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Narrative R&D disclosure and bank loans: Evidence from China☆,☆☆

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ABSTRACT

By taking advantage of machine learning and textual analysis method to construct narrative R&D disclosures, we investigate the impact of narrative R&D disclosures of China's listed firms on their access to bank financing with the two-way fixed effects model. We found that narrative R&D disclosures lead to an increase in bank financing of listed firms. This conclusion still holds after a series of robustness and endogeneity tests. Additionally, it is found that the enhancement of incremental information and banks' superiorities in processing complicated public information are the mechanisms. Finally, we further find that the positive impact of narrative R&D disclosures on bank loans is mainly manifested in the sample of firms operating in highly competitive industries, non-state-owned in nature and R&D-intensive.

1. Introduction

Innovation has long been documented as the major force of firms' development and economic growth (Solow, 1957). In fact, most studies show that R&D activities will lead to better future earnings and enhance the wealth of shareholders (Cockburn et al., 2000). However, financial constraint is a common problem faced by many firms conducting R&D activities. Different from developed economics, bank loans dominate the debt market of China, providing continuous and stable funding source to incumbent corporates fostering their R&D investments (Mande et al., 2000).

Meanwhile, R&D-intensive firms usually suffer from higher information asymmetry because of the complexity and exploration

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traits of R&D activities (Aboody and Lev, 2000), which make it hard for them to raise fund from outside. R&D-related disclosures are helpful in decreasing information asymmetry and alleviating R&D-intensive firms' financial constraints (Huang et al., 2021). Therefore, China Securities Regulatory Commission (CSRC) began to require China's listed companies to make detailed descriptions about their R&D activities (narrative R&D disclosure) in 2006.[5] Firms in China mainly seek loans from banks to conduct R&D activities given bank sectors' dominance in the debt market. At the same time, banks will search for information about their innovation activities to alleviate the information asymmetry in the lending process in order to reduce own lending risks. Therefore, a natural question to ask is that whether more narrative R&D disclosures will alleviate the information asymmetry and enhance banks' willingness to lend?

We try to answer this question by quantify narrative R&D disclosures with machine learning and textual analysis methods. In theory, there is a tension regarding the impact of more narrative R&D disclosures on bank financing. The intrinsic mechanisms are examined from two perspectives. From the perspective of incremental information, more narrative R&D disclosures will decrease the information asymmetry, reducing banks' information gathering costs and risks associated with debt contract, and further enhancing their willingness to lend. From the perspective of banks' information processing superiority, banks can comprehend and digest complicated narrative R&D disclosures with their alternative information channels and highly professional staff repositories (Petersen and Rajan, 1994).

This study contributes to several areas. Firstly, it contributes to the innovation in measuring R&D-related information disclosures. Given its great significance of R&D investments in enhancing firms' future values, stakeholders are especially concerned with firms' R&D disclosures. However, it is difficult to measure firms' R&D-related disclosures for empirical analysis. Some studies using quantitative financial data such as R&D spending, patent applications to proxy for R&D-related information disclosures suffered in distinguishing the effect of R&D-related disclosures from R&D investment or outputs (Griffin et al., 2022). While others which adopt man-made R&D dictionary to measures narrative R&D disclosures sustain great subjectivity (Merkley, 2014). We creatively adopted a "Seed word+Word2Vec " machine learning method to construct a R&D-words list which can minimize potential bias associated with man-made R&D dictionaries. Second, it supplements the research on the influencing factors of bank financing (Kim and Valentine, 2021) from the perspective of narrative R&D disclosures. Albeit the great importance of bank financing in supporting China's firms' R&D investments, yet there are few papers exploring the effect of firms' narrative R&D disclosures on bank financing. Third, it contributes to the research regarding banks' strength in processing complicated public information by innovatively exploring the impact of narrative R&D disclosures on firms' bank loans.

