

CAN INVESTOR ATTENTION DEFUSE THE RISK OF CORPORATE ZOMBIFICATION? – EMPIRICAL EVIDENCE FROM LISTED COMPANIES IN CHINA

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Abstract. Solving the risk of zombification of enterprises and relieving their business difficulties, as a key element of supply-side structural reform, is the pain point of the conversion of old and new dynamic energy and the difficulty of economic transformation and upgrading. In the Internet era, the impact on business operations is also expanding with the widening of investor attention channels. This paper selects Chinese listed companies from 2011-2020 as a research sample, and the empirical results show that, first, investor attention can effectively reduce the risk of transforming enterprises into zombie enterprises, i.e., the risk of corporate zombification decreases as the level of investor attention increases; second, there is heterogeneity in the role of investor attention in resolving the risk of corporate zombification; third, further mechanism tests find that along with Third, further mechanistic tests reveal that as the level of investor attention increases, the level of environmental uncertainty decreases and the annual market value of individual stocks increases, thereby reducing the risk of corporate zombification. The findings of this paper provide theoretical support and empirical evidence for further improving the risk mitigation of corporate zombification, promoting the “de-emphasis” of enterprises, and leading the high-quality and healthy development of enterprises.

Keywords: zombie enterprises, investor focus, mechanism of action, probit model, empirical studies, business management.

JEL Classification: G4, M1.

Introduction

As China's economy enters a new normal, some inefficient and highly indebted enterprises begin to show the risk of zombification, which puts greater pressure on the healthy development of the overall economy. In this context, how to resolve the risk of corporate zombies has become the focus of economists (Xiao & Guo, 2021). Since China's reform and opening up, China has achieved world-renowned economic growth, but in the process of rapid development, some enterprises are subject to factors such as excess capacity, environmental

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constraints, and slow scientific and technological progress, and gradually fall into difficulties (Kane, 1987). In this context, the risk of corporate zombification not only undermines the effectiveness of market resource allocation, but may also have a negative impact on financial stability and the job market (Nishimura et al., 2005). At the same time, with the rise of the Internet, especially the popularity of the mobile Internet, investors' attention to enterprises is constantly expanding (Smales, 2020), and investors' attention to enterprises has gradually become the objective performance of enterprise operation level and its future development vane, which has a positive effect on driving stock prices and enhancing corporate vitality.

Investor attention refers to the degree of attention paid by investors to an enterprise or industry, which is reflected in the concern for the development prospects, profitability, market position and other aspects of the enterprise. It is found that investor attention has potential information disclosure and market supervision effects, which can prompt enterprises to pay more attention to business strategy adjustment, technological innovation, corporate governance and other aspects of improvement. Under the framework of information asymmetry theory, investor attention affects the quality and quantity of enterprise information disclosure, thereby improving the information environment and market supervision of enterprises, and reducing the uncertainty of the enterprise environment. Secondly, with the help of behavioral finance theory, the impact of investor attention on corporate management and investor behavior, and its positive role in the process of mitigating the risks of zombie enterprises, are discussed. Finally, under the framework of corporate governance theory, investor attention motivates enterprises to improve their governance structure, improve decision-making quality, and optimize resource allocation. Therefore, increasing investor attention may have a positive significance for resolving the risk of corporate zombies.

Existing research has explored the focus on zombie firms from multiple aspects, including the definition (Hoshi & Kashyap, 2010), causes (Fukuda & Nakamura, 2011), hazards (Du & Li, 2019), identification (Fukuda & Nakamura, 2011), and disposal and prevention of zombie firms (Liang, 2017). These studies provide a solid foundation for understanding the nature and impact of zombie enterprises. Scholars have formed a relatively consistent understanding of the characteristics and potential impact of zombie enterprises in theory, but there are still many specific details and implementation methods to be further explored and improved in terms of empirical research and policy recommendations. It is worth noting that most of the existing research on zombie companies focuses on government decision-making and bank operations, and less on other possible influencing factors. Investor attention is an area that is closely related to zombie companies but has not been fully studied. Scholars have already achieved some results in their research on investor attention, such as exploring its impact on stock returns, corporate value, foreign exchange markets, and government policy feedback. However, the role and potential of investor attention in mitigating the risks of zombie companies have not been fully appreciated. In short, the knowledge and understanding of zombie enterprises in existing research provide us with valuable references. However, to fully understand the role of investor attention in mitigating the risks of zombie companies, more needs to be done in terms of theoretical and empirical research.

