05]

hidden contracts or ‘hidden rules’ of a company act as an important supervisory force (Allen et al., 2005; Chen et al., 2014). Therefore, via an important external governance mechanism, media is conducive to the improvement of corporate governance (Liu and McConnell, 2013; Yang et al., 2014; Rogers et al., 2016). Prior literature has documented two schools of thought about the way media can achieve a supervisory effect on corporate governance in China (Zhang and Su, 2015). One mechanism is through the instigation of government involvement; while the other, via the impact on executives’ reputation (Liu and McConnell, 2013). In the first case, government intervention is a critical step to realise the effect of media supervision over corporate governance, and the repercussions and responses generated by media reports are the essential conditions in bringing government ‘attention’ and ‘intervention’. By reporting and disseminating corporate information, media reports help to reduce possible asymmetry between firms and investors. Hence, media has a significantly positive effect on corporate investment efficiency (Zhang and Su, 2015; Jonathan et al., 2016). In the second case, media reports attract corporate executives’ attention, and subsequently, those executives may feel the pressure to enhance corporate governance within their firms (Liu and McConnell, 2013). In this latter case, media reports need neither to generate repercussions nor to attract the attention of government departments; instead, company executives feel the need to improve corporate governance for the sake of personal reputation and to eliminate possible operational risks arising from the increased scrutiny.

The effect of media outlets on corporate governance depends not only on the difference in the dissemination mechanism but also on the choice of media report tendency, i.e., whether a report is positive or negative. Compared with the strong governance effect of negative

media reports, positive media reports place less pressure on firms' senior executives. Instead, it can inspire them and boost their confidence; hence, enhance their investment willingness, which produces overinvestment (Deephouse, 2000; Bednar, 2012). This overinvestment activity reduces overall investment efficiency and produces a negative effect on corporate governance (Malmendier and Tate, 2008; Zhang and Su, 2015). Based on the above discussion, we expect positive and negative media reports to affect corporate investment efficiency in a different direction, and hence we posit the following two hypotheses:

H1: Media reports have a positive effect on corporate investment efficiency;

H2a: Positive media reports when combined with investment opportunities are negatively related to corporate investment efficiency;

H2b: Negative media reports when combined with investment opportunities are positively related to corporate investment efficiency.

Furthermore, for enterprises of different ownership types, e.g., state-owned (SOEs) or non-state owned (non-SOEs), the effect of media reports varies. China has a large number of non-SOEs, which are significantly different from SOEs in terms of financing, investment opportunities, corporate governance mechanism and media preference (Chen et al., 2011b; Jonathan et al., 2016). Prior research on the impact of media supervision on investment efficiency has produced mixed results. Zhu and Tan (2014) revealed that media supervision alleviates inefficient investment in both SOEs and non-SOEs, but is more binding for non-SOEs. However, He et al. (2008) found that the executive reputation mechanism caused by media supervision has a very limited effect on the governance of executives' behaviour in SOEs. The reasons for this result may be attributed to the Chinese context. China is

undergoing significant market reform. SOEs still account for a large proportion of the national ownership structure. Instead of using a transparent procedure, which allows the board of directors to select agents independently, using an open and fair competition among candidates, SOEs apply a top-down appointment system to recruit their management agents. Within this unique context, media supervision of SOEs' corporate governance is realised by capturing the attention of relevant administrative agencies rather than the reputation of their executives (Lai et al., 2014). We therefore expect that the above effects will vary between SOEs and non-SOEs.

2.2. Online social networks, media supervision and investment efficiency

'Online social networks' refer to individuals' socialising and networking activities via the use of internet-based social media sites such as Facebook, LinkedIn, and Twitter. Most sites allow users to share interest and exchange messages in their special interest group (Fotiadis and Stylos, 2017). The messages between users are publically accessible and can be captured by using web crawling or spidering software (Mislove et al., 2007; Chang, 2018). The online social networking sites have the advantage of 'real-time interaction' that traditional media lack. Active and instant exchange of ideas and messages between investors and managers enhance information disclosure, alleviating the problem of information asymmetry and improving the efficiency of governance (Blankespoor et al., 2014). As a platform for releasing corporate information, a firm's online social network gathers all kinds of supporters,⁵ termed fans, who are interested in the corporate's business philosophy,

⁵ The groups of supporters are called 'Fensi' in Chinese, which is translated as 'fans' in this study.

innovation, research and development, organisational culture, product services, and information disclosure. Consequently, the interaction and engagement of the fans form an interconnected online social networking community on the corporate social media account. Within the corporate online social media account, all stakeholders such as the government, investors, and customers, share investment information and communicate their thoughts and concerns.

Recent literature is increasingly investigating the influence of online social networks on the performance of the various aspects of a business, i.e., marketing, human resource management, and education (Wahsh et al., 2016; Yasse and Husin, 2017; Pimmer et al., 2016). However, there is still no study on the effect of online social networking on corporate governance and investment efficiency. Recently, Rosati et al. (2018) revealed that the disclosure of corporate information through online social networks significantly affects the current stock price. The authors found that online social networks correlate with traditional media and that the impact of online social networks on stock price is contingent on traditional media visibility, e.g., a positive moderating effect for low-visibility firms. The evidence of the correlation between the traditional media report and online social media networking can also be seen in the case of JD.com described in the introductory section. However, unlike traditional media reporting news and information by media agents, corporate online social networks typically release ‘favorable’ messages and statements which are in the firm’s interests. For example, when media portray a firm in a negative way, the firm’s online social networking platforms are more likely to release information to ‘disclose the truth’, which is a timely solution to the problem of asymmetric information (Lee et al., 2015). In this study, we

suggest that the use of online social networking can moderate the effect of positive media reports on corporate investment inefficiency by correcting the effect direction from negative towards positive. When media reports positive news about a company, the executive is more likely to engage in over-investment activities (Deephouse, 2000; Bednar, 2012; Malmendier and Tate, 2008). Meanwhile, on online social networking platforms, investors and other online community stakeholders can constantly communicate and engage with the firm's executive board. This interaction and communication subsequently alter executive decisions and reduce investment inefficiency. Hence, online social networks can alleviate the principal-agent problem between executives and shareholders (Lai et al., 2014; Liu and McConnell, 2013) and enhance corporate governance (Lee et al., 2015; Blankespoor et al., 2018).

From the above discussion, we expect online social networks to eventually improve corporate governance and investment efficiency. Therefore, we propose the following hypotheses:

H3: Online social networks have a significant effect on investment efficiency;

H4a: Online social networks moderate the effect of positive media reports when combined with investment opportunities on investment inefficiency, by correcting the direction of the effect from negative towards positive;

H4b: Online social networks moderate the positive effect of negative media reports when combined with investment opportunities on investment efficiency, by reducing the size of the negative effect.

Drawing upon relevant literature, we developed our research framework as a summary of the

hypotheses under discussion (Figure 1). Following previous research in media supervision and corporate investment efficiency (e.g., Chen et al., 2014; Rogers et al., 2016), we expect that traditional media supervision improves investment efficiency (H₁). We argue in this research that positive and negative media reports affect corporate investment efficiency differently and therefore, we examine their effects on investment efficiency separately (H_{2a} and H_{2b}). Meanwhile, online social networks have been widely applied to strategy development and business practices (Pappas et al., 2018). However, little documented research has investigated the effect of online social networks on corporate investment efficiency and hence we will fill in the gap in this research (H₃). Further, the JD story described in the introduction section demonstrates an example of how corporates use online social networks to interact with traditional media. This justifies our interest in how online social networks moderate the effects of traditional media of both positive and negative media supervision on investment efficiency (H_{4a} and H_{4b}).

[Insert Figure 1 about here]

3. Data and methodology

3.1. Sample selection and data

Our sample of listed A-shares is obtained from the CSMAR database, and it covers the period 2011 to 2016. Our screening and sampling criteria are as follows. We first eliminate all companies that had been delisted or entered the Chinese market in the period after 2016. We also excluded all firms in the financial and insurance sectors since those two sectors use different accounting principles. We also eliminated all those firms with incomplete/missing information. As a result, we developed a total sample from the CSMAR database of 5646

firms. To carry out panel data regression, we considered only those media reports, e.g., reports of Merger & Acquisition, which may have an impact on the investment behaviour of those firms. As a result, we developed a sample of 1404 media observations. To study the difference in the effects between firms with media reports and a control sample comprised of firms without media reports, we used a firm-matching methodology. Each firm with records of media reports was paired with one non-media counterpart based on company size. From the original 5,646 records, we obtained a sample of 2,808 records (1404 paired-matched firms).