2. Literature review and hypotheses development

2.1. Literature review

1. Bank loans of firms

The literature on bank loans related to our research mainly focuses on two aspects: First, scholars commonly agree that information asymmetry is the main contributor of enterprises' financial constraints (Myers and Majluf, 1984). Bharath et al. (2009) argued that corporate credit shortage, asymmetric government inputs, and excessive demand for funds similarly contribute to the rigidity gap in corporate loan needs. Chen et al. (2013) argued that the good bank-enterprise relations and private channels can reduce the information asymmetry, thereby increasing corporate credit availability. Second, many studies documented that banks have superiorities in processing complicated public information with their alternative information channels. Unlike the public markets, banks tend to focus on specific industries or regions, emphasizing on relationship lending, which involves repeated interactions over time as well as encourages them to collect information about borrowers (Bharath et al., 2009). Meanwhile, firms are relatively more willing to reveal their proprietary information to some private lenders such as banks or loan syndicate. Griffin et al. (2022) found that R&D-active firms preferred single-lender to multi-lender private loan financing.

2. R&D-related information disclosures

Regarding the determinants of R&D information disclosures, previous studies posit that managers face a trade-off between the costs and the advantages when making R&D disclosing decisions (Huang et al., 2021). Managers make voluntary disclosures only when the increase in firm value from information disclosures exceeds costs (Zhong, 2018). Further, many researchers indicate that managers would like to make voluntary R&D disclosures especially for firms with more innovation effort, higher intensity of exploratory innovation, poorer earnings performance

As to the consequence of R&D information disclosures, some studies focus on the relation between firms' performance or future value with R&D information disclosures (Kim and Valentine, 2021), others investigate how narrative R&D disclosures affect earnings management, analyst forecasts and R&D mispricing (Jia, 2018). Additional studies find corporates strategically leverage R&D disclosures to make impression management, affect stock prices (Glaeser and Landsman, 2021). In addition, Merkley (2014) uses textual analysis approach to measure firms' narrative R&D disclosures and finds that it negatively affects earnings performance, but reduces

[5] The No. 2 Guidelines on the Content and Format of Information Disclosure in Annual Reports by Companies Issuing Public Securities (Revised Edition 2005) states: "listed firms are supposed to disclose their R&D projects, innovation plans and risks related to R&D investments in the scheduled annual report.".

the cost of debt (Arvid and Kleimeier, 2021). Saidi and Žaldokas (2021) find that R&D information disclosures help firms to switch creditors.

3. Research reviews

Although these studies provide insights about the determinants and consequences of R&D information disclosures, they do not specifically examine the relationship between R&D disclosures and bank loans. Besides, most studies focus on the disclosures of quantitative financial data such as R&D spending, patent applications, ignoring qualitative information like narrative R&D disclosures which is increasingly important.

2.2. Hypotheses development

We develop hypothesis from two aspects: incremental information and banks' superiority in processing complicated public information.

Firstly, most studies argue that narrative R&D disclosures enhance outsiders' knowledge of corporates' R&D strategies by conveying incremental information. Compared to quantitative disclosures of R&D-related expenditures or patent outputs, qualitative narrative R&D disclosures are concrete and comprehensive (Merkley, 2014; Cazier and Pfeiffer, 2016). Narrative R&D disclosures can deliver elaborate and detailed information regarding companies' R&D investments, progress and potential outcomes. Therefore, we argue that narrative R&D disclosures will make banks more informed of firms' innovation activities, reducing the information risks associated with information asymmetry and enhancing banks' willingness to lend by conveying incremental information regarding firms' innovation activities.

Secondly, banks have advantages in processing complicated public information channels and can better monitor the borrowers with their superior professional expertise (Merkley, 2014; Blankespoor et al., 2020). Most banks tend to dominate in specific industries or regions, and also emphasize on relationship lending, which involves repeated interactions over time and collects information about borrowers (Myers, 2001). Besides, banks' staff are endorsed with stronger professionalism due to their long-term engagement in specific bank lending business and affairs, enabling them to better recognize and interpret complicated information. Therefore, we believe that more narrative R&D disclosures can make banks informed of firms' innovation activities and enhance banks' willingness to lend.

