

Deciphering the Influence of the Tone of Management Discussion and Analysis on Corporate Innovation: Integrating Textual Analysis with Empirical Corporate Data

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Abstract

How does Management's Discussion and Analysis (MD&A) sentiment tone affect corporate innovation? The influence mechanism is straight and very robust. To some extent, the positive sentiment tone, representing a psychological state, serves as an intermediary between macro or micro conditions and corporate innovation. This paper uses a machine learning method to measure the MD&A sentiment tone and get innovation indicators in a broader sense. The fix effect model shows that when the value of a firm's positive sentiment tone increases by 1 unit, its innovation increases by approximately 1.02 units. Eliminating industry and market effects, the exclusive sentiment tone information owned by the firm would still play a strong influence on innovation.

Keywords Discussion and analysis sentiment tone • Corporate innovation • Text analysis • Listed companies

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1 Introduction

As the Chinese economy navigates its metamorphosis from rapid expansion to an era distinguished by quality enhancement, innovation has emerged as the linchpin of economic advancement. Within this transformative landscape, corporations are at the vanguard of national technological innovation, with managerial acumen being a critical catalyst for innovation within these entities. Diverse managerial attributes—encompassing personal networks, the seasoned insights of CEOs, and the stability of executive teams—have been correlated with their capacity to drive corporate innovation. Concurrently, the burgeoning field of positive psychology, which examines how fostering positive traits like optimism, resilience, and motivation can enhance individual and organizational performance, has garnered increasing interest for its potential to enhance the performance of small and medium-sized enterprises (SMEs) and to underpin the impetus for corporate innovation initiatives.

This article endeavors to elucidate the nexus between the emotion captured in the MD&A reports, and the trajectory of corporate innovation. The authors seek to delineate the mechanisms by which the sentiment woven into MD&A documents can exert both direct and indirect influences on a company's innovative endeavors.

Employing a synthesis of textual analysis and machine learning techniques, this study dissects the emotional substratum of MD&A documents to assess their bearing on corporate innovation. It leverages an extensive dataset of publicly traded companies to quantify innovation and its associated metrics, while also endeavoring to isolate the sentiment tone's role in innovation by stripping away industry and market-level data from the analysis.

The research uncovers that between 2008 and 2021, an increment of one unit in the MD&A's sentiment tone corresponded to a 1.02 unit escalation in innovation among exemplary enterprises. The findings underscore the pivotal role that the sentiment tone of MD&A documents plays in corporate innovation, standing robust against shifts in both the external and internal milieu. This profound impact is rigorously evaluated through a two-stage mediation regression approach.

This study enriches the corpus of existing literature by offering empirical substantiation that the emotional tone of MD&A narratives wields a significant influence over corporate innovation. It introduces a pioneering viewpoint regarding the manner in which psychological capital, as reflected in the tonality of managerial discourse, can ignite human potential and catalyze the evolution of high-caliber enterprise development. The implications of these findings for investors are profound, enabling them to harness sentiment analysis within MD&A to prognosticate future corporate performance, thereby informing their investment decisions with greater acumen.

The architecture of this article is meticulously organized, with Section 2 delineating the construction and statistical synthesis of the data, Section 3 showcasing the principal empirical findings pertaining to investment and capital structuring decisions, and

Section 4 encapsulating the overarching conclusions extracted from the study's investigative journey.

2 Theoretical Analysis

In the contemporary economic landscape, marked by pronounced volatility, the realm of business has encountered formidable psychological trials. The preservation of an affirmative psychological disposition is of paramount importance for enterprises, as it facilitates the genesis of pioneering concepts and strategic maneuvers, crucial for navigating the tumultuous waters of unpredictability. By cultivating an optimistic outlook, organizations are poised to bolster their operational efficacy and fortify their resilience against adversities, including economic recessions and other extraneous stressors.

For the workforce, typically, individuals endowed with robust psychological capital are often appraised by their superiors as exhibiting a more pronounced propensity for innovation relative to their counterparts with diminished psychological capital (Muhammad Abbas, 2015). Psychological capital encapsulates the constellation of positive psychological attributes—encompassing mindset, emotions, and behaviors—that are instrumental in amplifying an employee's productivity and, by extension, the overarching performance of the corporation. Should the emotive tenor of a company's MD&A exude positivity, optimism, and inspiration, it stands to invigorate the workforce's psychological well-being, thereby augmenting their psychological capital. This surge in psychological capital is likely to engender enhanced employee productivity, elevated morale, and an uptick in corporate performance. The executive echelons can amplify the company's psychological capital by adeptly leveraging the emotive resonance of their MD&A narratives, thereby inspiring employees to commit themselves wholeheartedly to their professional endeavors (Pandey et al., 2021). Li et al. (2022) have delved deeper into the interplay between affective leadership, psychological capital, established employee practices, and the innovation performance of the staff.

Conversely, for the leadership cadre, the motivational underpinnings of leadership development are undergirded by a sense of self-efficacy, hope, optimism, and resilience. The edifice of psychological capital must be expanded to encompass the developmental context of leadership (Pitichat, 2018). Empirical studies have probed the ramifications of authentic leadership (AL) and transformational leadership (TL) on the service innovation behavior (SIB) of their subordinates. The thematic content and emotive articulation of MD&A narratives frequently mirror the leadership ethos and managerial philosophy of the executive suite. An executive team that projects a positive leadership ethos and an uplifting emotive tone is likely to bolster the confidence and esprit de corps of their subordinates, thereby enhancing their work output and collaborative ethos, which in turn can catalyze the service innovation endeavors of the team members (Schuckert et al., 2018). Research indicates that there is a positive correlation between genuine leadership and the communication dynamics among leadership members,

which in turn positively influences the performance of the followers, with a more pronounced effect on those with lower psychological capital as opposed to those with higher psychological capital (Wang et al., 2014). Thus:

Hypothesis: An optimistic discourse and analysis sentiment tone is posited to stimulate and enhance the innovative capacity of an organization.

3 Data

This study commences with a corpus of Chinese A-share listed companies, meticulously curated as the foundational dataset and subsequently amalgamated with psychological capital metrics through the application of textual analysis techniques.

Our inquiry initiates with an examination of active, publicly traded enterprises from the year 2008 onwards, ensuring that the total asset figures are comprehensively accounted for. This approach yields an extensive dataset encompassing 4,537 companies, amassing a total of 64,097 firm-year observations spanning the period from 2008 to 2021. The temporal resolution of our data is set to an annual frequency, with the conclusion of 2007 serving as a pivotal juncture. We have meticulously excised any stocks that have undergone the *ST and ST designations or have been delisted during the purview of our study. Furthermore, in light of the financial sector's unique structural dynamics, entities within this domain have been deliberately excluded from our sample. To mitigate the distorting effects of outliers, winsorization is used to limit the impact of extreme values on the analysis results for all financial data pertaining to the companies under scrutiny. We have also imposed a criterion requiring that firms must exhibit a continuous presence in our dataset for each year of their inclusion. These methodological refinements culminate in a refined sample comprising 4,412 firms and 36,417 firm-year observations.

Corporate Innovation Metrics — Our methodology for capturing corporate innovation is predicated on the compilation of patent filings for each respective company. The metric employed is the natural logarithm of the annual patent count at year-end. A comparative analysis between the volume of corporate patent applications and the proportion of corporate research and development (R&D) expenditure reveals a congruence in their data architectures. However, in deference to the imperative of scrutinizing the ramifications of psychological capital, we have elected to adopt the patent application metric as the definitive proxy for corporate innovation.

Divergent perspectives often characterize prior scholarly discourse on the indices of corporate innovation. A subset of scholars posits that the mere enumeration of patent applications and the quantification of R&D investment may not encapsulate the multifaceted essence of corporate innovation. To fortify the validity of our regression outcomes, this paper employs textual analysis to delineate an index of corporate innovation, thereby underpinning the subsequent robust regression analysis.

The construction of our corporate innovation index via textual analysis unfolds in a tripartite sequence. The inaugural phase entails the identification of voluntary disclosure indicators culled from annual reports, which are replete with a lexicon of

innovation-related terms from a multitude of vantage points, as delineated in Table 1. The subsequent phase involves an unrestricted lexical search within the annual MD&A narratives, wherein each firm i is subjected to scrutiny for each year under review. The crux of this phase is the dichotomous quantification of qualitative indicators, assigning a value of 1 for disclosed items and 0 for omissions. The final phase encompasses the enumeration of lexical occurrences within the text and the execution of a normalization process on the raw data.

Table 1 Lexicon of Voluntary Disclosure Indicators

Lexicon of Voluntary Disclosure Indicators	The concept of corporate innovation culture; Business strategy innovation; Management system innovation; Organizational structure innovation; Market risk; Technology and product update risk; Risk of proprietary technology leakage and brain drain; Innovation partners; corporate innovation objectives; Innovation project development plan; Innovative talent training plan; Introduction to the innovation team and its members; Employee innovation incentives; Profit model; Sales revenue of new products; Detailed description of the core technology of the innovation project; Progress of innovation projects; Reasons for the change of innovation input intensity compared with the previous year; R&D institutions or R&D centers; R&D mode; Number of patented projects; Number of patents under application; Proportion of technicians in employees; R&D expenditure capitalization ratio; R&D intensity.
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This analysis delineates the variance in the extent of innovation-related information disclosure across various sectors. It is observed that the scientific research and technology service sectors stand at the pinnacle in terms of transparency regarding their innovative endeavors. However, the limited number of entities within these sectors restricts the overall impact on the comprehensive assessment of corporate innovation disclosure in China. Conversely, the residential service, repair, and ancillary service industries exhibit the lowest levels of disclosure, potentially attributable to the constrained scope of innovation within these domains and the limited foreseeability of innovation-derived revenue.

