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INFORMATION DISCLOSURE AND THE PEER EFFECT OF CORPORATE TECHNOLOGY INNOVATION¹

¹Xinyao Yang

School of Finance
Henan University of Economics and Law
NO.180, Jinshui East Road
Zhengzhou, Henan, 450016
China
E-mail: xinyao_1211@126.com

²Zheng Shi

School of Economics, Huazhong University of Science and Technology
No.1037, Luoyu Road
Hongshan District, Wuhan, Hubei, 430074
China
E-mail: sz908@hust.edu.cn

³Chengxing Li

School of Finance, Zhongnan University of Economics and Law
No.182, Nanhu Road
Wuhan, Hubei, 430073
China
E-mail: xltx666_0109@163.com

¹**Xinyao Yang**, PhD, associate professor, is currently working at School of Finance, Henan University of Economics and Law. Her research interests focus on corporate-finance and corporate governance.

²**Zheng Shi** (*corresponding author*), PhD candidate, is currently studying at the School of Economics, Huazhong University of Science and Technology. His research interest focuses on corporate finance.

³**Chengxing Li**, is currently studying at the School of Finance, Zhongnan University of Economics and Law. Her research interest focuses on corporate finance.

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ABSTRACT. *Information disclosure is an essential means to improve the effectiveness of the capital market. How to promote capital market development by perfecting the information disclosure system is constantly an important topic of the supervision department and academic circle. To discuss the profound effects of information disclosure on enterprises in the capital market, based on information theory and dynamic competition theory, using the data of 1158 Chinese listed enterprises on the growth enterprise market (GEM) from 2009 to 2022, the influences of information disclosure on peer effect of corporate technology innovation were explored through multivariate regression method. Results show that information disclosure can strengthen the peer effect of corporate technology innovation, which may be further intensified with the increasing enrichment of information disclosure paths and contents.*

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The registration system reform policy implemented in China's GEM in 2020 could promote the peer effect of corporate technology innovation. While enterprises with poorer external and internal information environmental transparency are benefiting from the positive effects of increased information disclosure degree, increasing information disclosure degree has strong competitive influences on the peer effect of technology innovation of enterprises. Conclusions not only provide some causal references to the promotion of information disclosure on the peer effect of technology innovation but also verify the policy effect of registration system reform in GEM and disclose the important role of China's registration system reform in improving resource allocation efficiency of capital markets.

KEYWORDS: peer effects, information disclosure, technology innovation, GEM, registration system.

JEL classification: D43, G18, M41, O32.

Introduction

Information disclosure is the main way for listed enterprises to open their corporate information to the public. High-quality information disclosure is not only conducive to decreasing industrial uncertainty, decreasing synchronism of share price (Shroff *et al.*, 2017; Yin *et al.*, 2019), and improving stock liquidity (Agarwal *et al.*, 2015), it is also one of the important characteristics of a mature financial market. The information disclosure quality of enterprises not only directly influences the information enrichment degree of capital market but can also provide increment information to peer enterprises or help peer enterprises with economic decision-making (Badertscher *et al.*, 2013), decrease capital cost of enterprises, and affect the share price of peer enterprises (Shroff *et al.*, 2017). China's capital market generally has a low information disclosure level and mainly stays at the stage of mandatory information disclosure (Cao *et al.*, 2020). Specifically, the prospectus is the information disclosure material required in the capital market. The prospectus of initial public offering (IPO) is the first open systematic information disclosure for the listing of enterprises and an information disclosure document required by all capital markets worldwide. A lot of corporate information is recorded in the prospectus, such as development history, ownership structure, financing goal, core competitiveness, and position in industry. The information disclosure quality of the prospectus is directly connected with external evaluation to the enterprises and economic decision of peer enterprises (Edmans *et al.*, 2015).

Corporate innovation is a process of assimilation and exploitation of existing information to produce new information (Aghion, Jaravel, 2015). Additionally, imitation of industrial leaders contributes to lower R&D cost and smaller risks (Kong *et al.*, 2022), and technology innovation among enterprises may turn out producing imitation learning effect (Lieberman, Asaba, 2006). Hence, peers' technology innovations commonly tend to exhibit the peer effect, a phenomenon supported throughout previous literature (Bloom *et al.*, 2013; Gordon *et al.*, 2020; Grebel, Nesta, 2020). From this perspective, researchers are paying more attention to factors that may affect the peer effect in corporate technology innovation. Regarding internal factors, academics have investigated executive pay (Kaustia *et al.*, 2015), financial constraints (Seo, 2020), and other variables that may affect the peer effect in

corporate technology innovations; concerning external factors, economic policy uncertainty (Peng *et al.*, 2021), industry competition (Posen *et al.*, 2013), and the level of information asymmetry (Lu *et al.*, 2022) are determinants of this peer effect. Despite the valuable insights of the above literature on the influencing factors of corporate technology innovation peer effect, a notable gap may be apparent in research concerning the role of information disclosure within the Growth Enterprise Market (GEM) of China A shares. GEM is the place that gathers Chinese innovative enterprises. In 2022, the R&D strength of listed enterprises on GEM reached 4.9%. Listed enterprises on GEM have higher requirements on information disclosure, because investors and peer enterprises need more detailed R&D information to make decisions (Merkley, 2014).

Information and competition theories solidly support the mechanism through which the information disclosure degree affects the peer effect in enterprises' technology innovations (Lieberman, Asaba, 2006). Information theory suggests that management tends to mitigate strategic risks by assimilating information from other enterprises and adjusting its behavior to counteract the challenges of information uncertainty. The public disclosure of corporate information generates positive externalities on the decision-making of peers, leading to enhanced innovation through imitation-learning on the technology and R&D investment among enterprises (Aghion, Jaravel, 2015; Bernard *et al.*, 2020). With its innovative attributes, the GEM imposes stricter requirements on enterprises' disclosure, enriching peers with access to forefront industry information and unique technology, which facilitates innovative decision-making. According to dynamic competition theory, enterprises adopt imitation and learning strategies from peers as tactics to maintain their position in the competitive landscape. Heightened competition within the industry strengthens the correlation between the corporate's R&D disclosures and its peers' innovation activities (Gordon *et al.*, 2020). This connection is further underscored by the superior innovation abilities of GEM-listed enterprises through intensifying competitive pressures on other firms due to their leading position. Competitive pressures can drive peers to raise their R&D investment, adjusting their investment strategies to remain competitive. Considering the cost of innovation disclosure, few enterprises voluntarily include this information in their annual reports (Roychowdhury *et al.*, 2019). Conversely, the prospectus, a crucial method of mandatory disclosure, aims to be as exhaustive as possible to clarify its development capability, innovation capacity, industry competitive position, and future development focus to capture more investors' attention. Additionally, these information disclosures offer peers valuable insights into the status of R&D and the innovation prospect. Based on an effective review of the existing peer effect of corporate technology innovation, this study highlights the problem of whether information disclosure degree can promote such effect. Theoretically, it supplements contents on behavioural economics from the perspective of enterprises. Practically, it verifies the policy effect of registration system reform emphasizing on "information disclosure." Moreover, it improves the resource allocation efficiency of capital market by perfecting the information disclosure system and encouraging society the continuous practice of the innovation-driven development strategy.

The contributions of this study lie in two aspects: (1) this study investigates the impact of information disclosure on the technology innovation peer effect among companies listed in China's Growth Enterprise Market (GEM) within the same industry, utilizing the mandatory text information disclosure requirement in the prospectus. The previous literature has limited studies relating mandatory disclosure to the peer effect behavior in capital markets, a handful of studies have taken corporate annual reports as the study topic for analysis (Yuan *et al.*, 2022; Wang *et al.*, 2023). Compared to corporate annual reports, the prospectus offers more

representative proprietary innovation information, making it more accessible for peers to obtain valuable R&D information from them. This study contributes to the existing literature on the influence of disclosure practices on corporate behavior. (2) In this study, the influences of registration system reform on the peer effect of corporate technology innovation are explored. The findings can offer some theoretical references to the comprehensive evaluation of the implementation effect of registration system reform and enlightenments to a perfect information disclosure system for registration system reform while promoting progress in the market allocation of elements.

The remainder of this study is organized as follows. Section 1 proposes the research hypotheses through literature review and theoretical analysis of relations between information disclosure and peer effect of corporate technology innovation. Section 2 introduces the data source, variable definition, and model setting of this study. Then, it carries out the descriptive statistical analysis. Section 3 analyses the empirical results. It first implements the regression analysis of the reference regression model and then provides an endogenous test and a robustness test. Next, further analysis is carried out. Based on the above text, the moderating influences of registration system reform on the peer effect of corporate technology innovation and the relevant heterogeneity are discussed. Section 4 discusses the causes of empirical results. Section 6 summarizes the conclusions and managerial implications.