In contrast, R&D-related disclosures usually entails higher proprietary costs (Kim and Valentine, 2021), which can prevent managers form disclosing authentic and accurate information about their R&D projects. Obfuscation theory indicates that managers are likely to obscure narrative R&D disclosures to avoid proprietary costs under mandatory disclosure requirements (Dye, 2011). Narrative R&D disclosures can commit more ambiguities and managerial opportunism than other categories of disclosures. Therefore, more narrative R&D disclosures with vagueness will reduce their understandability and usefulness, hence raise information asymmetry and decrease bank lending. Based on the above analysis, this paper proposes the following hypotheses:

H1a: Narrative R&D disclosures increase bank loans.
H1b: Narrative R&D disclosures decrease bank loans.

3. Research design

3.1. Sample selection and data sources

This paper selects China's listed companies between 2007 and 2022 as the research sample. It excludes the financial industry and observations with missing variables. It then winsorizes the continuous variables by 1 % and finally yields an unbalanced panel sample with 10,015 firm-year observations. Firms complete annual reports come from the CNINF.[6] All other data are from CSMAR database.[7]

3.2. Definition and description of main variables

1. Explanatory variable:narrative R&D disclosure (NarRd), which is calculated as the number of R&D-related words or phrases divided by the total number of words in every annual report with adjustment by the average value for the industry. This paper uses machine learning and text analysis methods to identify R&D-related words,[8] which is different from Merkley (2014) who manually construct R&D word list.
2. Explained variable:bank loans (BankLoan), following Chakraborty et al. (2022), which is calculated as the total bank debt scaled by total assets.

[6] http://www.cninfo.com.cn/new/index
[7] https://data.csmar.com/
[8] The specific indicator construction process is not shown due to space limitations and can be obtained from the authors.

3. Control variables: we selected two control variables at the executive, company levels, the definition of variables are shown in Table 1. Moreover, we control for firm and year fixed effects.[9]

3.3. Regression model

The following model is conducted to test the main hypothesis.

$$\mathrm{BankLoan}_{i,t} = \alpha_0 + \beta_1 \mathrm{NarRd}_{i,t-1} + \sum_{j=2}^{17} \beta_j \mathrm{Controls}_{i,t-1} + \mathrm{Firm}_i + \mathrm{Year}_{t-1} + \varepsilon_{i,t} \quad (1)$$

In model (1),$\mathrm{BankLoan}_{i,t}$ is the bank loans of firm i in period t,$\mathrm{NarRd}_{i,t-1}$denotes the narrative R&D disclosures of firm i in period t-1. $\mathrm{Controls}_{i,t-1}$are control variables.$\mathrm{Firm}_I$ and Year_{t-1} are the firm and year fixed effect. If β_1 is significantly positive(negative), it means that narrative R&D disclosures can significantly increase(decrease) firms' bank loans.

4. Empirical tests and analysis of results

4.1. Narrative R&D disclosures and bank loans

Table 2 reports the relation between narrative R&D disclosures and bank loans. Columns (1) and (2) show that the coefficients before and after adding controlling variables are 0.166 and 0.136 respectively, which are both significant at 1 % level, indicates that narrative R&D disclosures have a significant enhancing effect on bank loans. And for every 1 % increase in the standard deviation of narrative R&D information, bank lending increases by 3.45 % relative to its mean value after adding controlling variables. This result validates hypothesis H1a. With regard to control variables, the coefficients on firm size and cash flow are significantly positive and negative respectively, consistent with the previous studies.

We further distinguish between long and short-term bank loans. In columns (3) and (4), the coefficients of short and long-term loans are 0.125(significant) and 0.011(not significant). This result indicates that banks are inclined to provide short-term loans to enhance the monitor of R&D-intensive firms because of the high risks and uncertainties associated with R&D investments (Lin et al., 2012).