Our media reports' data were collected from the CNKI database. In line with Fang et al. (2014), we selected seven mainstream financial media from the database, namely The China Securities Journal, Shanghai Securities News, Securities Times, Securities Daily, The Economic Observer, 21st Century Business Herald, and China Business Journal. After data cleaning, 7581 records remained. Furthermore, we followed a strict screening procedure to ensure that only reports relevant to corporate investment were selected. We classified non-derogatory wording reports concerning future investment expectations and positive evaluations as positive reports and classified non-complimentary wording reports concerning worries and negative evaluations as negative ones. This resulted in a sample of 429 media reports related to 234 listed companies, of which 312 reports were reported as positive and 117 as negative. The category of investment-related media reports is based on the lists of Xinhua Dictionary terms, and Baidu terms about common investment in China's capital market; the categories of positive and negative reports-related media reports are based on the list of Xinhua Dictionary terms about positive and negative evaluation of China's capital

market (Appendix A).

Finally, we also used data from online social networks. WeChat, QQ, Sina Weibo, and Tencent Weibo are the most popular social network platforms in China. Among them, Sina Weibo and Tencent Weibo are the ones most popularly used by Chinese corporates as a means of releasing information and communicating with their stakeholders and the wider public. Therefore, we collected the data for this study from Sina Weibo and Tencent Weibo. When examining the Corporate Tencent Weibo data, we noticed that there is very limited evidence of engagement and interaction in terms of users' 'repost' and 'reply' records. Therefore, we selected only data from the Corporate Sina Weibo platform as a proxy of online social network activity.

The Weibo data mainly consists of (i) the status of the company's official account on Sina Weibo (Yes or No), (ii) number of followings, (iii) number of followers (or Weibo fans), (iv) number of posts (original), and (v) number of forwards of those posts. The variation of these numbers reflects the extent of corporate online social networking capabilities and efforts made by the firms. We first piloted the data collection by adopting a Python crawler approach, in line with Sanner (1999). This involved collecting and verifying the blog data of Dehua TB New Decoration Material Co., Ltd, a listed company in China. We collected 3,295 posts from the company's official account on Sina Weibo covering the entire period from 2011 to 2016. We then proceeded using a manual screening process to confirm the validity of the pilot data and to verify their accuracy. To overcome certain issues with data extraction,⁶

⁶ During this stage we noticed that the biggest difficulty using the automated data collection method is that the Python algorithm can be flagged by the Sina Weibo network as abnormal access because it repeatedly enters the company's official account to collect data. This affected considerably the speed and inevitably our progress on the data collection stage.

we organised a data collection team of 15 research assistants which managed to identify a total of 692,515 posts related to 234 companies, including 28,222 posts relevant to corporate investment and 664,293 posts otherwise.⁷

To identify investment-relevant posts, we screen the collected data according to the following rules: Firstly, we select the official account of the listed company or the CEO's account or the account with the largest number of fans. The reason for such a rule is that when companies choose to release official information on Weibo, they often post it through the account with the largest number of fans. Besides, the account with the largest number of fans is very likely to have multiple re-posts of relevant information. Thus, we select the account with the largest number of fans to also remove possible duplication issues; secondly, we screen multiple posts with exactly the same content and selected the one with the most 'forwards' while eliminating the others; thirdly, posts relevant to corporate social responsibility (social welfare, etc.), important information disclosure, inspection of important leaders, major scientific and technological breakthrough plans, major project cooperation, company development planning, major personnel appointments, and financial data release topics are treated as investment-relevant posts. This results in a total number of 1,404 observations to be used for our analysis.

3.2. Variables and measures

We classify media reports into three categories, namely (i) the total number of reports, (ii) the number of positive reports, and, (iii) the number of negative reports. Our

⁷ Similarly, there are 670,886 forwards irrelevant to corporate investment information of our sample firms.

measurement is different from that of Zhang and Su's (2015), where media governance is classified as 'high' or 'low' level using The *Chinese Media Development Index Report* by Guoming Yu. In terms of online social networks, we investigate the Sina Weibo, which has a wide and significant influence in China. Data on online social networks is collected from corporate Sina Weibo accounts, including the number of followings, number of followers (or fans in Chinese), number of posts, and number of 'forwards'.

We adopt a similar methodology to Chen et al. (2011b) and use investment expenditure as our dependent variable acting as a proxy for investment efficiency. Media reports and online social networks are our two main explanatory variables. In line with Yang and Zhao (2016), we define the total media reports (*Tmedia*) as the natural logarithm of one *plus* the number of media reports. Using a similar approach, we also decompose the total media reports into positive and negative ones with *Pmedia* and *Nmedia* estimated as the natural logarithm of 1 *plus* the number of positive (negative) news' reports. Following Chen et al. (2011b), we also use cash flow (Cfo), financial leverage (Lev), investment opportunity (Tq), company Size (Size), equity financing (Seo) and listing year (List) as control variables. The model variables are all treated with a lag phase to reduce possible endogeneity. The definitions of the variables are presented in Table 1.

[Insert Table 1 about here]

3.3. Model development

Online social networking or social media communities have been studied in broad terms using various approaches when combined with a specific research domain. For instance, in behavioral adoption, using survey data and structural equation modeling is popular (Mital et

al., 2018); in analyzing user sentiments and associated emotion, experiment data and fuzzy modeling are used (Karyotis et al., 2018). In our research domain, i.e., corporate finance, according to Modigliani and Miller (1958), the firm's investment policy is solely dependent on its investment opportunities as measured by Tobin's Q (1969). Chen et al. (2011b) introduced government intervention into the model in order to examine the effect of political connection on the investment inefficiency in Chinese SOEs. We revise the investment-efficiency model developed by Chen et al. (2011b) and formulate our econometric models, Model 1 and Model 2. In Model 1, we add media reports to that of Chen et al. (2011b), investigating the impact of media reports on corporate investment efficiency, which is a further development to the model of Zhang and Su (2015). Zhang and Su (2015) examined the effect of media governance on corporate overinvestment behavior, while Model 1 distinguishes the difference of the impact of positive and negative media reports on corporates' investment efficiency.

Further, in Model 2 we add the variable of online social networks to Model 1, assessing its effect on corporate governance. In line with most prior literature on investment efficiency (Lai et al., 2004; Chen et al., 2011b), our endogenous variable in the measure has a one year lag to that of the explanatory variables. This approach is different from the one used in Chen et al. (2011b) as unlike their study we attempt to measure the impact of changes in media reports to corporates' investment efficiency.⁸ These models are algebraically illustrated as:

$$\begin{aligned}
INV_{i,t} = & a_0 + a_1 Tq_{i,t-1} + a_2 Media_{i,t-1} + a_3 (Tq_{i,t-1} \times Media_{i,t-1}) + a_4 CFO_{i,t-1} \\
& + a_5 Lev_{i,t-1} + a_6 SEO_{i,t-1} + a_7 Size_{i,t-1} + a_8 Listage_{i,t-1} + \varepsilon_{i,t}
\end{aligned} \tag{1}$$

and,

⁸ The detailed discussion of our theoretical contributions to the literature follows in the discussion section.

$$\begin{aligned}
INV_{i,t} = & a_0 + a_1Tq_{i,t-1} + a_2Media_{i,t-1} + a_3Sn_{i,t-1} + a_4(Tq_{i,t-1} \times Media_{i,t-1}) \\
& + a_5(Tq_{i,t-1} \times Media_{i,t-1} \times Sn_{i,t-1}) + a_6CFO_{i,t-1} + a_7Lev_{i,t-1} + a_8SEO_{i,t-1} \\
& + a_9Size_{i,t-1} + a_{10}Listage_{i,t-1} + \varepsilon_{i,t}
\end{aligned} \tag{2}$$

where all variables are explained in Table 1.

In our empirical tests, we firstly use Model 1 to examine H1, H2a, and H2b, which focuses on the interaction effect of *Media reports* and *investment opportunities (Tq)* on investment efficiency. If the regression coefficient is positive, it indicates that media reports when combined with investment opportunities improve investment efficiency; otherwise, they reduce it. We then use Model 2 to examine H3, H4a, and H4b, which focuses on the interaction effect of *Media reports*, *Tq*, and *Online social networks (Sn)* on investment efficiency. We expect the interaction effect of *Media reports*, *Tq* and *Sn* to be opposite to that of *Media reports* and *Tq*, indicating that online social networks have a positive moderating effect on media governance over investment efficiency. In both models, *Media* will be replaced by *Tmedia*, *Pmedia*, and *Nmedia*, respectively.

