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Original Paper

Disentangling Oil Price Shocks and Corporate Financial Risk: The Moderating Role of Environmental Disclosure

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Abstract

This study investigates the effect of different types of oil price shocks—supply, demand, and risk shocks—on corporate financial risk and further explores whether environmental information disclosure moderates this relationship. Drawing on a panel dataset of 18,630 firm-year observations from Chinese listed companies, the analysis adopts a structural decomposition approach to oil price volatility. The findings reveal that oil price shocks significantly exacerbate corporate financial risk, with supply-side shocks exhibiting the most pronounced effects, followed by demand and risk shocks. Notably, the heterogeneity reveals that non-state-owned enterprises and energy-intensive industries exhibit greatersensitivity to oil price shocks. Firms with more transparent environmental disclosure demonstrate greater resilience to oil shocks. The results support the view that environmental disclosure mitigates financing constraints and information asymmetry, thereby reducing firms' vulnerability to external energy shocks. This analysis introduces environmental disclosure as a novel moderating mechanism that enhances corporate risk management and sustainability alignment. These findings offer practical implications for firms navigating volatile energy markets and provide a more nuanced understanding of the energy–finance nexus.

Keywords

Oil price shocks, Financial risk, Heterogeneity, Environmental disclosure

1. Introduction

Oil plays a critical role in economic growth and business operations, and these years have witnessed heightened oil price volatility driven by complex global geopolitical, demand-side, and supply-side dynamics (Byrne et al., 2019; Kilian, 2014). The transmission of oil price fluctuations to both macroeconomic outcomes and firm-level behaviors has attracted significant attention of scholars and managers around the world (Hamilton, 1996; Lütkepohl & Netšunajev, 2014; Yang et al., 2021; Yilmazkuday, 2021; Zhao et al., 2016). Given oil's essential role as a production input, its price fluctuations have been shown to significantly influence firms' cost structures, investment decisions, capital allocation, and ultimately, their financial stability (Chen et al., 2020; Kilian, 2009; Kilian &

Murphy, 2014; Wen et al., 2021). In particular, oil price shocks may elevate financial risk by tightening firms' financing conditions and introducing uncertainty into strategic planning.

While prior studies have linked oil price volatility to corporate performance, stock crash risk, corporate leverage and debt risk exposure (Fan et al., 2021; Sun et al., 2022; Xiao et al., 2022), relatively few have accounted for the heterogeneity of oil shocks. Recent advancements in energy economics emphasize the importance of identifying the source of oil price fluctuations—whether arising from supply disruptions, demand-side factors, or precautionary motives—since each shock transmits differently through the economy (Kilian, 2009; Ready, 2018). Despite this progress, the implications of decomposed oil shocks for corporate financial risk remain underexplored, especially in emerging markets where firms face greater financing constraints and institutional complexity.

In parallel, environmental responsibility and information disclosure have become increasingly central to corporate governance and risk management. These research focus on the association between environmental performance and corporate behavior such as risk management strategies (Suttipun, 2023), corporate performance (Mendiratta et al., 2021) and cost of debt (Maaloul et al., 2023). Environmental and social responsibility disclosures—especially those related to environmental performance—can reduce information asymmetry, enhance firm reputation, and improve access to external financing (Goss and Roberts, 2011; Maaloul et al., 2023). From a signaling theory perspective, proactive environmental disclosure reflects a firm's long-term commitment to sustainability and responsible resource use, which may alleviate market concerns during times of exogenous shocks such as oil price surges (Li et al., 2022; Maaloul et al., 2023; Mendiratta et al., 2021). Moreover, recent studies suggest a potential two-way link: oil price uncertainty can also affect corporate social responsibility, environmental strategies and sustainability investment decisions (Hassen & Hamdi, 2022).

Building on these theoretical foundations, this study investigates two interconnected questions: First, how do supply shocks, demand shocks, and risk shocks of oil price affect corporate financial risk? Second, can environmental information disclosure moderate this relationship by enhancing firm resilience to energy market volatility?

To address these questions, the study constructs a firm-level panel dataset comprising 18,630 firm-year observations from Chinese listed companies between 2008 and 2019. This context is particularly suitable for two reasons. First, during its critical phase of economic transformation, the country's massive demand for oil and the inflationary pressures from recent oil price hikes make it an exemplary setting to study how oil shocks impact firm-level financial health. Second, considering the special institutional background, the Chinese government is highly concerned about dual-carbon strategy and ecological construction, which provides an appropriate research context to explore the risk-mitigating role of environmental disclosure on the oil shock-financial risk relationship.

Methodologically, the study adopts the oil price decomposition approach proposed by Kilian (2009) and Ready (2018) to distinguish between oil supply, aggregate demand, and risk-driven shocks. The

research then examines effects of different oil shocks on corporate financial risk, and clarify the mechanism of oil shocks affecting financial risk. Further, it explores the moderating role of environmental disclosure, measured by whether firm discloses environment-related content in its CSR reports. The results indicate that oil shocks significantly increase corporate financial risk, especially in privately owned firms and energy-intensive industries. Importantly, firms with higher levels of environmental information disclosure exhibit lower sensitivity to oil shocks, consistent with the risk-buffering effects of transparency and stakeholder engagement.

This study advances the scholarly discourse surrounding energy shock–financial risk system interdependencies through two dimensions. First, it advances the understanding of how the source of oil price fluctuations differentially affects firm-level financial risk, addressing a gap in prior research that has largely treated oil volatility as homogenous. Second, it introduces environmental information disclosure as a novel moderating factor in the oil shock–financial risk nexus, offering theoretical and empirical insights into how sustainability practices can mitigate external energy shocks. These findings empower organizations to proactively manage the challenges posed by oil shocks and align their practices with environmental sustainability objectives by integrating ESG dimensions into corporate risk management and strategic resilience frameworks.

2. Literature Review and Research Hypothesis

2.1 Oil Shocks and Corporate Financial Risk

Some related studies focus on identifying the major sources that cause oil price fluctuations and use various methods to recognize oil shocks. Kilian (2009) proposed a metrical method to break real crude oil prices down into three components using a structural VAR model. Ready (2018) presented a new method for decomposing oil price volatility into supply shock and demand shock, which are defined as the return of the Oil Companies Global Index and the remaining variation of oil price, respectively. Motivated by the study by Ready (2018), this study employs a structural VAR model to divide price volatility into three distinct parts.

On this basis, previous studies have demonstrated that oil price volatility can significantly affect debt ratio, equity returns, corporate payment decisions, corporate earnings management and capital cost (Abraham, 2015; Alquist et al., 2020; Haushalter et al., 2002; Kang et al., 2017; Lin & Wu, 2022; Mokni, 2020; Prodromou, 2022; Wong & Hasan, 2021). As acknowledged by Gupta and Krishnamurti (2018), although numerical studies explore the connection between oil prices and corporate performance, there is limited evidence regarding corporate risk-taking. Oil price uncertainty positively affects stock price crash risk (Xiao et al., 2022), and the similar conclusion that supply, demand, and risk shocks all contribute to elevated levels of bank risk is reached in the research of Jin et al. (2022). However, there is a scarcity of research addressing the financial risk stemming from these oil shocks.