The purpose of this paper is to answer three questions: First, does investor attention have a significant impact on mitigating the risk of corporate zombies? Second, what is the

mechanism of investor attention in resolving the risk of corporate zombies? Third, is there heterogeneity in the impact of investor attention on mitigating the risk of corporate zombification? Based on this, this paper will take empirical analysis as the main line in the current context of China, and explore how investor attention plays a role in the process of corporate zombification risk resolution (Guo & Wang, 2021). Firstly, the formation of zombie enterprises under the new normal of China's economy is analyzed and accurately measured. Secondly, this paper expounds the connotation of investor attention and its role in the process of resolving zombie enterprises, and analyzes its mechanism. Finally, from the perspective of policy recommendations, specific measures on how to increase investors' attention to resolve the risk of corporate zombies are proposed. It is hoped that through the study of this issue, it will provide a theoretical basis for relevant policy formulation and contribute to the healthy development of China's economy.

1. Literature review

The current research on zombie enterprises mainly focuses on the definition, causes, hazards, identification, disposal, and prevention of zombie enterprises. Zombie enterprises have two main characteristics: on the one hand, they are less profitable and carry a heavy debt burden; on the other hand, they no longer have the ability to survive on their own, relying on the support of the government, financial institutions and shareholders to survive (Hoshi & Kashyap, 2010; Nakamura & Fukuda, 2013). The existence of zombie enterprises poses a great burden on the growth of enterprises and the development of the national economy, exacerbates overcapacity, leads to resource mismatch, causes waste of resources, and induces financial risks (Kwon et al., 2015). In addition, the products produced by zombie enterprises are generally not competitive in the market, and their long-term survival will disrupt the fair competition mechanism in the market (Nishimura et al., 2005).

In the face of the harm caused by corporate zombification, scholars have analyzed the causes in depth and tried to find ways to crack them. The reasons for the formation of zombie enterprises are divided into government decision-making and bank operations. In terms of governmental decision-making, the government provides large amounts of policy subsidies to zombie enterprises, expecting employment support, economic development data, officials' performance, and the development of local commercial banks (Wang & Liu, 2018), while lowering the supervision of loans to financial institutions and indulging in the lending behavior of banks, which accelerates the formation of zombie enterprises (Chernobai & Yasuda, 2013). In addition, loopholes in the development and implementation of government laws on corporate bankruptcy have exacerbated the process of corporate zombification (Fukuda & Nakamura, 2011). In terms of bank operations, banks continued to lend to highly indebted firms due to their own operational needs and regulatory pressure (Homar & Wijnbergen, 2013; Hoshi & Kashyap, 2010). Peek and Rosengren (2005) found that the worse-run Japanese firms received more bank loans in 1993–1999. The more poorly run Japanese firms received bank loans in 1993–1999, which exacerbated corporate zombification.

To reduce the probability of zombie enterprise formation, scholars have conducted systematic research from identification to disposal prevention. Caballero et al. (2008) have con-

structured a standard system for identifying zombie enterprises, i.e., the CHK method, by which, given the market prime rate, if the actual interest expense of an enterprise is lower than the lower limit of interest expense given by the market, it is considered a zombie enterprise. Fukuda and Nakamura (2011) further developed the “excessive borrowing method” to identify zombie enterprises based on the CHK method, i.e., the FN-CHK method. Based on the CHK method, if a firm’s earnings before interest and tax are greater than the calculated market best interest expense, it is considered a healthy firm and is removed from the zombie firms. In addition, the policy community also has a set of identification criteria for zombie enterprises. In 2015, the Chinese government proposed specific criteria for cleaning up zombie enterprises: for enterprises that have sustained losses for more than three years and are not in line with the direction of structural adjustment, they should be “cleared” using asset restructuring, property rights transfer, and bankruptcy, i.e., if an enterprise has negative profits for three consecutive years, the enterprise will be “cleared”. Mean that if an enterprise has negative profits for three consecutive years, the enterprise will be identified as a zombie enterprise. The great danger of zombie enterprises makes their prevention particularly important. Current scholars mainly focus on diversifying executive positions (Guo & Wang, 2021), streamlining fixed assets (Fukuda & Nakamura, 2011), promoting ownership reform (Jiang et al., 2018), enhancing environmental regulation (Du & Li, 2019), improving enterprises’ technological innovation capabilities (Liang, 2017), precision government subsidies (Yang et al., 2021), optimization of industrial policies (Xiao & Guo, 2021) among other aspects, suggest initiatives related to the prevention of corporate zombification.