4.2. Robustness test

We conduct some robustness for hypothesis H1a: (1) Replacing the measure of the dependent variable (BankLoan to Fdloan). (2) Replacing the independent variable (NarRd to InnoDis). (3) Considering the estimation bias caused by mean regression, we conduct the test at 25 % and 75 % quartiles separately. (4) Adding board independence and diversity to the control variables. The above results are shown in Table 3, in consistent with hypothesis H1a.

4.3. Mitigation of endogeneity problems

There may be some endogeneity issues, such as omitted variables and sample selection bias of estimation due to incomplete sample selection for objective reasons. The following methods are applied to alleviate possible endogeneity problems.

4.3.1. The propensity score matching method (PSM)

We used both PSM paired and entropy balance sample to conduct our research. After PSM (One to one matching and "put back" approach) and entropy balancing, 6,874 and 9,875 valid sample observations were obtained respectively. The coefficients of narrative R&D disclosures on bank loans are 0.139 and 0.165 respectively in columns (1) and (2) of Table 4, which are both significant.

4.3.2. The difference in difference method (DID)

In September 2012, CSRC issued the CFAR2012, which requires more specific innovation information disclosures. Therefore, we predict the positive association between narrative R&D disclosures and bank loans to be accentuated after CFAR2012. We construct the following model:

$$\mathrm{BankLoan}_{i,t} = \alpha_0 + \beta_1 \mathrm{Treat}_i * \mathrm{Post}_t + \beta_2 \mathrm{Post}_t + \sum_{j=2}^{17} \beta_j \mathrm{Controls}_{i,t-1} + \mathrm{Firm}_i + \mathrm{Year}_{t-1} + \varepsilon_{i,t} \quad (2)$$

Where treat is a dummy variable that equals to 1 for treatment firms, and 0 for control firms. Post equals to 1 if the firm-year observation is after fiscal year 2013 and 0 otherwise. The result is shown in column (3) of Table 4. The coefficient of Treat*Post is 0.323 and significant.

[9] Descriptive statistics for the above variables are not shown due to space limitations and can be obtained from the authors.

Table 1
Definition and metrics of the control variables.

Variables	Definition
Receiv	Net accounts receivable divided by total assets.
InvPat	Percentage of invention patents to total applied patents in current year.
PatAp	Natural logarithm of the number of patents in the current year (including both joint and individual applicated patents).
PPE	Net fixed assets divided by total assets.
SOE	An indicator variable that equals one if the firm is a state-owned enterprise at the end of year, and zero otherwise.
DA	Discretionary accruals at fiscal year-end, based on the cross-sectional modified Jones (1991) model.
RdExp	Natural logarithm of research and development expenses in the current year.
StkR	Inventory ratio, measured as net value of inventories divided by total assets.
Top10	Shareholding ratio of top ten shareholders.
CF	Net cash flow from operating activities divided by total assets.
ROA	Return on assets, measured as net profit divided by total assets at the end of year.
Lev	Financial leverage, the ratio of total liabilities to total assets at the end of year.
Size	Enterprise size, natural logarithm of total assets at the end of year.
Board	Board size, natural logarithm of the number of board members at the end of year.
Growth	The average growth rate of operating income for recent three years.
Return	Annual return is equal to the annual return on individual stocks after taking into account the reinvestment of cash dividends and adjusting events of stock dividends, stock reset and stock splits.

Table 2
Baseline regression of narrative R&D disclosures and bank loans.