Theoretically, two plausible mechanisms exist by which oil shocks influence corporate financial risk. Firstly, volatilities in oil prices serve as indicators of economic conditions, risk exposure, and

consumption demand. Escalating oil shocks elevate uncertainty levels and exacerbate financing constraints, consequently heightening the probability of firms facing financial distress (Lundqvist & Vilhelmsson, 2018; Phan et al., 2019). For a simple example, supply-driven changes in oil prices can trigger uncertainty and potentially increase the debt risk or cash flow risk for companies, as production costs rise. Specifically, the oil shocks may affect corporate production cost, borrowing cost, and the ability to borrow and repay existing debt, which in turn affects cash flow, debt structure and risk, in line with the findings of Jin et al. (2022) and Xiao et al. (2022). The higher the volatility of oil price, the greater the financial risk faced by the enterprise. Elevated oil price fluctuations exhibit a significant positive correlation with heightened corporate financial risk exposure.

Secondly, in accordance with signal transmission theory, the volatility of oil prices conveys indications regarding future uncertainties, with uncertainty representing a significant risk factor. During periods of heightened shocks, elevated oil prices can inflate business production costs, subsequently leading to diminished profits (Bugshan et al., 2023; Zhang et al., 2020). Managers are compelled to solicit financial backing from investors, thereby engendering agency dilemmas between managers and owners. For instance, demand shocks are primarily influenced by oil consumption and consumer demand, influenced by purchasing power and economic conditions, where weakened demand can exacerbate operational challenges and erode profitability. The company's adoption of a wait-and-see reaction may result in the concealment of unfavorable information, amplifying information asymmetry and agency conflicts. Consequently, the initial hypothesis 1 is put forward.

H1: Oil price shocks are positively associated with corporate financial risk.

2.2 Environmental Disclosure

It has been a research hotspot to improve corporate environmental disclosure (Fan et al., 2020), and there is growing concern about the role of environmental disclosure (Luo et al., 2022; Nguyen & Phan, 2020; Wang et al., 2023; Zheng & Ren, 2019). On the one hand, some research focusing on the relationship between oil price uncertainty and CSR activities demonstrate that oil price uncertainties negatively influence the CSR engagement (Hassen & Hamdi, 2022; Phan et al., 2021). On the other hand, environmental actions such as CSR and ESG engagement could mitigate financial risk, and numerous studies indicate that improving ESG performance contributes to reducing corporate financial vulnerability (Atif & Ali, 2021; Di Tommaso & Thornton, 2020; Lian et al., 2023; Suttipun, 2023). Extending from these researches, this study further investigates the role of environmental disclosure and explore whether the buffer effects exist among companies that disclose more environmental information.

Environmental information disclosure may play moderating roles in the relationship drawing upon the following aspects. Firstly, environmental information disclosure could mitigate financing constraints and affect a company's ability to access capital markets (Luo et al., 2022). Specifically, companies with strong environmental practices tend to attract socially responsible investors and enhance willingness of investors who are willing to invest in these companies at favorable costs of capital. It may facilitate

easier and more cost-effective access to capital markets, thereby enhancing creditworthiness of the company. In this way, enterprises would improve their financing capacity influencing and reduce financing constraints.

Secondly, based on signaling theory, the disclosure of environmental information contribute to alleviate information asymmetry and agency conflict (Saeed & Zamir, 2021). Environmental information related to ESG and corporate social responsibility serves as a mechanism to communicate signals related to corporate reputation and brand value to the market, contributing to corporate transparency (Lian et al., 2023). Companies with strong governance policies and practices tend to establish a reputation for ethical and responsible behavior, thereby safeguarding their brand value and reducing the likelihood of negative publicity or legal issues. Moreover, environmental requirements play a critical role in bolstering a firm's resilience in the face of changing oil market. Companies that prioritize environmental performance are more effective in creating and launching new products and services, diversify their revenue streams, and decrease their reliance on oil and energy. By doing so, they can reduce their exposure to oil price fluctuations and mitigate financial risk when confronted with volatile oil price shocks. Building upon these observations, Hypothesis 2 is proposed.

H2: Environmental information disclosure mitigates the positive association between oil price shocks and corporate financial risk, serving as a moderating mechanism.

2.3 Corporate Heterogeneities

Companies with different ownership natures and industries exhibit different degrees of sensitivity to oil price shock. Consistent with the findings of Scholtens and Yurtsever (2012), the impacts of oil price fluctuations differ significantly across industries. Based on the industrial classification, energy-intensive sectors such as energy and materials exhibit a higher level of sensitivity to oil price shocks (Chen et al., 2020). Given that energy and material industries heavily rely on oil or petroleum products as raw materials, any fluctuations in oil prices directly affect production costs, profit margins, and related debt indicators within these industries. Generally, firms with high energy consumptions are accompanied by high carbon emissions, which usually face greater financing constraints (Ji et al., 2019).

The existing literature has studied the differences in the ownership structure. Cao et al. (2020) find that non-SOEs and small-size firms are more vulnerable to oil price volatility due to more severe financing constraints. State-owned enterprises, by contrast, generally possess stronger institutional support to buffer against external disruptions (Zhang et al., 2015). Therefore, non-state-owned enterprise may fail to adjust investment and financing strategies promptly due to information asymmetry and resource problems. Compared to state-owned companies, non-SOEs experience a more pronounced impact. Accordingly, hypothesis 3 is proposed.

H3: The effects of oil price shocks vary across firm characteristics, with greater impacts observed among privately owned firms and energy-intensive industries.

3. Data and Research Design

3.1 Data Sources

This study utilizes a dataset comprising 18,630 firm-year observations from Chinese listed companies spanning 2008 to 2019. Firm-level financial and accounting data are from the China Stock Market & Accounting Research (CSMAR) database. To enhance data reliability, the study excludes financial firms, companies under special treatment (ST), and those flagged for particular transfer (PT) status due to abnormal operations. To mitigate the influence of outliers, key continuous variables are winsorized at the 1st and 99th percentiles.

3.2 Variable Measures

3.2.1 Independent Variable: Oil Price Shocks

This study applies the popularly employed Ready (2018) oil price shocks measure which is constructed by the three specific measurements: oil production index, oil price changes, and expected returns. The volatility index (VIX) is a rational proxy for risk changes. The author further used the residuals of the ARMA(1,1) as a new VIX to prevent unexpected changes in the VIX. Following this method, oil price changes are decomposed with a structural VAR model. In sum, oil price variations are expressed as the sum of three distinct shocks rather than being normalized based on shock volatility.