1. Theoretical Analysis and Hypothesis Development

1.1 Existence of the Peer Effect of Corporate Technology Innovation

Innovation is the first power that drives high-quality economic development. Corporate innovation is a process that generates new information by comprehensively absorbing and exploiting technological information (R&D and patent), industrial information (comparable enterprises and industrial development prospects), upstream and downstream market information of products, and capital market information (Kong *et al.*, 2022). According to statistics, the proportion of China's R&D investment in GDP increased from 1.44% in 2008 to 2.55% in 2022. And in the same period, the proportion of R&D investment of America in GDP is 2.6%. Thus, China still has to increase its R&D investment. From the macroscopic perspective, enterprises are the backbone forces of national technological innovation, and their independent innovation ability is a key factor that influences the scientific technological and industrial reform effect of a country. From the microscopic perspective, technology innovation is the source for a corporate to acquire market shares in the industry. However, innovation input of enterprises has a long recovery period with high failure risks and high financial consumption. According to the dynamic competition theory, enterprises in the same industry are competitors with each other, when one takes action, others will produce corresponding chain interaction behavior to maintain their relative competitive advantages, individual enterprises may pay high attention to the relevant decisions and behaviors of their counterparts and take corresponding countermeasures. Thus, when a certain corporate engages in technology innovation practice, peers will imitate and learn from similar behaviors to minimize the risk of high-cost innovation (Gordon *et al.*, 2020; Bustamante, Frésard, 2021). Imitation behaviors of other enterprises' economic decision also include imitation of technology innovation behaviors of peer enterprises, which called the peer effect of corporate technology innovation. Prior studies found that financing decision of enterprises may be influenced by cash flow information or management layer information of peer enterprises and enterprises in the same region (Leary, Robert, 2014; Chen, Ma, 2017; Dougal

et al., 2015). Based on the above analysis, the first hypothesis is proposed to verify the existence of the peer effect of corporate technology innovation.

H1: Corporate innovation decision is influenced by the decisions of peer enterprises. The peer effect exists among corporate technology innovation decisions.

1.2 Information Disclosure and the Peer Effect of Corporate Technology Innovation

With references to the interpretation logic of corporate innovation imitation behaviors based on information- and rivalry-based theories (Lieberman, Asaba, 2006), from the perspective of information-based theories, enterprises may choose to imitate innovation behaviors of peer enterprises in the information uncertainty environment to decrease such adverse effect. Many studies have demonstrated that enterprises may refer to the disclosed information of other peer enterprises when making economic decisions (Shroff *et al.*, 2017; Yang *et al.*, 2020). With respect to innovation decisions, peer enterprises may imitate and learn the R&D investments of their opponents (Chircop *et al.*, 2020; Li *et al.*, 2021; Kim *et al.*, 2021). Increasing information disclosure degree implies comprehensive industrial information and rich characteristic information of peer enterprises. The core competitiveness, technological advantages, business performance, profit prediction, and industrialization degree of core technologies disclosed in the prospectus can help peer enterprises decrease information uncertainty, obtain a better understanding and evaluation of the industrial and market spaces, and seek new investment opportunities (Bonsall *et al.*, 2013; Edmans *et al.*, 2015). Consequently, peer enterprises will lower information uncertainty through characteristic information disclosed in the prospectuses to imitate innovation investment strategies of other enterprises, thus producing a peer effect of corporate technology innovation. In view of rivalry-based theories, innovation, an important strategy covering the state at the upper layer and enterprises at the bottom line, plays an irreplaceable role in the long-term development of enterprises and future development trends of the industry. Competition is one of the potential powers to stimulate corporate technology innovation. In industries with fierce competition, enterprises will pay close attention to the innovation strategy of opponents and take the initiative to imitate to keep their market shares (Gordon *et al.*, 2020). Internal logic lies in that innovation investment has uncertain benefits, and enterprises will choose the imitative innovation strategy to lower market risks (Guler *et al.*, 2002). As the main field of national innovation-driven development strategy, GEM and the Sci-Tech innovation board have natural advantages in technology innovation and may become strong competitors in the future. This scenario will intensify the competitive pressure among peer enterprises in the industry (Lieberman, Asaba, 2006; Liu *et al.*, 2022) and may cause changes in R&D investment behaviors (Badertscher *et al.*, 2013). Peer enterprises also bear pressure brought by external investors, which facilitates enterprises to adjust their innovation strategies. Hence, enterprises may increase R&D investment and adjust their technology innovation decision due to competitive pressure of the same industry to maintain their competitiveness. Based on the above analysis, the second hypothesis is proposed:

H2: Information disclosure of GEM enterprises can facilitate the peer effect of corporate technology innovation.

1.3 Registration System Reform and the Peer Effect of Corporate Technology Innovation

On February 1st, 2023, the registration system reform for stock issuance was initiated formally and comprehensively. After the pilot implementation of the registration system reform in the Sci-Tech innovation board, GEM, and Beijing Stock Exchange, a comprehensive registration system reform began to be implemented on the main boards of the Shanghai Stock Exchange and Shenzhen Stock Exchange. Distinct from the approval system of approval first and then listing, supervision organizations may have strict quality control over enterprises that tend to be listed. The registration system shifts attention from profit index to information disclosure, lowers standards for listing, decreases administrative intervention to listing of enterprises, and delegates the initiative of resource allocation to the market. In the IPO stage, bourses periodically accept application materials and then inquire enterprises for listing, while issuing institutions answer the inquiry letters. The entire process is supervised by intermediary agencies to guarantee the authenticity of information. Some studies have demonstrated that inquiry letters of China bourses have increased the quality of information disclosure from the supervision level (Brown *et al.*, 2018). Reply letters of issuing institutions will be thoroughly reflected in the Prospectus (Submitted Draft). The ultimate prospectus could better represent the real appearance of listed enterprises and reflect the positive influences of registration system reform (disclosure first and then approval) on information disclosure. Hence, the dummy variable whether registration system reform is executed on the basis of GEM is used as the moderator variable in further analysis. It tests whether registration system reform can positively moderate the peer effect of corporate technology innovation. Hence, the third hypothesis is proposed:

H3: Registration system reform can promote the peer effect of corporate technology innovation.

2. Methodology

2.1 Data

This study chose a total of 1,158 listed enterprises on China's GEM from October 30th, 2009 to December 31st, 2022. ST and ST* enterprises, financial-industrial enterprises, and samples with missing observation values of core variables are deleted. All continuous variables have winsorized at +1%; then, 6,591 observation values are involved in the regression. The data needed by independent variables come mainly from the CSMAR Database. Corporate characteristic data and financial data needed by control variables are collected from the East money Choice Database and Wind Database. Text analysis data come from WinGo Database, the first artificial intelligence financial data platform based on disclosed texts of listed enterprises in China. Prospectuses that are disclosed by sample enterprises are collected and reviewed by Web crawler technology. Indexes are updated by Python word segmentation technology and text information, which are then extracted, analyzed, and calculated. Finally, the cumulatively disclosed word number of prospectuses is gained. In this study, data processing and empirical analysis are both completed by using Stata 17.0 software.

2.2 Variables

In this study, the R&D investment of target enterprises (*RD*) was the dependent variable. R&D investment is a key element for enterprises to reflect their core competitiveness (Cohen and Levinthal, 1989). Existing studies have rigorously investigated R&D investment level (He *et al.*, 2009; Naveed, Shabbir, 2022; Sun *et al.*, 2023). With references to the measurement method of Junguo *et al.* (2021), this study measured the R&D investment of target enterprises through normalized logarithm of the annual R&D investment of enterprises.

Average innovation investment level of peer enterprises was the independent variable. Referring to Leary and Roberts (2014), enterprises in the same industry to the target corporate are used as peer enterprises, and the minimum number of peer enterprises is two. The peer enterprises are measured by the mean of the R&D investment sum of all listed enterprises, except corporate *i* (the corporate itself) in industry *j* in *t*-1 years. The second-level codes of the industry in the Guidance on Industry Classification of Listed enterprises of the China Securities Regulatory Commission are used as the industry classification standards.

Table 1. Variable definition

Variable type	Variable code	Variable definition	Variable description
Dependent Variable	<i>RD</i>	R&D investment of enterprises	The R&D investment of target enterprises through normalized logarithm of the annual R&D investment of enterprises.
Independent variable	<i>RD_peer</i>	Average R&D investment of peer enterprises	The mean of R&D investment sum of all listed enterprises, except corporate <i>i</i> (the corporate itself) in industry <i>j</i> in <i>t</i> -1 years
Moderator variables	<i>Num_{i,j,t-1}</i>	Number of prospectuses	The logarithm of the quantity obtained by adding one to the number of prospectuses of industry <i>j</i> , to which corporate <i>i</i> belongs, in year <i>t</i> -1
	<i>Word_{i,j,t-1}</i>	The cumulative disclosed word number in the prospectuses	The cumulative disclosed word number in the prospectuses of all enterprises in year <i>t</i> -1 in industry <i>j</i> (If there is a corporate listed on the Gem in the <i>t</i> -1 year of the <i>j</i> industry where the corporate <i>i</i> is located)
	<i>R_{i,j,t-1}</i>	Whether experienced the registration system reform	From 2021 onwards, the value of <i>R</i> for corporate <i>i</i> is set to 1; if not, take <i>R</i> equal to 0.
Control variables	<i>lnAge</i>	Listed years of enterprises	The time from listing to year <i>t</i> and choose its natural logarithm
	<i>TobinQ</i>	Tobin Q value	The ratio of total market capitalization divided by total assets of the corporate
	<i>Cash</i>	Cash holdings	The ratio of cash and cash equivalents plus trading financial assets are divided by total assets of the corporate
	<i>Indi</i>	Ratio of institutional ownership	The institutional ownership ratio
	<i>Capital</i>	Fixed asset ratio	The Net fixed assets are divided by total assets of the corporate
	<i>TOP1</i>	The ownership ratio of the largest shareholder	The ownership ratio of the largest shareholder
	<i>ROA</i>	Return on total assets	The Net profit is divided by total assets of the corporate
	<i>Independent</i>	Proportion of independent directors	Independent directors as a percentage of the Board

Source: authors' own results.