4. Results and analysis

4.1. Descriptive statistics and analysis

The descriptive statistics of sample variables are presented in Table 2. The average value for online social networking is 0.335; while for media reports, positive reports and negative reports are 0.131, 0.104, and 0.033, respectively. With the same method of statistical approach, the descriptive characteristics of other variables in this research are close to those of previous studies (e.g., Zhang and Su, 2015).

[Insert Table 2 about here]

Table 3 presents the descriptive analysis of paired and media samples. From this table, we can see that the mean values of investment expenditure for both types of samples are similar (i.e., 0.046 versus 0.045) with minor differences for the cases of all other variables. For example, the mean value of the proxy for investment opportunities (Tq) in the case of the media samples is 1.815, which is marginally larger than that of the paired samples (1.017). This is also evident in the case of all other variables with no statistically significant difference between the values of the paired and media samples (see Table 4). This allows us to generalise our test results from the media sample to all samples.

[Insert Tables 3 and 4 about here]

4.2. Regression results

Model 1 is used to test the hypotheses H1, H2a, and H2b, while Model 2 tests H3, H4a, and H4b. We chose the maximum likelihood estimation method (ML) in our tests since this methodological approach offers important advantages for the logistic regression used in this study such as allowing us to get model estimates without using prior distributions and addressing possible problems of endogeneity. The use of such a method is in line with prior methodological literature, e.g., Villas-Boas and Winer (1999), and Park and Gupta (2008). Also, the statistical properties of the ML approach have more consistency and less bias when there are a sufficiently large number of observations (Gelman et al., 2008).

The results of model 1 are presented in Table 5. Column (1) shows the regression results of the effect of the total number of media reports on firms' investment efficiency. We find that investment opportunities (*coefficient of 0.008, z-value of 4.685*), and total media reports (*coefficient of 0.019, z-value of 2.105*) are all significantly and positively related to

investment efficiency. The interaction of the total number of media reports and investment opportunities is negatively and significantly related to the efficiency of investment expenditure (*coefficient of -0.007, z-value of -1.845*). This could be attributed to the fact that the effect of positive media reports is much stronger than that of the negative ones, further boosting the confidence of company's management to promote excessive investment (Malmendier and Tate, 2008). Such activities can subsequently lead to a reduction in investment efficiency so that the effect of media supervision on corporate governance has weakened or become dysfunctional.

To further explore the effect of media reports on investment efficiency, we separate all media reports into positive and negative ones. Columns (2) and (3) of Table 5 present the regression results of the effects of positive and negative media reports on investment efficiency. Overall, we find a statistically significant relationship between the number of positive media reports and the aspect of investment efficiency (*coefficient of 0.025, z-value of 1.988*); however, the interaction of such positive reports with investment opportunities is significantly and negatively related to investment efficiency (*coefficient of -0.015, z-value of -2.407*). Column (3) of Table 5 shows that the effect of negative media reports on investment efficiency is statistically insignificant. Of all the control variables used in this model, the results for the cash flow (*Cfo*), leverage (*Lev*) and equity financing (*Seo*) are consistent with the findings reported in Chen et al. (2011b). Our results also show that the age of the listed firms is negatively related to investment efficiency, indicating that older firms with both positive and negative media coverage are more likely to engage in activities that lead to a deterioration of investment efficiency. Overall, these results support hypotheses H1 and H2a

but reject hypothesis H2b.

[Insert Table 5 about here]

We further examine the possible differences in the effects of media supervision on investment efficiency between SOEs and non-SOEs of the Chinese listed companies. According to Table 6, the effects of the total media reports (coefficients of 0.023, *z-values of 2.011*) and the positive media reports (coefficients of 0.025, *z-values of 1.988*) on investment efficiency for the SOEs group are both positive and statistically significant. The interaction effects of combined total media reports or positive media reports with investment opportunity are both negative and significant in the SOEs group (coefficients of -0.015, *z-value of -2.614*; coefficients of -0.015, *z-value of -2.407*). These results are consistent with those reported for the full sample test in Table 5.

The picture from the non-SOEs shows a different story. According to Table 6, the total media reports, the positive reports, the negative reports, and the interaction of media reports with investment opportunities (columns 3, 5 and 7) are all insignificantly related to investment expenditure in non-SOEs.

[Insert Table 6 about here]

We now proceed with the investigation of the effect of online social networks on investment efficiency. We anticipated that online social networks, as a resource or social capital, should be relatively equally accessible for all companies, including both SOEs and non-SOEs. Table 7 reports the results of the link between online social networks and investment efficiency, with the former being a proxy for corporate governance. According to the results, the interaction effect of combined investment opportunities and online social

networks with the total media reports is positive and statistically significant (coefficient of 0.012, z-value of 2.214). In contrast, the interaction effects of combined investment opportunities with the total media reports (coefficient of -0.015, z-value of -2.928) or the positive reports (coefficient of -0.012, z-value of -2.124) are negative and statistically significant. Our results suggest that too many positive reports in traditional media promote corporates' excessive investment behaviour that subsequently leads to investment inefficiency. Furthermore, the presence of online social networks appears to act as a catalyst for investment efficiency, as the relevant relationships are changed from negative to positive and statistically significant (coefficients of 0.012 and 0.015, respectively).

[Insert Table 7 about here]

The comparative analysis of the online social networking effect upon SOEs versus non-SOEs is shown in Table 8. We found in SOEs that the regression coefficients of the interaction of media reports and investment opportunities with online social networks are insignificant (*coefficients of 0.007 and 0.011 respectively, z-values of 0.736 and 0.976 respectively*), indicating that online social networking of SOEs cannot effectively alleviate the negative effect of media reports on corporate investment efficiency.

By contrast, in the case of the non-SOEs, the interaction effect of combining the three variables (total media reports, investment opportunities and online social networks) on investment efficiency, is positive and significantly significant (coefficient of *0.016, z-value of 2.296*). This result is also confirmed in the case of positive media reports, and the relevant coefficient is 0.020 (*z-value of 2.309*) while the relevant effect is insignificant (coefficient of 0.003, *z-value of 0.629*) for the case of the negative ones. These results reveal that the online

social networks of non-SOEs significantly reverses the negative effect of media reports, possibly preventing irrational and excessive corporate investment decision-making. This improves corporate governance and investment efficiency.

[Insert Table 8 about here]

To investigate further the influential mechanism of online social networks on investment efficiency, we used the number of fans in the corporate Weibo accounts as the indicator of the intensity of corporate's online social networking and the media users' engagement level (Rosati et al., 2018). We conducted a comparative analysis of two different intensity groups based on the number of fans, namely, Lgroup (Large group of fans) versus Sgroup (Small group of fans). To do so, we used the average number of fans (2364.07) in the corporate Sina accounts as our cutoff point. All firms with an average number of fans above the statistical mean are classified as part of the Lgroup and vice versa (Appendix B). The results of this comparative analysis are presented in Table 9.

According to Table 9, our results suggest that the moderation effect of online social networking is insignificant for the small fans group (e.g., coefficient of 0.026, *z-value of 1.517*). In the *Lgroup*, the interaction effect (*coefficient of 0.025, z-value of 2.787*) of combined negative media reports and investment opportunities with online social networks is positive and statistically significant at the 1% level. Our results suggest that the existence of online social networking can enhance the aspect of corporate governance for these firms only when affected by negative media reports and in the large fan groups.

[Insert Table 9 about here]

To examine the robustness of our findings, we divide the number of positive reports by

the total number of reports to obtain the reported positive tendency as a substitute for total media reports. We also substitute the variable of online social networking with the number of subscriptions. Both alternative variables are introduced into Model 2 for robustness testing. Results, presented in Table 10, are consistent with both the full sample regression and the regressions for the SOE and non-SOEs groups. This suggests that our original test results are robust.