Table 1 reports the decomposed shocks, where the columns represent oil supply shock (*oss*), oil demand shock (*ods*), and oil risk shock (*ors*), respectively. The results indicate that demand shocks showed the similar trend to the supply shocks, and both fluctuated in a smaller range, while oil risk shocks presented a large fluctuation.

Table 1. Decomposed Oil Shocks Over Time

Year	Supply Shock (%) (oss)	Demand Shock (%) (ods)	Risk Shock (%) (ors)
2008	-8.5310	-8.7570	113.2042
2009	11.5798	16.7832	68.8802
2010	3.8118	5.3073	29.1488
2011	2.8034	6.1270	55.2526
2012	-3.4090	1.0677	-11.9410
2013	1.6044	-1.8620	-53.6770
2014	-13.4520	-10.4050	-31.4350
2015	-4.8210	-8.4800	-18.6780
2016	5.9487	6.2146	-36.9220
2017	3.4712	-5.2760	-95.9950
2018	-7.6000	-0.4270	14.8713
2019	8.9610	-0.3010	-54.8380

Notes. This table denotes oil demand shocks, supply shocks, and risk shocks (in percentage terms) from 2008 to 2019.

3.2.2 Dependent Variable: Corporate Financial Risk

The empirical research employs yearly indicators of corporate financial risk as dependent variables. In the baseline model, financial distress is measured using the *Z-score*, a widely recognized proxy for corporate financial risk and the likelihood of financial failure (Altman, 1968). The *Z-score* assesses financial vulnerability by incorporating a weighted average of financial metrics, including the proportion of working capital, the ratio of retained earnings to total capital and capital structure, making it a key indicator for evaluating a firm's financial health and stability. A higher Z-value reflects reduced debt risk and is shaped by factors such as capital structure, asset base, profitability, and growth potential. Firms with elevated Z-values exhibit stronger financial health and a lower probability of bankruptcy, whereas a smaller Z-value meaning financial distress, with bankruptcy looming.

KZ index, obtained from the Financial Distress database in CSMAR, serves as an additional measure of financial distress risk. It provides insights into the financial health and vulnerability, aiding in the assessment of their potential risk of financial difficulties. The KZ index is derived from a combination of financial ratios and indicators that encompass factors such as profitability, liquidity, leverage and solvency. Generally, an elevated KZ index value is commonly associated with tighter financing conditions and increased financial distress.

3.2.3 Firm-level Moderator and Control Variables

The data primarily originates from environmental management and environmental disclosure carrier database in CSMAR, primarily examining whether publicly listed firms report information related to environmental special actions, environmental protection, and other pertinent details within their annual reports. This study also utilizes the Bloomberg ESG dataset, which encompasses over 120 categories derived from multiple sources. The extent of ESG disclosure is assessed based on the scoring of its three core dimensions. Noting that corporate annual reports are not the sole avenue for environmental information, this study also investigates the inclusion of environmental information within CSR reports to assess its moderating effect of environmental disclosure.

Following prior research (Chen et al., 2020; Henriques & Sadorsky, 2011), the study includes the following firm-level control variables: company size, firm age, profitability, Tobin's Q, sale growth rate, debt capacity and cash flow. Specifically, *Size* is measured by the natural logarithm of total assets, while *Age* is the logarithm of the number of years since incorporation. Profitability is captured by return on assets (*ROA*), and *Tobin's Q* serves as a proxy for investment opportunities. The growth rate of revenue is a crucial metric used to assess the growth and development capacity of enterprises, denoted as *growINC*. *Capratio* measures the debt capacity and cash flow factor denoted as *cfdc* represents the ratio of cash flow to maturity debt.

3.3 Descriptive Statistics

The summary statistics of major variables are shown in Table 2. In terms of environmental information, based on the mean values, it is observed that 24.4% of companies disclosed environment-related information in their CSR reports, while an average of 11.5% and 12.8% disclosed environmental goals

and special actions in their annual reports, respectively.

Table 2. Summary Statistics

variable	mean	sd	p50	min	max
oss	0.009	7.182	1.604	-13.452	11.580
ods	-0.555	6.667	-0.427	-10.405	16.783
ors	-13.478	52.784	-18.678	-95.995	113.204
ZScore	4.727	5.668	2.939	-0.042	37.137
KZ	1.316	2.419	1.513	-5.559	6.951
age	2.816	0.349	2.833	1.609	3.466
size	22.129	1.284	21.956	19.705	26.071
ROA	0.039	0.062	0.037	-0.234	0.211
growINC	0.182	0.442	0.109	-0.581	2.885
TobinQ	2.038	1.317	1.605	0.878	8.648
cfdc	8.918	41.837	0.781	-23.161	350.066
FC	0.480	0.275	0.503	0.000	0.987
ESG	21.033	7.194	20.248	1.240	64.115
csrreport	0.244	0.430	0.000	0.000	1.000
epgoal	0.115	0.320	0.000	0.000	1.000
epact	0.128	0.335	0.000	0.000	1.000

Notes. Among the main variables, oss, ods, and ors are the key independent variables. ZScore and KZ index serve as proxy variables for measuring the company's financial distress risk. ESG, csrreport, epgoal, and epact represent variables related to environmental information disclosure.

3.4 Research Design

To analyze the impact of disaggregated oil price shocks on corporate financial risk, the study begins with a baseline regression using oil shocks proposed by Ready (2018). The model provides a more direct interpretation of the target variables' coefficients.

$$ZScore_{i,t} = \alpha_i + \gamma_t + \beta Oil\_Shock_t + \delta\, \Sigma Controls_{i,t-1} + \varepsilon_{i,t} \quad (1)$$

where $ZScore_{i,t}$ represents the corporate risk and the possibility of financial failure for firm *i* in year *t*. A smaller *ZScore* means greater risk and greater chance of suffering financial distress. α_i and γ_t represent unobserved firm-specific and time-fixed effects (Chen et al., 2020; Fan et al., 2021; Sun et al., 2022), which may decrease the potential impacts of unobserved elements. The coefficients β denote the sensitivity of corporate risk to the three types of oil shocks. The term $Contorls_{i,t-1}$ encompasses various control variables as described above. The introduction of variable lags can avoid omitted variable bias

and reduce endogeneity concerns, following established research practices (Keele & Kelly, 2006; Ren et al., 2023).

4. Empirical Results

4.1 Main Results of the Effect of Oil Shocks on Corporate Financial Risk

The study empirically investigates the impact of oil shocks on corporate financial risk by estimating Equation (1). The results of Columns (1)–(3) in Table 3 show that there are significantly negative correlations between the different oil price shocks (*oss*, *ods*, and *ors*) and *ZScore*. That is to say, the higher oil price shocks, the smaller *ZScore* (i.e., the greater debt risk), and the impact degree of the three shocks behaves quite differently, which supports the H1. These findings speak to many studies that investigated how corporate responded to oil shocks (Fan et al., 2021; Gupta and Krishnamurti, 2018; Xiao et al., 2022).