In our study, we have adopted the conventional metric of patent application volume as the explanatory variable within our benchmark model, aligning with established scholarly work. Furthermore, we incorporate the variable of corporate innovation derived from textual analysis to reinforce the robustness and extensibility of our analytical framework, thereby lending credence to the conclusions drawn in this paper.

Sentiment Tone of MD&A — Prior research on psychological capital has predominantly utilized questionnaire-based surveys to gauge various dimensions such as self-efficacy, hope, optimism, resilience, and emotional intelligence. However, the efficacy of these methodologies in capturing an accurate reflection of an enterprise's psychological capital is a subject that merits further scrutiny. This paper zeroes in on the sentiment tone of MD&A documents, which are indicative of the psychological disposition articulated by the management team and, by extension, influence the

corporation's innovative trajectory. We harness textual analysis methodologies to construct the relevant variables.

Table 2 Text analysis of innovation for different industries

Industry	Obs	Mean	Std.	Dev.	Min
Transportation, storage and postal services	1,126	0.0120	0.0073	0.0031	0.0433
Accommodation and catering	89	0.0158	0.0080	0.0031	0.0362
Information transmission, software and information technology services	2,699	0.0320	0.0123	0.0031	0.0598
Agriculture, forestry, animal husbandry and fishery	471	0.0234	0.0124	0.0031	0.0583
Manufacturing	22,923	0.0305	0.0122	0.0031	0.0598
Health and social work	136	0.0232	0.0123	0.0039	0.0595
Residential services, repair and other services	4	0.0120	0.0028	0.0086	0.0148
Construction	945	0.0243	0.0102	0.0031	0.0598
Real estate	1,445	0.0165	0.0076	0.0031	0.0598
Wholesale and retail	1,920	0.0164	0.0089	0.0031	0.0598
Education	104	0.0196	0.0121	0.0032	0.0598
Culture, sports and entertainment	546	0.0180	0.0083	0.0031	0.0556
Water conservancy, Environment and public facilities management	630	0.0222	0.0116	0.0031	0.0598
Electricity, heat, Gas and water Production and supply	1,385	0.0148	0.0082	0.0031	0.0598
Scientific research and technology services	385	0.0374	0.0134	0.0031	0.0598
Leasing and business services	591	0.0168	0.0083	0.0031	0.0564
comprehensive	172	0.0206	0.0117	0.0031	0.0584
Mining	846	0.0177	0.0104	0.0031	0.0598

This study employs a methodology inspired by the seminal work of Hanley and Hoberg (2010) to quantify the emotional inclinations evident in the MD&A sections of annual reports from listed companies. The MD&A sections encompass a rich tapestry of information, ranging from historical operational data to analyses of external environmental factors, market dynamics, and risk profiles, replete with a spectrum of positive and negative perspectives. Our analytical approach leverages a lexical assessment, specifically the dictionary method, utilizing a curated emotional lexicon that distinguishes between positive and negative sentiment words to ascertain the overall sentiment tone of the text. It is posited that the prevalence of positive lexical items in these reports is indicative of an affirmative psychological stance.

In the extraction of these variables, the process commences with the procurement of annual reports, focusing on the MD&A segments, sourced from the official repositories of the Shanghai and Shenzhen Stock Exchanges. These excerpts are meticulously compiled into Excel spreadsheets for structured analysis. Subsequently, we harness the Loughran and McDonald (2011) lexicon, translated by Kingsoft Ciba, in conjunction with the Chinese Emotional Polarity Dictionary from Taiwan University, to dissect the sentiment embedded within the reports. The quantification involves a tally of positive and negative lexical items, culminating in the normalization of these counts against the total word count of the text.

Table 3 Summary Statistics of Variables

Variables	Obs	Mean	Std. Dev.	Min	Max
winnovation1	36,417	0.8957	1.4910	0	5.9026
winnovation_text	36,417	0.0270	0.0130	0.0031	0.0598
wpsy	36,417	0.1429	0.0278	0.08447	0.2229
wlasset	36,417	22.0788	1.2898	19.8049	26.2067
wvaip	36,417	21.5847	48.2619	-29.0956	384.3505
wvaic	36,417	21.6203	48.3232	-29.0956	384.5233
windex	36,417	587.0317	219.428	0	845.45
wstd	36,417	0.3808	0.209	0.0269	0.8902
wnpr	36,417	0.0437	0.0649	-0.2653	0.2244
wcurrent	36,417	2.5388	2.6744	0.3114	16.2129
wcf	36,417	0.0202	0.1034	-0.2425	0.4236
wage	36,417	24.2643	5.3976	12	41
wadr	36,417	0.4256	0.2098	0.0558	0.9079
wfr1	36,417	0.2147	0.1625	0.0020	0.6965
wfr2	36,417	0.9301	0.0855	0.5256	1
wincomegro~1	36,234	0.3841	1.0155	-0.7121	6.9433
wincomegro~2	36,385	0.1846	0.4047	-0.5442	2.4463
wtb1	36,417	2.0472	1.2840	0.8393	7.9988
wtb2	36,417	2.2366	1.4405	0.8767	8.8053
wlargestho~e	36,417	34.6402	14.8583	8.65	74.09

We compute the enterprise size using natural logarithm of total assets at the end of the period. Profitability needs to be controlled, i.e., Net profit/average balance of total assets. We compute the ratio of enterprise operation risk, i.e., (accounts payable + advances from customers) / current liabilities). We compute the ratio of fixed assets divided by total assets at the end of the period. We use the current ratio as: (total current assets / total current liabilities). We compute cash flow ratio as: (net cash flow from investing activities + net cash flow from financing activities + net cash flow from operating activities) / total assets. We use Tobin Q, calculated by (Total market value + long-term loans + bonds payable + short-term loans + financial liabilities measured at fair value with changes included in current profits and losses + derivative financial liabilities + short-term bonds payable) / Enterprise assets. We also consider other

variables such as enterprise leverage Enterprise leverage and the shareholding ratio of major shareholders.

4 Sentiment Tone in MD&A and its Impetus on Corporate Innovation

In this segment, we delve into an examination of the influence exerted by the sentiment tone present within MD&A documents on the innovative endeavors of corporations. Our objective is to quantify the magnitude of this impact, employing both conventional panel modeling techniques and sophisticated textual analysis at the corporate level.

4.1 Empirical Strategy

We run different specifications of a standard innovation equation. Specifically, for firm i , at date t , innovation is given by:

$$(1) winnovation1_{i,t} = \alpha_i + \beta_1 wpsy_{i,t} + \beta_2 t + \beta_3 t^2 + \beta_4 dgdp_{i,t} + \beta_5 wlasset_{i,t} + \beta_6 wcurrent_{i,t} + \beta_7 wfr1_{i,t} + \beta_8 wcf_{i,t} + \beta_9 wtb1_{i,t} + \beta_{10} wstd_{i,t} + \beta_{11} wnpr_{i,t} + \beta_{12} wadr_{i,t} + \beta_{13} wlargestholderrate_{i,t} + \varepsilon_{i,t}$$

where $winnovation1_{i,t}$ is the number of patents applications to measure innovation activities, typically, the natural logarithm of the number of invention patent applications at the end of the period. $wpsy_{i,t}$ is the sentiment tone of MD&A. $dgdp1_{i,t}$ denotes the cyclical variable representing GDP normalized by detrending and standardization:

$$(2) dgdp1_{i,t} = \frac{gdp_{i,t} - \min(gdp_{i,t})}{\max(gdp_{i,t}) - \min(gdp_{i,t})}$$

Where, $gdp_{i,t}$ is the constant price level of GDP in that year, $\min()$ represents the minimum value, $\max()$ represents the maximum value, and $dgdp1_{i,t}$ represents the GDP data that has been filtered. After such processing, the minimum value is 0 and the maximum value is 1. This processing method enables the regression equation to measure the changes in the variables explained by macroeconomic conditions as they change from bad to good.

$wlasset_{i,t}$ controls for the enterprise size, using natural logarithm of total assets at the end of the period. $wcurrent_{i,t}$ is the current ratio. $wfr1_{i,t}$ is the ratio of fixed assets, $wcf_{i,t}$ is the cash flow ratio, $wtb1_{i,t}$ is the ratio of Tobin Q. $wstd_{i,t}$ is the ratio of enterprise operation risk, measuring enterprise operational risk with high-risk operational asset level. $wnpr_{i,t}$ is the ratio of profitability. $wadr_{i,t}$ is the leverage ratio and $wlargestholderrate_{i,t}$ is the shareholding ratio of major shareholders, and considering that there may be trend items in the regression, linear and quadratic time trend items are added as explanatory variables.

In the presence of a favorable sentiment tone in the MD&A, a subset of firms is likely to leverage this positive outlook to underpin their innovation initiatives. Companies that project an optimistic sentiment tone are well-positioned to catalyze personal growth

and enhance performance. Human capital, recognized as the cornerstone of an enterprise's competitive edge, can be optimally harnessed by instilling a positive, nurturing, and invigorating psychological milieu among staff. This, in turn, can galvanize team spirit and passion.

Our model delineates the mechanism by which a firm's annual innovation, as measured by the variable $\text{winnovation1}_{i,t}$, is influenced by the prevailing positive sentiment tone within its management. This relationship is explored through a regression analysis that maps the firm's innovation efforts against the current sentiment tone, thereby quantifying the innovative value generated by an uplift in positive sentiment. The resultant coefficient, denoted as β , serves as a composite measure of this value. If a firm's positive sentiment tone is indeed influential, this coefficient will manifest as positive. In the baseline model, β reflects the extent to which the average firm in the sample can utilize its sentiment tone to foster innovation.