Investor attention is an important proposition in the study of market effectiveness and business operations. Kahneman and Tversky (1973) proposed that investor attention refers to the systematic deviation of investors’ expectations about the future, which is a contradiction between complicated market information and the limited attention of investors. Current scholarly research on investor attention focuses on two aspects, the impact of investor attention on the market and the measure of investor attention itself. Investor attention, as a limited allocation of investors’ attention in the face of a plethora of market information, is a visual representation of how much attention investors pay to an individual in the market. Its impact on the market is mainly reflected from four perspectives: first, regarding stock returns, relevant research shows that the level of attention of outside investors to listed companies, to a certain extent, has a supervisory and restrictive effect on listed companies, thus improving stock returns and reducing transaction costs and risks (Da et al., 2011); second, corporate value, in addition to explicit values such as stocks, companies also have implicit values such as goodwill. Baker and Wurgler (2012) show that investor attention is indeed related to firm value, which brings about value fluctuations, including explicit value such as stocks, and implicit value such as goodwill. Third, the foreign exchange market, along with economic globalization, the foreign exchange market has become one of the major investment markets. Cooper et al. (2001) found that there is also a significant impact of investor attention on the foreign exchange market, and the orientation of investor attention is more obvious when the level of exchange rate volatility is high. Fourth, government policy feedback, the impact of investor attention on markets such as the stock market and foreign exchange will further influence the relevant government decisions, and the government will tend to more robust

policies when formulating relevant policies considering the impact of the fluctuations in investor attention caused by them on market prosperity or industry development (Smales, 2020). In addition, the impact of investor attention differs depending on its subject, i.e., the attention of institutional investors is more likely to be catered to by companies, resulting in greater market volatility (Chiu et al., 2021), while the attention of retail investors is easily ignored, but it may become a hidden problem for company operations (Hao & Xiong, 2021).

Due to the great influence of investor attention on the market, scholars continue to improve its measurement methods in subsequent studies. Barber and Odean (2008) first used extreme returns and excess trading volume as variable indicators of investment attention in their study, and this indicator provides an objective portrayal of investor attention to a certain extent, but it has problems such as unclear characterization variables and large bias in empirical studies. The relevant metrics have been improved in subsequent studies, such as the amount of media coverage (Fan et al., 2017), trading volume (Li et al., 2013), and the number of advertising expenses invested metric (Lou, 2014) to portray investor attention.

2. Research hypothesis

The direct element that affects the risk of zombification of enterprises is the profitability of enterprises, for listed companies the main body of their profitability is the main business income, and the elements that affect their income include costs, market environment, sales level, and financing ability (Mathuva, 2010). While investor attention represents investors' investment intention, it also represents investors' demand for information (Drake et al., 2012). The increase in investors' information acquisition demand indicates the increase in investors' intention to invest in an individual company among the complicated pieces of information, and the increase in investment intention will directly affect investment behavior (Aren & Hamamci, 2020). Therefore, the ability of investors' attention to mitigate the risk of zombification of listed companies is mainly reflected in investment behavior. In addition, firms' organizational structure may vary significantly depending on their equity types, which in turn affects the level of the role of investor attention in mitigating the risk of corporate zombification.

Based on the above analysis, this paper proposes the following four hypotheses.

H1: The improvement of investor attention can effectively dissolve the risk of corporate zombification.

H2: There is firm-type heterogeneity in the effect of investor attention on the dissolution of corporate zombification risk.

The limitations of investors' information access and processing ability, coupled with the rapid development of mobile Internet platforms, make investors face great difficulties in choosing their investments, especially since retail investors' selection difficulties are more obvious (Da et al., 2011). One of the solutions to investors' selection difficulties is to choose among stocks that attract their attention; therefore, investors tend to buy stocks that receive more of their attention, and this buying behavior causes upward pressure on stocks (Smales, 2020), which pushes up stock prices. Studies such as Mitchell and Mulherin (1994) can show that there is a positive relationship between the number of daily news announcements and stock returns of Dow Jones companies.

Based on the above analysis, this paper proposes the following four hypotheses.

H3: The increase in investor attention can solve the risk of corporate zombification by increasing the value of corporate stocks.

At the same time, investor attention causes market orientation to a certain extent, especially a large amount of institutional investors' attention will drive the attention of more retail investors (Gompers & Metrick, 2001). Market orientation is one of the important factors affecting the external environment of firms, and studies have shown that firms' business behavior is influenced by both the external and internal environment (Shin & Park, 1999; Schiantarelli, 1996). Therefore, the changes in the external environment brought by measurable investor attention will clarify the external business environment and lower the threshold for corporate managers to obtain and analyze the external environment, thus weakening the impact of external environment uncertainty on corporate development to resolve the issue risk of corporate zombification.

Based on the above analysis, this paper proposes the following four hypotheses.

H4: Increased investor attention can drive the resolution of corporate zombification risk by influencing uncertainty in the corporate environment.