Table 3. Estimated Results of Benchmark Regression

	(1)	(2)	(3)
	ZScore	ZScore	ZScore
oss	-0.459***		
	(-3.92)		
ods		-0.070***	
		(-3.92)	
ors			-0.010***
			(-3.92)
L.age	-1.429***	-1.429***	-1.429***
	(-3.34)	(-3.34)	(-3.34)
L.size	-0.814***	-0.814***	-0.814***
	(-8.94)	(-8.94)	(-8.94)
L.ROA	5.557***	5.557***	5.557***
	(6.76)	(6.76)	(6.76)
L.growINC	-0.122**	-0.122**	-0.122**
	(-2.23)	(-2.23)	(-2.23)
L.TobinQ	0.746***	0.746***	0.746***
	(11.62)	(11.62)	(11.62)
L.cfdc	0.002	0.002	0.002
	(1.32)	(1.32)	(1.32)
L.Capratio	-0.271***	-0.271***	-0.271***
	(-7.45)	(-7.45)	(-7.45)

_cons	29.360***	25.225***	24.714***
	(8.84)	(10.38)	(10.61)
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
N	18631	18631	18631
adj. R-sq	0.194	0.194	0.194

Notes. The significance levels of ∗∗∗, ∗∗, and ∗ represent statistical significance at the 1%, 5%, and 10% levels, respectively. The following tables illustrate the same.

Specifically, oil supply, oil demand and oil risk shocks negatively correlate with *ZScore*, and coefficients are -0.459, -0.070 and -0.010. In this scenario, a one-standard deviation increase in supply shock is associated with a decrease of approximately 3.297 in *ZScore*, whereas the same change of *ods* might decrease *ZScore* by 0.467 approximately. Notably, oil supply shocks exert a more pronounced effect on evaluating corporate financial risk. This finding aligns with recent evidence indicating a stronger driving effect of supply-side factors on oil price volatility (Huang et al., 2021; Wei and Guo, 2022).

In terms of supply shock effect, the decrease in the output level in the upstream industry chain directly leads to an increase of marginal costs in companies that especially use crude oil as a raw material. Supply-side shocks, in particular, often deliver long-lasting effects to the market, accompanied by the surge in global fuel, electricity and other consumer goods, and in this context economic downturn seems hunting the global. Rising oil shocks drive up the level of uncertainty and risk taken by companies, and firms may become more reliant on debt financing, increasing their asset–liability ratios and heightening financial distress risk. This mechanism is consistent with the viewpoints of Chen et al. (2020). Moreover, supply shocks tend to have persistent and structural impacts, as they reflect constraints on production capacity and are often accompanied by broader inflationary pressures—further amplifying uncertainty in business operations and investment planning.

Demand shocks reflect shifts in global economic activity. When driven by expansion, they may raise input prices and revenues simultaneously; however, when linked to downturns, they reduce demand and firm profitability. Firms facing falling demand may cut investments and adopt conservative financial policies, which can inadvertently worsen their financial position. Risk shocks capture precautionary responses to uncertainty about oil market conditions. While they reflect market sentiment more than real supply-demand imbalances, they may still trigger strategic reactions such as delayed investments or liquidity hoarding. However, their short-term and indirect nature tends to yield a weaker impact on financial outcomes.

4.2 Mechanisms of Oil Price Shocks: Financing Constraints and Agency Costs

Oil price uncertainty may affect the costs of business production and profits, thus influencing investment opportunities and solvency (Bugshan et al., 2023; Zhang et al., 2020). Rising oil shocks

drive up the level of uncertainty and risk taken by companies, and impact financing constraints, thus increasing the likelihood of a firm falling into financial distress (Phan et al., 2019). Moreover, oil price shocks convey signals not only of corporate cash flow but also of associated risk (Gupta & Krishnamurti, 2018). According to the signaling theory, the management is motivated to increase favorable or hide unfavorable information, thus aggravating the agency problem and increasing information asymmetry between internal stakeholder and external parties. Asset turnover rate is the proxy variable for financing constraints (*FC*) and agency costs (*AC*) index obtained from CSMAR to test the influence channels (Ang et al., 2000; Khan et al., 2016). A low value of agency measure by asset turnover rate illustrates a higher agency cost. Based on the research of Ren et al. (2023) and Chen et al. (2018), the channel effects of financing constraints and agency costs are studied by using the two-step regression.

Table 4 lists how oil shocks affect corporate financial risk through the channel variables. Panel A presents the channel of financing constraints and the relations between oil shocks and *FC* are tested in the first step. Specifically, the indirect impact of oil supply shocks on financial risk is estimated at -0.159 (-0.062*2.57), while the direct impact is -0.299, as reported in columns (1) and (2) of Panel A. Similarly, the results of *ods* and *ors* align with those for *oss*, reinforcing the conclusion that financing constraints serve as a mediating role, amplifying the effects of oil shocks on financial risk. Panel B shows the channel of agency costs and the results of first step are listed in columns (1) (3) and (5). The two-stage regression results support the influence channel of agency costs.

Table 4. Influence Mechanism for Oil Shocks on Corporate Financial Risk

Panel A. Influence channel of financing constraints (*FC*)						
	(1)	(2)	(3)	(4)	(5)	(6)
	FC	ZScore	FC	ZScore	FC	ZScore
oss	-0.062***	-0.299***				
	(-11.44)	(-2.62)				
ods			-0.010***	-0.046***		
			(-11.44)	(-2.62)		
ors					-0.001***	-0.006***
					(-11.44)	(-2.62)
FC		2.570***		2.570***		2.570***
		(9.42)		(9.42)		(9.42)
_cons	5.039***	16.409***	4.476***	13.720***	4.407***	13.387***
	(33.66)	(4.97)	(41.06)	(5.53)	(42.17)	(5.60)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes

Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	18632	18631	18632	18631	18632	18631
adj. R-sq	0.364	0.205	0.364	0.205	0.364	0.205
Panel B. Influence channel of agency costs (*AC*)						
	(1)	(2)	(3)	(4)	(5)	(6)
	AC	ZScore	AC	ZScore	AC	ZScore
oss	0.044**	-0.512***				
	(2.53)	(-4.43)				
ods			0.007**	-0.078***		
			(2.53)	(-4.43)		
ors					0.001**	-0.011***
					(2.53)	(-4.43)
AC		1.217***		1.217***		1.217***
		(11.15)		(11.15)		(11.15)
_cons	0.226	29.090***	0.624	24.480***	0.673*	23.910***
	(0.44)	(8.94)	(1.62)	(10.29)	(1.82)	(10.48)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	18585	18585	18585	18585	18585	18585
adj. R-sq	0.067	0.205	0.067	0.205	0.067	0.205
Panel C. Influence path revalidation (*Information Transparency*)						
	(1)	(2)	(3)	(4)	(5)	(6)
	ZScore	ZScore	ZScore	ZScore	ZScore	ZScore
Transparency	High	Low	High	Low	High	Low
oss	-0.020	-0.356**				
	(-0.05)	(-2.00)				
ods			-0.003	-0.055**		
			(-0.05)	(-2.00)		
ors					-0.000	-0.008**
					(-0.05)	(-2.00)
_cons	27.347**	25.426***	27.167***	22.220***	27.145***	21.824***
	(2.18)	(5.72)	(2.85)	(7.20)	(2.95)	(7.44)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