We also include a firm fixed effect α_i , designed to capture specific innovation shocks, as well as the time effects β_2 and β_3 , to control the time trend. Finally, the variable dgdg controls for the overall impact of the economic cycle on innovation, irrespective of the typical cyclicity for different types of the firms. Shocks $\varepsilon_{i,t}$ are clustered at the firm $\times$ year level. This correlation structure is conservative given that the explanatory variable of interest innovation is defined at the firm level (Hashmi, 2013).

Let us also highlight that the coefficient β_1 measures how a firm's innovation responds to each additional 1 unit of positive sentiment tone. This specification allows us to abstract from firm-specific shocks that would affect firms both with and without positive sentiment tone.

Table 4 presents the results of various regression specifications for Equation (1). The first column initiates with the most rudimentary estimation of Equation (1), devoid of supplementary control variables. It is observed that as the positive sentiment tone escalates, so too do the innovation endeavors of firms. The foundational coefficient stands at 1.113, indicating that for each increment of one unit in positive sentiment tone, innovation is augmented by a corresponding 1.113 units.

Progressing to the second column, we incorporate the preliminary control variable dgdg , designed to reflect macroeconomic conditions. However, its impact does not achieve statistical significance. Advancing to the third column, we introduce the variable wlasset , which serves as a proxy for firm size, aligning with established academic discourse. The coefficient associated with wlasset is 0.106, reaching significance at the 1 percent confidence level. This suggests that as firms transition from a smaller to a larger size, moving by one unit, their innovation output escalates by 10.6 percentage points, and by 9.20 percentage points with each increment of one standard deviation in firm size. Concurrently, the coefficient for the positive sentiment tone, denoted as wpsy , is recalibrated to 1.046, retaining its statistical significance at the 1 percent confidence level. Although somewhat reduced, it remains indistinguishable from its counterpart in the initial column in terms of statistical significance.

Table 4 Basic Regression: how positive sentiment tone influence corporate innovation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
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variables	winnovation 1	winnovation 1	winnovation 1	winnovation 1	winnovation 1	winnovation 1	winnovation 1
	1.113***	1.122***	1.046***	1.032***	1.035***	1.024***	1.020***
wpsy	(0.0207)	(0.0209)	(0.0195)	(0.0192)	(0.0193)	(0.0191)	(0.0190)
	3.291	3.319	3.095	3.019	3.030	2.972	2.953
		-0.0148	-0.0193	-0.0166	-0.0156	-0.0145	-0.0149
dgdp		(-0.0030)	(-0.0040)	(-0.0034)	(-0.0032)	(-0.0029)	(-0.0030)
		-0.786	-1.020	-0.869	-0.818	-0.754	-0.770
			0.106***	0.103***	0.101***	0.111***	0.118***
wlasset			(0.0920)	(0.0889)	(0.0872)	(0.0958)	(0.102)
			4.672	4.496	4.382	4.580	4.790
				0.152	0.269**	0.259*	0.222
wnpr				(0.0066)	(0.0117)	(0.0113)	(0.0094)
				1.140	1.992	1.910	1.560
				-0.121**	-0.0789	-0.0776	-0.0879
wstd				(-0.0171)	(-0.0111)	(-0.0109)	(-0.0123)
				-2.082	-1.332	-1.308	-1.481
					0.298***	0.289***	0.288***
wfr1					(0.0325)	(0.0315)	(0.0314)
					3.060	2.960	2.949
					-0.0105**	-0.0087	-0.0112*
wcurrent					(-0.0189)	(-0.0156)	(-0.0201)
					-2.041	-1.644	-1.959
						-0.0751	-0.0732
wcf						(-0.0052)	(-0.0051)
						-1.436	-1.394
						0.0146*	0.0141*
wtb1						(0.0126)	(0.0121)
						1.889	1.800
							-0.109
wadr							(-0.0153)
							-1.241
wlargest							-0.0017
holderrat							(-0.0171)
e							-1.113
	0.0909***	0.0885***	0.0702***	0.0744***	0.0763***	0.0739***	0.0726***
trend	(0.251)	(0.244)	(0.194)	(0.205)	(0.211)	(0.204)	(0.201)
	11.01	9.856	7.214	7.425	7.629	7.254	7.131
	0.0016***	0.0015***	0.0012**	0.0015***	0.0016***	0.0015***	0.0015***
trend2	(-0.0806)	(-0.0737)	(-0.0605)	(-0.0730)	(-0.0758)	(-0.0727)	(-0.0739)
	-3.630	-3.006	-2.436	-2.826	-2.940	-2.809	-2.852
Constant	0.0494	0.0626	-2.128***	-2.020***	-2.050***	-2.284***	-2.298***

Observations	36,417	36,417	36,417	36,417	36,417	36,417	36,417
R-squared	0.044	0.044	0.046	0.047	0.047	0.048	0.048
Number of code	4,412	4,412	4,412	4,412	4,412	4,412	4,412

Notes: This table reports the results for innovation and positive sentiment tone. Each cell contains a column with three numbers. The first number is the regression estimate, the second number reports the effect on the dependent variable of a one standard deviation change in the regressor, and the third number is the t-statistic. Robust beta in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

In the fourth column, we incorporate control variables that align with the established return-risk framework in traditional finance theory, specifically focusing on return on assets and the risk inherent in business operations. The coefficient for *wnpr* (return on net profit) is posited to be of notable significance, as an upsurge in profitability is expected to channel more resources into innovation endeavors. Conversely, the coefficient for *wstd* (standard deviation of assets) is anticipated to be markedly negative, given that an elevated level of operational risk can impede a firm's capacity to foster innovation.

As depicted in Table 4, the propensity for innovation, while maintaining a positive inclination, fails to achieve statistical significance. The coefficient for *wstd* is recorded as -0.121, which is deemed significant at the 5 percent confidence level. The standardized beta value stands at -0.0171, implying that for every one-standard deviation escalation in operational risk, there is a corresponding uptick of 1.71 percent in the level of innovation. Meanwhile, the coefficient for *wpsy* (sentiment tone of MD&A), which gauges the positive psychological impact, is recalibrated to 1.032. It retains its statistical significance at the 1 percent confidence level, closely mirroring the value observed in the initial column.

In Column 5, the analysis incorporates asset variables that are conjectured to sway the dynamics of innovation, namely the fixed assets ratio (*wfr1*) as a gauge for long-term financial commitment and the current ratio (*wcurrent*) as a measure of short-term liquidity. It bears emphasis that these metrics exhibit contrasting sensitivities. The coefficient for *wfr1* is 0.298, which is markedly positive and attains a high level of statistical significance at the 1 percent confidence level. On the contrary, the coefficient for *wcurrent* is -0.0105, signifying a negative correlation that is also statistically significant at the 5 percent confidence level. This intriguing contrast in the directional impact of these coefficients suggests that an escalation of one unit in the fixed assets ratio is linked to an average increase of 0.298 in the innovation metric, potentially due to the imperative for enduring capital assets in the innovation process. In stark contrast, an analogous increment in the current ratio is correlated with an average decrease of 0.0105 in innovation, which might be rationalized by the diversion of immediate liquidity towards operational facets other than innovation.

Column 6 introduces state variables that are conventionally utilized in the estimation of innovation equations, namely the cash flow ratio (wcf) and Tobin's Q (wtb1). The coefficients for these variables exhibit negative and positive sensitivities, respectively, yet neither coefficient attains a high degree of statistical significance.

In Column 7, the analysis is enriched by incorporating a broader array of enterprise-level variables, including leverage (wadr) and the shareholding ratio of controlling shareholders (wlargestholderrate). The coefficient for the sentiment tone of Management Discussion and Analysis (wpsy) is recalibrated to 1.020, which remains strongly significant at the 1 percent confidence level and is statistically indistinguishable from its initial column counterpart. These incremental regression analyses corroborate the hypothesis that an affirmative sentiment tone in MD&A discussions significantly fosters corporate innovation.

The sensitivity to macroeconomic conditions, which is not statistically significant, was unexpected. Our initial hypothesis posited a positive relationship between the amelioration of macroeconomic conditions and innovation. However, the findings in the second column suggest, albeit cautiously, that this anticipated positive effect may be mediated by the positive sentiment tone. The coefficient for return on net profit (wnpr) in the fourth column also lacks statistical significance. Given the robust sensitivity associated with the positive sentiment tone, it is plausible to surmise that this tone may also act as an intermediary for the impact of wnpr. To empirically test this conjecture, we have executed a two-stage regression model designed to assess the mediating effect.

$$(2) \text{winnovation1}_{i,t} = \alpha_i + \beta_2 t + \beta_3 t^2 + \beta_4 \text{lgdp}_{i,t} + \beta_4 \text{lasset}_{i,t} + \beta_5 \text{current}_{i,t} + \beta_6 \text{fr1}_{i,t} + \beta_7 \text{cf}_{i,t} + \beta_8 \text{tb1}_{i,t} + \beta_9 \text{std}_{i,t} + \beta_{10} \text{npr}_{i,t} + \beta_{11} \text{largestholderrate}_{i,t} + \varepsilon_{i,t}$$

As delineated in Equation (2), the variable wpsy has been omitted in comparison to Equation (1), and reflects the temporal lag of macroeconomic conditions on micro enterprises. In Equation (2), we incorporate the lagged term of $\text{lgdp}_{i,t}$. This equation is employed to ascertain whether $\text{lgdp}_{i,t}$ and $\text{npr}_{i,t}$ exert a direct influence on $\text{innovation1}_{i,t}$. The subsequent step in assessing the intermediary effect entails the estimation of the ensuing equation.

$$(3) \text{wpsy}_{i,t} = \alpha_i + \beta_2 t + \beta_3 t^2 + \beta_4 \text{lgdp}_{i,t} + \beta_4 \text{lasset}_{i,t} + \beta_5 \text{current}_{i,t} + \beta_6 \text{fr1}_{i,t} + \beta_7 \text{cf}_{i,t} + \beta_8 \text{tb1}_{i,t} + \beta_9 \text{std}_{i,t} + \beta_{10} \text{npr}_{i,t} + \beta_{11} \text{largestholderrate}_{i,t} + \varepsilon_{i,t}$$

Since the effect of positive sentiment tone is tested above, it is no need to confirm again. The hypothesis here is that positive sentiment tone plays the intermediary effect for macroeconomic condition and return ratio. Equation (3) is used to test if the two variables have effects on positive sentiment tone, and reflects the time lag of macroeconomic conditions on micro enterprises ($\text{lgdp}_{i,t}$).