The text characteristic index built by the prospectus of GEM enterprises, the number of prospectuses, and the number of cumulative disclosed words in the prospectuses are used as the moderator variables. The first moderator variable is the number of prospectuses. Shroff *et al.* (2017) used the number of peer enterprises as the index to measure information size that the corporate can acquire. Based on this idea, the number of prospectuses ($num_{i,j,t-1}$) is used to represent the influencing degree of information disclosure of the same industry. The higher value of $num_{i,j,t-1}$ implies that the corporate has more channels to acquire peer information during comprehensive decision-making of innovation investment. The second moderator variable is a text characteristic index is built by the prospectus of GEM enterprises. Loughran *et al.* (2013; 2014a; 2014b) and Wu *et al.* (2022) measured content enrichment of qualitative information by the text length of the document. Hence, the cumulative disclosed word number in the prospectuses ($Word_{i,j,t-1}$) is applied in this study to measure the abundance of disclosed information of the corporate. In this study, a statistic on cumulative word number in the prospectuses of GEM enterprises is carried out by using Python, finally obtaining logarithms and normalizing them.

Referring to Chen and Ma (2017), this study chooses indexes that may influence innovation input of enterprises as control variables. We also include industry and year-fixed effects in our regression. (1) Listed years of enterprises (*lnAge*): calculate the time from listing to year t and choose its natural logarithm. (2) Cash of enterprises (*Cash*): calculate the ratio of the sum of monetary capital and trading financial assets in total assets to measure cash flow of the corporate. (3) Shareholding ratio of institutions (*Indi*): the higher *Indi* value represents the higher attention and better performance of the corporate. (4) Corporate TobinQ value (*TobinQ*): it is expressed by *TobinQ*, and the enterprises with higher values possess more innovation resources. (5) Fixed assets ratio (*Capital*): calculate the ratio of net fixed assets in total assets, and it can somewhat reflect the development strength of enterprises. (6) Share proportion of the largest shareholder (*TOPI*): the higher share proportion of the largest shareholder represents the higher ownership concentration. (7) Return on total assets (*ROA*): it is calculated by the ratio of net corporate profit in total assets. (8) Proportion of independent director (*Independent*): calculate the proportion of independent directors in the number of board members.

Specific descriptions and calculation methods of different variables are introduced in *Table 1*.

2.3 Modeling

To test the moderating effects of information disclosure degree over the peer effects of technology innovation, the following moderation equations are built in this study:

$$RD_{i,j,t} = \alpha + \gamma_0 RD_peer_{-i,j,t-1} + \gamma_1 Controls_{i,j,t-1} + \sum Industry + \sum Year + \varepsilon_{ijt} \tag{1}$$

$$RD_{i,j,t} = \alpha + \gamma_0 RD_peer_{-i,j,t-1} + \gamma_1 RD_peer_{-i,j,t-1} * num_{i,j,t-1} + \gamma_2 num_{i,j,t-1} + \gamma_3 Control_{i,j,t-1} + \sum Industry + \sum Year + \varepsilon_{i,j,t} \tag{2}$$

$$RD_{i,j,t} = \alpha + \beta_0 RD_peer_{-i,j,t-1} + \beta_1 RD_peer_{-i,j,t-1} * Word_{i,j,t-1} + \beta_2 Word_{i,j,t-1} + \beta_3 Control_{i,j,t-1} + \sum Industry + \sum Year + \varepsilon_{i,j,t} \tag{3}$$

In the above equations, *i*, *j*, and *t* represent enterprises, industry, and year, respectively. $RD_{i,j,t}$ represents the innovation input of corporate *i* of industry *j* in year *t*.

$RD_peer_{-i,j,t-1}$ represents the average innovation investment of all enterprises, except corporate i in industry j in year $t-1$. $num_{i,j,t-1}$ represents the number of prospectuses in industry j where corporate i belongs in year $t-1$. $Word_{i,j,t-1}$ represents the mean of total word number in the prospectuses of all listed enterprises in industry j in year $t-1$. $Control_{i,j,t-1}$ represents the control variable of enterprises i in year $t-1$. $\sum Industry$ and $\sum Year$ represent the fixed effects of industry and year, respectively. $\epsilon_{i,j,t}$ represents a random error term. Interaction terms are set in Eqs. (2) and (3), and the interaction term coefficients are γ_1 and β_1 , respectively. If γ_0 of Eq. (1) is significantly positive, the existence of peer effects is verified. If γ_1 and β_1 of Eqs. (2) and (3) are significantly positive, information disclosure has a positive moderating effect over the peer effects of enterprises.

2.4 Descriptive Statistical Analysis

Table 2 shows the descriptive statistics of major variables. The minimum and maximum of RD are 15.45 and 20.34, respectively, with a mean of 17.68 and a standard deviation of 0.996.

Table 2. Descriptive statistics of main variables

Variable	Obs	Mean	S.d.	Min	Max
RD	6,591	17.68	0.996	15.45	20.34
RD_peer	5,239	17.67	0.527	11.88	19.34
num	6,775	3.528	1.158	0.693	5.159
Word	6,628	7.899	4.027	0	12.44
lnAge	6,696	1.375	0.795	0	2.639
TobinQ	6,696	3.682	2.447	1.187	14.63
Indi	6,654	21.49	19.03	0	151.0
Capital	6,693	0.0552	0.0517	1.41e-05	0.464
Cash	6,696	0.236	0.172	0.00247	0.925
TOP1	6,775	29.81	12.53	2.120	85.50
ROA	6,491	0.0348	0.0549	-0.601	0.536
Independent	6,775	0.384	0.0543	0.200	0.750

Notes: Table 2 presents the summary statistics of the key variables in this study. Means, standard deviation, minimums, and maximums for key variables from 2009-2022 are covered.

Source: authors' own results.

This result reflects that GEM enterprises pay high attention to innovation investment, and innovation investment of sample enterprises differs slightly. The average innovation investment of peer enterprises is 17.67, which can somewhat reflect that the technology innovation of key corporate and peer corporate has a convergence effect. In moderator variables, the maximum and minimum of prospectus numbers are 5.159 and 0.693, respectively, with a mean of 3.528. This result indicates that corporate numbers of different industries are significantly different, thus resulting in remarkable differences in information acquisition methods among different industries. The maximum word number in prospectuses is 12.44, with a mean of 7.875, indicating the profound differences in information disclosure degree among enterprises.

3. Results Analysis

3.1 Basic Regression Analysis

Table 3 lists the regression results of Model (1). The coefficient of *RD_peer* in Column (1) is 0.1132 and is significant on the 5% level under control over two-way fixed effects. This finding reflects the significant existence of peer effect of corporate technology innovation. In other words, the technology innovation levels of peer enterprises can increase technology innovation of enterprises by 11%, thus verifying H1: technology innovation investment of enterprises has peer effects.

Table 3. Basic regression results

Variables	(1) <i>RD</i>	(2) <i>RD</i>	(3) <i>RD</i>
<i>RD_peer</i>	0.1132** (2.2040)	0.1491** (2.0746)	0.1169** (2.3215)
<i>num</i>		0.0499 (0.8959)	
<i>RD_peer*num</i>		0.0967** (2.5328)	
<i>Word</i>			0.0064** (2.2711)
<i>RD_peer*Word</i>			0.0137*** (2.8474)
<i>lnAge</i>	0.3636*** (7.4617)	0.3592*** (7.4485)	0.3462*** (26.3323)
<i>Indi</i>	0.0038 (0.4465)	0.0019 (0.2115)	0.0006*** (2.6795)
<i>TobinQ</i>	0.0007 (0.9089)	0.0012 (1.5472)	0.0035* (1.7738)
<i>Capital</i>	0.7766*** (3.1095)	0.6846*** (2.8179)	0.7823*** (10.2730)
<i>Cash</i>	-0.1356 (-1.1319)	-0.1356 (-1.1089)	-0.1259*** (-3.9859)
<i>TOPI</i>	-0.0066** (-1.9926)	-0.0051* (-1.6470)	-0.0058*** (-8.5722)
<i>ROA</i>	1.1914*** (6.5793)	1.3615*** (7.1037)	1.2657*** (19.0596)
<i>Independent</i>	-0.7493*** (-2.7400)	-0.6179** (-2.2108)	-0.6643*** (-7.8422)
<i>_cons</i>	14.5024*** (14.7645)	13.5207*** (9.6046)	15.2756*** (53.9869)
<i>Year FE</i>	YES	YES	YES
<i>Industry FE</i>	YES	YES	YES
<i>N</i>	4989	4817	5009

Notes: All regressions include year and industry fixed effects. Column (1) indicates the regression result of the peer effects of corporate technology innovation. Column (2) and (3) indicate the regression results of the moderating effects of information disclosure degree on the peer effect of corporate technology innovation. ***, ** and * represent the significance level of 1%, 5% and 10% respectively.

Source: authors' own results.