N	2402	9083	2402	9083	2402	9083
adj. R-sq	0.164	0.203	0.164	0.203	0.164	0.203

Notes. This table shows influence channels through which oil shocks affect corporate financial risk. Panel A and Panel B present oil shocks could affect corporate financial risk through financing constraints (*FC*) and agency problem (*AC*). The proxy variable of *Information Transparency* is used to measure agency problem and Panel C lists the grouped regression results of path analysis. The significance levels of ∗∗∗, ∗∗, and ∗ represent statistical significance at the 1%, 5%, and 10% levels, respectively.

To further explore the channel mechanism through which oil shocks influence financial risks, this study revisits the agency channel, employing information transparency as a proxy variable to assess agency issues. Enterprises with high levels of transparency are adept at efficiently transmitting and communicating information, thus mitigating information asymmetry within and outside the organization. This can serve as an alternative variable for addressing the agency problem.

With respect to information transparency, this research adopts mechanism tests similar to Zhang et al. (2022) and categorize the samples into two groups: those characterized by high information transparency (indicated by a level of "A" in CSMAR, and assigned a value of 1 to *Information Transparency*) and those in the low information transparency group (a value of 0). Panel C of Table 4 provides insights from the grouped regression analysis, demonstrating that the adverse effects are more pronounced in firms with lower information transparency. This supports the notion that information opacity exacerbates the financial risks.

4.3 Moderating Role of Environmental Disclosure

The reason why enterprises fall into the dilemma of financing constraints largely stems from the presence of information asymmetry between investors and companies (Kaplan & Zingales, 1997). If corporate environmental responsibility serves as a credible signal of a firm's commitment to environmental initiatives, one would anticipate a positive market response to the information, which signal the commitment to improving reputation and facilitating access to capital. As a result, it may alleviate financing constraints and reduce firms' vulnerability to external shocks. This mechanism is incorporated into the empirical framework to assess its moderating role in the relationship.

Based on the environmental disclosure database in CSMAR, the variable of *EPGoal* (*epgoal*) is assigned a value of 1 if a firm reports its past environmental achievements and future sustainability objectives. Similarly, *EPSpecialAct* (*epact*) is set to 1 when a company discloses participation in specialized environmental protection initiatives and corporate social responsibility programs. Otherwise, if the company does not disclose such information, both *EPGoal* and *EPSpecialAct* are assigned values of 0. To assess the moderating role of environmental information disclosure, the study incorporates cross-multiplying terms in the following model.

$$ZScore_{i,t} = \alpha_i + \gamma_t + \beta_1 Oilshock_t + \beta_2 EP_{i,t} + \beta_3 EP_{i,t} * Oilshock_t + \delta\, \Sigma Controls_{i,t-1} + \varepsilon_{i,t} \quad (2)$$

where $EP_{i,t}$is the measure of environmental protection information level of firm i at year *t*, including two dimensions of *EPSpecialAct* and *EPGoal*. $EP_{i,t} * Oil\_Shock_t$ are interaction terms between environmental protection information and oil shocks (*oss, ods,* and *ors*). In Eq. (2), the focus lies on interaction terms β_3, and the consistency of a set of signs is used to judge whether the $EP_{i,t}$ has strengthened or weakened the interaction of oil shocks and financial risks. As per the underlying theory discussed above, environmental disclosure can exert positive effects on enterprises and mitigate the impact of oil price fluctuations on corporate financial risk.

Table 5. Moderating Effect of Environmental Management Information Disclosure

Panel A. Effect of environmental protection goal disclosure (*epgoal*)			
	ZScore	ZScore	ZScore
oss	-0.457***		
	(-3.90)		
ods		-0.072***	
		(-4.01)	
ors			-0.010***
			(-3.84)
epgoal	0.005	0.011	-0.014
	(0.09)	(0.22)	(-0.25)
epgoal*oss	0.010**		
	(1.98)		
epgoal*ods		0.019***	
		(3.08)	
epgoal*ors			-0.001
			(-1.51)
Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
N	18631	18631	18631
adj. R-sq	0.194	0.194	0.194
Panel B. Effect of environmental protection special action (*epact*)			
	ZScore	ZScore	ZScore
oss	-0.456***		
	(-3.89)		

ods		-0.072***	
		(-4.02)	
ors			-0.010***
			(-3.96)
epact	-0.078	-0.050	-0.069
	(-1.31)	(-0.85)	(-1.08)
epact*oss	0.010**		
	(2.21)		
epact*ods		0.032***	
		(4.94)	
epact*ors			0.000
			(0.34)
Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
N	18631	18631	18631
adj. R-sq	0.194	0.195	0.194

Notes. Panel A presents the effects of environmental protection goal (*epgoal*) on the relationship between oil shocks and financial risk, and Panel B displays the moderating effect of environmental protection special action (*epact*). The main concern here is the coefficient of interaction term.∗∗∗, ∗∗, and ∗ denote the statistical significance at the 1%, 5%, and 10% level.

Table 5 presents the statistically significant interactions. Notably, the coefficients of oil supply shocks and oil demand shocks exhibit opposite signs to their respective interaction terms, indicating that corporate environmental management disclosure helps mitigate the financial risks. Specifically, Panel A highlights the role of environmental disclosure related to corporate sustainability objectives (*epgoal)*. The interaction terms between oil supply shocks (oil demand shocks) and environmental disclosure yield coefficients of 0.01 and 0.019, respectively. This suggests that firms publicly disclosing their environmental goals exhibit lower sensitivity to oil shocks. Panel B demonstrates the interaction terms are statistically significant, which confirm similar results. The disclosure of special environmental actions mitigates the adverse impact of oil price shocks, aligning with H2.

4.4 Heterogeneity Analyses

The study further investigates whether the relationship between oil price shocks and corporate financial risk varies across diverse firm characteristics. Given that enterprises across diverse industries and ownership structures face different financing constraints and internal agency issues, it is reasonable to expect substantial heterogeneity in their responses to oil price shocks. For instance, the average indicator of financing constraints for state-owned enterprises and private firms stands at 0.362 and

0.570 respectively, while the mean for the full samples is 0.480, indicating that private enterprises face higher financing constraints. To that end, the research conducts heterogeneity analysis from the perspectives of ownership structure and industry category.