[Insert Table 10 about here]

5. Discussion

5.1. Discussion of the main findings

The summary of our main findings is displayed in Table 11. Firstly, we find that traditional media reports significantly improve the efficiency of corporate investment (H1). This result is consistent with Zhang and Su (2015). The authors used China's A-share listed firms from 2007 to 2011, and the empirical results supported the supposition that media reports, acting as external supervision and informal governance mechanisms, enhance corporate investment efficiency. Our empirical results update the results of Zhang and Su (2015) using a sample of Chinese A-share listed companies for the period 2011 to 2016.

[Insert Table 11 about here]

Secondly, our results suggest a significantly negative effect of combined positive media reports with investment opportunities on investment efficiency (H2a). There are many possible reasons for this result which are beyond the scope of this study. However, the most plausible explanation, in our view, is that positive media reports stimulate management to

increase investment and further overinvestment, which results in investment inefficiency. This finding is in line with the previous study by Malmendier and Tate (2008), suggesting that overconfident CEOs overestimate their ability to generate returns from merger and acquisition decisions, which results in overpaying for target companies or undertaking value-destroying mergers. Further, and in contrast to Zhang and Su (2015), our research distinguishes positive media reports from negative ones and their different effects on investment efficiency.

Thirdly, our study suggests that overall, online social networks affect corporates' investment efficiency positively (H3) and they correct the overinvestment effect, which combined positive media reports with investment opportunities (H4a). This is an original finding in this study. The reason behind this result is in line with the study by Ferrara (2014), which suggested that online social networking increases the possibility of information aggregation and fission and thus, investors have more opportunities to obtain relevant information to help with their rational investment decision. The effect of negative media reports when combined with investment opportunities (H2b) or with both online social networks and investment opportunities (H4b) is insignificant.

Finally, the effects of traditional media on investment efficiency are significant for SOES but not for non-SOEs, which is associated with H1 and H2a. In contrast, we found that the effects of online social networks on investment efficiency are significant for non-SOEs but not for SOEs, which is associated with H3 and H4a. The different effect of online social networks and traditional media associated with the ownership structure of the corporates is initially puzzling (Zhang and Su, 2015; Jonathan et al., 2016). In China, there are a small

number of powerful and large SOEs and a large number of small and medium-sized non-SOEs, where the SOEs have more power than their non-SOEs counterparts in leveraging and networking the social capital of the traditional media such as TV and magazines as these are controlled by the government. This is in line with prior literature, suggesting that there is discriminatory treatment between SOEs and non-SOEs in China, such as more financial resources, e.g., bank loans, being more available for SOEs than for non-SOEs (Liu et al., 2018). Our finding about the effects of traditional media is different from the previous studies. For instance, Zhu and Tan (2014) suggest that media supervision has a negative effect on investment efficiency in both SOEs and non-SOEs; He et al. (2008) suggest that media supervision has a very limited effect on corporate investment in SOEs.

What is new in our study is the identification of the differing effects of online social networks. Non-SOEs can access and use online social networks to interact with investors though their access to capital investment is rather scarce (Wu et al., 2013). Due to the lack of transparency in the firms' information disclosure, online social networking platforms such as Weibo play a unique role in providing opportunities for the public and active investors to engage in virtual communication and socialisation as a way of pursuing the 'truth' and identifying suitable investment opportunities (Du and Lai, 2018).

5.2. Theoretical implications

The findings in this study provide insights into corporate governance, investment efficiency and sustainability strategy (Klettner et al., 2014; Benlemlih and Bitar, 2018) in the digital era, when online social networks are a key driver of corporate strategy (Crifo et al., 2019). Big data applications such as online social networks provide great access to business

information and this in turn requires corporates to embrace big data applications in corporate governance and strategy development (Pappas et al., 2018). Our findings provide timely and empirical support for theoretical implications relevant to the theme of this Special Issue: big data, analytics and its application as a driver of innovation and strategy development.

Firstly, online social networking and traditional media reports play different roles in terms of corporate governance. The effect of traditional media on corporate governance depends on government intervention and the voluntary behaviour of executives (Zhang and Su, 2015). However, the mainstream financial media in China tend to report the investment behaviour of companies in a positive way which purposefully, and either consciously or subconsciously, improves the reputation and personal image of senior executives (Jin and Yu, 2018). As a result, positive media reports boost managerial overconfidence resulting in overinvestment. Meanwhile, some of the leading investors in the stock market often adopt the ‘foot voting’ approach to media reports though these reports may be not aligned to their individual beliefs and investment principles. Therefore, traditional media reports fail to effectively improve firms’ investment efficiency and are more likely lead to overinvestment and hence, inefficiency of the investment.

On the contrary, corporate online social networks represented by Weibo in China rapidly spread information to relevant participants and a wide audience through the use of, for example, ‘post’, ‘forward’ and ‘re-post’ (Hales et al., 2018). Relevant investors can get important information from the corporate Weibo account and interact with both corporate and other peer investors through the use of media functional tools such as ‘forward’, ‘comment’ and ‘like’. Under these circumstances, senior executives are inclined to monitor investors’

responses, engage with online social media communication and respond with changes in capital market activity (Hales et al., 2018; Blankespoor et al., 2018).

Secondly, there are significant differences in the communication mechanisms between traditional media and online social networks. Traditional media often conveys relevant information from the corporate to the wider public through media reports. As an independent medium, these analytical reports about a firm are mostly based on the information disclosed by the firms' management to the public and are combined with the opinions of specialist teams of business analysts. During busy periods, corporate information could be over-interpreted or misinterpreted, further enhancing the problem of information asymmetry between investors and the firms' management. Moreover, the accessibility to and the dissemination of traditional media information is also constrained by the nature of such media, i.e., one-way communication. For example, as information is transmitted one-way (media to the audience), media outlets cannot choose who to convey the information to; there is a lack of accurate real-time feedback. Also, small and medium-size investors have poorer access to relevant information and fewer opportunities to participate in the dissemination of such information. As the dissemination mechanisms/information channels that traditional media use attract the government's attention, any possible public or corporate intervention happens very slowly. As a result, the one-way communication model used by traditional media not only makes it difficult to form an adequate/efficient investor-centralized communication channel using media reports but also appears to be significantly unable to attract the government's attention and intervention when it is needed. On the contrary, these limitations and weaknesses of traditional media are overcome in the case of online social

networks. Individual members of corporate social media communities not only help to enhance information accessibility to a wider audience but also promote corporate communication by reposting or forwarding all relevant posts on Weibo. This intense interaction can then form threads of ‘hot’ issues, which are more likely to attract the attention of government departments or firms’ senior executives to enhance corporate governance and improve efficiency in terms of corporate investment.

6. Conclusions and recommendations

This study empirically examined how the interaction of online social networks with traditional media supervision affects corporate governance and investment efficiency in particular. Our findings indicate that media reports fail to act as a corporate governance mechanism with regard to investment efficiency when there are excessive investment opportunities available. The existence of online social networks helps firms to curb the combined negative effect of media reports and investment opportunities on investment efficiency, exerting a significant governance effect, particularly for non-SOEs. Apart from the traditional function of information dissemination, online social networking socialises wider corporate stakeholders and effectively compensates for the dysfunction of media reports as a corporate governance mechanism. This is an original contribution from this study, which adds to the knowledge of corporates’ external governance mechanism. Previous literature has discussed the effect of traditional media reports on investment efficiency (Chen et al., 2011a; Cheng et al., 2013; Dutta and Nezlobin, 2017; Munzel et al., 2018) or the effect of online social networks on individual behavior or stock prices (Lee et al., 2015; Rosati et al., 2018). However, the interaction effect of combining online social networks with traditional media

reports has rarely been investigated. Hence, our study fills in this gap and updates to knowledge of corporate governance in a new context where advanced technologies such as online social media are considered for their potential to enhance corporate governance and strategy development (Blazquez and Domenech, 2018).

Through the comparative analysis of the large fans group versus the small fans group, we found that social media networking can significantly reduce the negative effect of negative media reports on corporate investment in the large fans group but insignificantly in the small group. This is a novel finding though it needs more investigation in the future. This finding provides practical implications to enhance corporate governance on how to best utilize online social media to enhance corporate governance and improve investment efficiency.

Based on the current study with its limitations, we look forward to future research developments. There is a variation of investment efficiency across industries or sections in different countries. For instance, the investment efficiency in the United Kingdom's National Health Service (NHS) has been criticised (e.g., Chang et al., 2011) while it is less exposed to the public attention outside of the NHS on social media platforms due to Data Protection Acts. This research focuses on Chinese listed firms. Hence, in the future, there is potential to investigate differences between China and the UK in a specific sector or industry such as healthcare. Also, in China, investment efficiency may be affected by local government policies and their involvement in corporates' media supervision and online social networks (Veronica et al., 2019), and therefore, regional or provincial differences in investment efficiency in this regard could be another future research direction.