Table 5 First-step regression of intermediary effect

variables	(1) winnovation1	(2) winnovation1
wnpr	0.268* (0.0117)	

	1.910	
lgdp		0.0097* (0.0066)
		1.798
wlasset	0.119*** (0.103)	0.112*** (0.0971)
	4.860	4.392
wstd	-0.0816 (-0.0115)	-0.0736 (-0.0103)
	-1.376	-1.204
wfr1	0.288*** (0.0314)	0.268*** (0.0292)
	2.946	2.651
wcurrent	-0.0113** (-0.0202)	-0.0110* (-0.0199)
	-1.965	-1.847
wcf	-0.0590 (-0.0041)	-0.0210 (-0.0015)
	-1.122	-0.388
wtb1	0.0153** (0.0132)	0.0041 (0.0033)
	1.966	0.450
wadr	-0.105 (-0.0148)	-0.0896 (-0.0126)
	-1.198	-0.988
wlargestholderrate	-0.0018 (-0.0178)	-0.0020 (-0.0197)
	-1.163	-1.248
trend	0.0673*** (0.186)	0.0628*** (0.179)
	6.767	6.746
trend2	-0.0014*** (-0.0697)	-0.0011** (-0.0534)
	-2.697	-2.206
dgdp	-0.0112 (-0.0023)	
	-0.577	
Constant	-2.157***	-1.970***
Observations	36,417	34,022
R-squared	0.047	0.051
Number of code	4,412	4,412

Notes: Robust beta in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Column 1 and 2 in Table 5 implement the first-step regression where winnovation1 are regressed on wnpr and lgdp without wpsy. Let us first briefly comment on the first-step regressions, which are direct estimations of equation (2). The coefficient of wnpr in column 1 is 0.268, significant at the 10 percent confidence level and the standard beta is 0.0117, in other words, the profitability of firms has some positive effect on innovation activity. The same conclusion applies to lgdp. The coefficient of lgdp in column 2 is 0.0097, significant at the 10 percent confidence level and the standard beta is 0.0066, which means that the macroeconomic condition has some positive effect on

innovation activity. The results indicate that the macro and micro mechanism exist without positive sentiment tone, although the significance is not too obvious. The second step is to run equation 3, evaluating the intermediary effect. The results are listed in Table 6.

Table 6 Second-step regression of intermediary effect

variables	(1) wpsy
	0.0468***
wnpr	(0.108) 14.29
	0.0009***
lgdp	(0.0323) 9.993
	0.0017***
wlasset	(0.0773) 3.593
	0.0061***
wstd	(0.0452) 4.697
	-0.0004
wfr1	(-0.0025) -0.183
	1.00e-05
wcurrent	(0.0010) 0.0854
	0.0138***
wcf	(0.0509) 11.61
	0.0011***
wtb1	(0.0490) 6.456
	0.0036*
wadr	(0.0269) 1.864
	-7.78e-05***
wlargestholderrate	(-0.0410) -2.715
	-0.0058***
trend	(-0.875) -28.22
	0.0001***
trend2	(0.325) 12.34

Constant	0.143***
Observations	34,022
Number of code	4,412
R-squared	0.352

Notes: Robust beta in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Column 1 in Table 6 tests whether the relation between macro-micro variables and innovation depends on the mediating effect of positive sentiment tone. To do so, we regress the positive sentiment tone on macroeconomic condition and profitability. The estimated coefficients for lgdp and wnpr are 0.0009 and 0.0468 respectively, remains significant at the 1 percent confidence level. The estimated coefficients are both positive and strongly significant, indicating that our results are not driven by direct effect but depends quite much on positive sentiment tone. Of course, the interpretation of the coefficient on this specification is not directly comparable to the one in equation 1, which cautiously tell that positive sentiment tone squeezes out the influence of the other two variables here. The economic magnitude implied by this specification is very obvious that positive sentiment tone plays quite a key role in the determination of innovation that it will rule out some direct effect from macro and micro variables.

4.2 Robustness Checks

Table 7 offers an extensive suite of robustness checks for the core estimation portrayed in Equation (1), as presented in the seventh column of Table 4.

In the inaugural column, we harness an innovation metric rooted in textual dissection, termed `winnovation_text`, serving as our dependent variable. A conceivable concern emerges: this innovation metric, derived from textual analysis, might include an index of innovation based on patent application volumes. In the event that a company deliberately intensifies its innovation endeavors in concert with an increase in positive sentiment tone, the textual analysis-based innovation metric would encompass patent application activities. As a result, the variables employed here would contain an abundance of information, acting as compelling ancillary evidence that reinforces the robustness of our conclusions. We identify a positive and statistically significant coefficient within this framework (0.0519). The variance in the coefficient's magnitude, when juxtaposed with the figure noted in the fifth column of Table 4, could be ascribed to the unique dimensions embedded within the variables being examined.

In the second column, we adopt `innovation_text` as our dependent variable, meticulously controlling for the confounding effects of firm size and economic cycles. Upholding the principle of incremental regression, we have incorporated further controls for a range of potential influence mechanisms within columns three to four, with particular emphasis on the incorporation of the lagged positive sentiment tone within these columns. The resultant coefficient for the positive sentiment tone in the fourth column is 0.0541, signifying that an increment of one unit in the positive sentiment tone correlates with a corresponding escalation of 0.0541 units in innovation.

This coefficient reaches a high threshold of statistical significance, marked at the 1 percent confidence level. The standard beta coefficient stands at 0.113, which suggests that for each standard deviation increase in the positive sentiment tone, the level of innovation is augmented by 0.113 units. This effect is of a more substantial economic scale when juxtaposed with the observations noted in the fifth column of Table 4. Our findings are in harmony with the configuration of the innovation variable in this segment, indicating that the upswing in positive sentiment tone not only catalyzes an increase in patent applications but also invigorates a comprehensive array of innovative pursuits.

In our analytical discourse, Columns 5 and 6 revisit the estimations across separate temporal strata: Column 5 delves into the period post-2010, while Column 6 examines the epoch leading up to 2019. With a considerate gaze upon the economic tremors induced by the financial crisis, the interval from 2007 to 2010 has been deliberately excised from our temporal subsets. In the pursuit of methodological equilibrium, the subsequent quadrennial period has also been removed from our purview. Column 7 of Table 4 presents a synthesis of regression analyses, a consolidation that, while efficient in aggregation, might otherwise eclipse the intrinsic variability in the innovation elasticity across time spans. For instance, the susceptibility of innovation to economic catalysts may manifest differently within an economy on the ascent compared to one in recession. To counterbalance this, we have re-evaluated the estimations for Equation (1) over two discrete chronological segments—2011 to 2021 and 2007 to 2018—as illustrated in Column 7 of Table 4. The emergent coefficients are statistically significant throughout both periods, thereby reinforcing the tenacity of our analytical conclusions. The estimated coefficient β_1 is higher after 2010 than before 2019 (1.684 versus 1.172), and not statistically different. During different time periods, the significance and the magnitude of the coefficient of interest seems to appear the same.

Table 7 Robustness Regression Results

variables	(1) innovatio n_text	(2) innovatio n_text	(3) innovatio n_text	(4) innovatio n_text	(5) winnovati on1	(6) winnovati on1	(7) winnovati on1
wpsy	0.0519*** (0.109) 17.89	0.0536*** (0.112) 18.33	0.0516*** (0.108) 18.80	0.0541*** (0.113) 19.65	1.684*** (0.0253) 3.801	1.172*** (0.0248) 3.473	2.986*** (0.0556) 9.786
lwpsy			-0.006* (-0.0075) -1.728	-0.0047** (-0.0099) -2.304			
wlasset		0.0002 (0.0174) 1.025	0.0002 (0.0188) 1.111	0.0002 (0.0218) 1.212	0.110*** (0.0911) 3.849	0.0980*** (0.0943) 3.823	0.00470 (0.00407) 0.561
dgdg		- 0.0033*** (-0.0743)	- 0.0033*** (-0.0755)	- 0.0035*** (-0.0794)	-0.0250 (-0.0048)	0.0276 (0.0048)	-0.0293 (-0.00592)
wnpr		-24.33	-24.14 0.0068***	-24.84 0.00560** *	-1.075 0.248	0.973 0.0584	-0.924 1.119***