4.4.1 Differences in Firm Ownership Structure

Given the distinct social and economic roles, striking differences may exist among companies with different ownership natures. Oil price shocks negatively affect corporate financing and investment decisions based on state ownership structure, as supported by prior research (Cao et al., 2020; Fan et al., 2021). For state-owned enterprises, due to the special economic and social functions, they are more likely to obtain supportive policy and government intervention, and have advantages over private enterprises in obtaining financing resources and alleviating financing constraints. Consequently, oil price shocks may result in greater financial risks for private enterprises and conduct group regression analyses based on ownership characteristics.

Table 6. Heterogeneous Effects of Ownership Structure

	(1)	(2)	(3)	(4)	(5)	(6)
	ZScore	ZScore	ZScore	ZScore	ZScore	ZScore
	State-owned	Private	State-owned	Private	State-owned	Private
oss	-0.190	-0.441**				
	(-1.40)	(-2.22)				
ods			-0.029	-0.068**		
			(-1.40)	(-2.22)		
ors					-0.004	-0.009**
					(-1.40)	(-2.22)
L.age	-0.834*	-1.198*	-0.834*	-1.198*	-0.834*	-1.198*
	(-1.71)	(-1.77)	(-1.71)	(-1.77)	(-1.71)	(-1.77)
L.size	-0.517***	-0.849***	-0.517***	-0.849***	-0.517***	-0.849***
	(-5.42)	(-6.13)	(-5.42)	(-6.13)	(-5.42)	(-6.13)
L.ROA	6.170***	5.482***	6.170***	5.482***	6.170***	5.482***
	(7.15)	(5.08)	(7.15)	(5.08)	(7.15)	(5.08)
L.growINC	-0.019	-0.230***	-0.019	-0.230***	-0.019	-0.230***
	(-0.44)	(-2.65)	(-0.44)	(-2.65)	(-0.44)	(-2.65)
L.TobinQ	0.707***	0.669***	0.707***	0.669***	0.707***	0.669***
	(8.55)	(7.49)	(8.55)	(7.49)	(8.55)	(7.49)
L.cfdc	0.000	0.001	0.000	0.001	0.000	0.001
	(0.11)	(0.69)	(0.11)	(0.69)	(0.11)	(0.69)
L.Capratio	-0.191***	-0.406***	-0.191***	-0.406***	-0.191***	-0.406***

	(-6.51)	(-6.56)	(-6.51)	(-6.56)	(-6.51)	(-6.56)
_cons	18.212***	29.412***	16.497***	25.441***	16.285***	24.950***
	(4.51)	(5.84)	(5.58)	(7.20)	(5.75)	(7.40)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	8303	9016	8303	9016	8303	9016
adj. R-sq	0.176	0.217	0.176	0.217	0.176	0.217

Notes. This table presents heterogeneous effects of oil price shocks on corporate risk based on ownership structures. Columns 1, 3, and 5 showcase the influences of oil price supply shock, demand shock, and risk shock on the financial risk of state-owned enterprises, while columns 2, 4, and 6 illustrate the corresponding effects for private enterprises.

In Table 6 columns (2) (4) and (6) demonstrate the impact of three oil shocks on private companies. For these companies, oil shocks are associated with smaller *ZScore* values, indicating an increasing level of financial risk. In contrast, the results are not remarkable in statistical for state-owned companies as shown in columns (1) (3) and (5). The underlying reason is that state-owned companies possess significant bargaining power in market competition and have easier access to resource, thereby limiting the impact of oil price shocks. However, private companies operating at the end of the industrial chain, particularly those involved in manufacturing products, demonstrate a heightened sensitivity to fluctuations in crude oil prices. These private companies are not only responsive to oil price shocks but are also more susceptible to debt risks due to changes in the macroeconomic environment.

4.4.2 Differences in Firm Industry Responses to Oil Price Shocks

An empirical study is conducted at the industry level to unveil the heterogeneity of spillover effects more clearly (Pal and Mitra, 2019; Yasmeen et al., 2019), which aim to assist companies in formulating more effective investment strategies and implementing robust risk management practices. Based on the transmission path of crude oil within China's industrial chain, it is theoretically expected that upstream companies would exhibit greater sensitivity to oil price shocks, while downstream companies, situated at the demand end of the industrial chain, would be less affected. Consequently, listed companies are classified into two categories: energy-intensive industries, and other industries. Companies involved in energy production, energy consumption and utilizing energy as raw materials directly or indirectly are under much more stress in operation and emission reduction, so managers have more incentives selectively to disclose information, thus exacerbating information asymmetry. The presence of information asymmetry hampers their ability promptly to adjust investment and financing decisions. Therefore, oil shocks exert more pronounced impacts on energy-intensive industries than other industries.

Table 7. Heterogeneous Effects of Industry Category

	(1)	(2)	(3)	(4)	(5)	(6)
	ZScore	ZScore	ZScore	ZScore	ZScore	ZScore
	Energy-intensive	Other	Energy-intensive	Other	Energy-intensive	Other
oss	-0.689**	-0.449***				
	(-2.20)	(-3.49)				
ods			-0.106**	-0.069***		
			(-2.20)	(-3.49)		
ors					-0.015**	-0.009***
					(-2.20)	(-3.49)
L.age	-1.899	-1.381***	-1.899	-1.381***	-1.899	-1.381***
	(-1.59)	(-3.04)	(-1.59)	(-3.04)	(-1.59)	(-3.04)
L.size	-1.007***	-0.811***	-1.007***	-0.811***	-1.007***	-0.811***
	(-5.82)	(-7.42)	(-5.82)	(-7.42)	(-5.82)	(-7.42)
L.ROA	2.938	5.741***	2.938	5.741***	2.938	5.741***
	(1.32)	(6.46)	(1.32)	(6.46)	(1.32)	(6.46)
L.growINC	0.173	-0.135**	0.173	-0.135**	0.173	-0.135**
	(1.61)	(-2.30)	(1.61)	(-2.30)	(1.61)	(-2.30)
L.TobinQ	0.876***	0.725***	0.876***	0.725***	0.876***	0.725***
	(5.50)	(10.26)	(5.50)	(10.26)	(5.50)	(10.26)
L.cfdc	0.006**	0.001	0.006**	0.001	0.006**	0.001
	(2.23)	(0.76)	(2.23)	(0.76)	(2.23)	(0.76)
L.Capratio	-0.238***	-0.268***	-0.238***	-0.268***	-0.238***	-0.268***
	(-4.72)	(-5.92)	(-4.72)	(-5.92)	(-4.72)	(-5.92)
_cons	36.961***	29.114***	30.754***	25.073***	29.986***	24.573***
	(4.49)	(7.69)	(5.41)	(8.90)	(5.56)	(9.08)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	3425	15206	3425	15206	3425	15206
adj. R-sq	0.191	0.194	0.191	0.194	0.191	0.194

Notes. Columns 1, 3, and 5 demonstrate the outcomes regarding the impact of the three oil price shocks on the financial risk of energy-intensive enterprises, while the remaining columns depict the corresponding results for other industries.