3. Study design

3.1. Model setting

To deeply explore the correlation between investors' attention and the resolution of corporate zombification risk, the following Tobit model is constructed in this paper.

$$Prob(zom_risk_{it} = 1) = \beta_0 + \beta_1 investor_{it} + \beta_2 X_{it} + v_t + \mu_i + \varepsilon_{it}. \quad (1)$$

Among them, subscript i denotes the city, t denotes the year, and $Prob(zom_risk_{it} = 1)$ represents the possibility of listed companies becoming zombie enterprises, i.e., the risk of zombification of enterprise i in year t . $Investor_{it}$ denotes the investor attention of enterprise i in year t . X_{it} denotes other control variables that affect the risk of zombification of enterprises over time. v_t represents the time-fixed effect; μ_i denotes the individual firm fixed effect; ε_{it} denotes the random error term; coefficient β_0 is a constant term, and β_2 is the coefficient vector of each control variable. The coefficient β_1 is the core parameter of interest in this paper, indicating the effect of investor attention on the impact on the risk of corporate zombification.

3.2. Variable selection

Explained variables: zombie enterprise identification (zom_risk), there are two main approaches regarding the identification of zombie enterprises namely the CHK method and the FN-CHK method, both of which require strict data quality (Jin et al., 2019), considering the important role played by the government in studies related to zombie enterprises in China, thus, to understand the actual profitability of an enterprise, In addition to deducting credit subsidies from corporate profits, government subsidies need to be deducted. Therefore, this paper refers to the relevant study by Huang and Chen (2017) and

selects the improved FN-CHK method to identify the zombie enterprises among Chinese listed companies, i.e., an enterprise whose total actual profit after deducting all kinds of subsidies is negative for three consecutive years is defined as a zombie enterprise. The enterprise is recorded as 1 in the current year and 0 in the opposite year, and the obtained results are shown in Figure 1. It can be seen that the current zombification rate of Chinese listed companies is still on the rise overall, with a significant decline after 2015 and a rebound after 2017, indicating that the Chinese government's work to promote the structural reform on the supply side to remove zombie enterprises has been effective, and at the same time indicating that the work to remove should be promoted at the same time to strengthen the construction of the prevention mechanism of enterprise zombification risk, to consolidate the results of the previous work.

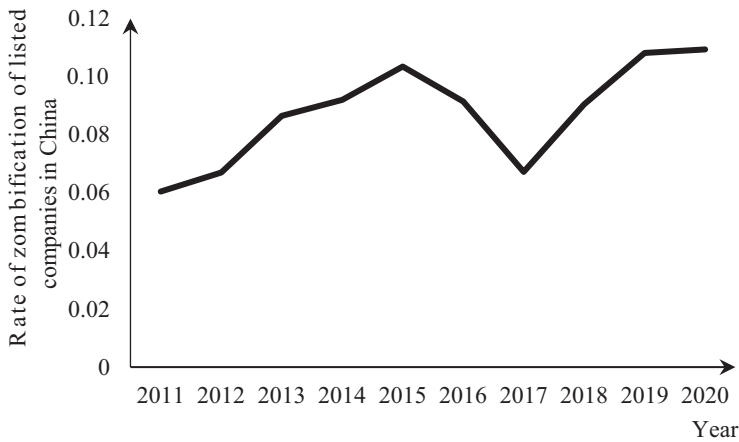


Figure 1. Rate of zombification of listed companies in China

Explanatory variable: Investor attention (*investor_mean*), the measure of investor attention has been extensively studied by scholars, mainly in terms of the firm itself and the external environment. In this paper, we refer to Fan et al. (2017) and Zhang and Tang (2022) and use the Baidu index as a characterization variable of investor concern. The Baidu index is the number of searches provided by Baidu for elements such as the abbreviation or full name of a company on computer and mobile, dating back to June 5, 2006, on the computer and January 1, 2011, on mobile. Considering the dramatic increase in investors' information access brought by the mobile Internet, the annual average of the Baidu index from 2011 to 2020 is selected here as a characterization variable of investors' attention and logarithmically treated. Meanwhile, the logarithm of the annual total the value of Baidu index (*Investor_total*) is used as a replacement variable for robustness testing. Control variables: To mitigate the estimation bias arising from omitted variables and improve the accuracy of the regressions, other relevant factors that may impact corporate zombification are selected as control variables in this paper. These include firm size (*Size*), equity checks and balances (*Balance*), years of listing (*ListAge*), number of directors (*Board*), and management expense ratio (*Mfee*). The description of each control variable is shown in Table 1.