As shown in *Table 3*, with considerations to control variables and two-way fixed effects, the regression results of the prospectus number are added in on the basis of H1. The coefficient of the interaction term $RD_peer*num$ is 0.0967 and is significant on the 5% level. This finding reflects that prospectus number can positively moderate the peer effect of technology innovation of GEM enterprises, indicating that the higher disclosure information abundance in GEM enterprises can stimulate the motivation of enterprises to learn and imitate behaviors of peer enterprises. Column (3) lists the regression results of the cumulative disclosed word number of the prospectus based on H1. The coefficient of the interaction term $RD_peer*Word$ is 0.0137 and is significantly positive at the 1% level. This result demonstrates that increasing prospectus contents can promote the peer effect of corporate technology innovation in the same industry cluster. Therefore, H2 is verified.

3.2 Endogenous Processing

3.2.1 Test of Instrumental Variables

In the above analysis, the influences of external environment of enterprises on their innovation behaviors are ignored when studying the peer effect of corporate technology innovation. The same external environmental impacts may also generate convergence effect to technology innovation in the same industry cluster. To solve the endogenous problem, with references to the research method of corporate financing decision-making of Leary and Roberts (2014), the specific return on stocks of peer enterprises is used as the instrumental variable of corporate technology innovation investment for estimation.

This study deems the specific return on stocks as a highly appropriate instrumental variable for the following reasons: (1) share price changes can reflect information on corporate innovation investment. After the influencing factors of external environment of enterprises (e.g., industrial market) are eliminated, only information regarding share price changes in peer enterprises is covered, which can accurately reflect the technology innovation of enterprises. This scenario meets the correlation requirements of instrumental variables. (2) Specific return on stocks only covers information of stocks, and specific return on stocks of peer enterprises (mean) does not contain factors that may influence the whole market and industry. The specific return on stocks of peer enterprises has no direct relations with technology innovation of target enterprises, thus meeting the endogenous requirements of instrumental variables. (3) The Fama French three-factor model used in the instrumental variable has been extensively applied in related studies. Based on the three-factor model, factor of momentum is added into the three-factor model to build the specific return on stocks, which could separate corporate information well. (4) Compared with the financial indexes of enterprises, corporate direct manipulation of share price is difficult and objective. The model construction formula of specific return on stocks is:

$$r_{ijt} - rf_t = \alpha_{ijt} + \beta_{ijt}^{IND} (\bar{r}_{-ijt} - rf_t) + \beta_{ijt}^M MKT_t + \beta_{ijt}^{SMB} SMB_t + \beta_{ijt}^{HML} HML_t + \beta_{ijt}^{MOM} MOM_t + \eta_{ijt} \quad (4)$$

$$\hat{r}_{ijt} - rf_t = \hat{\alpha}_{ijt} + \hat{\beta}_{ijt}^{IND} (\bar{r}_{-ijt} - rf_t) + \hat{\beta}_{ijt}^M MKT_t + \hat{\beta}_{ijt}^{SMB} SMB_t + \hat{\beta}_{ijt}^{HML} MOM_t + \eta_{ijt} \quad (5)$$

$$\hat{\eta}_{ijt} = (\hat{r}_{ijt} - rf_t) - (\hat{r}_{ijt} - rf_t) \quad (6)$$

r_{ijt} represents the return on stocks of corporate i in industry j in month t . rf_t represents the risk-free return rate in month t . \bar{r}_{-ijt} represents the average return on stocks of corporate i

in industry j in month t . MKT_t , SMB_t , HML_t , and MOM_t represent market, scale, book value ratio, and factor of momentum of the Carhart four-factor model, respectively. η_{ijt} represents the random disturbance term.

Table 4. IV estimation results

Variables	(1)	(2)	(3)
	<i>RD</i>	<i>RD</i>	<i>RD</i>
<i>RD_peer</i>	1.0051*** (4.0381)	1.7093 (1.188)	1.5748*** (2.6596)
<i>num</i>		0.1949* (0.108)	
<i>RD_peer*num</i>		0.8884** (0.440)	
<i>Word</i>			0.0076* (1.8852)
<i>RD_peer*Word</i>			0.0617** (2.0310)
<i>lnAge</i>	0.0019 (0.0327)	0.6403*** (0.054)	0.7213*** (5.5764)
<i>Indi</i>	0.0000 (0.0141)	0.0082 (0.010)	-0.0007 (-0.1051)
<i>TobinQ</i>	-0.0000 (-0.0950)	0.0118*** (0.001)	0.0027*** (3.3394)
<i>Capital</i>	-0.0022 (-0.0139)	2.2958*** (0.406)	0.6110* (1.6923)
<i>Cash</i>	-0.0187 (1.8641)	0.7122*** (0.151)	0.1136 (1.1230)
<i>TOPI</i>	-0.0008 (-0.0166)	-0.0035** (0.001)	-0.0023 (-1.0901)
<i>ROA</i>	-0.0000 (-0.0262)	4.0945*** (0.493)	0.4236** (2.3593)
<i>Independent</i>	0.0030 (0.0369)	0.3211 (0.325)	-1.0036*** (-3.3641)
<i>_cons</i>	-17.6694*** (-4.4607)	-16.3079 (21.396)	-7.7428 (-0.8231)
<i>Cragg-Donald Wald F statistic</i>	30.5959	206.11	215.06
<i>Year FE</i>	YES	YES	YES
<i>Industry FE</i>	YES	YES	YES
<i>N</i>	2851	2592	2870

Notes: All regressions include year and industry fixed effects. The results of first-stage regression of 2SLS are both significant under 1% levels, while column (1), (2) and (3) indicates the regression results of the three models in the second stage. ***, ** and * represent the significance level of 1%, 5% and 10% respectively.

Source: authors' own results.

Data of sample enterprises in the first three years are used for regression of Eq.(4) at the beginning of each year. The expected monthly excess return of each stock in the sample period is calculated by substituting the regression coefficient in the previous step into Eq.(5): $\hat{r}_{ijt} - rf_t$. Data from Eqs.(4) and (5) are brought into Eq.(6) to calculate the monthly specific return on each stock. Second, the average monthly specific return on stocks in a year is calculated, thus the annual specific return on each stock is obtained. The average annual

specific return on stocks of peer enterprises is used as the instrumental variable in this study. Table 4 shows the regression results of the two-stage least square method (2SLS) based on average annual specific return on stocks of peer enterprises.

The weak instrumental variable test results show that the F value is far higher than the empirical value (10) under the 1% level, indicating that the specific return on stocks of peer enterprises meets the correlation requirements with endogenous variable. Through regression of Eq (1), the regression coefficient of RD_peer to the instrumental variable in the first stage is significantly under the 1% level, which further proves the strong correlation between the instrumental variable and endogenous variable. After endogeneity is controlled, RD_peer remains significantly positive under the 1% confidence level as can be seen from Column (1). This result proves the existence of peer effect of technology innovation between focal enterprises and peer enterprises. Through regression of Eqs (2) and (3), the coefficients of RD_peer and $RD_peer*num$ are both significant under 1% in the first stage. Moreover, the F value is far higher than the empirical value (10) under the 1% confidence level. This result proves the strong correlation between instrumental variable and endogenous variable. Columns (2) and (3) show the regression results of Eqs (2) and (3) in the second stage, respectively. After endogeneity is controlled, the regression coefficients of $num*RD_peer$ and $Word*RD_peer$ relative to RD are significantly positive under 5% and 1% levels, respectively. This finding reflects that the abundance degree of information disclosure can promote the peer effect of corporate technology innovation. Overall, the above reference regression results are robust.

3.2.2 Lag Regression

A specific time interval exists in information transfer among enterprises and information decision-making of enterprises. In other words, some hysteresis phenomena occur from the information acquisition of enterprises to reflection on technology innovation decision-making of enterprises (Gordon *et al.*, 2020). To reduce the endogenous problem caused by reverse causality, the lag two phases of core independent variable and control variables are chosen for further regression.

Table 5. Considering Time-lag effect

Variables	(1)	(2)	(3)
	RD	RD	RD
RD_peer	0.1346** (2.0152)	0.1077 (1.3969)	0.0380 (0.7409)
num		0.0507 (0.9927)	
$RD_peer*num$		0.0810** (2.0858)	
$Word$			0.0003 (0.1112)
$RD_peer*Word$			0.0163*** (2.6662)
$lnAge$	0.2957*** (5.7650)	0.2813*** (3.4724)	0.3007*** (5.9875)
$TobinQ$	0.0130* (1.7520)	0.0110 (1.4867)	0.0146** (2.0212)

Table 5 (continuation). Considering Time-lag effect

Variables	(1) RD	(2) RD	(3) RD
<i>Indi</i>	0.0012 (1.4323)	0.0012 (1.4133)	0.0010 (1.2853)
<i>Capital</i>	0.6041** (2.5088)	0.3346 (1.4065)	0.5101** (2.3385)
<i>Cash</i>	0.0129 (0.1073)	0.0423 (0.3410)	0.0262 (0.2255)
<i>TOPI</i>	-0.0045 (-1.3865)	-0.0013 (-0.4502)	-0.0046 (-1.4412)
<i>ROA</i>	0.8795*** (4.9041)	1.0293*** (5.9300)	1.0458*** (5.8285)
<i>Independent</i>	-0.5164* (-1.7501)	-0.4743 (-1.6316)	-0.5152* (-1.7798)
<i>_cons</i>	15.0088*** (13.3684)	14.0371*** (10.0493)	16.6751*** (18.4219)
<i>Year FE</i>	YES	YES	YES
<i>Industry FE</i>	YES	YES	YES
<i>N</i>	3802	3352	4061

Notes: All regressions include year and industry fixed effects. The results of first-stage regression of 2SLS are both significant under 1% levels, while column (1), (2) and (3) indicates the regression results of the three models in the second stage. ***, ** and * represent the significance level of 1%, 5% and 10% respectively.