				(0.0333)	(0.0274)	(0.0102)	(0.0027)	(0.0487)
				6.292	4.992	1.543	0.358	8.334
				0.0021***	0.0010**	-0.104	-0.191***	0.260***
wstd				(0.0336)	(0.0162)	(-0.0138)	(-0.0312)	(0.0365)
				4.362	2.111	-1.597	-2.900	7.239
wfr1					0.0010	0.304***	0.200**	-0.202***
					(0.0121)	(0.0307)	(0.0252)	(-0.0221)
					1.081	2.656	1.972	-4.712
wcurrent					9.41e-05*	-0.0099	-0.0091	0.0085*
					(0.0190)	(-0.0170)	(-0.0185)	(0.0153)
					1.869	-1.513	-1.550	2.486
					-	-0.0501	-0.142**	-0.0501
wcf					0.0018***			
					(-0.0143)	(-0.0032)	(-0.0113)	(-0.00348)
					-4.308	-0.797	-2.490	-0.707
					-	0.0154*	0.0136*	-0.0159**
wtb1					0.0004***			
					(-0.0427)	(0.0127)	(0.0130)	(-0.0137)
					-7.148	1.751	1.673	-2.490
					-	-0.123	-0.103	-0.396***
wadr					0.0034***			
					(-0.0535)	(-0.0163)	(-0.0166)	(-0.0557)
					-4.391	-1.172	-1.106	-7.969
wlargest					1.58e-05	-0.0003	-0.0023	-
holderrat								0.0039***
e					(0.0177)	(-0.0026)	(-0.0260)	(-0.0387)
					1.299	-0.155	-1.394	-7.307
trend	0.0025***	0.0020***	0.0019***	0.0019***	0.120***	0.0523***	0.101***	
	(0.781)	(0.607)	(0.583)	(0.576)	(0.241)	(0.131)	(0.280)	
	34.55	24.87	23.27	22.73	5.248	4.532	11.30	
	-	-8.73e-	-8.19e-	-7.96e-	-	0.0003	-0.0004	
trend2	0.0001***	05***	05***	05***	0.0036***			
	(-0.653)	(-0.481)	(-0.452)	(-0.439)	(-0.148)	(0.0103)	(-0.0199)	
	-31.86	-22.27	-19.61	-18.98	-3.325	0.375	-0.766	
Constant	0.0084***	0.0077**	0.0072*	0.0083**	-2.470***	-1.875***	-0.333*	
Observations	36,417	36,417	36,416	36,416	30,871	25,411	36,417	
R-squared	0.089	0.101	0.105	0.111	0.028	0.051	0.076	
Number of code	4,412	4,412	4,412	4,412	4,412	3,372		

Notes: Robust beta in parentheses: *** p<0.01, ** p<0.05, * p<0.1

4.3 Heterogeneity

Crescenzi et al. (2015), in a distinct context, have remarked that the susceptibility of innovation to change is subject to variation across various sectors and corporate entities. The extent to which a positive sentiment tone exerts influence continues to be an empirical enigma. We address this by employing a triad of heterogeneity metrics: (i) the magnitude of the size effect; (ii) the intrinsic qualities of the enterprise; and (iii) the

characteristics of the industry. These dimensions are elaborated in Section IA. We proceed to estimate Equation (3) in isolation for firms categorized as either "constrained" or "unconstrained."

As delineated in Equation (1), the coefficients for firm size, denoted by *wlasset*, in columns 3 through 7 of Table 8 consistently surpass the threshold of 0.1. This observation compels us to contemplate the ramifications of a positive sentiment tone across a spectrum of firm sizes. The precise manner in which innovation's sensitivity is modulated by firm size, particularly in relation to specific types of enterprises, remains shrouded in ambiguity. This too is an empirical query that we seek to resolve within the following analytical framework:

$$(4) \text{winnovation1}_{i,t} = a_i + \sum_{j=1}^J I_{i,t}(j) \{ \beta_{1,j} \text{wpsyten}_{i,t} \} + \beta_2 t + \beta_3 t^2 + \beta_4 \text{dgdp}_{i,t} + \beta_5 \text{wcurrent}_{i,t} + \beta_6 \text{wfr1}_{i,t} + \beta_7 \text{wcf}_{i,t} + \beta_8 \text{wtb1}_{i,t} + \beta_9 \text{wstd}_{i,t} + \beta_{10} \text{wnpr}_{i,t} + \beta_{11} \text{wlargestholderrate}_{i,t} + \varepsilon_{i,t}$$

The methodology we employ in this study involves the creation of categorical groupings based on firm size, followed by the compilation of time series data aggregated according to these size classifications. Let $I_{i,t}(j)$ be an indicator function that assumes a value of 1 if firm *i* is a member of group *j* at time *t*, with our analysis encompassing ten distinct firm groups. Additionally, let *wpsyten*_{*i,t*} represent the positive sentiment tone of firm *i* within group *j* during period *t*. The first column of Table 8 provides an estimation of these ten groups within the framework of Equation (4). This approach is designed to address the size effect, acknowledging that the positive sentiment tone of larger firms may be a catalyst for innovation. The analysis reveals notable size heterogeneity, particularly within the upper echelons of the distribution. For instance, the data for the top 70 percent of firms suggest that innovation is markedly influenced by a positive sentiment tone. The coefficients attributed to *wpsyten4* and *wpsyten5* are 0.858 and 0.795, respectively, which, while approximately 25 percent less than the coefficient in Equation (1), maintain statistical significance at the 5 percent level. Table 8 further illustrates that the coefficient for *wpsyten6* closely mirrors that derived from the foundational equation. From *wpsyten7* onwards, the impact of the positive sentiment tone escalates with increasing firm size. The coefficient for *wpsyten10* is 2.714, which is not only statistically significant at the 1 percent confidence level but also indicates a substantial effect: a ten-standard deviation increase in the positive sentiment tone (0.2779) is associated with a 52 percent increase in the standard deviation of innovation.

Table 8 Heterogeneity brought by size

variables	(1) winnovation1
	-0.147 (-0.0045)
<i>wpsyten1</i>	-0.340 0.106 (0.0032)
<i>wpsyten2</i>	0.262

	0.353 (0.0104)
wpsyten3	0.888 0.858** (0.0252)
wpsyten4	2.237 0.795** (0.0233)
wpsyten5	2.080 1.118*** (0.0327)
wpsyten6	2.905 1.545*** (0.0446)
wpsyten7	3.811 1.574*** (0.0459)
wpsyten8	3.784 1.817*** (0.0529)
wpsyten9	3.950 2.714*** (0.0790)
wpsyten10	4.646 -0.0142 (-0.0029)
dgdp	-0.735 0.275* (0.0120)
wnpr	1.942 -0.0920 (-0.0129)
wstd	-1.551 0.292*** (0.0318)
wfr1	2.993 -0.0099* (-0.0177)
wcurrent	-1.720 -0.0649 (-0.0045)
wcf	-1.231 0.0092 (0.0079)
wtb1	1.211 -0.0725 (-0.0102)
wadr	-0.831 -0.0016 (-0.0164)
wlargestholderrate	-1.071 0.0747*** (0.206)
trend	

	7.295
	-0.0014***
trend2	(-0.0703)
	-2.681
Constant	0.249**
Observations	36,417
Number of code	4,412
R-squared	0.048

Notes: Robust beta in parentheses*** p<0.01, ** p<0.05, * p<0.1

As delineated in Table 9, we categorize the enterprises into three distinct groups: state-owned enterprises, private enterprises, and other enterprises. A pronounced cross-sectional heterogeneity characterizes the sensitivity of innovation to the varying nature of these enterprises. Columns 1-3 utilize winnovation1 as the dependent variable, with Column 1 representing private enterprises, Column 2 representing state-owned enterprises, and Column 3 representing other enterprises. Private enterprise groups exhibit, on average, twice the sensitivity to positive sentiment tone in innovation compared to state-owned enterprise groups. For instance, a private enterprise group company boasts a coefficient of 1.413, contrasting with the 0.604 coefficient of a state-owned enterprise group company. The coefficients in Column 1 are significant at the 1 percent confidence level, surpassing that of the baseline model. This finding suggests that the positive sentiment tone significantly influences private enterprises, a phenomenon not observed in other types of firms.

Columns 4-6 employ innovation_text as the dependent variable, with Column 4 for private enterprises, Column 5 for state-owned enterprises, and Column 6 for other enterprises. The coefficients for these three types of firms are numerically analogous, yet the coefficient for private enterprises in Column 4 is modestly larger than those of other firm types. This indicates that beyond patent application activities, a positive sentiment tone indeed exerts an influence across all firm types, spurring a more diverse array of innovation activities.

Table 9 Heterogeneity brought by enterprise nature

variables	(1) winnovati on1	(2) winnovati on1	(3) winnovati on1	(4) innovation _text	(5) innovation _text	(6) innovation _text
wpsy	1.413*** (0.0307)	0.604 (0.0100)	1.176 (0.0213)	0.0562*** (0.130)	0.0517*** (0.103)	0.0436*** (0.0893)
wlasset	2.869 0.112*** (0.115)	1.140 0.110*** (0.0763)	1.019 0.147* (0.123)	12.39 0.0003 (0.0327)	12.34 0.0003 (0.0215)	5.563 0.0004 (0.0383)
dgdg	3.327 0.0080 (0.0017)	2.925 -0.0172 (-0.0034)	1.897 -0.0552 (-0.0108)	0.960 -0.0023*** (-0.0530)	1.024 -0.0043*** (-0.102)	0.734 -0.0034*** (-0.0749)
wnpr	0.250 -0.156 (-0.0067)	-0.640 0.327 (0.0142)	-0.996 0.757** (0.0351)	-10.69 0.0063*** (0.0284)	-21.87 0.0046*** (0.0242)	-7.975 0.0061** (0.0321)
wstd	-0.629 -0.0920	1.626 -0.0666	2.233 -0.172	2.911 0.0016*	3.136 0.0005	2.356 0.0006