Table 1. Description of control variables

Control variables	Calculation method	Unit
Company size (Size)	Ln total assets for the year	–
Balance of shareholding (Balance)	Sum of the shareholding of the second to fifth largest shareholder/shareholding of the first largest shareholder	%
Years on the market (ListAge)	ln(current year – year of launch + 1)	–
Number of Directors (Board)	Ln Number of Board of Directors	–
Management expense ratio (Mfee)	Administrative expenses/operating income	%

3.3. Data sources and descriptive statistics

To better examine the impact of investor attention on corporate zombification risk, considering the availability and completeness of data, this paper refers to relevant literature (Luo et al., 2023), and given that the Baidu index is more complete after 2011 and other A-share listed companies' data may have weaker completeness after 2020, this paper selects 2447 companies as the empirical sample with a total of 21547 observations. The main data comes from the CSMAR database and Baidu website¹ and fills in a few missing values by linear interpolation. The specific content is shown in Table 2.

Table 2. shows the descriptive statistics of the main variables.

Variables	Observations	Mean	Standard deviation	Min	Max
<i>zom_risk</i>	21 547	0.1320	0.3386	0	1
<i>Investor_mean</i>	21 547	6.1694	1.1912	0.0036	14.202
<i>Investor_total</i>	21 547	12.0474	1.2964	1.0986	20.1015
<i>Size</i>	21 547	22.2593	1.3786	15.5772	28.6365
<i>Balance</i>	21 547	0.7049	0.6088	0	3.9888
<i>ListAge</i>	21 547	2.2217	0.8066	0	3.4340
<i>Board</i>	21 547	2.1365	0.1996	1.0986	2.8904
<i>Mfee</i>	21 547	0.2076	14.4189	3.2456	55.3496

4. Analysis of empirical results

4.1. Baseline regression

To reduce the possible impact of multiple cointegrations and improve the accuracy of the empirical results, this paper uses the VIF method to test the explanatory variables, and the results are shown in Table 3. The maximum value of the variable VIF is 1.43 and the minimum value is 1.10, both of which are smaller than the minimum value of 10 required by the rule of thumb, indicating that the model can control the bias of the results caused by multicollinearity. In previous studies, the influencing factors of corporate zombifica-

¹ Baidu index URL: <https://index.baidu.com/v2/index.html#/>

tion risk are often analyzed from internal and external factors such as macroeconomic environment, corporate management level, corporate financial status, government policies and regulatory environment, and external risks, but the commonality of these influencing factors is that they do not take into account the role of market factors in corporate development. Therefore, this paper explores the impact of investors' attention on the resolution of corporate zombification risk from the market perspective to make up for the lack of this influencing factor in related studies.

Table 3. VIF test

Variable	Investor_mean	Size	Balance	ListAge	Board	Mfee
VIF	1.26	1.43	1.06	1.27	1.11	1.00
1/VIF	0.7932	0.7004	0.9474	0.7889	0.9044	0.9980

Table 4 reports the estimation results of the probit model of equation (1). By adding control variables step by step, it can be seen that: with or without adding control variables, investor attention has a negative and significant relationship with firms becoming zombie firms at the 5% level, indicating that investor attention can significantly reduce the risk of firm zombification, so H1 is verified.

Table 4. Benchmark regression results

	(1)	(2)	(3)	(4)	(5)	(6)
	zom_risk	zom_risk	zom_risk	zom_risk	zom_risk	zom_risk
Investor_mean	-0.1096** (0.0156)	-0.0577*** (0.0165)	-0.0578*** (0.0165)	-0.0390** (0.0171)	-0.0390** (0.0171)	-0.0392** (0.0171)
Size		-0.2370*** (0.0197)	-0.2374*** (0.0196)	-0.3801*** (0.0219)	-0.3774*** (0.0223)	-0.3703*** (0.0224)
Balance			-0.0617* (0.0353)	0.0726* (0.0371)	0.0744** (0.0372)	0.0720* (0.0372)
ListAge				1.0638*** (0.0527)	1.0648*** (0.0528)	1.0585*** (0.0528)
Board					-0.0702 (0.1136)	-0.0657 (0.1138)
Mfee						0.0649*** (0.0210)
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Individual fixation effect	Yes	Yes	Yes	Yes	Yes	Yes
Constant term	-1.5898*** (0.1084)	3.2367*** (0.4102)	3.2840*** (0.4109)	4.1770*** (0.4354)	4.2676*** (0.4595)	4.0977*** (0.4628)
N	21547	21547	21547	21547	21547	21547

Note: Standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4.2. Robustness tests

4.2.1. Replacement model

Since the zombie enterprise identification results are 0, 1 variable, the logit model is chosen here to replace the probit model for regression testing to enhance the robustness of the underlying regression results, and the regression model Equation (2) shows that each variable is explained in the same way as Equation (1).

$$\text{Logit}(zom_risk_{it} = 1) = \beta_0 + \beta_1 investor_{it} + \beta_2 X_{it} + v_t + \mu_i + \varepsilon_{it}. \quad (2)$$

Columns (1) and (2) in Table 5 report the regression results of the logit model, which show that investor concern is negatively significant at the 5% level on whether a firm becomes a zombie firm regardless of whether control variables are included, indicating that the underlying regression results are robust.