Reference

- Akins, B.K., Ng, J., Verdi, R.S., 2012. Investor competition over information and the pricing of information asymmetry. *Accounting Review*. 87(1), 35-58.
- Armstrong, C.S., Core, J.E., Taylor, D.J., Verrecchia, R.E., 2011. When does information asymmetry affect the cost of capital? *Journal of Accounting Research*. 49(1), 1-40.
- Babutsidze, Z., 2018. The rise of electronic social networks and implications for advertisers. *Technological Forecasting & Social Change*. 137, 27-39.
- Bednar, M. K., 2012. Watchdog or Lapdog? A behavioural view of the media as a corporate governance mechanism. *Academy of Management Journal*. 55 (1), 131-150.
- Benlemlih, M., Bitar, M., 2018. Corporate Social Responsibility and Investment Efficiency. *Journal of Business Ethics*, 148(3), 647–671.
- Blankespoor, E., Miller, G. S., White, H. D., 2014. The role of dissemination in market liquidity: Evidence from firms' use of Twitter. *Accounting Review*. 89 (1), 79-112.
- Blankespoor, E., 2018. Firm communication and investor response: A framework and discussion integrating social media. *Accounting, Organizations and Society*. July 68-69, 80-87.
- Blazquez, D., Domenech, J., 2018. Big Data sources and methods for social and economic analyses. *Technological Forecasting & Social Change*, 130, 99–113.
- Cao, Y., Dong, Y., Lu, Y., Ma, D., 2018. Does institutional ownership improve firm investment efficiency? *Emerging Markets Finance and Trade*, 1-21.
- Crifo, P., Escrig-Olmedo, E., Mottis, N., 2019. Corporate Governance as a Key Driver of Corporate Sustainability in France: The Role of Board Members and Investor Relations. *Journal of Business Ethics*, 159(4), 1127–1146.
- Chang, V., 2018. A proposed social network analysis platform for big data analytics. *Technological Forecasting & Social Change*. 130, 57-68.
- Chang, V., De Roure, D., Wills, G., Walters, R. J., Barry, T. 2011. Organisational sustainability modelling for Return on Investment (ROI): Case studies presented by a National Health Service (NHS) Trust UK.(Report). *CIT Journal of Computing and Information Technology*, 19(3), 177-192.
- Chen, F., Hope, O., Li, Q., Wang, X., 2011a. Financial reporting quality and investment efficiency of private firms in emerging markets. *The Accounting Review*, 86(4),1255-1288.
- Chen, S., Sun, Z., Tang, S., 2011b. Government intervention and investment efficiency: Evidence from China. *Journal of Corporate Finance*. 17(2), 259-271.
- Chen, Y., Wang, Y., Lin, L., 2014. Independent directors' board networks and controlling shareholders' tunnelling behaviour. *China Journal of Accounting Research*. 7(2), 101-118.
- Cheng, M., Dhaliwal, D., Zhang, Y., 2013. Does investment efficiency improve after the disclosure of material weaknesses in internal control over financial reporting? *Journal of Accounting and Economics*, 56(1), 1-18.

- Deephouse, D., 2000. Media reputation as a strategic resource: An integration of mass communication and resource-based theories. *Journal of Management*. 26(6), 1091-1112.
- Du, X., Lai, S., 2018. Financial distress, investment opportunity, and the contagion effect of low audit quality: Evidence from China. *Journal of Business Ethics*. 147 (3), 565-593.
- Dutta, S., Nezlobin, A., 2017. Dynamic effects of information disclosure on investment efficiency. *Journal of Accounting Research*, 55(2), 329-369.
- Dyck, A., Volchkova, N., Zingales, L., 2008. The corporate governance role of the media: Evidence from Russia. *The Journal of Finance*. 63 (3), 1093-1135.
- Fang, L.H., Peress, J., Zheng, L., 2014. Does media coverage of stocks affect mutual funds' trading and performance? *The Review of Financial Studies*. 27(12), 3441-3466.
- Ferrara, E., 2014. *Measurement and Analysis of Online Social Networks Systems*. Springer: New York.
- Fotiadis, A. K., Stylos, N., 2017. The effects of online social networking on retail consumer dynamics in the attractions industry: The case of 'E-da' theme park, Taiwan. *Technological Forecasting & Social Change*. 124, 283-294.
- Gelman, A, Jakulin, A, Pittau, M. G., Su, Y., 2008. A weakly informative default prior distribution for logistic and other regression models. *The Annals of Applied Statistics*. 2(4), 1360-1383.
- Hales, J., Moon, J.R., Swenson, L.A., 2018. A new era of voluntary disclosure? Empirical evidence on how employee postings on social media relate to future corporate disclosures. *Accounting, Organizations and Society*, 68-69, 88-108.
- Jensen, M., 1986. Agency costs of free cash flow, corporate finance, and takeovers. *American Economic Review*, 76 (2): 323–29.
- Jin, X., Yu, J., 2018. Government governance, executive networks and corporate investment efficiency. *China Finance Review International*, 8(2), 122-139.
- Karyotis, C., Doctor, F., Iqbal, R., James, A., Chang, V., 2018. A fuzzy computational model of emotion for cloud based sentiment analysis. *Information Sciences*, 433-434, 448-463.
- Kizgin, H., Jamal, A., Rana, N., Dwivedi, Y., Weerakkody, V., 2018. The impact of social networking sites on socialization and political engagement: Role of acculturation. *Technological Forecasting & Social Change*. <https://doi.org/10.1016/j.techfore.2018.09.010>
- Klettner, A., Clarke, T., Boersma, M., 2014. The Governance of Corporate Sustainability: Empirical Insights into the Development, Leadership and Implementation of Responsible Business Strategy. *Journal of Business Ethics*, 122(1),145–165.
- Lai, S., Liu, C., Wang, T., 2014. Increased disclosure and investment efficiency. *Asia-Pacific Journal of Accounting & Economics*. 21(3), 308-327.
- Lee, L. F., Hutton, A. P., Shu, S., 2015. The role of social media in the capital market: Evidence from consumer product recalls. *Journal of Accounting Research*. 53 (2), 367- 404.
- Liu, B., McConnell, J. J., 2013. The role of the media in corporate governance: Do the media

- influence managers' capital allocation decisions? *Journal of Financial Economics*. 110(1), 1-17.
- Liu, Q., Pan, X., Tian, G.G., 2018. To what extent did the economic stimulus package influence bank lending and corporate investment decisions? Evidence from China. *Journal of Banking and Finance*. 86(C), 177-193.
- <https://www.imf.org/external/pubs/ft/wp/2016/wp16203.pdf> (accessed 18 November 2018).
- Malmendier, U., Tate, G., 2008. Who makes acquisitions? CEO overconfidence and the market's reaction. *Journal of Financial Economics*. 89 (1), 20-43.
- Mislove, A., Marcon, M., Gummadi, K. P., Druschel, P., Bhattacharjee, B., 2007. Measurement and analysis of online social networks. In *Proceedings of the 7th ACM SIGCOMM conference on Internet measurement*, 29-42.
- Mital, M., Chang, V., Choudhary, P., Papa, A., Pani, A.K., 2017. Adoption of internet of things in India: A test of competing models using a structured equation modeling approach. *Technological Forecasting & Social Change*, 136, 339-346.
- Modigliani, F., Miller, M. H., 1958. The cost of capital, corporation finance and the theory of investment. *The American Economic Review*, 48(3), 261-297.
- Munzel, A., Meyer-Waarden, L., Galan, J., 2018. The social side of sustainability: Well-being as a driver and an outcome of social relationships and interactions on social networking sites. *Technological Forecasting & Social Change*. 130, 14-27.
- Mutchler, J. F., Hopwood, W., Mckeown, J. M., 1997. The influence of contrary information and mitigating factors on audit opinion decisions on bankrupt companies. *Journal of Accounting Research*. 35(2). 295-310.
- Myers, S. C., Majluf, N. S., 1984. Corporate financing and investment decisions when firms have information that investors do not have. *Journal of Financial Economics*. 13 (2), 187-221.
- Pappas, I.O., Mikalef, P., Giannakos, M.N., Krogstie, J., Lekakos, G., 2018. Big data and business analytics ecosystems: paving the way towards digital transformation and sustainable societies. *Information Systems and e-Business Management*, 16(3), 479-491.
- Park, S., Gupta, S., 2009. Simulated maximum likelihood estimator for the random coefficient logit model using aggregate data. *Journal of Marketing Research*, 46(4), 531-542.
- Porta, R. L., Lopez-De-Silanes, F., Shleifer, A., 1999. Corporate ownership around the world. *The Journal of Finance*. 54(2). 471-517.
- Richardson, S., 2006. Over-investment of free cash flow. *Review of Accounting Studies*. 11 (2-3), 159-189.
- Rogers, J. L., Skinner, D. J., Zechman, S. L. C., 2016. The role of the media in disseminating insider-trading news. *Review of Accounting Studies*. 21 (3), 1-29.
- Rosati, P., Deeney, P., Cummins, M., van der Werff, L., Lynn, T., 2018. Social media and stock price reaction to data breach announcements: Evidence from US listed companies.