	(-0.0143)	(-0.0090)	(-0.0224)	(0.0268)	(0.0083)	(0.0092)
	-0.970	-0.811	-0.848	1.951	0.802	0.445
	0.163	0.361**	0.495	-0.0003	0.0027**	0.0002
wfr1	(0.0227)	(0.0312)	(0.0512)	(-0.0048)	(0.0275)	(0.0026)
	1.254	2.375	1.279	-0.222	2.063	0.0845
	-0.0091	-0.0069	-0.0251	-7.19e-05	0.0002**	-0.0001
wcurrent	(-0.0126)	(-0.0134)	(-0.0468)	(-0.0106)	(0.0356)	(-0.0282)
	-0.995	-0.906	-1.622	-0.604	2.574	-0.987
	0.0168	-0.0693	-0.188	-0.0014*	-0.0018***	-0.0019
wcf	(0.0010)	(-0.0053)	(-0.0127)	(-0.0091)	(-0.0167)	(-0.0145)
	0.170	-1.012	-1.236	-1.811	-3.460	-1.289
	0.0149	0.0069	0.0310	-0.0003***	-0.0004***	-0.0006***
wtb1	(0.0132)	(0.0058)	(0.0288)	(-0.0307)	(-0.0414)	(-0.0585)
	1.226	0.621	1.313	-2.775	-5.503	-2.870
	-0.170	-0.0439	-0.170	-0.0016	-0.0047***	-0.0047**
wadr	(-0.0255)	(-0.0056)	(-0.0232)	(-0.0255)	(-0.0729)	(-0.0724)
	-1.302	-0.332	-0.649	-1.180	-4.684	-2.309
	-0.0037	0.0012	-0.0022	5.06e-08	3.24e-05*	-1.49e-05
wlargesthol	(-0.0406)	(0.0103)	(-0.0223)	(5.98e-05)	(0.0342)	(-0.0175)
derrate	-1.549	0.499	-0.493	0.0027	1.838	-0.411
	0.0597***	0.0996***	0.0658**	0.0017***	0.0019***	0.0017***
trend	(0.186)	(0.250)	(0.179)	(0.582)	(0.577)	(0.516)
	3.992	6.153	2.125	14.48	15.06	7.671
	-0.0009	-0.0026***	-0.0013	-7.01e-05***	-8.51e-05***	-7.45e-05***
trend2	(-0.0487)	(-0.120)	(-0.0633)	(-0.394)	(-0.472)	(-0.401)
	-1.144	-3.203	-0.822	-11.19	-13.77	-6.644
Constant	-2.311***	-2.171***	-2.868*	0.0017	0.0094*	0.0089
Observations	13,778	18,756	3,883	13,778	18,756	3,883
R-squared	0.049	0.048	0.053	0.128	0.108	0.104
Number of code	1,195	2,781	436	1,195	2,781	436

Notes: Robust beta in parentheses:*** p<0.01, ** p<0.05, * p<0.1

Table 10 presents a diverse array of estimates that reveal the heterogeneity across different industries.

Given that the manufacturing sector constitutes the majority of our sample observations—a substantial 22,923 out of a total 36,417, translating to 62.95%—we have bifurcated our analysis into the manufacturing and non-manufacturing industries. Column 1, which focuses on the manufacturing industry, employs *winnovation1* as the dependent variable. It is observed that the sensitivity of enterprises to innovation in response to a positive sentiment tone is 1.308, a figure that holds firm at the 5% significance level. Even though the coefficient in Column 2 is somewhat reduced to 0.607, it maintains its statistical significance at the 10% level, approximately half that of Column 1. Columns 3 and 4 shift the focus to *innovation_text* as the dependent variable. The coefficient for the positive sentiment tone here is 0.0589, which not only remains significant at the 1% level but also exceeds the magnitude of the coefficient found in Column 4. The analysis concludes that the positive sentiment tone within the

manufacturing industry exerts a more pronounced influence on innovation activities compared to its non-manufacturing counterpart.

Table 10 Heterogeneity brought by industry

variables	(1) winnovation 1	(2) winnovation 1	(3) innovation_te xt	(4) innovation_te xt
wpsy	1.308** (0.0219) 2.508	0.607* (0.0164) 1.791	0.0589*** (0.129) 14.54	0.0429*** (0.0988) 11.08
wlasset	0.203*** (0.146) 5.021	0.0593** (0.0805) 2.550	0.0007*** (0.0696) 3.017	-0.0002 (-0.0235) -0.767
dgdg	-0.0181 (-0.0034) -0.676	-0.0177 (-0.0050) -0.721	-0.0041*** (-0.101) -22.25	-0.0025*** (-0.0596) -12.49
wnpr	0.296 (0.0119) 1.399	-0.136 (-0.0081) -0.850	0.0063*** (0.0331) 4.283	0.0045*** (0.0229) 2.654
wstd	-0.0821 (-0.0010) -0.833	-0.0639 (-0.0138) -1.028	0.0011 (0.0178) 1.600	0.0016** (0.0287) 2.297
wfr1	0.267* (0.0227) 1.727	0.195** (0.0359) 2.011	0.0008 (0.0087) 0.636	0.0010 (0.0155) 0.762
wcurrent	-0.0082 (-0.0139) -0.994	-0.0117 (-0.0271) -1.644	0.0001* (0.0239) 1.768	7.60e-05 (0.0150) 0.842
wcf	-0.0819 (-0.0053) -1.151	-0.0962 (-0.0089) -1.417	-0.0022*** (-0.0188) -4.026	-0.0008 (-0.0062) -1.138
wtb1	0.0126 (0.0098) 1.177	0.0011 (0.0013) 0.113	-0.0003*** (-0.0353) -4.573	-0.0006*** (-0.0600) -5.516
wadr	-0.168 (-0.0204) -1.192	-0.0376 (-0.0078) -0.452	-0.00357*** (-0.0569) -3.420	-0.00286** (-0.0502) -2.555
wlargesthold errate	0.0015 (0.0129) 0.608	-0.0021 (-0.0312) -1.409	2.94e-05* (0.0336) 1.779	9.86e-06 (0.0125) 0.562
trend	0.110*** (0.275) 7.301	0.0231** (0.0916) 2.064	0.0023*** (0.751) 20.65	0.0011*** (0.383) 10.47
trend2	-0.0027*** (-0.122) -3.583	-0.0003 (-0.0212) -0.485	-0.0001*** (-0.606) -18.90	-4.03e-05*** (-0.236) -7.001
Constant	-4.253***	-1.063**	-0.0032	0.0153***
Observations	22,923	13,494	22,923	13,494
R-squared	0.067	0.023	0.133	0.086
Number of code	2,950	1,462	2,950	1,462

Notes: Robust beta in parentheses: *** p<0.01, ** p<0.05, * p<0.1

We also take into account the heterogeneity introduced by specific policies. In this regard, our sample is bifurcated into two distinct categories of regression analysis, in accordance with the criteria defining specialized, special, and innovative small and medium-sized enterprises (SMEs). The State Council of China first introduced the concept of such enterprises in a document dated April 26, 2012. Subsequently, in July 2013, the Ministry of Industry and Information Technology officially advocated for the development of these specialized, special, and new SMEs. With this policy-induced heterogeneity in view, we aim to discern whether the impact of a positive sentiment tone is more pronounced among these specialized and innovative enterprises.

Given that the policy pertains to small and medium-sized entities within the manufacturing sector, we further refine our classification to include only those manufacturing enterprises whose size is below the established quartiles, assigning a value of 1 to those qualifying as specialized, special, and new SMEs, and 0 otherwise. Acknowledging the time lag typically associated with policy implementation, we have conducted regression analyses for the periods post-2013 and post-2016 to scrutinize the policy's heterogeneity. Columns 1-2 utilize *winnovation1* as the dependent variable, while Columns 3-4 employ *innovation_text* with samples from after 2013. However, the results indicate that the coefficients are not statistically significant, prompting a focus on the findings from Columns 3-4. Here, the positive sentiment tone's coefficient stands at 0.107 for specialized, special, and new SMEs, significant at the 1 percent level, whereas for other firm types, the coefficient is slightly smaller, yet substantially similar.

Columns 5-6 incorporate samples from after 2016, revealing that the coefficient for the positive sentiment tone has risen to 0.130 for specialized, special, and new SMEs, still significant at the 1 percent level, and notably higher than the coefficient in Column 3. Conversely, the coefficient for other types of firms has decreased to 0.0969, which is markedly lower. These findings suggest that the policy concerning specialized, special, and new SMEs has effectively amplified the influence of a positive sentiment tone on corporate innovation.