As anticipated, there exists a positive correlation between oil price shocks and corporate financial risk, with all regression coefficients displaying negative significantly in Table 7. Moreover, the impact on

the two sectors varies and difference between the two groups is statistically significant. The absolute values of all coefficients for energy-intensive industries surpass those of other industries, aligning with the aforementioned H3.

4.5 Robustness Test

4.5.1 An Alternative Measure of Financial Risk

To further validate the robustness of the estimated results, this research conducts additional tests by introducing alternative proxy variables of financial risk. Specifically, it replaces the *ZScore* with the *KZ* index, which assesses financial distress risk and financing constraints. The findings presented in Table 8 demonstrate the influence of various oil price shocks on corporate financial risk, which reinforce the reliability of initial conclusions. Moreover, the regression coefficients underscore that the impact of supply shock is more pronounced, as evidenced by that a one-standard deviation increase in oil supply shock (oil demand shock) increases the KZ index by 6.50 (0.93) approximately.

Table 8. Robustness Tests of Replacing Measures of Corporate Financial Risk

	(1)	(2)	(3)
	KZ	KZ	KZ
oss	0.905***		
	(13.15)		
ods		0.139***	
		(13.15)	
ors			0.019***
			(13.15)
L.age	1.477***	1.477***	1.477***
	(5.60)	(5.60)	(5.60)
L.size	0.409***	0.409***	0.409***
	(8.52)	(8.52)	(8.52)
L.ROA	-7.064***	-7.064***	-7.064***
	(-17.50)	(-17.50)	(-17.50)
L.growINC	-0.041	-0.041	-0.041
	(-1.29)	(-1.29)	(-1.29)
L.TobinQ	0.112***	0.112***	0.112***
	(4.39)	(4.39)	(4.39)
L.cfdc	-0.002***	-0.002***	-0.002***
	(-4.26)	(-4.26)	(-4.26)
L.Capratio	0.247***	0.247***	0.247***
	(11.47)	(11.47)	(11.47)

_cons	-20.804***	-12.651***	-11.642***
	(-11.43)	(-9.64)	(-9.27)
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
N	18632	18632	18632
adj. R-sq	0.234	0.234	0.234

Notes. In this table, the robustness test is conducted by substituting the *ZScore* for KZ index. ***, **, and * denote the significance at the 1%, 5%, and 10% levels, respectively.

4.5.2 Robustness Test on the Moderating Effect of Environmental Disclosure

This study further conductes robust tests by replacing the environmental protection target (*epgoal*) and environmental protection special action (*epact*) with two alternative proxies: the environmental information disclosure carrier (*CSRreport*) and rating of environmental, social, and governance (*ESG*). It enables a more comprehensive examination of how environmental disclosure moderates the relationship between oil price fluctuations and corporate financial risk.

CSR reporting serves as a key mechanism for communicating a company's social performance, strategic objectives, and sustainability initiatives. It typically encompasses disclosures on environmental impact mitigation efforts, including energy and resource conservation, waste management, and sustainable practices. However, CSR reports vary in scope, and not all provide explicit or comprehensive details specifically related to environmental protection. In the analysis, *CSRreport* is assigned a value of 1 if the company's social responsibility report disclosed environment-related information; otherwise, it is assigned a value of 0.

Table 9. Alternative Measures of Environmental Information Disclosure

	(1)	(2)	(3)	(4)	(5)	(6)
	KZ	KZ	KZ	KZ	KZ	KZ
CSRreport	1	0	1	0	1	0
oss	0.842***	0.938***				
	(6.45)	(10.86)				
ods			0.129***	0.144***		
			(6.45)	(10.86)		
ors					0.018***	0.020***
					(6.45)	(10.86)
L.age	1.135**	1.587***	1.135**	1.587***	1.135**	1.587***
	(2.44)	(4.69)	(2.44)	(4.69)	(2.44)	(4.69)
L.size	0.545***	0.408***	0.545***	0.408***	0.545***	0.408***

	(5.72)	(6.94)	(5.72)	(6.94)	(5.72)	(6.94)
L.ROA	-8.477***	-5.975***	-8.477***	-5.975***	-8.477***	-5.975***
	(-10.33)	(-12.91)	(-10.33)	(-12.91)	(-10.33)	(-12.91)
L.growINC	-0.087	-0.032	-0.087	-0.032	-0.087	-0.032
	(-1.36)	(-0.83)	(-1.36)	(-0.83)	(-1.36)	(-0.83)
L.TobinQ	0.039	0.118***	0.039	0.118***	0.039	0.118***
	(0.72)	(3.87)	(0.72)	(3.87)	(0.72)	(3.87)
L.cfdc	-0.001	-0.003***	-0.001	-0.003***	-0.001	-0.003***
	(-1.23)	(-3.95)	(-1.23)	(-3.95)	(-1.23)	(-3.95)
L.Capratio	0.138***	0.272***	0.138***	0.272***	0.138***	0.272***
	(3.82)	(10.14)	(3.82)	(10.14)	(3.82)	(10.14)
_cons	-22.534***	-21.275***	-14.951***	-12.823***	-14.013***	-11.777***
	(-6.24)	(-9.56)	(-5.65)	(-8.10)	(-5.52)	(-7.78)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	5461	13171	5461	13171	5461	13171
adj. R-sq	0.294	0.214	0.294	0.214	0.294	0.214

Notes. Columns 1, 3, and 5 display regression results for companies that have disclosed environment-related information in their CSR reports (*CSRreport* equals to 1), while columns 2, 4, and 6 show the results for companies that have not disclosed such information (i.e. *CSRreport* equals to 0).

The grouped regression results for firms that do not disclose environment-related information in their CSR reports are reported in columns 2, 4, and 6 in Table 9. Notably, when environmental information is absent from CSR disclosures, the regression coefficient is larger. Specifically, the coefficients for enterprises that disclose and do not disclose environmental information in their CSR reports are 0.938 and 0.842 respectively, implying the positive impact of supply shock on KZ is higher when there is no related information disclosure. This suggests that oil price fluctuations exacerbate financial constraints, leading to a higher *KZ* index and an increased risk of financial distress.

To deepen the analysis of the moderating effect, the study incorporates regional heterogeneity by considering the regulatory environment of the firms' operating locations. Given the diversity in environmental regulations across different regions, it is prudent to account for the potential regional disparities that might influence the role of environmental information. To address this, the regional environmental regulation as a control variable is incorporated. Specifically, it derives the regional environmental regulations across all provinces, utilizing two primary metrics: investment in pollution control and the ratio of industrial added value to GDP (Jiang and Zhao, 2019; Yu and Wu, 2022). The outcomes presented in Table 10, validate and reinforce the reliability of findings.