4.2.2. Substitution of explanatory variables

Replacing the explanatory variables is also a common placebo test. In this paper, the logarithm of the total annual value of the Baidu index (*Investor_total*) is selected as the replacement variable for robustness testing, and the results are shown in columns (3) and (4) in Table 5. As can be seen, after replacing the explanatory variables, investor concern is still negatively significant at the 5% level on whether a firm becomes a zombie firm, indicating that the underlying regression results are robust.

4.2.3. Instrumental variables method

To further reduce the endogeneity problem caused by mutual causality, omitted variables, and measurement errors, this paper selects the two-step IVprobit model to test the endogeneity of the benchmark regression concerning Yuan's study (2018).

Considering the requirement of strict homogeneity of instrumental variables, this paper selects the spatial proximity of listed companies (*spatial_pro*) as the instrumental variable, which is calculated as the mean value of the distance between listed companies and other listed companies and takes the inverse, specifically, the distance between listed companies and other listed companies are consistent with the hypothesis of strict homogeneity of instrumental variables and highly unrelated to the explanatory variables.

At the same time, the mean value of the distance between listed companies and other listed companies reflects the spatial agglomeration level of listed companies side-by-side.

Generally speaking, if the spatial agglomeration level of listed companies in a region is high, the agglomeration level of factors such as economy, capital, and population in the region is higher (Anokhin et al., 2019), and listed companies are more likely to receive investors' attention. Therefore, in this paper, the spatial proximity of listed companies is selected as the instrumental variable, and the regression results are shown in columns (5) and (6) in Table 5, where column (5) indicates the first-order regression and column (6) indicates the second-order regression.

The results show that, firstly, if the general Probit model is used for estimation, it will bias the regression results because the endogeneity of investor concern is ignored; secondly,

the spatial proximity of listed companies has strong explanatory power for the endogenous variable investor concern, and the investor concern remains significant for whether listed companies become zombie enterprises; finally, both Wald test and AR test are significant at 1% level, indicating that the instrumental variables selected in this paper are not weak instrumental variables.

Table 5. Regression results of the robustness test

	(1)	(2)	(3)	(4)	(5)	(6)
	zom_risk	zom_risk	zom_risk	zom_risk	spatial_pro	zom_risk
Investor_mean	-0.1276*** (0.0315)	-0.0751** (0.0345)			0.0000*** (0.0000)	-1.8572*** (0.4097)
Investor_total			-0.0943*** (0.0138)	-0.0343** (0.0150)		
control variable	No	Yes	No	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Individual fixation effect	Yes	Yes	Yes	Yes	Yes	Yes
AR test						50.39*** P = 0.0000
Wald test						20.55*** P = 0.0000
N	9138	9138	21547	21547	21547	21547

Note: Standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4.3. Heterogeneity analysis

According to the existing research, it is known that the property rights attributes of enterprises have significant effects on the organizational structure, management mode, and capital stability of enterprises. Therefore, this paper analyzes the heterogeneity of listed companies according to their equity properties to investigate whether there is heterogeneity in the influence of investors' attention on whether they become zombie enterprises under different equity properties, and the results are shown in Table 6.

In Table 6, columns (1) to (6) are central state-owned enterprises, local state-owned enterprises, collective enterprises, private enterprises, public enterprises, foreign enterprises, and other enterprises. According to the regression results, it can be seen that except for public enterprises and foreign enterprises, investors' concern is negatively significant at a 5% level on whether the listed companies become zombie enterprises, and the degree of influence is ranked as collective enterprises, other enterprises, central state-owned enterprises, local state-owned enterprises, and private enterprises, and H2 is confirmed. The possible reasons for this are, first, that public enterprises, due to their special characteristics, are those established and operated by the government to solve the market failure problem, i.e., to provide essential public goods and services to the public, to solve the external utility problem, to promote

social justice, to regulate and balance macroeconomic development, etc. The survival of such enterprises mainly depends on government support, so they are less affected by the external environment. Secondly, foreign-owned enterprises are often supported by foreign parent companies because the main body of their capital is foreign capital, so their profitability is not only influenced by the domestic market, but also by the operation of foreign parent companies, and therefore their degree of influence by the attention of domestic investors is weaker.