- Research in International Business and Finance*. 9 (7), 1-12.
- Sanner, M., 1999. Python: A programming language for software integration and development. *Journal of Molecular Graphics & Modelling*. 17 (1), 57-61.
- Tetlock, P. C., 2011. All the news that's fit to reprint: Do investors react to stale information? *Review of Financial Studies*. 24 (5), 1481-1512.
- Veronica, S. G., Manlio, D. P., Shlomo, T., Antonio, M., Victor, C. 2019. International social SMEs in emerging countries: Do governments support their international growth? *Journal of World Business*. In Press.
- Villas-Boas, J. M., Winer, R. S., 1999. Endogeneity in brand choice models. *Management science*, 45 (10), 1324-1338.
- Wu, W., Firth, M., Rui, O. M., 2014. Trust and the provision of trade credit. *Journal of Banking and Finance*. 39 (1), 146-159.
- Yang, D., Lu, Z., Luo, D., 2014. Political connections, media monitoring and long-term loans. *China Journal of Accounting Research*. 7(3), 165-177.
- Yang, D., Zhao, C., 2016. Excess employment, media coverage and corporate valuation: Labour contract law in China. *China Journal of Accounting Studies*. 4(1), 1-19.
- Zavyalova, A., Pfarrer, M.D., Reger, P. K., Shapiro, D.L., 2012. Firm actions and industry spillovers on media coverage following wrongdoing. *Academy of Management Journal*. 55 (5), 1079-1101.
- Zhang, H., Su, Z., 2015. Does media governance restrict corporate overinvestment behavior? Evidence from Chinese listed firms. *China Journal of Accounting Research*. 8 (1), 41-57.

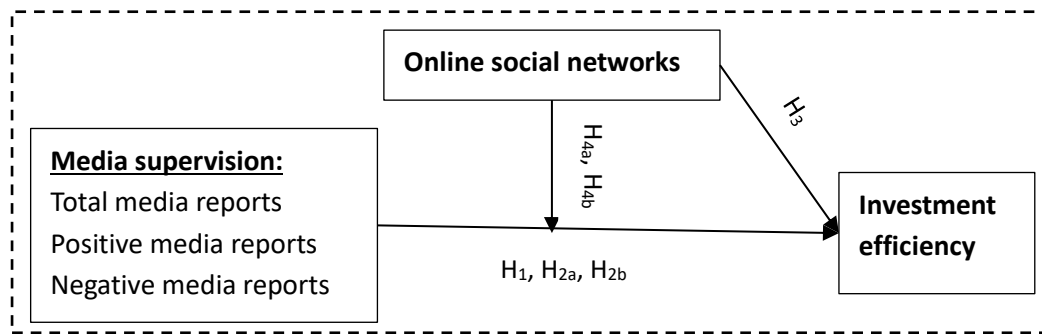
Appendix A. Category of media reports and list of key terms used for the categorization

Category	Key term
Investment related reports	acquisition; merger; stock subscription; stock and share; construction; transnational investment; project; project investment; investment scale; investment earnings; investment contracts; investment return; investment risk; risk control; investment; quoting a price; completion of investment; investment in research and development; project investment; equity investment; investment in intangible assets; merger of companies; asset restructuring; asset placement; overinvestment; underinvestment; investment bubbles; partnership investment; investment financing; investment failure; investment analysis; investor research; investment coordination committee; fund research; infrastructure investment; foreign investment; diversified investment; cultural investment; investment in tourism projects; establishment of branch companies; new project; investment loans; investment bonus
Positive reports	investment; model; bull; investment income exceeds expectations; investment gains; private capital raising; investment return; net profit exceeds expectations; earnings per share; positive and profitable; multiple benefits; bonus and dividend; positive evaluation; smooth progress, promote the implementation of the project; increase the quota of the entrusted financial credit; completion of investment; go up; counterattack; profits on the books; surprisingly selected; year-on-year growth; good performance; unanimously approved by the board of directors; rise by a big margin; a sharp increase; steady improvement; place high hopes; speed up; shareholding reform; hopefully; fund issuance; breakthrough; the top leader of earnings; promotion; new inventions gain worldwide attention; soar; proposed investment; widely admired and followed; new development opportunities; sign; sail with the wind; foreign investment; the first limit-up after falling; sign an agreement on capital increase and investment; cooperate; joint capital increase; joint investment; successful acquisition; recovery; favorite; reshuffle; ignite the market; increase the investment; Gold will shine; good return on investment; bull; advance on; new peak; push hard into; successful backdoor listing; opportunities; value-added; investment opportunities; limit-up
Negative reports	quoting a price; cut; compress; illegal; violations; investment failure; potential risks; earnings are hard to estimate; shadow; net profit fall; earnings decline; exchange losses; resignation; rumor; drop out; suspension for investigation; adverse to long-term development; suspend; net loss; crisis; conceal poor performance; claims; terminate the cooperation with the government; fall; depression; reduce; break the law; being punished; problems; losses; narrow escape; being caught in trouble; slide; attempted listing; being shuffled; overall renewal; go down; narrow down; short of money; uncertain prospects; ‘miscarriage’; Being denied; overinvestment; debt crisis; financial constraints; financial austerity; underinvestment; investment progress lags behind

Appendix B. Descriptive statistics of fan groups in the corporate Sina accounts

<i>Fan group</i>	N	Mean of fans	<i>SD</i>	<i>Median of fans</i>	Min of fans	Max of fans
<i>Full sample</i>	510	790408.153	3524915.265	9141	9	23294204
<i>Small group</i>	258	1560283.233	4837780.688	290000	9141	23294204
<i>Large group</i>	252	2364.070	2743.519	1177	9	9141

Figure 1. Research framework



Note: Hypotheses with letters 'a' and 'b' indicate the interaction effect of positive or negative media reports when combined with investment opportunities.

Table 1. Definitions of relevant variables

Type	Variables	Symbol	Definitions of variables
Explained variable	Investment expenditure	<i>Inv</i>	(Cash for buying fixed assets, intangible assets, and other long-term assets <i>minus</i> net cash for disposing of recovered fixed assets, intangible assets, and other long-term assets) / total assets
	Online social network	<i>Sn</i>	The number of followings <i>plus</i> the number of Weibo fans <i>plus</i> the number of posts <i>plus</i> the number of forwards. (Corporate official Sina account: Yes, $S_n=1$; No, $S_n=0$)
Explanatory variable	The total number of reports	<i>Tmedia</i>	Natural logarithm of the total number of reports +1
	The number of positive reports	<i>Pmedia</i>	Natural logarithm of the number of positive reports +1
	The number of negative reports	<i>Nmedia</i>	Natural logarithm of the number of negative reports +1
Control variable	Cash flow	<i>Cfo</i>	Firm's net operating cash flows
	Leverage	<i>Lev</i>	Net assets/total assets
	Listing age	<i>List</i>	Listing age
	Investment opportunities	<i>Tq</i>	Tobin's Q ratio estimated as the sum of the market value of tradable shares <i>plus</i> the book value of non-tradable shares and liabilities <i>divided by</i> the book value of total assets
	Seasoned equity offerings	<i>Seo</i>	Capital raised via seasoned equity offerings / Total assets
	Size	<i>Size</i>	Total assets
	Industry	<i>Ind</i>	Industry
	Year	<i>Year</i>	Year

Table 2. Descriptive statistics of variables

<i>Variable</i>	<i>N</i>	<i>Mean</i>	<i>Median</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>
<i>Inv</i>	2808	0.052	0.031	0.051	-0.472	0.373
<i>Sn</i>	2808	0.335	0	0.253	0	1
<i>Tmedia</i>	2808	0.131	0	0.34	0	3.510
<i>Pmedia</i>	2808	0.104	0	0.312	0	2.201
<i>Nmedia</i>	2808	0.033	0	0.162	0	2.203

Notes: *Inv* stands for firms' investment expenditure; *Sn* stands for the online social network; *Tmedia* stands for the total number of media reports; *Pmedia* stands for the number of positive media reports; *Nmedia* stands for the number of negative media reports.