Source: authors' own results.

Table 5 lists the results. Column (1) shows the results of lagging two phases of Model (I), where the independent variable is significantly positive under the 5% level. The regression results of lagging two phases of Eqs. (2) and (3) are listed in Columns (2) and (3), respectively. The interaction terms are significantly positive under 5% and 1% levels. This finding indicates that the conclusions remain true with preliminary considerations to endogenous problems. Moreover, information disclosure has long-term influences on the peer effect of corporate technology innovation.

3.3 Robustness Test

3.3.1 Change Measurement Indexes

Referring to Chen and Ma (2017), this section measures technology innovation investment by the proportion of R&D investment and operation revenues, which is a new standard distinct from the above text. Regression results of Eq (1) are shown in Column (1) of Table 6. The explanatory variable is significantly positive relative to the dependent variable under the 5% level, thus verifying H1. In Columns (2) and (3), the interaction terms are significantly positive under 5% and 1% levels, while control variables are added in. This finding reflects that increasing the information disclosure degree of peer enterprises can promote the peer effect of corporate technology innovation. Hence, H2 remains true without any changes.

Table 6. Measuring RD with different indicators

Variables	(1) RD	(2) RD	(3) RD
<i>rd_peer</i>	0.1562** (2.2478)	0.2572*** (3.1125)	0.2143*** (3.1424)
<i>num</i>		0.0001 (0.0434)	
<i>rd_peer*num</i>		0.1032** (2.0683)	
<i>Word</i>			0.0003* (1.6878)
<i>rd_peer*Word</i>			0.0201*** (4.2493)
<i>lnAge</i>	0.0022 (0.6716)	0.0023 (0.7167)	0.0022 (0.6628)
<i>Indi</i>	-0.0011** (-2.1367)	-0.0010** (-2.0412)	-0.0011** (-2.2073)
<i>TobinQ</i>	-0.0001 (-1.6236)	-0.0001 (-1.4239)	-0.0001 (-1.4638)
<i>Capital</i>	0.0506*** (3.5201)	0.0509*** (3.5268)	0.0509*** (3.5615)
<i>Cash</i>	0.0034 (0.3429)	0.0051 (0.5323)	0.0036 (0.3736)
<i>TOPI</i>	-0.0005** (-2.4116)	-0.0005** (-2.3896)	-0.0005** (-2.4190)
<i>ROA</i>	-0.0271** (-2.0666)	-0.0260** (-1.9894)	-0.0267** (-2.0292)
<i>Independent</i>	-0.0280 (-1.5652)	-0.0261 (-1.4738)	-0.0280 (-1.5653)
<i>_cons</i>	0.1036*** (6.1461)	0.0955*** (5.6811)	0.0982*** (5.8959)
<i>Year FE</i>	YES	YES	YES
<i>Industry FE</i>	YES	YES	YES
<i>N</i>	4699	4699	4699

Notes: All regressions include year and industry fixed effects. The results of first-stage regression of 2SLS are both significant under 1% levels, while column (1), (2) and (3) indicates the regression results of the three models in the second stage. ***, ** and * represent the significance level of 1%, 5% and 10% respectively.

Source: authors' own results.

3.3.2 Add Peer Characteristic Variables

In the group network, characteristics of peer enterprises, such as cash flow, internal management, and capital structure, are also important reference elements when target enterprises are making decisions in imitation behaviors (Yong and Jing, 2022). To control disturbances of peer characteristics to the peer effect of corporate technology innovation, *TobinQ_peer*, *Independent_peer*, *TOPI_peer*, *Cash_peer*, and *Capital_peer* are all included in the control variables in this study. Table 7 presents the regression results. Results remain robust after the control variables of peer characteristics are added in.

Table 7. Considering peer characteristic control variables

Variables	(1) RD	(2) RD	(3) RD
<i>RD_peer</i>	0.1102** (2.0883)	0.1265* (1.8541)	0.1010** (2.1375)
<i>num</i>		0.0325 (0.5663)	
<i>RD_peer*num</i>		0.0952** (2.3496)	
<i>Word</i>			0.0053* (1.7375)
<i>RD_peer*Word</i>			0.0144*** (3.2411)
<i>lnAge</i>	0.3626*** (7.4411)	0.3622*** (7.4689)	0.3652*** (7.4939)
<i>Indi</i>	0.0060 (0.7994)	0.0002 (0.0197)	0.0006 (0.0659)
<i>TobinQ</i>	0.0007 (0.9108)	0.0010 (1.3257)	0.0006 (0.7462)
<i>Capital</i>	0.7747*** (3.2644)	0.6547*** (2.7716)	0.7776*** (3.1068)
<i>Cash</i>	-0.1282 (-1.1169)	-0.1551 (-1.2680)	-0.1403 (-1.1740)
<i>TOPI</i>	-0.0060* (-1.8330)	-0.0048 (-1.5441)	-0.0055* (-1.7176)
<i>ROA</i>	1.1568*** (6.6463)	1.2911*** (6.5825)	1.2028*** (6.3181)
<i>Independent</i>	-0.6967** (-2.5130)	-0.6032** (-2.1398)	-0.6454** (-2.2824)
<i>Cash_peer</i>	0.1661 (0.5837)	0.2995 (1.0300)	0.1677 (0.5974)
<i>Capital_peer</i>	0.2581 (0.4306)	0.9435 (1.2927)	0.8455 (1.0488)
<i>TOPI_peer</i>	0.0039 (1.1855)	0.0015 (0.2688)	0.0008 (0.1880)
<i>TobinQ_peer</i>	0.0290** (2.4719)	0.0233* (1.7920)	0.0304** (2.4981)
<i>Independent_peer</i>	0.6759 (0.8856)	1.2399 (1.5571)	0.8438 (1.1599)
<i>_cons</i>	13.5568*** (12.7826)	12.0680*** (8.7115)	13.7302*** (13.9173)
<i>Year FE</i>	YES	YES	YES
<i>Industry FE</i>	YES	YES	YES
<i>N</i>	4952	4723	5000

Notes: All regressions include year and industry fixed effects. The results of first-stage regression of 2SLS are both significant under 1% levels, while column (1), (2) and (3) indicates the regression results of the three models in the second stage. ***, ** and * represent the significance level of 1%, 5% and 10% respectively.

Source: authors' own results.

3.4 Further Analysis

3.4.1 Test of Registration System Reform Effect

Considering that registration system reform has been implemented on GEM since August 24th, 2020, if year *t* is set to 2020 and after, let *R*=1; otherwise, *R*=0, where *R* represents whether corporate *i* has experienced registration system reform.

To test the moderating effect of registration system reform on the peer effect of technology innovation, a moderator variable is added based on Eq. (7).

$$RD_{i,j,t} = \alpha + \gamma_0 RD_peer_{-i,j,t-1} + \gamma_1 RD_peer_{-i,j,t-1} * R_{i,j,t-1} + \gamma_2 R_{i,j,t-1} + \gamma_3 Control_{i,j,t-1} + \sum Industry + \sum Year + \varepsilon \tag{7}$$

Table 8. Registration system reform

Variables	(1)	(2)
	<i>RD</i>	<i>RD</i>
<i>RD_peer</i>	0.0646* (1.9190)	0.0570* (1.7256)
<i>R</i>	1.8417*** (3.4138)	1.3160** (2.2111)
<i>RD_peer*R</i>	0.1029** (2.3853)	0.0980** (2.3229)
<i>lnAge</i>		0.3615*** (11.9584)
<i>Indi</i>		0.0011** (2.2136)
<i>TobinQ</i>		0.0028 (0.6463)
<i>Capital</i>		0.7025*** (4.2010)
<i>Cash</i>		-0.1577** (-2.2424)
<i>TOPI</i>		-0.0057*** (-3.8609)
<i>ROA</i>		1.3652*** (9.0128)
<i>Independent</i>		-0.6569*** (-3.5088)
<i>_cons</i>	15.0244*** (22.5024)	15.2357*** (20.9369)
<i>Year FE</i>	YES	YES
<i>Industry FE</i>	YES	YES
<i>N</i>	5030	4817

Notes: All regressions include year and industry fixed effects. The results of first-stage regression of 2SLS are both significant under 1% levels, while column (1), (2) and (3) indicates the regression results of the three models in the second stage. ***, ** and * represent the significance level of 1%, 5% and 10% respectively.

Source: authors' own results.

As shown in Column (1) of *Table 8*, without the involvement of control variables, the coefficient of *RD_peer*R* is significantly positive on the 1% level when only fixed effect of

year and industry are controlled. As shown in Column (2), with considerations to control variables and control over two-way fixed effects, the coefficient of RD_peer*R is significantly under the 1% level. This finding indicates that registration system reform can positively moderate the peer effect of technology innovation of GEM enterprises. In other words, issuing registration system reform policy can stimulate motivations of enterprises to learn and imitate technologies of peer enterprises.