Table 10. Regression Including Control Variable of Regional Environmental Regulation

	(1)	(2)	(3)	(4)	(5)	(6)
	KZ	KZ	KZ	KZ	KZ	KZ
CSRreport	1	0	1	0	1	0
oss	0.833***	0.938***				
	(6.38)	(10.84)				
ods			0.128***	0.144***		
			(6.38)	(10.84)		
ors					0.018***	0.020***
					(6.38)	(10.84)
_cons	-22.376***	-21.271***	-14.870***	-12.824***	-13.941***	-11.778***
	(-6.19)	(-9.56)	(-5.62)	(-8.10)	(-5.50)	(-7.78)
Regional Environment	Yes	Yes	Yes	Yes	Yes	Yes
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	5461	13171	5461	13171	5461	13171
adj. R-sq	0.295	0.214	0.295	0.214	0.295	0.214

Notes. This table shows results of the regression including regional variable. ***, **, and * denote the significance at the 1%, 5%, and 10% levels, respectively.

Given the current emphasis on environmental protection and carbon emissions, enterprises inevitably are exposed to the influence of oil fluctuations, considering the role of oil as a significant fossil energy source. As part of the robustness analysis, this study employs ESG performance as an alternative proxy for environmental information disclosure. The level of ESG disclosure is categorized into high and low groups. Since oil prices and their volatility are usually macro measurements, there are fewer endogenous problems associated with corporate risk.

Nonetheless, concerning the disclosure of environmental information, there is a valid concern regarding the potential endogeneity between ESG and the firm's financial risk. To alleviate the potential endogeneity issue, this study employs the ESG levels of other firms within the same industry as a measure of ESG performance of the enterprise, following the approach in prior literature (Breuer et al., 2018). To classify firms based on their level of ESG disclosure, high-disclosure group is defined as those with an ESG score above the annual mean (*ESGind* =1) and a low-disclosure group as those with a score below the mean (*ESGind* =0). The regression results examining the interaction between ESG disclosure and oil shocks are presented in Table 11.

Table 11. Robustness Test of Environmental Information Disclosure

	(1)	(2)	(3)
	ZScore	ZScore	ZScore
oss	-0.171***		
	(-2.73)		
ods		-0.616***	
		(-3.62)	
ors			-0.036***
			(-3.57)
ESGind	-0.244*	-0.192	-0.171
	(-1.71)	(-1.35)	(-0.98)
ESGind*oss	0.024**		
	(2.22)		
ESGind*ods		0.046***	
		(3.29)	
ESGind*ors			0.004
			(1.20)
L.age	-4.207***	-4.220***	-4.211***
	(-2.98)	(-2.98)	(-2.98)
L.size	-0.912***	-0.901***	-0.916***
	(-4.48)	(-4.44)	(-4.50)
L.ROA	8.539***	8.514***	8.564***
	(5.04)	(5.02)	(5.05)
L.growINC	-0.073	-0.068	-0.078
	(-0.55)	(-0.51)	(-0.58)
L.TobinQ	0.553***	0.558***	0.550***
	(4.47)	(4.52)	(4.46)
L.cfdc	0.000	0.000	0.000
	(0.38)	(0.39)	(0.37)
L.Capratio	-0.157***	-0.157***	-0.159***
	(-3.01)	(-3.02)	(-3.05)
_cons	34.469***	36.410***	34.943***
	(5.07)	(5.07)	(5.13)
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
N	4359	4359	4359

adj. R-sq	0.152	0.153	0.151

Notes. This table uses ESG level of the industry as the proxy variable to revalidate the conclusions. The main concern is the coefficient of the interaction term between oil shock and ESG. ∗∗∗, ∗∗, and ∗ denote the significance at the 1%, 5%, and 10% levels, respectively.

The findings suggest that higher oil shocks correspond to a smaller *ZScore* (higher financial risk), consistent with the conclusion of benchmark regression. Moreover, the coefficients of the interaction terms between *ESGind* and different oil shocks (*oss*, *ods*, *ors*) are uniformly positive, with the interactions involving oil supply and demand shocks achieving statistical significance. These findings suggest that firms with higher ESG disclosure levels are less vulnerable to the financial risks induced by oil price fluctuations. The results lend empirical support to the view that ESG transparency plays a stabilizing role by enhancing corporate credibility, improving stakeholder trust, and reducing information asymmetry. The moderating effect aligns with the viewpoints of Di Tommaso and Thornton (2020), and Suttipun (2023). Overall, the evidence reinforces the notion that robust ESG disclosure can help insulate firms from the adverse financial implications of energy market volatility.

5. Conclusion

The transmission of oil price volatility to firm-level financial stability has long been a critical concern for both scholars and corporate managers. This study contributes to this discourse by examining how different types of oil shocks affect corporate financial risk in the context of Chinese listed firms. The results confirm that heightened oil price shocks, particularly those driven by supply-side disruptions, significantly increase financial distress. These effects operate primarily through channels such as increased financing constraints and heightened information asymmetry.

Further analysis reveals that the impact of oil shocks is not uniform across firms. Private enterprises and those operating in energy-intensive industries are more vulnerable to oil-driven financial risk, likely due to their limited access to policy support and greater exposure to raw material cost fluctuations. This heterogeneity emphasizes the importance of accounting for firm-specific characteristics when assessing the financial consequences of macro-level energy shocks.

In addition, this study also examines the moderating role of environmental information disclosure. The findings suggest that firms with more transparent environmental practices—measured through CSR reporting—are better able to cushion the adverse financial impacts of oil shocks. Environmental disclosure appears to reduce information asymmetry, improve market confidence, and enhance firms' ability to access financing, thereby mitigating the transmission of external energy shocks to internal financial risk.

These findings offer several practical implications for both corporate strategy and public policy. When faced with oil price shocks, companies should closely monitor macroeconomic uncertainty, explore the potential impact of various shocks on business operations, and accordingly adjust strategies which

include improving the accuracy of investment decisions and maximizing profits (Haushalter et al., 2002; Wang et al., 2017). In particular, private enterprises and energy-intensive industries should clearly understand the mediating role of environmental disclosure, and place greater emphasis on environmental protection strategies within the global economic cycle and prevailing conditions (Tang et al., 2010). Finally, government should advocate for the development of new energy sources and reduce reliance on oil and other traditional forms of energy. In the context of China's dual-carbon strategy and industrial upgrading, the government should increase support for renewable energy industries, guide enterprises toward greener production, and reduce overreliance on traditional fossil fuels. These measures are essential not only for improving firm-level financial resilience but also for fostering long-term economic and environmental sustainability.

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