Table 3. Descriptive statistics of the paired and media samples

<i>Variable</i>	Resource	N	Mean	SD	Median	Min	Max
<i>Inv</i>	Media samples	1404	0.046	0.053	0.032	-0.468	0.371
	Paired samples	1404	0.045	0.055	0.032	-0.597	0.365
<i>Size</i>	Media samples	1404	9.932	0.690	9.821	8.293	12.382
	Paired samples	1404	10.271	0.485	10.243	8.232	11.897
<i>Tq</i>	Media samples	1404	1.815	2.173	1.142	0.091	31.423
	Paired samples	1404	1.017	1.225	0.680	0.007	22.333
<i>Cfo</i>	Media samples	1404	5.428	15.899	4.420	-84.690	445.260
	Paired samples	1404	5.385	14.548	4.710	-93.010	255.910
<i>Seo</i>	Media samples	1404	0.157	0.285	0.110	0	9.050
	Paired samples	1404	0.118	0.241	0.080	0	5.140
<i>Lev</i>	Media samples	1404	0.231	0.192	0.210	0	1.130
	Paired samples	1404	0.258	0.182	0.230	0	0.910

Notes: *Inv* stands for firms' investment expenditure; *Sn* stands for online social network; *Size* is a proxy for the firm's total assets; *Tq* is a proxy for the firms' investment opportunities; *Cfo* stands for the firm's net operating cash flows; *Seo* captures any additional equity capital raised by the firm; and, *Lev* is a proxy for firm's leverage estimated as the proportion of firm's net assets to its total asset

Table 4. Mean difference analysis of the paired and media samples

<i>Variable</i>	<i>obs</i>	<i>Mean</i>	<i>obs(paired)</i>	<i>Mean(paired)</i>	<i>Mean-diff</i>	<i>t</i>
<i>Inv</i>	1404	0.046	1404	0.046	-0.000	-0.035

Notes: ***, ** and * indicate statistical significance at the 1%, 5% and 10% respectively.

Table 5. Regression results of media supervision and investment efficiency

<i>Variables</i>	<i>Inv. Efficiency</i> (1)	<i>Inv. Efficiency</i> (2)	<i>Inv. Efficiency</i> (3)
$Tq_{i,t-1}$	0.008*** (4.685)	0.010*** (3.910)	0.007*** (4.472)
$Tmedia_{i,t-1}$	0.019** (2.105)		
$Tq_{i,t-1} \times Tmedia_{i,t-1}$	-0.007 (-1.845)		
$Pmedia_{i,t-1}$		0.025** (1.988)	
$Tq_{i,t-1} \times Pmedia_{i,t-1}$		-0.015** (-2.407)	
$Nmedia_{i,t-1}$			0.017 (0.749)
$Tq_{i,t-1} \times Nmedia_{i,t-1}$			-0.008 (-0.763)
$Cfo_{i,t-1}$	0.065** (2.575)	0.063** (2.024)	0.064** (2.549)
$Lev_{i,t-1}$	0.056*** (3.043)	0.007*** (2.839)	0.057*** (3.068)
$Seo_{i,t-1}$	0.050** (1.980)	0.048 (1.380)	0.049** (1.975)
$Size_{i,t-1}$	0.003 (1.478)	-0.001 (-0.383)	0.003 (1.490)
$List_{i,t-1}$	-0.003*** (-5.747)	-0.004*** (-5.887)	-0.003*** (-5.736)
<i>Constant</i>	-0.013 (-0.252)	-0.092 (-1.456)	-0.012 (-0.236)
<i>Industry</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
<i>Year</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
<i>Observations</i>	2808	2808	2808

Notes: Columns 1, 2, and 3 present the regression results of the effects of a total number of media reports, positive and negative media reports on investment efficiency. Tq is a proxy for the firms' investment opportunities; $Tmedia$ stands for the total number of reports; $Pmedia$ stands for the number of positive reports; $Nmedia$ stands for the number of negative reports; Cfo stands for the firm's net operating cash flows; Lev is a proxy for firm's leverage estimated as the proportion of firm's net assets to its total assets; Seo captures any additional equity capital raised by the firm; $Size$ is a proxy for the firm's total assets; $List$ is the number of listed years for the firm acting as a proxy for stock market maturity, *Industry and Year* report controlling for relevant fixed effects. Z-values are in brackets; *** and ** indicate statistical significance at the 1% and 5% respectively.

Table 6. Comparative analysis of the media supervision effect in SOEs and non-SOEs

<i>Variables</i>	<i>Inv. Efficiency</i>		<i>Inv. Efficiency</i>		<i>Inv. Efficiency</i>	
	<i>(1)</i>		<i>(2)</i>		<i>(3)</i>	
	<i>SOE</i>	<i>Non-SOE</i>	<i>SOE</i>	<i>Non-SOE</i>	<i>SOE</i>	<i>Non-SOE</i>
$Tq_{i,t-1}$	0.010*** (4.017)	0.008*** (3.148)	0.010*** (3.910)	0.007*** (2.884)	0.009*** (3.575)	0.007*** (3.09)
$Tmedia_{i,t-1}$	0.023** (2.011)	0.020 (1.322)				
$Tq_{i,t-1} \times Tmedia_{i,t-1}$	-0.015*** (-2.614)	-0.004 (-0.806)				
$Pmedia_{i,t-1}$			0.025** (1.988)	0.003 (0.151)		
$Tq_{i,t-1} \times Pmedia_{i,t-1}$			-0.015** (-2.407)	0.003 (0.503)		
$Nmedia_{i,t-1}$					0.026 (0.813)	0.017 (0.469)
$Tq_{i,t-1} \times Nmedia_{i,t-1}$					-0.024 (-1.22)	-0.005 (-0.357)
<i>Constant</i>	0.091 (1.434)	-0.133 (-1.436)	0.092 (1.456)	-0.136 (-1.464)	0.091 (1.429)	-0.136 (-1.470)
<i>Control variables</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
<i>Observations</i>	1662	1146	1662	1146	1662	1146

Notes: Tq is a proxy for the firms' investment opportunities; $Tmedia$ stands for the total number of reports; $Pmedia$ stands for the number of positive reports; $Nmedia$ stands for the number of negative reports; SOE stands for state-owned enterprise; Z-values are in brackets; *** and ** indicate statistical significance at the 1% and 5% respectively.

Table 7. Combined effect of online social networking and media reports on investment efficiency

<i>Variables</i>	<i>Inv. Efficiency (1)</i>	<i>Inv. Efficiency (2)</i>	<i>Inv. Efficiency (3)</i>
<i>Tq_{i,t-1}</i>	0.008*** (4.881)	0.008*** (4.642)	0.007*** (4.381)
<i>Sn_{i,t-1}</i>	-0.014** (-2.265)	-0.013** (2.148)	-0.011 (-1.915)
<i>Tmedia_{i,t-1}</i>	0.020** (2.239)		
<i>Tq_{i,t-1} × Tmedia_{i,t-1}</i>	-0.015*** (-2.928)		
<i>Tq_{i,t-1} × Tmedia_{i,t-1} × Sn_{i,t-1}</i>	0.012** (2.214)		
<i>Pmedia_{i,t-1}</i>		-0.012 (-1.286)	
<i>Tq_{i,t-1} × Pmedia_{i,t-1}</i>		-0.012** (-2.124)	
<i>Tq_{i,t-1} × Pmedia_{i,t-1} × Sn_{i,t-1}</i>		0.015** (2.245)	
<i>Nmedia_{i,t-1}</i>			0.021 (0.895)
<i>Tq_{i,t-1} × Nmedia_{i,t-1}</i>			-0.010 (-0.942)
<i>Tq_{i,t-1} × Nmedia_{i,t-1} × Sn_{i,t-1}</i>			0.006 (1.775)
<i>Cfo_{i,t-1}</i>	0.065*** (2.581)	0.064** (2.535)	0.062** (2.476)
<i>Lev_{i,t-1}</i>	0.054*** (2.888)	0.054*** (2.921)	0.055*** (2.987)
<i>Seo_{i,t-1}</i>	0.049 (1.952)	0.049 (1.946)	0.051** (2.021)
<i>Size_{i,t-1}</i>	0.003 (1.236)	0.003 (1.263)	0.003 (1.324)
<i>List_{i,t-1}</i>	-0.003*** (-5.823)	-0.003*** (-5.835)	-0.003*** (-5.793)
<i>Constant</i>	0.004 (0.087)	0.004 (0.073)	0.001 (0.010)
<i>Industry</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
<i>Year</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
<i>Observations</i>	2808	2808	2808