3.4.2 Heterogeneity Analysis

(1) Heterogeneity test based on the external information environment of peer enterprises

Table 9. External information environment of peer enterprises

Variables	(1)	(2)	(1)	(2)
	<i>Attention=0</i> <i>RD</i>	<i>Attention=0</i> <i>RD</i>	<i>Attention=1</i> <i>RD</i>	<i>Attention=1</i> <i>RD</i>
<i>RD_peer</i>	0.2228*** (3.2303)	0.1628*** (2.7930)	0.2374*** (3.0839)	0.1456*** (3.1884)
<i>num</i>	0.0170 (0.3842)		-0.0708 (-0.8558)	
<i>RD_peer*num</i>	0.1071*** (3.3021)		0.0835* (1.6550)	
<i>Word</i>		0.0001 (0.0102)		0.0088** (2.0999)
<i>RD_peer*Word</i>		0.0143** (2.2055)		0.0087* (1.6728)
<i>lnAge</i>	0.2882*** (5.5716)	0.2353*** (3.3052)	0.3804*** (5.4176)	0.3940*** (5.7654)
<i>Indi</i>	0.0156*** (2.6983)	-0.0113 (-1.2083)	0.0216*** (3.5780)	0.0260*** (4.0115)
<i>TobinQ</i>	0.0012 (1.5471)	-0.0006 (-0.6030)	-0.0000 (-0.0524)	-0.0001 (-0.1145)
<i>Capital</i>	0.3398 (1.6348)	0.0816 (0.3231)	0.5031* (1.6659)	0.5306* (1.7538)
<i>Cash</i>	-0.0813 (-0.7372)	0.0817 (0.5757)	-0.0872 (-0.6061)	-0.1180 (-0.7812)
<i>TOP1</i>	-0.0070** (-2.2774)	-0.0003 (-0.0819)	-0.0069* (-1.8622)	-0.0110*** (-2.7971)
<i>ROA</i>	0.9614*** (5.5282)	1.0335*** (3.1569)	0.7370*** (3.6754)	0.7995*** (4.2245)
<i>Independent</i>	-0.5889** (-2.3690)	-0.7055** (-2.1267)	-0.5204 (-1.5150)	-0.5042 (-1.5616)
<i>_cons</i>	12.3432*** (9.1188)	13.3882*** (14.0237)	12.5817*** (8.3919)	15.0490*** (16.6192)
<i>Year FE</i>	YES	YES	YES	YES
<i>Industry FE</i>	YES	YES	YES	YES
<i>N</i>	3256	1704	1616	1696

Notes: All regressions include year and industry fixed effects. The results of first-stage regression of 2SLS are both significant under 1% levels, while column (1), (2) and (3) indicates the regression results of the three models in the second stage. ***, ** and * represent the significance level of 1%, 5% and 10% respectively.

Source: authors' own results.

The analyst is an important information intermediary in the capital market (Holland *et al.*, 2003). The professional report interpretation and analysis ability of analysts can help investors deepen their understanding of corporate information. Therefore, if brokerage analysts have higher tracking degree to a corporate, it can better decrease the adverse effect caused by information uncertainty. Thus, enterprises can acquire more effective information with better external information environment (Gordon *et al.*, 2020). Then, enterprises with good external information environment are benefiting less from increasing information disclosure, whereas enterprises less concerned by analysts are benefiting more from “information disclosure” policy required by registration system reform. Referring to Li *et al.* (2014), this study measures the external information environment of enterprises by attention of analysts and uses the research report number provided by analysts as the measurement index. The more research reports indicate the better external information environment. If the research report number is higher than the median of the year in the same industry, $Attention=1$; and if the research report number is lower than the median of the year in the same industry, $Attention=0$. Grouped regressions of two moderator variables to the peer effect of corporate technology innovation are carried out.

As shown in *Table 9*, the interaction term between prospectus number and technology innovation investment as well as the interaction term between total word number in prospectus and technology innovation investment is significantly positive under the 1% level in the group with poor external information environment, and they are significantly positive under the 10% level in the group with good external information environment. Overall, with the increasing perfection of the information disclosure system, enterprises with poorer external information environment and fewer research reports of analysts can acquire information of peer enterprises more comprehensively and professionally for their decision-making in technology innovation investment.

(2) Heterogeneity test based on the internal information environment of peer enterprises

When internal information transparency is low, share price cannot fully reflect relevant characteristic information of enterprises. For enterprises with poor internal information environment, information disclosure can promote a stronger peer effect of technology innovation in the process of registration system reform. To verify such deduction, referring to the measurement in the studies of Zang (2007) and Wu *et al.* (2022), the internal information transparency of enterprises is measured by earnings management level of the previous stage. The higher degree of earnings management implies a poorer internal information environment of enterprises. In this study, the degree of earnings management is measured by the absolute of discretionary accruals (DA) which is calculated from the modified Jones model. If the degree of earnings management is higher than the median of the same industry in the year, let $DA=1$; If the degree of earnings management is lower than the median, let $DA=0$. On this basis, grouped regressions of peer effect of corporate technology innovation under the influences of two moderator variables are carried out.

Table 10 shows the empirical results. In Columns (1) and (2), the coefficients of two interaction terms of enterprises with strong earnings management and poor internal information environment are significantly positive on the 5% level, and R&D innovation investment of peer enterprises is also significantly positive. In Columns (3) and (4), the coefficient of enterprises with weak earnings management is significantly under 1% level, while the coefficient of enterprises with good information environment is positive but insignificant. Based on the above analysis, enterprises with poor information environment and less innovation information easily benefit from the positive influences of increasing

information disclosure degree on technology innovation of peer enterprises, and the peer effect is stronger. This situation further demonstrates the importance of "information disclosure" as the primary requirement of registration system reform.

Table 10. Internal information environment of peer enterprises

Variables	(1)	(2)	(3)	(4)
	<i>DA=1</i>	<i>DA=1</i>	<i>DA=0</i>	<i>DA=0</i>
	<i>RD</i>	<i>RD</i>	<i>RD</i>	<i>RD</i>
<i>RD_peer</i>	0.1351* (1.9355)	0.2273*** (3.7856)	0.1221 (1.4303)	0.0766 (1.5002)
<i>num</i>	0.0220 (0.4276)		0.0082 (0.1284)	
<i>RD_peer*num</i>	0.0845** (2.4632)		0.0748* (1.6526)	
<i>Word</i>		0.0074* (1.8762)		0.0020 (0.4494)
<i>RD_peer*Word</i>		0.0152** (2.4638)		0.0089 (1.5430)
<i>lnAge</i>	0.3604*** (7.5436)	0.3563*** (6.2472)	0.2873*** (3.9596)	0.3001*** (5.7053)
<i>Indi</i>	0.0033 (0.3637)	0.0208*** (2.7165)	-0.0118 (-0.7896)	-0.0117* (-1.6792)
<i>TobinQ</i>	0.0012 (1.5452)	0.0013 (1.4981)	0.0004 (0.3528)	-0.0003 (-0.3502)
<i>Capital</i>	0.5859** (2.5304)	0.3175 (1.1131)	0.9490*** (2.9252)	1.0356*** (4.0996)
<i>Cash</i>	-0.1577 (-1.2977)	-0.0346 (-0.2624)	-0.2884* (-1.7207)	-0.2353** (-2.0915)
<i>TOP1</i>	-0.0051* (-1.6800)	-0.0024 (-0.6474)	-0.0075* (-1.8844)	-0.0086*** (-3.8087)
<i>ROA</i>	1.3547*** (7.0417)	1.1219*** (5.2387)	1.2464*** (4.7065)	0.9938*** (4.1531)
<i>Independent</i>	-0.6033** (-2.1619)	-0.3957 (-1.3833)	-0.4483 (-1.1673)	-0.5329* (-1.9290)
<i>_cons</i>	13.7709*** (9.9864)	12.3794*** (10.8839)	14.5827*** (9.2713)	15.1807*** (14.8297)
<i>Year FE</i>	YES	YES	YES	YES
<i>Industry FE</i>	YES	YES	YES	YES
<i>N</i>	4779	2447	2431	2530

Notes: All regressions include year and industry fixed effects. The results of first-stage regression of 2SLS are both significant under 1% levels, while column (1), (2) and (3) indicates the regression results of the three models in the second stage. ***, ** and * represent the significance level of 1%, 5% and 10% respectively.

Source: authors' own results.

(3) Heterogeneity test based on the degree of competition of the involved industry

Baggs *et al.* (2007) believed that the industrial degree of competition can influence information disclosure degree of enterprises in the industry. In view of rivalry-based theories, peer enterprises are apt to increase R&D investment after obtaining innovation information to keep the competitive edges. For industries with higher degree of competition, R&D behaviors of enterprises are easily influenced by R&D behaviors of peer enterprises (Gordon *et al.*, 2020). Consequently, enterprises with higher degree of competition are easily influenced by peer enterprises and increase R&D investment. By contrast, enterprises with higher degree of industrial monopoly have weaker peer effect of technology innovation. With references to

previous studies, the industrial degree of competition is measured by the Herfindahl-Hirschman Index (*HHI*) under the China Securities Regulatory Commission (CSRC) secondary industry classification in this study. If *HHI* of the involved industry is higher than the median, let *HHI*=1; otherwise, let *HHI*=0. Samples are divided into low- and high-competition industrial groups for the regression of Eqs. (2) and (3), respectively.