Table 11 Heterogeneity brought by policy

variables	(1) winnovation1	(2) winnovation1	(3) innovation_text	(4) innovation_text	(5) innovation_text	(6) innovation_text
wpsy	4.086 (0.0517)	-1.456 (-0.0210)	0.107*** (0.168)	0.104*** (0.169)	0.130*** (0.195)	0.0969*** (0.153)
wlasset	1.471 0.987*** (0.229)	-0.917 0.114 (0.0293)	4.967 0.0006 (0.0170)	6.849 -0.0021* (-0.0619)	4.465 0.0001 (0.0033)	4.632 -0.0038** (-0.107)
dgdg	3.213 -0.0024 (-0.0005)	0.848 -0.0272 (-0.0060)	0.299 -0.0070*** (-0.193)	-1.773 -0.0061*** (-0.150)	0.0354 -0.0086*** (-0.237)	-2.260 -0.0075*** (-0.187)
wnpr	-0.0226 -0.277 (-0.0115)	-0.418 0.661 (0.0337)	-7.596 0.0180*** (0.0920)	-11.76 0.0067** (0.0381)	-7.129 0.0162* (0.0824)	-10.95 0.0060 (0.0359)
	-0.331	1.627	2.617	2.071	1.758	1.537

wstd	-0.0952 (-0.0126)	-0.387* (-0.0565)	0.0024 (0.0394)	0.0021 (0.0341)	0.0077** (0.118)	0.0016 (0.0261)
wfr1	-0.293 1.627** (0.113)	-1.900 0.561 (0.0499)	0.996 0.0099* (0.0849)	1.499 -0.0045 (-0.0445)	2.448 0.0030 (0.0251)	0.990 -0.0019 (-0.0180)
wcurrent	2.086 0.0238 (0.0559)	1.610 -0.0071 (-0.0166)	1.866 0.0003 (0.0875)	-1.473 -0.0001 (-0.0273)	0.403 0.0004 (0.118)	-0.510 -7.23e-05 (-0.0187)
wcf	0.783 -0.428* (-0.0380)	-0.482 -0.228 (-0.0196)	1.566 -0.0008 (-0.0086)	-0.920 0.0005 (0.0044)	1.596 -0.0026 (-0.0274)	-0.401 0.0027 (0.0254)
wtb1	-1.651 0.0828** (0.0786)	-1.486 0.0352** (0.0393)	-0.380 -0.0001 (-0.0157)	0.361 -0.0002 (-0.0210)	-0.922 0.0003 (0.0318)	1.633 0.0001 (0.0133)
wadr	2.115 -0.0318 (-0.0030)	2.089 -0.351 (-0.0415)	-0.529 0.0045 (0.0521)	-1.127 -0.0010 (-0.0134)	0.739 0.0027 (0.0295)	0.573 0.0021 (0.0269)
wlargesthol derrate	-0.0370 -0.0230 (-0.192)	-1.060 0.0027 (0.0260)	0.861 2.18e-05 (0.0225)	-0.387 6.89e-05 (0.0735)	0.362 0.0001 (0.101)	0.589 0.0001 (0.124)
trend	-1.202 0.793*** (1.197)	0.562 0.349*** (0.556)	0.186 0.0009 (0.162)	1.023 0.0030*** (0.535)	0.650 0.0002 (0.0267)	1.400 0.0016 (0.176)
trend2	3.225 -0.0352*** (-1.249)	3.040 -0.0136*** (-0.503)	0.532 -3.74e-05 (-0.164)	3.147 -0.0001*** (-0.495)	0.0351 2.59e-06 (0.0079)	0.387 -5.91e-05 (-0.174)
Constant	-3.406 -23.30***	-2.721 -3.163	-0.556 0.0037	-2.981 0.0465*	0.0102 0.0089	-0.382 0.0881**
Observations	1,287	3,190	1,287	3,190	939	2,187
R-squared	0.083	0.020	0.142	0.138	0.184	0.171
Number of code	442	962	442	962	371	767

Notes: Robust beta in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table 12 presents the regression outcomes for samples stratified by geographic regions. Column 1 focuses on firms hailing from the eastern region, while Column 2 examines those situated in the central region, and Column 3 delves into the western region. Employing innovation_text as the dependent variable, the regression reveals a hierarchy of coefficients reflecting the influence of positive sentiment tone, with the western region exhibiting the most pronounced effect, followed by the eastern and central regions, respectively.

Table 12 Heterogeneity brought by region

variables	(1) innovation_text	(2) innovation_text	(3) innovation_text
wpsy	0.0529*** (0.109)	0.0472*** (0.103)	0.0609*** (0.140)
wlasset	15.49 9.39e-05 (0.0092)	6.357 0.0010** (0.0897)	7.870 -1.74e-06 (-0.0002)

	0.405	2.155	-0.00431
	-0.0036***	-0.0041***	-0.0025***
dgdp	(-0.0817)	(-0.0932)	(-0.0580)
	-21.50	-11.44	-6.998
	0.0055***	0.0064**	0.0034
wnpr	(0.0266)	(0.0321)	(0.0176)
	3.961	2.373	1.275
	0.0011*	0.0011	0.0005
wstd	(0.0174)	(0.0172)	(0.0086)
	1.912	0.781	0.469
	0.0010	0.0007	0.0011
wfr1	(0.0116)	(0.0093)	(0.0157)
	0.892	0.353	0.502
	0.0001**	1.19e-05	-2.19e-05
wcurrent	(0.0290)	(0.0022)	(-0.0042)
	2.306	0.108	-0.164
	-0.0016***	-0.0017	-0.0023**
wcf	(-0.0128)	(-0.0122)	(-0.0170)
	-3.136	-1.512	-1.996
	-0.00043***	-0.0004***	-0.0004***
wtb1	(-0.0406)	(-0.0449)	(-0.0424)
	-5.797	-2.615	-2.885
	-0.0024**	-0.0066***	-0.0043***
wadr	(-0.0370)	(-0.106)	(-0.0739)
	-2.428	-3.589	-2.676
wlargestholderra	2.62e-05*	-5.60e-06	-9.13e-08
te	(0.0292)	(-0.0063)	(-0.0001)
	1.755	-0.185	-0.00344
	0.0020***	0.0015***	0.0017***
trend	(0.600)	(0.471)	(0.574)
	19.99	7.404	8.623
	-8.43e-05***	-5.91e-05***	-7.26e-05***
trend2	(-0.462)	(-0.329)	(-0.419)
	-17.00	-5.850	-7.328
Constant	0.0099**	-0.0038	0.0097
Observations	25,300	6,092	5,025
R-squared	0.111	0.120	0.115
Number of code	3,231	658	523

Notes: Robust beta in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

4.4 More consideration of the mechanism

The MD&A section of each corporate entity encompasses an array of details pertaining not solely to the internal operations and business strategies of the firm, but also to considerations that are common across the corporate landscape, such as the myriad aspects of market risk. On the one hand, it is a universal truth that all publicly traded companies operate within the confines of the same overarching macroeconomic milieu. Conversely, companies listed within the same industry must contend with analogous industrial policies and a suite of other industry-specific attributes. Therefore, this paper refers to Hanley and Hoberg (2010), extracts industry ($psy_{l,t}$) and market

($psy_{M,t}$) information from positive sentiment tone variables, and removes these information that is duplicate or similar to other companies in the same industry or companies in other industries, so that positive sentiment tone variables only reflect the unique information of the enterprise itself. The number of enterprises in the industry is set to P, and the number of all enterprises in the market is set to Q. The specific calculation process is as follows:

$$(5) psy_{I,t} = \frac{1}{P-1} \sum_{j=1, j \neq i}^J psy_{j,t}$$

$$(6) psy_{M,t} = \frac{1}{Q-P} \sum_{j=1, j \neq i}^{Q-P} psy_{j,t}$$

$$(7) psy_{i,t} = \gamma_0 + \gamma_1 psy_{I,t} + \gamma_2 psy_{M,t} + \mu_{i,t}$$

The regression results obtained from the above formula define the residual as the exclusive positive sentiment tone information of the enterprise, which is named **information_{i,t}**.

We use **information_{i,t}** to observe the sensitivity of innovation to exclusive positive sentiment tone information. The regression analysis presented in Table 13 robustly substantiates the influence exerted by the exclusive positive sentiment tone on the realm of innovation. In Column 1, with winnovation1 serving as the dependent variable, the coefficient of the exclusive sentiment tone information is estimated at 0.728, deeming it statistically significant at the 5% confidence level. This finding underscores the potency of the sentiment tone in driving innovation. Moving to Column 2, where innovation_text is employed as the dependent variable, the coefficient is calculated at 0.0620, which is also statistically significant, this time at the 1% confidence level. This further reinforces the notion that the sentiment tone, when isolated from industry and market noise, holds a pivotal role in shaping innovative endeavors.

Table 13 Influence of exclusive positive sentiment tone information

variables	(1) winnovation1	(2) innovation_text
information	0.728** (0.0114) 1.997	0.0620*** (0.110) 17.77
wlasset	0.119*** (0.103) 4.844	0.0003 (0.0273) 1.519
dgdg	-0.0113 (-0.0023) -0.582	-0.0033*** (-0.0760) -24.19
wnpr	0.236* (0.0103) 1.659	0.0052*** (0.0253) 4.609
wstd	-0.0864 (-0.0121) -1.456	0.0010** (0.0151) 1.978
wfr1	0.285*** (0.0311) 2.924	0.0008 (0.0097) 0.870

	-0.0111*	0.0001**
wcurrent	(-0.0199)	(0.0219)
	-1.935	2.174
	-0.0627	-0.0013***
wcf	(-0.0044)	(-0.0098)
	-1.195	-2.952
	0.0155**	-0.0004***
wtb1	(0.0134)	(-0.0339)
	1.998	-5.751
	-0.109	-0.0036***
wadr	(-0.0153)	(-0.0564)
	-1.241	-4.655
wlargestholderr	-0.0018	1.42e-05
ate	(-0.0176)	(0.0159)
	-1.147	1.175
	0.0671***	0.0015***
trend	(0.185)	(0.479)
	6.748	19.47
	-0.0014***	-7.26e-05***
trend2	(-0.0692)	(-0.400)
	-2.676	-17.95
Constant	-2.144***	0.0162***
Observations	36,413	36,413
R-squared	0.048	0.118
Number of code	4,411	4,411

Notes: Robust beta in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

In our preceding investigation, we discerned a pronounced impact of the positive sentiment tone on the trajectory of corporate innovation. Our subsequent inquiry sought to ascertain the presence of either mediating or moderating effects within this dynamic. Despite our diligent efforts, the quest for mediating effects proved elusive, prompting a refocused examination on potential moderating influences. Our scrutiny identified three pivotal variables: the caliber of internal governance (windex), the efficacy of operational capacity (wito), and the robustness of credit capacity (wfr1). Here, operational capacity is epitomized by the inventory turnover rate, while credit capacity is denoted by the ratio of fixed assets.