	BankLoan		StLoan	LtLoan
	(1)	(2)	(3)	(4)
NarRd	**0.166*** **	**0.136*** **	**0.125*** **	**0.011**
	(5.44)	**(5.15)**	**(4.92)**	**(0.62)**
Receiv		−19.499***	−2.197	−16.516***
		(−2.76)	(−0.35)	(−3.57)
InvPat		−0.030	−0.091	0.064
		(−0.20)	(−0.74)	(0.65)
PatAp		0.149	0.111	0.036
		(1.58)	(1.28)	(0.58)
PPE		−0.220	1.954	−2.205*
		(−0.14)	(1.45)	(−1.88)
SOE		1.177	0.502	0.687
		(1.40)	(0.73)	(1.22)
DA		−1.924*	−1.350	−0.526
		(−1.67)	(−1.26)	(−0.78)
RdExp		1.434	0.042	1.278
		(0.25)	(0.01)	(0.42)
StkR		−2.317	3.196	−5.354***
		(−0.93)	(1.45)	(−3.21)
Top10		−1.168	−1.835	0.644
		(−0.75)	(−1.25)	(0.63)
CF		−16.925***	−12.874***	−3.991***
		(−10.65)	(−8.87)	(−4.43)
ROA		−2.647	−3.418	0.817
		(−1.08)	(−1.54)	(0.57)
Lev		24.291***	16.469***	7.732***
		(19.00)	(13.85)	(9.76)
Size		0.818**	−0.243	1.050***
		(2.15)	(−0.70)	(4.31)
Board		−1.725*	−0.840	−0.883
		(−1.71)	(−0.90)	(−1.50)
Growth		−1.051*	−0.542	−0.489
		(−1.82)	(−1.09)	(−1.14)
Return		−0.191	−0.235	0.052
		(−1.06)	(−1.51)	(0.46)
Firm/Year	Yes	Yes	Yes	Yes
Intercept	19.772***	−1.486	16.692**	−17.982***
	(21.64)	(−0.18)	(2.27)	(−3.50)
N	10,015	10,015	10,015	10,015
Adj-R^2	0.022	0.157	0.113	0.072

Note: (1) ***, **, and * represent statistically significant levels of 1 %, 5 %, and 10 %, respectively, for two-tailed tests; (2) Data in parentheses are t-values adjusted for clustering and white heteroskedasticity; (3) Due to space limitations, the test results of the control variables are not shown in the following tables. Same below.

Table 3
Robustness tests.

	Fdloan	BankLoan			
	(1)	(2)	(3)	(4)	(5)
NarRd	**0.170*** **		**0.131*** **	**0.049*** **	**0.135*** **
	(6.33)		**(13.01)**	**(15.89)**	**(5.17)**
InnoDis		**0.122*** **			
		(4.94)			
Indepr					−8.919***
					(−3.49)
Diversity					0.405
					(1.46)
Controls	Yes	Yes	Yes	Yes	Yes
Firm/Year	Yes	Yes	Yes	Yes	Yes
Intercept	50.914***	−1.859	−1.939	0.690	5.623
	(6.90)	(−0.23)	(−1.10)	(0.33)	(0.67)
N	10,015	10,015	10,015	10,015	10,015
Adj-R^2	0.109	0.157	0.157	0.159	0.161

Note: (1) Fdloan (the one-period incremental bank loans), which is calculated by yearly bank loans change scaled by total assets; (2) InnoDis is narrative R&D disclosure without adjusting the average value for industry.

Table 4
Endogeneity testing.

	PSM		DID	IV		GMM
	BankLoan			NarRd	BankLoan	BankLoan
	(1)	(2)	(3)	(4)	(5)	(6)
NarRd	0.139***	0.165***			0.095***	0.067**
	(5.54)	(5.73)			(2.81)	(2.01)
Treat*Post			1.059*			
			(1.97)			
Post			−7.014***			
			(−6.46)			
IndusNarRd				0.203**		
				(2.16)		
BankLoan_1						0.128***
						(4.13)
BankLoan_2						0.021*
						(1.91)
AR (1)						0.000
AR (2)						0.162
Hansen						0.126
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm/Year	Yes	Yes	Yes	Yes	Yes	Yes
Intercept	3.654	15.124***	−2.385	3.016	1.703	1.529***
	(0.40)	(6.15)	(−0.30)	(1.08)	(0.79)	(2.97)
N	6,874	9,875	10,015	10,015	10,015	10,015
Adj-R^2	0.151	0.700	0.156	0.185	0.146	0.563

Note: (1) For DID, we define the treatment firms as those whose average R&D intensity (R&D expenditures/Sales) over the three years before the disclosure requirements change was in the top third of the sample and the control firms otherwise.