Table 11. Degree of competition of the involved industry

Variables	(1)	(2)	(3)	(4)
	<i>HHI</i> =0	<i>HHI</i> =0	<i>HHI</i> =1	<i>HHI</i> =1
	<i>RD</i>	<i>RD</i>	<i>RD</i>	<i>RD</i>
<i>RD_peer</i>	0.1239 (1.4293)	0.1050 (1.5610)	0.1804 (1.4777)	0.0755 (0.8866)
<i>num</i>	0.0448 (0.6221)		0.1180 (1.1718)	
<i>RD_peer*num</i>	0.1070** (2.2186)		0.1154* (1.6539)	
<i>Word</i>		0.0043 (1.0589)		0.0090* (1.6472)
<i>RD_peer*Word</i>		0.0221*** (2.9533)		0.0251** (2.5165)
<i>lnAge</i>	0.3215*** (4.3444)	0.3125*** (4.4942)	0.4154*** (5.7120)	0.4090*** (5.7838)
<i>Indi</i>	-0.0039 (-0.2992)	-0.0006 (-0.0517)	0.0122 (0.9744)	0.0142 (1.1676)
<i>TobinQ</i>	0.0014 (1.2689)	0.0005 (0.4750)	0.0002 (0.2061)	-0.0000 (-0.0543)
<i>Capital</i>	0.3439 (1.0649)	0.3405 (1.1028)	0.3599 (1.0494)	0.4519 (1.2884)
<i>Cash</i>	-0.2073 (-1.3048)	-0.1688 (-1.0723)	-0.1189 (-0.6836)	-0.1825 (-1.0969)
<i>TOP1</i>	-0.0061 (-1.3672)	-0.0087* (-1.9158)	-0.0074* (-1.9420)	-0.0076** (-2.0644)
<i>ROA</i>	1.4549*** (6.1774)	1.1544*** (5.0882)	1.8037*** (4.2539)	1.7784*** (3.9019)
<i>Independent</i>	-0.6692** (-1.9866)	-0.5894* (-1.8289)	-1.2161*** (-2.9507)	-1.4019*** (-3.5148)
<i>_cons</i>	13.7027*** (8.3205)	14.3498*** (11.5064)	13.5181*** (5.9727)	15.7768*** (10.6372)
<i>Year FE</i>	YES	YES	YES	YES
<i>Industry FE</i>	YES	YES	YES	YES
<i>N</i>	2096	2101	1783	1773

Notes: All regressions include year and industry fixed effects. The results of first-stage regression of 2SLS are both significant under 1% levels, while column (1), (2) and (3) indicates the regression results of the three models in the second stage. ***, ** and * represent the significance level of 1%, 5% and 10% respectively.

Source: authors' own results.

Table 11 shows the empirical results. The interaction term between prospectus number and technology innovation investment as well as the interaction term between the total word number in prospectus and technology innovation investment are significantly positive under the 5% and 1% levels in the industrial group with high degree of competition and low degree of industrial monopoly. Conversely, they are significant in the industrial group with a high

degree of industrial monopoly, but the coefficients are lower than those of the industry with lower degree of industrial monopoly. Overall, increasing information disclosure degree can better promote the peer effect of corporate technology innovation in the industry with higher degree of competition. This finding conforms to the rivalry-based theories.

(4) Heterogeneity test based on property rights of enterprises

Table 12. Property rights of enterprises

Variables	(1) <i>SOE=0</i> <i>RD</i>	(2) <i>SOE=0</i> <i>RD</i>	(3) <i>SOE=1</i> <i>RD</i>	(4) <i>SOE=1</i> <i>RD</i>
<i>RD_peer</i>	0.1738** (2.2295)	0.1170* (1.9176)	0.0225 (0.1309)	0.0018 (0.0179)
<i>num</i>	0.0690 (1.1529)		-0.1569 (-1.0882)	
<i>RD_peer*num</i>	0.1004** (2.3943)		0.0319 (0.3447)	
<i>Word</i>		0.0085*** (2.9440)		0.0014 (0.1664)
<i>RD_peer*Word</i>		0.0190*** (2.8777)		0.0115 (0.9919)
<i>lnAge</i>	0.3697*** (7.2579)	0.3760*** (7.4138)	0.3625** (2.1747)	0.3362** (2.0087)
<i>Indi</i>	0.0005 (0.0547)	0.0010 (0.1013)	0.0373 (1.2974)	0.0344 (1.1820)
<i>TobinQ</i>	0.0015* (1.8424)	0.0012 (1.5703)	-0.0004 (-0.1557)	-0.0000 (-0.0085)
<i>Capital</i>	0.5622** (2.2641)	0.5909** (2.3860)	0.8463 (1.0141)	0.8366 (0.9979)
<i>Cash</i>	-0.1549 (-1.2085)	-0.1779 (-1.3820)	0.1358 (0.3046)	0.1648 (0.3651)
<i>TOPI</i>	-0.0071** (-2.0187)	-0.0080** (-2.3047)	0.0019 (0.3479)	0.0016 (0.2898)
<i>ROA</i>	1.3907*** (7.1059)	1.3885*** (7.0341)	0.4165 (0.3810)	0.4445 (0.4073)
<i>Independent</i>	-0.7109** (-2.3734)	-0.7875*** (-2.6827)	0.0642 (0.0796)	0.1221 (0.1517)
<i>_cons</i>	12.2532*** (8.4578)	13.6596*** (12.7997)	15.7577*** (4.9769)	15.9672*** (8.7328)
<i>Year FE</i>	YES	YES	YES	YES
<i>Industry FE</i>	YES	YES	YES	YES
<i>N</i>	4303	4303	504	504

Notes: All regressions include year and industry fixed effects. The results of first-stage regression of 2SLS are both significant under 1% levels, while column (1), (2) and (3) indicates the regression results of the three models in the second stage. ***, ** and * represent the significance level of 1%, 5% and 10% respectively.

Source: authors' own results.

Based on the special institutional background of China, differences in property rights will influence the information acquisition degree of enterprises. Some studies have demonstrated that there are differences between state-owned enterprises and private enterprises in terms of resources or corporate governance, while the technology innovation strategy of state-owned enterprises and private enterprises also relatively have heterogeneity characteristics (Li, Greenwood, 2004; Ren *et al.*, 2022). On the one hand, state-owned enterprises are usually the party with information advantages due to natural connections with

government, and their responses to relevant natural policies can be reflected more quickly in the decision-making system of enterprises. Private enterprises lack such advantages that state-owned enterprises have, and they are apt to imitate and learn behaviors of other enterprises in the same industry. On the other hand, the degree of competition of private enterprises is fiercer than state-owned enterprises. The decision-making success or failure may directly determine the operation performances of enterprises. Consequently, the peer effect of corporate technology innovation is significant. Given that state-owned enterprises may have insufficient motivation in technology innovation due to their stability, private enterprises are benefiting more from the perfection of the information disclosure system. In this study, *SOE* is determined as 1 for private enterprises and foreign-owned enterprises, and it has a value of 0 for state-owned enterprises and central state-owned enterprises.

Table 12 shows the empirical results. For private enterprises, the interaction term between prospectus number and technology innovation investment as well as the interaction term between the total word number in prospectus and technology innovation investment is significant under 5% and 1% levels, respectively. For state-owned enterprises and central state-owned enterprises, the above two coefficients are positive but insignificant. This finding proves that the perfection degree of information disclosure system can promote the peer effect of technology innovation of private enterprises more than state-owned enterprises possibly because state-owned enterprises have strong information acquisition ability.

4 Discussions

All empirical results in this study have verified the proposed hypotheses. This finding implies that technology innovation peer effect exists among peer enterprises. Moreover, the degree of information disclosure may influence the peer effect of corporate technology innovation. Discussions are drawn as follows:

(1) In the GEM market, the peer effect of corporate technology innovation exists in the same industry. In other words, peer effects can improve the technology innovation investment level of enterprises. Continuous increase in information disclosure degree can facilitate the peer effect of corporate technology innovation, and such promotion is further intensified with the increase in information disclosure paths and contents, thus verifying H1 and H2. This finding is consistent with the research conclusions of Badertscher *et al.* (2013) as well as Bustamante and Frésard (2021). While previous literature is based on the peer effect of all investment behaviors of enterprises, this study refines the research perspective to the technology innovation investment of enterprises and argues that the technology innovation behaviors of enterprises in the same industry are also subject to the peer effect, which will be strengthened with the enhancement of the degree of disclosure, providing an enriched explanation of the dynamic competition theory from the perspective of technological innovation of enterprises. The peer effect of corporate technology innovation is attributed to the R&D risks of corporate technology innovation. To decrease such high-cost decision-making risks, enterprises may use the information for imitative rather than inventive activities. Moreover, increasing information disclosure degree can promote the peer effect of technology innovation of enterprises for the following reasons: Given the higher information disclosure degree in prospectus, the management layer can acquire more industrial information and market information, thus facing lower information uncertainty. Hence, the imitation and learning motivation of peer enterprises are further stimulated.