Table 14 presents a series of regression analyses that integrate these three variables, utilizing both winnovation1 and innovation_text as the dependent variables. Our findings indicate that the coefficients associated with the level of internal control are statistically significant at the 5% level in the initial two columns. The coefficients for operational capacity demonstrate significance at the 1% level across both columns, whereas the coefficients for credit capacity manifest significance at the 1% level in the first column, yet fail to achieve the same in the second column. However, when juxtaposed with the substantial influence of the positive sentiment tone, the impact of these three variables pales in comparison, a topic we shall delve into with greater rigor in the subsequent table.

Table 14 Moderating Effect Estimation (1)

variables	(1) winnovation1	(2) innovation_text
wpsy	1.032*** (0.0192) 2.992 7.88e-05**	0.0531*** (0.111) 18.30 6.60e-07**
windex	(0.0116) 2.307 -0.0005***	(0.0109) 2.417 -5.61e-06***
wito	(-0.0175) -3.182 0.284***	(-0.0224) -2.925 0.0010
wfr1	(0.0310) 2.918 0.113***	(0.0119) 1.078 0.0002
wlasset	(0.0976) 4.528 -0.0152	(0.0182) 1.017 -0.0035***
dgdg	(-0.0031) -0.787 0.201	(-0.0801) -25.32 0.0054***
wnpr	(0.0088) 1.415 -0.0853	(0.0264) 4.831 0.0011**
wstd	(-0.0120) -1.438 -0.0099*	(0.0167) 2.184 0.0001**
wcurrent	(-0.0178) -1.721 -0.0178	(0.0215) 2.106 -0.0012***
wcf	(-0.0012) -0.313 0.0125	(-0.0095) -2.705 -0.0004***
wtb1	(0.0108) 1.599 -0.105	(-0.0431) -7.170 -0.0034***
wadr	(-0.0148) -1.197 -0.0017	(-0.0538) -4.432 1.60e-05
wlargestholderr ate	(-0.0171) -1.119 0.0746***	(0.0180) 1.328 0.0019***
trend	(0.206) 7.331 -0.0016***	(0.575) 22.96 -7.86e-05***
trend2	(-0.0778) -3.001 -2.247***	(-0.433) -19.38 0.0081**
Constant	-2.247***	0.0081**
Observations	36,417	36,417
R-squared	0.048	0.112
Number of code	4,412	4,412

Notes: Robust beta in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table 15 reports results of the moderating effect of three kinds of variables. We generate three interaction terms as following:

$$(8)kk_{i,t} = wpsy_{i,t} * windex_{i,t}$$

$$(9)kk1_{i,t} = wpsy_{i,t} * wito_{i,t}$$

$$(10)kk2_{i,t} = wpsy_{i,t} * wfr1_{i,t}$$

Column 1 and 4 have showed that the coefficients for *kk* are not significant in both columns and the coefficients for internal control level become insignificant. Column 1 and 4 use *kk1* and report that the coefficient for *kk1* in column 2 is significant at 1% level ,but not significant in column 5, while the the coefficients of positive sentiment tone do not change much. Column 3 and 6 report the results using *kk2* and find that the results of the two columns are inconsistent. This result shows that the impact of positive sentiment tone on corporate innovation is direct and difficult to be adjusted by other variables.

Table 15 Moderating Effect Estimation (2)

variables	(1) winnovati on1	(2) winnovati on1	(3) winnovati on1	(4) innovation _text	(5) innovation _text	(6) innovation _text
wpsy	1.693** (0.0316) 2.428	0.911** (0.0170) 2.576	1.029** (0.0192) 2.024	0.0424*** (0.0889) 6.753	0.0539*** (0.113) 18.05	0.0444*** (0.0932) 10.51
windex	0.0002 (0.0356) 1.521			-1.88e-06 (-0.0312) -1.401		
wito		-0.0017*** (-0.0606) -3.751			2.79e-06 (0.0112) 0.477	
wfr1	0.284*** (0.0310) 2.914	0.284*** (0.0309) 2.917	0.294 (0.0320) 1.190	0.0009 (0.0115) 1.034	0.0010 (0.0127) 1.158	-0.0044** (-0.0538) -1.999
kk	-0.0011 (-0.0278) -1.041			1.75e-05* (0.0491) 1.920		
kk1		0.0089*** (0.0443) 2.765			-6.19e-05 (-0.0348) -1.528	
kk2			-0.0413 (-0.0007) -0.0274			0.0374*** (0.0714) 2.763
wlasset	0.111*** (0.0962) 4.449	0.119*** (0.103) 4.866	0.118*** (0.102) 4.782	0.0002 (0.0169) 0.934	0.0002 (0.0231) 1.302	0.0002 (0.0198) 1.101
dgdg	-0.0166 (-0.0034) -0.860	-0.0148 (-0.0030) -0.765	-0.0149 (-0.0030) -0.771	-0.0035*** (-0.0799) -25.30	-0.0035*** (-0.0799) -25.27	-0.0035*** (-0.0799) -25.29
wnpr	0.189 (0.0082) 1.328	0.231 (0.0100) 1.622	0.222 (0.0096) 1.560	0.0054*** (0.0262) 4.780	0.0056*** (0.0276) 5.032	0.0056*** (0.0273) 4.969
wstd	-0.0853	-0.0861	-0.0879	0.0010**	0.0010**	0.0011**

	(-0.0120)	(-0.0121)	(-0.0124)	(0.0163)	(0.0164)	(0.0170)
	-1.438	-1.452	-1.484	2.122	2.148	2.207
	-0.0102*	-0.0111*	-0.0112*	0.0001**	9.68e-05*	9.88e-05**
wcurrent	(-0.0184)	(-0.0200)	(-0.0201)	(0.0219)	(0.0195)	(0.0199)
	-1.776	-1.944	-1.959	2.150	1.926	1.962
wcf	-0.0256	-0.0747	-0.0733	-0.0010**	-0.0017***	-0.0016***
	(-0.0018)	(-0.0052)	(-0.0051)	(-0.0081)	(-0.0132)	(-0.0123)
	-0.443	-1.420	-1.393	-2.287	-3.966	-3.708
wtb1	0.0125	0.0143*	0.0141*	-0.0005***	-0.0004***	-0.0004***
	(0.0107)	(0.0123)	(0.0121)	(-0.0437)	(-0.0416)	(-0.0420)
	1.594	1.833	1.801	-7.259	-7.011	-7.068
wadr	-0.101	-0.111	-0.109	-0.0034***	-0.0035***	-0.0034***
	(-0.0141)	(-0.0156)	(-0.0153)	(-0.0540)	(-0.0546)	(-0.0544)
	-1.147	-1.267	-1.240	-4.444	-4.486	-4.470
wlargesthol	-0.0018	-0.0017	-0.0017	1.68e-05	1.61e-05	1.66e-05
derrate	(-0.0177)	(-0.0170)	(-0.0171)	(0.0189)	(0.0180)	(0.0186)
	-1.154	-1.110	-1.112	1.384	1.333	1.374
trend	0.0743***	0.0724***	0.0726***	0.0019***	0.0018***	0.0019***
	(0.205)	(0.200)	(0.200)	(0.575)	(0.571)	(0.574)
	7.307	7.103	7.144	22.96	22.87	22.87
trend2	-0.0016***	-0.0015***	-0.0015***	-7.87e-05***	-7.81e-05***	-7.86e-05***
	(-0.0776)	(-0.0729)	(-0.0739)	(-0.434)	(-0.430)	(-0.433)
	-2.994	-2.813	-2.859	-19.40	-19.28	-19.29
Constant	-2.311***	-2.307***	-2.300***	0.0099**	0.0074*	0.0093**
Observations	36,417	36,417	36,417	36,417	36,417	36,417
R-squared	0.048	0.048	0.048	0.112	0.112	0.112
Number of code	4,412	4,412	4,412	4,412	4,412	4,412

Notes: Robust beta in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

5 Conclusion

An increment of one unit in the positive sentiment tone of a firm's MD&A is correlated with an approximate escalation of 1.02 units in its innovation metrics. When considering a more expansive vista of innovation, this increment is calibrated to be approximately 0.0541 units. Such innovation is subject to the interplay of macroeconomic and micro-level conditions, with the positive sentiment tone serving as a pivotal mediator between these variables, as represented by macroeconomic indices and profitability.

Through the lens of textual analysis, which encompasses a more diverse array of innovative endeavors, it is projected that the positive sentiment tone wields a more substantial influence on innovation. The sway of the positive sentiment tone is characterized by a pronounced size effect, escalating progressively with the scale of the enterprise. As demonstrated within this article, the positive sentiment tone exerts its most profound influence on the innovative actions of private enterprises.

In our sample cohort, manufacturing enterprises constitute a notable segment, holding a substantial share within the economic framework. Consequently, the psychological impact on innovation is anticipated to be of considerable magnitude. The findings of this analysis suggest that within the manufacturing sector, the positive sentiment tone engenders a more notable influence on innovation activities when juxtaposed with the non-manufacturing sector. Particularly, the heterogeneity engendered by policies favoring specialized, special, and innovative SMEs within the manufacturing domain indicates that the positive sentiment tone is poised to exert a more significant effect on corporate innovation compared to other enterprises.

Moreover, by abstracting industry and market influences, the firm's proprietary positive sentiment tone information continues to exert a robust impact on innovation. Ultimately, the regression outcomes pertaining to moderating effects illustrate that the influence of the positive sentiment tone on corporate innovation is immediate and is not readily modified by other variables. The transition from the micro-level estimates provided in this article to the macro-level impact on innovation remains an enigma. Future research endeavors will be directed towards demystifying this conundrum.

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Compliance with Ethical Standards

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