Table 6. Regression results of heterogeneity analysis

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	zom_risk	zom_risk	zom_risk	zom_risk	zom_risk	zom_risk	zom_risk
Investor_mean	-0.1720*** (0.0367)	-0.1334*** (0.0390)	-3.7685*** (1.2894)	-0.0695*** (0.0256)	0.1882 (0.1198)	0.2226 (0.1390)	-0.4076** (0.1737)
control variable	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual fixation effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant term	0.3656 (1.3135)	3.0377*** (0.9954)	130.1537*** (39.7781)	-3.1683*** (0.4435)	4.6769** (2.3557)	7.9368** (3.0866)	1.9234 (3.9236)
N	2821	5524	130	11294	852	684	213

Note: Standard errors in parentheses⁺ $p < 0.1$, ^{**} $p < 0.05$, ^{***} $p < 0.01$.

4.4. Mechanism analysis

The above empirical results show that investor attention significantly reduces the risk of zombification of listed companies. Here in this paper, to further investigate the mechanism of the effect of investor attention on the risk of corporate zombification, we combine the two hypotheses H3 and H4 proposed above, and refer to the approach of Baron and Kenny (1986), and adopt the mediating effect model for testing, the model is shown below.

$$M_{it} = \lambda_0 + \lambda_1 investor_{it} + \lambda_2 X_{it} + \nu_t + \mu_i + \varepsilon_{it}; \tag{3}$$

$$Prob(zom_risk_{it} = 1) = \eta_0 + \eta_1 investor_{it} + \eta_2 X_{it} + \eta_3 X_{it} + \nu_t + \mu_i + \varepsilon_{it}, \tag{4}$$

where M_{it} denotes the mediating variable, the annual market value of listed company stocks and environmental uncertainty of listed companies are selected as the mediating variables in this section, and the rest of the variables are explained in line with Equation (1). The test of mediating effect is divided into two steps: In the first step, when the regression result of Equation (1) is significant, the coefficient λ_1 in Equation (3) is estimated, and if it is significant at the 10% level, it indicates that there is a significant effect of investors' attention on the mediating variables. In the second step, η_1 and η_2 in Equation (4) are estimated, and if both are significant, it indicates the existence of the mediating effect.

4.4.1. Analysis of the mediating effect of stock market value

According to the above analysis, it is known that investor attention may have an impact on whether a listed company becomes a zombie enterprise through the path of enhancing stock value. Here this paper selects the total annual individual stock market value of listed companies as a proxy variable for stock value (*Stock_vl*). The results of column (1) and column (2) in Table 7 show that investors' attention can significantly enhance the stock value of listed companies and reduce the probability of listed companies becoming zombie enterprises by this path, and solve the risk of zombification of listed companies, and H3 is verified.

4.4.2. Analysis of the mediating effect of environmental uncertainty

To confirm that investors' attention can reduce the risk of zombification of listed companies through the path of environmental uncertainty, this paper refers to the practice of Shen et al. (2012) and constructs the environmental uncertainty index (*EU*) of listed companies for measurement. The root cause of environmental uncertainty lies in the external environment, and changes in the external environment will lead to an impact on internal production and operation activities, which will eventually lead to the fluctuation of enterprise sales revenue (Bergh & Lawless, 1998). In the first step, we calculate the average sales revenue of the company in the past five years; in the second step, we estimate the abnormal sales revenue in the past five years using OLS; in the third step, we take the ratio of the standard deviation of the company's abnormal revenue in the past five years to the mean of the sales revenue in the past five years as the unadjusted industry uncertainty; in the fourth step, we take the median of the unadjusted industry uncertainty of companies in the same industry in the same year as the industry uncertainty. The fifth step takes the ratio of the unadjusted uncertainty to the industry uncertainty as the industry-adjusted uncertainty of the enterprise in the same year.

Columns (3) and (4) in Table 7 show the results of the test of the mediating effect of environmental uncertainty, and the results show that investor attention can significantly reduce the environmental uncertainty of enterprises and use this as the influence path to reduce the probability of listed companies becoming zombie enterprises, and H4 is verified.