(2) Changes in the stock issuing system of GEM in 2020 (approval system-registration system) can promote the peer effect of corporate technology innovation, which is a discovery

of this study. According to information theory, management tends to adjust their behavior by receiving information from their peers when there is information uncertainty. Registration system strengthens the attention to information disclosure. In the IPO stage, the inquiry system of bourses can increase information disclosure degree well, effectively lower the uncertainty of innovation investment, and help the management of peer enterprises with decision-making in innovation investment. Accordingly, registration system reform can promote the peer effect of corporate technology innovation. The previous literature employed the U.S. government budget crisis and changes in import tariffs as quasi-natural experiments, pointing out that enterprises may imitate the R&D investment behaviors of their rivals based on peer disclosure (Bernard *et al.*, 2020). Based on the reform of the registration-based IPO system, this study examines the applicability of the findings to the GEM, which is one of the backbones of China's technological innovations. The findings contribute compelling evidence supporting a further development of the registration-based IPO system in China's capital market.

(3) The promotion effect of information disclosure to the peer effect of corporate technology innovation is more obvious in corporate with poor external information environment than those with good external information environment. This finding is consistent with the research conclusions of Gordon *et al.* (2020) and Sun *et al.* (2022). In contrast to the previous literature, which used as an indicator of whether a corporate is located in relatively developed provinces or cities in China when examining the effect of differences in the external information environment on the heterogeneity of enterprises' technology innovations, this paper presents the differences in the external information environment of the enterprises more objectively in terms of the number of reports authored by analysts, which reduces the error that may be caused by the fact that there are differences in the information environment within the urban areas as well. Based on the above analysis, if security analysts pay higher attention to a corporate, their professional analysis of enterprises can decrease information uncertainty, so enterprises can acquire more effective information. Therefore, increasing information disclosure degree can promote the peer effect of technology innovation more than those with low attention of analysts. Regarding internal information disclosure, this study finds that it promotes the peer effect of technology innovation of enterprises with poor internal information environment more obviously than enterprises with good internal information environment, thus enriching the research insights of the technology innovation peer effects literature. In other words, enterprises can acquire less information in innovation decision-making if the information asymmetry among enterprises is higher. For these enterprises, increasing information disclosure degree can produce a stronger peer effect of corporate technology innovation.

(4) The promotion of information disclosure to the peer effect of corporate technology innovation is particularly more obvious in the industry with fiercer competition. This finding agrees with the findings of Durnev and Mangen (2020). Given the higher degree of competition in industry, the product homogeneity is more obvious. To keep the competitive edges, information disclosure of enterprises can have higher influences in innovation investment behaviors of other enterprises. For property rights of enterprises, Non-state-owned enterprises promote information disclosure more to the peer effect of technology innovation than state-owned enterprises. This finding is consistent with the findings of Yang *et al.* (2020). "Political relation" is an important reputation mechanism (Sun *et al.*, 2005). The natural connection between state-owned enterprises and government decreases the uncertainty of acquired information by enterprises. State-owned enterprises have more extensive sources of effective information. Therefore, information disclosure promotes the peer effect of

technology innovation of state-owned enterprises less than private enterprises. Based on previous literature, this study centers on investigating the existence of heterogeneity in the moderating effect of disclosure on the peer effect of enterprises' technology innovations concerning the degree of competition and property rights, which provides a complementary approach to further elaborating on the influencing factors of the peer effect.

Conclusions and Implications

Main Findings

Using the data of the listed enterprises of GEM from 2009 to 2022, the influences of information disclosure on the peer effect of technology innovation of enterprises were explored under the background of a registration system reform that centers on information disclosure. The following conclusions are drawn: (1) the peer effect of corporate technology innovation exists in the same industry. (2) Information disclosure can promote the peer effect of corporate technology innovation and facilitate collaborative development and progress of the industry. With the increase in the prospectus number and content abundance disclosed by GEM, the peer effect of corporate technology innovation is strengthened significantly. (3) Registration system reform can promote the peer effect of corporate technology innovation and prove that the registration system reform has positive policy effects on China's capital market. (4) In the industry with lower HHI, that is, higher degree of competition, the peer effect of corporate technology innovation is more easily influenced by the positive stimulation by the increased information disclosure degree. (5) The peer effect of technology innovation of enterprises with poor internal and external information environments benefits more from the bonus brought by increasing information disclosure degree. (6) Compared with state-owned enterprises, private enterprises are more likely to encounter the positive influences of two moderator variables. This finding is due to the fact that the information environment of private enterprises is slightly poorer than that of state-owned enterprises, and they have lower information transparency.

Managerial Implications

The conclusions of this study have important managerial implications.

(1) The positive effect of information disclosure on corporate technology innovation is developed fully. Thus, information disclosure has profound significance to the high-quality development of capital market during the comprehensive implementation of the registration system reform. Supervisors shall continuously perfect the information disclosure system, optimize the internal and external information environments of enterprises, strictly control the mandatory information disclosure quality, encourage more enterprises to disclose information voluntarily, and continuously standardize voluntary information disclosure behaviors. Moreover, as the milestone market-oriented reform of A-shares, the registration system shall fully develop the key role of markets in resource allocation, which needs to promote the implementation of the registration system, further enhance the medium and long-term construction of the registration system, as well as improve the disclosure standards of the sub-industry. Additionally, regulators should take the initiative to guide the market to pay attention to innovation development, perfect the innovation development system, and deeply implement the innovation-driven development strategies, and strengthen the support for high-tech modern industrial system.

(2) Increasing information disclosure degree may drive changes in R&D strategies and increase the R&D investment of other enterprises in the same industry. Meaning, that high-quality information disclosure is conducive to mutual learning and imitation among peer enterprises, thus forming a benign competitive environment and increasing the resource allocation efficiency of enterprises and the whole capital market. Therefore, the registration system shall consistently reinforce the issuer's system of being the primary responsibility for information disclosure. For regulators, it is crucial to effectively assume the role of the "night's watch", enhancing regulatory enforcement, and improving the information disclosure system, thereby fostering a capital market of high quality that is aligned with market mechanisms.

(3) For enterprises, attention to their peer disclosure and comprehension of its content shall be raised. The innovation information disclosed by peers encompasses valuable technical approaches and relatively sharp development focuses, which are of considerable referential significance in assisting enterprises in positioning themselves in the industry. As peers are both rivals and sources of learning and referring, the corporate may set up a professional department responsible for the summary and in-depth interpretation of peer disclosure. Meanwhile, the corporate shall leverage the professional analysis of disclosed information by analysts and institutional investors to fully absorb effective information, which may enhance the quality of decision-making through active learning, enabling the formulation of an innovative strategy suitable for their development.

Limitations and Future Directions

Some limitations that need attention should be raised. For example, influences among enterprises in the same region and mutual influences among enterprises in the same supply chain are ignored in the division of peer effects. The empirical data only uses the mandatory information disclosure-prospectus as the research objects, but voluntary information disclosure modes (e.g., teleconferencing and tone of management layer) can influence capital market more obviously at present. The voluntary information disclosure modes shall be interpreted through dictionary or machine learning methods in the future. Further deep studies on the relationship between voluntary information disclosure and the peer effect of corporate technology innovation are still needed.

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INFORMACIJOS ATSKLEIDIMAS IR ĮMONIŲ TECHNOLOGIJŲ INOVACIJŲ POVEIKIS**Xinyao Yang, Zheng Shi, Chengxing Li****SANTRAUKA**

Informacijos atskleidimas yra esminė priemonė kapitalo rinkos veiksmingumui gerinti. Kaip skatinti kapitalo rinkos plėtrą tobulinant informacijos atskleidimo sistemą, nuolat aktuali priežiūros skyriaus ir akademinio rato tema. Siekiant aptarti giluminį informacijos atskleidimo poveikį įmonėms kapitalo rinkoje, remiantis informacijos teorija ir dinaminės konkurencijos teorija, naudojant 1158 Kinijos biržoje listinguojamų įmonių duomenis apie augančią įmonių rinką (GEM) nuo 2009 iki 2022 m., informacijos atskleidimo įtakas. Taikant daugiamatės regresijos metodą, buvo tiriamas įmonių technologijų inovacijų tarpusavio poveikis. Rezultatai rodo, kad informacijos atskleidimas gali sustiprinti įmonių technologijų naujovių tarpusavio poveikį, kuris gali dar labiau sustiprėti didėjant informacijos atskleidimo keliams ir turiniui. 2020 m. Kinijos GEM įgyvendinta registracijos sistemos reformos politika galėtų paskatinti įmonių technologijų inovacijų tarpusavio poveikį. Nors įmonės, kurių išorinis ir vidinis informacijos aplinkos skaidrumas yra prastesnis, gauna naudos iš teigiamo padidėjusio informacijos atskleidimo laipsnio poveikio, didėjantis informacijos atskleidimo laipsnis daro didelę konkurencinę įtaką įmonių technologijų inovacijų tarpusavio poveikiui. Išvados ne tik pateikiamos kai kurios priežastinės nuorodos į informacijos apie technologijų naujovių tarpusavio poveikį atskleidimo skatinimą, bet ir patikrinamas GEM registracijos sistemos reformos politinis poveikis ir atskleidžiamas svarbus Kinijos registracijos sistemos reformos vaidmuo gerinant išteklių paskirstymo efektyvumą kapitalo rinkose.

REIKŠMINIAI ŽODŽIAI: tarpusavio efektai, informacijos atskleidimas, technologijų naujovės, GEM, registracijos sistema.