Notes: *Tq* is a proxy for the firms' investment opportunities; *Sn* stands for online social network; *Tmedia*, *Pmedia* and *Nmedia* stands for the numbers of total, positive and negative reports respectively; *Cfo* stands for the firm's net operating cash flows; *Lev* is a proxy for firm's leverage; *Seo* captures any additional equity capital raised by the firm; *Size* is a proxy for the firm's total assets; *List* is the number of listed years for the firm, *Industry* and *Year* report controlling for relevant fixed effects. Z-values are in brackets; *** and ** indicate statistical significance at the 1% and 5% respectively.

Table 8. Comparative analysis of the online social networking effect upon SOEs and non-SOEs' investment efficiency

Variables	Inv. Efficiency		Inv. Efficiency		Inv. Efficiency	
	(1)		(2)		(3)	
	SOE	Non-SOE	SOE	Non-SOE	SOE	Non-SOE
$Tq_{i,t-1}$	0.010*** (3.930)	0.008*** (3.287)	0.0098*** (3.828)	0.007*** (3.063)	0.009*** (3.554)	0.007*** (2.979)
$Sn_{i,t-1}$	0.001 (0.132)	-0.034*** (-3.189)	-0.001 (-0.091)	-0.031*** (-2.994)	0.003 (0.442)	-0.031*** (-2.951)
$Tmedia_{i,t-1}$	0.023** (2.000)	0.021 (1.405)				
$Tq_{i,t-1} \times Tmedia_{i,t-1}$	-0.021** (-2.204)	-0.015** (-2.146)				
$Tq_{i,t-1} \times Tmedia_{i,t-1} \times Sn_{i,t-1}$	0.007 (0.736)	0.016** (2.296)				
$Pmedia_{i,t-1}$			0.025 (1.949)	0.001 (-0.069)		
$Tq_{i,t-1} \times Pmedia_{i,t-1}$			-0.022** (-2.316)	-0.007 (-0.935)		
$Tq_{i,t-1} \times Pmedia_{i,t-1} \times Sn_{i,t-1}$			0.011 (0.976)	0.020** (2.309)		
$Nmedia_{i,t-1}$					0.0245 (0.775)	0.0245 (0.775)
$Tq_{i,t-1} \times Nmedia_{i,t-1}$					-0.023 (-1.160)	-0.023 (-1.160)
$Tq_{i,t-1} \times Nmedia_{i,t-1} \times Sn_{i,t-1}$					-0.004 (-0.629)	0.003 (-0.629)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1662	1146	1662	1146	1662	1146

Notes: Tq is a proxy for the firms' investment opportunities; Sn stands for online social network; $Tmedia$ stands for the total number of reports; $Pmedia$ stands for the number of positive reports; $Nmedia$ stands for the number of negative reports; SOE stands for state-owned enterprise; Z-values are in brackets; *** and ** indicate statistical significance at the 1% and 5% respectively.

Table 9. Comparative analysis of the interaction effect in Sgroup versus Lgroup

Variables	Inv. Efficiency		Inv. Efficiency		Inv. Efficiency	
	(1)		(2)		(3)	
	<i>Sgroup</i>	<i>Lgroup</i>	<i>Sgroup</i>	<i>Lgroup</i>	<i>Sgroup</i>	<i>Lgroup</i>
<i>Tq_{i,t-1}</i>	0.004 (0.857)	-0.004 (-0.69)	0.003 (0.57)	-0.003 (-0.552)	0.002 (0.503)	-0.002 (-0.368)
<i>Sn_{i,t-1}</i>	-0.050 (-1.921)	0.008 (0.229)	-0.047 (-1.794)	0.015 (0.407)	-0.035 (-1.367)	0.015 (0.436)
<i>Tmedia_{i,t-1}</i>	0.013 (0.552)	-0.005 (-0.211)				
<i>Tq_{i,t-1} × Tmedia_{i,t-1}</i>	-0.027 (-1.913)	-0.011 (-0.351)				
<i>Tq_{i,t-1} × Tmedia_{i,t-1} × Sn_{i,t-1}</i>	0.024 (1.682)	0.037 (1.166)				
<i>Pmedia_{i,t-1}</i>			-0.020 (-0.761)	-0.021 (-0.865)		
<i>Tq_{i,t-1} × Pmedia_{i,t-1}</i>			-0.019 (-1.207)	0.009 (0.341)		
<i>Tq_{i,t-1} × Pmedia_{i,t-1} × Sn_{i,t-1}</i>			0.026 (1.517)	0.024 (0.792)		
<i>Nmedia_{i,t-1}</i>					0.034 (0.576)	0.049 (0.901)
<i>Tq_{i,t-1} × Nmedia_{i,t-1}</i>					-0.008 (-0.339)	-0.007 (-0.281)
<i>Tq_{i,t-1} × Nmedia_{i,t-1} × Sn_{i,t-1}</i>					-0.003 (-0.305)	0.025*** (2.787)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations	258	252	258	252	258	252

Notes: *Tq* is a proxy for the firms' investment opportunities; *Sn* stands for online social network; *Tmedia* stands for the total number of reports; *Pmedia* stands for the number of positive reports; *Nmedia* stands for the number of negative reports; Z-values are in brackets; *** and ** indicate statistical significance at the 1% and 5% respectively.

Table 10. Robustness test

<i>Variables</i>	<i>Inv. Efficiency (1)</i>			<i>Inv. Efficiency (2)</i>		
	<i>Full samples</i>	<i>SOE</i>	<i>Non-SOE</i>	<i>Full samples</i>	<i>SOE</i>	<i>Non-SOE</i>
$Tq_{i,t-1}$	0.010*** (6.478)	0.010*** (3.971)	0.007*** (3.058)	0.008*** (4.819)	0.010*** (3.907)	0.008*** (3.261)
$Mediatrend_{i,t-1}$	0.019*** (3.028)	0.024** (2.036)	0.010 (0.592)	-0.0130** (-2.09)	0.0015 (0.20)	-0.032*** (-3.015)
$Tq_{i,t-1} \times Mediatrend_{i,t-1}$	-0.008*** (-3.082)	-0.016*** (-2.565)	-0.001 (-0.218)	-0.013** (-2.471)	-0.018 (-1.923)	-0.012 (-1.632)
$Tq_{i,t-1} \times Mediatrend_{i,t-1} \times Sn_{i,t-1}$	-	-	-	0.012 (1.942)	0.004 (0.376)	0.018** (2.361)
$Sn_{i,t-1}$	-	-	-	0.016 (1.664)	0.023** (1.984)	0.010 (0.643)
<i>Control variables</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
<i>Observations</i>	2808	1662	1146	2808	1662	1146

Notes: Tq is a proxy for the firms' investment opportunities; Sn stands for online social network; $Mediatrend$ stands for the proportion of positive reports to the total number of media reports; Z-values are in brackets; *** and ** indicate statistical significance at the 1% and 5% respectively.

Table 11. Summary of the test results.

Hypothesis	Support	Group comparison	
		For SOEs	For Non-SOEs
H1: Tmedia \rightarrow $^+$ Inv	YES	YES	NO
H2a: Pmedia*Tq \rightarrow $^+$ Inv	YES	YES	NO
H2b: Nmedia*Tq \rightarrow $^+$ Inv	NO	NO	NO
H3: Sn \rightarrow Inv	YES	NO	YES
H4a: Sn* Pmedia*Tq \rightarrow $^+$ Inv	YES	NO	YES
H4b: Sn* Nmedia*Tq \rightarrow $^+$ Inv	NO	NO	NO