4.3.3. The instrumental variable approach (IV)

See Larcker and Rusticus (2010), we selected year-industry level average narrative R&D disclosures (IndusNarRd, year-industry average disclosures of other firms) as the instrumental variable. The coefficient between instrumental variable and narrative R&D disclosures is 0.203 in column (4) of Table4, which is significantly. The coefficient of narrative R&D disclosures on bank loans is 0.095 in column (5) which is significant. Then, we conducted over-identification test, and p-value was 0.378. The instrumental variable is not related to the disturbance terms, which verified the exogeneity of the instrumental variable. The wald test showed minimum eigenvalue statistic was 28.23. So, the instrumental variable is "strong".

4.3.4. The system GMM

The coefficient of narrative R&D disclosures and bank loans is 0.067 and significant in column (6) of Table 4. The P value of the AR (1) test is less than 1 %, and AR (2) test is greater than 10 %, there is no second-order serial autocorrelation, and the model effectively overcomes the endogeneity problem. The P value of the Hansen test is 0.126, indicating that the instrumental variable is reasonable. The above tests alleviate the endogeneity problem of hypothesis H1a.

5. Channel analysis

5.1. The enhancement of incremental information

We test whether narrative R&D disclosures provide incremental information by investigating their impact on the readability of R&D texts and stock price synchronization(R^2). First, there will be more incremental information if the readability of annual reports is higher. Second, lower R^2 indicates more heterogenous information of incumbent companies. Column (1) of Table5 shows that the coefficient of narrative R&D disclosures on readability (Rdread) is 0.300, which is significant at 1 % level, indicating that narrative R&D disclosures enhance disclosure readability, and for every 1 % increase in the standard deviation of narrative R&D disclosures, the readability increases by 23.19 % relative to its mean value; Columns (2) and (3) show that the coefficients of narrative R&D disclosures on stock price synchronization (SPI2, PI2) are −0.007 and −0.006, which are significant, indicating that narrative R&D disclosures reduce stock price synchronization and provides incremental information.

5.2. The bank information processing superiority

The close business tie with client companies endowed banks with greater superiority to interpret complicated public information by providing alternative private information channels. To demonstrate this point, we divided the sample into two groups according to previous business relationship, the results are shown in columns (4) and (5) of Table 5. For firms with banks' business ties (Business), the coefficient of narrative R&D disclosures on bank loans is 0.152, which is significant. For the firms without banks' business relationship (Non-Business), the coefficient is not significant. This result confirms banks' superiority in interpreting narrative complicated R&D disclosures because of their business ties with client companies.

Above results demonstrate that the narrative R&D disclosures play an intrinsic mechanism role in enhancing bank loans, supported by the enhancement of incremental information and bank information processing superiority.

6. Further analysis

6.1. Industry competitiveness

The operating cost is higher for firms in more competitive environment. Innovation is the key to maintaining a company's core competencies. To maintain industry competitiveness, firms in highly competitive industries need to make more R&D disclosures to deter competitors (Glaeser and Landsman, 2021). Therefore, the narrative R&D disclosures for firms in industries which are competitive brings more incremental information to the market and reduces information asymmetry, which leads to greater bank loans. The results are shown in columns (1) and (2) of Table 6. Narrative R&D disclosures are more likely to alleviate the bank loans problem for firms in more keenly competitive industries.