Previous studies have found that there is indeed heterogeneity in the impact of investor attention on corporate zombification risk, and this heterogeneity may be related to the nature of corporate equity. The nature of an enterprise's equity can be broadly classified into two categories: state-owned equity and private equity. These two types of equity nature have different impacts on the management, financing ability, and market competition of enterprises, which leads to the heterogeneity of the impact of investors' attention on the risk of zombie enterprises. Considering the specificity of the nature of equity in China, this paper further discusses the heterogeneity in seven categories: central state-owned enterprises, local state-owned enterprises, collective enterprises, private enterprises, public enterprises, foreign-funded enterprises, and other enterprises, and concludes that there is heterogeneity in the effect of investor attention on whether they become zombie enterprises under different equity properties. In the empirical regressions, we also find that there is no significant effect of investor attention on the risk of zombification among public and foreign enterprises, which enriches the existing studies.

Table 7. Regression results of the intermediary effect

	(1)	(2)	(3)	(4)
	Stock_vl	zom_risk	EU	zom_risk
Investor_mean	22.8687***	-0.0417**	-0.0791***	-0.0791***
	(2.4542)	(0.0172)	(0.0136)	(0.0136)
Stock_vl		-0.0060***		
		(0.0003)		
EU				0.0171*
				(0.0091)
control variable	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes
Individual fixation effect	Yes	Yes	Yes	Yes
Constant term	-30.4697	-3.1546***	3.5530***	0.3155***
	(41.1686)	(0.2873)	(0.2283)	(0.0699)
N	21547	21547	21547	21547

Note: Standard errors in parentheses⁺ $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4.5. Research implications

Based on the above findings, this study draws the following revelations: firstly, when facing the risk of zombification, enterprises should further enhance their awareness of investors’ attention and strengthen the construction of related fields. At the same time, enterprises should also focus on the attention of investment enterprises when making foreign investments to increase the return on investment. Secondly, enterprises should analyze the difference in the impact of investor attention on enterprise zombification risk from their own property rights attributes, and focus on the role of political and economic policies characterized by enterprise property rights in the impact of investor attention on enterprise zombification risk. Again, enterprises should further enhance their operation of the stock market and pay attention to the role of the mechanism of stock value to further resolve the risk of zombification. Finally, pay attention to environmental construction and weaken the uncertainty of corporate business environment to enhance the weakening effect of investor attention on corporate zombification risk.

Conclusions and recommendations

This paper selects Chinese listed companies from 2011–2020 as the research sample to explore the relationship between investor attention and corporate zombification risk and draws the following conclusions. Firstly, investor attention can effectively reduce the risk of corporate zombification, i.e., the possibility of listed companies becoming zombie enterprises decreases as the level of investor attention increases; secondly, there is heterogeneity in the effect of investor attention on the resolution of the risk of zombification, specifically, except

for public enterprises and foreign enterprises, there is a significant negative influence of investors' concern on whether listed companies become zombie enterprises, and the degree of influence is ranked as collective enterprises, other enterprises, central state-owned enterprises, local state-owned enterprises, and private enterprises; thirdly, the influence of investors' attention on the risk of zombification can be realized through two paths: enhancing the stock value of listed companies and reducing the environmental uncertainty of listed companies.

Based on the above findings, this study draws the following revelations and suggestions: first, companies should re-examine the diffusion effect of information dissemination in the digital economy era, strengthen their information disclosure level, welcome investors' research with an open attitude, and achieve the effectiveness of companies' investment decisions with the help of external investors' supervision, At the same time, they should play the role of the mechanism of stock market value and environmental uncertainty, and enhance their strategic determination and vision to weaken the stock market volatility and environmental changes on profitability and reduce the risk of corporate zombification. Secondly, investors should review the situation, look at the sudden hot information in the market rationally, consider the information released by the listed company and the information in the stock bar, and consider the information released by the listed company and the information in the stock bar, and conduct in-depth analysis in conjunction with the financial statements disclosed by the company to reduce the risk of decision-making due to information asymmetry. Finally, the supervisory department should strengthen the supervision of information disclosure of listed companies, improve the corresponding supervisory mechanism, reduce the speculative motive of enterprises and the degree of information asymmetry in the capital market, and provide more channels that can promote investors to explore the information of listed companies, improve the supervision and management of new media communication media, and provide reasonable guidance to investors' investment behavior, to promote the smooth and healthy operation of China's capital market.

This paper explores in depth the influence of investors' attention on reducing the risk of zombification of enterprises, and provides a scientific basis for further improving policy adjustment and revitalizing zombie enterprises. However, there are some shortcomings: on the one hand, this paper selects listed companies as the research sample, and the research object has certain specificity, and the research on non-listed companies still needs to be supplemented, and the follow-up research can conduct in-depth research on non-listed companies and comparative analysis; on the other hand, the research explores the mediating role of stock value and environmental uncertainty in the influence of investor attention on the risk of corporate zombification. It enriches the mechanism-related studies, but there is still a need to supplement the mechanism studies on the moderating effect and other aspects.

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