6.2. Firms' ownership

China's state-owned firms are typically perceived to be easier in gaining bank loans because of government support. While for non-state-owned firms, they face stronger loans constraints. Therefore, we predict that the positive effect of narrative R&D disclosures on bank financing will mainly demonstrate in non-state-owned firms. As shown in columns (3) and (4) of Table 6, narrative R&D disclosures are more likely to alleviate the bank loans problem of non-state-owned enterprises.

6.3. Firms' type

Innovative firms face high risks, including possible innovation failures, uncertain returns on R&D, and fluctuating cash flows. These

Table 5
Channel analysis.

	Rdread	SPI2	PI2	BankLoan	
				Business	Non-Business
	(1)	(2)	(3)	(4)	(5)
NarRd	**0.300*** **	**−0.007***	**−0.006***	**0.152*** **	**0.076**
	(16.18)	**(−1.85)**	**(−1.81)**	**(4.59)**	**(0.79)**
Controls	Yes	Yes	Yes	Yes	Yes
Firm/Year	Yes	Yes	Yes	Yes	Yes
Intercept	26.408***	4.973***	4.815***	−7.802	7.230
	(19.86)	(5.23)	(5.02)	(−0.71)	(0.56)
N	10,009	9,786	9,786	6,566	3,449
Adj-R^2	0.491	0.283	0.270	0.163	0.112

Note: (1) The readability of narrative R&D disclosures is equal to the percentage of commonly used words in R&D-related text; (2) Stock price asynchrony is calculated by acquiring the R^2 from the regression of individual stock return on the average market return.

Table 6
Heterogeneity Analysis.

BankLoan						
	High (1)	Low (2)	Non-SOE (3)	SOE (4)	R&D-intensive (5)	Non-R&D-intensive (6)
NarRd	**0.150*** **	**0.002**	**0.142*** **	**0.044**	**0.131*** **	**0.099**
	(6.01)	**(0.03)**	**(5.68)**	**(0.30)**	**(3.62)**	**(0.97)**
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm/Year	Yes	Yes	Yes	Yes	Yes	Yes
Intercept	9.264	0.210	0.000	5.060	−5.873	0.506
	(0.77)	(0.02)	(0.00)	(0.31)	(−0.48)	(0.05)
N	4,922	5,091	6,850	3,165	4,329	5,686
Adj-R^2	0.142	0.158	0.153	0.186	0.153	0.161

Note: (1) The measure of industry competitiveness is the Herfindahl index, which is the sum of the squares of the percentages of total industry revenues accounted for by individual firms in an industry; (2) State-owned enterprise is defined when the government has ownership or control of its capital;(3) R&D-intensive firms are those of which the R&D revenue is above the sample mean value.

firms may find it difficult to obtain financing from outside. R&D-intensive firms suffer more information asymmetry and financial constraint problem. Therefore, more narrative R&D disclosures will reduce the information risk especially for R&D-intensive firms' fundamentals and facilitates the monitoring of lenders (Arvid and Kleimeier, 2021). As shown in columns (5) and (6) of Table 6, narrative R&D disclosures are more likely to enhance the bank loans of R&D-intensive firms.

7. Conclusion

We examine the economic consequences of narrative R&D disclosures from the perspective of bank loans. Using machine learning and textual analysis method, we innovatively quantify firms' narrative R&D disclosures. We find narrative R&D disclosures increase firms' information transparency and facilitate their access to bank loans. This paper uses a series of robustness tests (replacement of metrics and regression models), and some econometric methods (PSM, DID, IV, and GMM) to alleviate potential endogeneity problems and ensure the robustness of the main research conclusion. In spite of bank loans, there are various financing channels such as public bond, stocks and venture capital. Whether and how narrative R&D disclosures will affect firms' other source of financing will be a direction for future exploration. Meanwhile, how other aspects of annual report text disclosures will have an impact on corporate activities also requires further studies.

Author statament

Author1(First Author):Conceptualization; Data curation; Validation; Writing – original draft
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Data availability

Data will be made available on request.

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