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Which uncertainty measures matter for corporate financialization? Evidence from China intensive polluted industries

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ABSTRACT

Corporate financialization in intensively polluting industries has become a critical factor in understanding the intersection of financial behaviour and sustainable development. This study investigates which specific forms of uncertainty including economic policy, monetary policy, trade policy, and oil price uncertainty can significantly influence financialization within China's intensively polluting sectors. Utilizing a panel dataset of Chinese A-share listed companies from $2011Q_1$ to $2022Q_4$, this study applies Principal Component Analysis (PCA) to construct a multidimensional index of financialization, followed by panel regression analysis. Findings reveal that global economic policy uncertainty exerts the most significant impact on corporate financialization in these industries. Furthermore, financing constraints negatively moderate this relationship, while Environmental, Social, and Governance (ESG) practices have positive moderating effects. Firms with higher managerial overconfidence exhibit increased levels of financialization. Additionally, heterogeneity exists across firms, with those incurring higher environmental protection fees, non-state-owned enterprises, and firms based in developed eastern regions displaying elevated financialization levels. Diversification and external monitoring also positively influence this relationship. Robustness tests confirm the consistency of these findings, providing valuable insights for firms seeking to strategically leverage ESG, financial technology (FinTech), and financialization practices in response to fluctuating uncertainties.

PLAIN LANGUAGE SUMMARY

Corporate financialization in intensively polluting industries significantly shapes the interplay between financial strategies and sustainable development. This study highlights that global economic policy uncertainty is the most influential factor driving financialization within China's intensively polluting sectors. Key findings reveal that financing constraints weaken this relationship, while Environmental, Social, and Governance (ESG) practices enhance it, underscoring the importance of sustainability in financial decision-making. Firms with higher managerial overconfidence and those incurring higher environmental protection fees, as well as non-state-owned enterprises and those in developed regions, exhibit greater financialization. These insights suggest that firms can strategically leverage ESG practices, financial technology (FinTech), and external monitoring to navigate uncertainties effectively. The study provides critical guidance for policymakers and firms to balance economic performance with environmental responsibilities, fostering sustainable economic transitions amidst global uncertainties.

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Corporate financialization; economic policy uncertainty (EPU); environmental social and governance (ESG); financing constraints; intensive polluted industries; managerial overconfidence

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SUBJECTS
Corporate Finance; Finance; Corporate Governance; Corporate Social Responsibility & Business Ethics

1. Introduction

The financialization of nonfinancial firms, defined as the shift from traditional business investments to financial market activities such as assets, payments, and leverage, has garnered increasing attention in recent years (Davis, 2016; Rabinovich & Reddy, 2024). This phenomenon has significantly reshaped corporate

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strategies, often leading to a reallocation of resources from long-term productive investments to short-term financial gains. In the context of intensively polluting industries in China, this shift is particularly concerning. These industries, which are pivotal to the country's economic growth, face mounting pressures to balance economic objectives with environmental sustainability (Jiang et al., 2022; Zhang et al., 2023). Despite their critical role, the redirection of resources toward financial activities undermines green innovation and environmental protection efforts, posing challenges to achieving China's low-carbon development goals.

Existing literature highlights the aggregate impact of economic policy uncertainty (EPU) on firm-level financialization, with studies suggesting that firms increase cash reserves or liquid assets in response to policy unpredictability (Altig et al., 2020; Zhao & Su, 2022). However, the role of specific types of uncertainties, such as monetary, trade, or oil price uncertainties, remains underexplored, particularly in environmentally impactful sectors. This lack of differentiation in uncertainty measures limits our understanding of their distinct effects on financialization behaviour. Intensively polluting industries, given their dual role as economic drivers and environmental risk contributors, warrant a closer examination of how such uncertainties influence their financial strategies.

Addressing this gap is essential to aligning corporate financial strategies with sustainability goals, particularly in China's intensively polluting industries. These industries not only contribute significantly to economic development but are also major sources of environmental degradation. Financialization in these sectors diverts resources away from green innovation, hindering progress toward sustainable development. This study aims to investigate how specific uncertainty measures—economic, monetary, trade, and oil price—drive financialization in these industries. Additionally, it examines how financing constraints, ESG practices, and managerial overconfidence moderate these relationships, providing a nuanced understanding of financialization behaviour under varying conditions of uncertainty.

To address the identified gaps, this study seeks to answer the following research questions:

1. Which types of uncertainties, such as economic, monetary, trade, or oil prices, most significantly influence financialization in China's intensively polluting industries?
2. How do financing constraints and ESG practices moderate the relationship between uncertainties and financialization?
3. What role does managerial overconfidence play in shaping firms' financialization behaviour under conditions of uncertainty?

This study makes several contributions to the literature. First, by disaggregating EPU measures, it provides a more detailed understanding of how specific uncertainties affect corporate financialization (Lee & Jeon, 2022; Phan et al., 2021). Second, it employs a multidimensional PCA-based index to measure financialization, capturing a broader range of behaviours beyond traditional metrics. Finally, it explores the moderating roles of financing constraints, ESG practices, and managerial overconfidence, offering actionable insights for policymakers and industry leaders to design strategies that align financialization with sustainability goals. These contributions are particularly relevant for fostering resilience and sustainability in one of the world's most industrially intensive economies.

The remaining paper is distributed across the following sections. In Section 2, the past research work has been documented supporting the study hypotheses and the theoretical framework's presentation. In Section 3, the research methodology is described. The outcomes of the data analysis are analysed and presented in Section 4. Section 5 describes the findings, implications, limitations, and suggestions for further research.

2. Literature review and hypotheses development

2.1. Corporate financialization

Financialization has attracted significant attention in recent decades (Klinge et al., 2021; Yahya & Lee, 2023; Zhang & Zheng, 2024). From a macro perspective, financialization highlights the increasing dominance of financial markets and institutions in economic development. Epstein (2005) describes financialization as the shift of the main business from productive to financial and highlights the importance of the financial sector. Similarly, Krippner (2005) financialization is a growing importance of finance in the economy.

From a micro perspective, previous studies define corporate financialization as nonfinancial firms shifting their investment from traditional business to financial ones (Si et al., 2024; Zhao & Su, 2022). However, Rabinovich and Reddy (2024), and Davis (2018a) argues that the concept of corporate financialization lacks clarity. Intensive polluted industries' financialization includes different dimensions and behaviour changes. First, the main characteristics are investments from traditional businesses to financial products, generating profits mainly from the financial markets (Jin et al., 2022; Si et al., 2024; Zhao & Su, 2022). Second, increasing share repurchases, pay-out ratio, and leverage ratio, which applied to maximize shareholder value ideology, and respond to financial market pressure (Davis, 2018a; Rabinovich & Reddy, 2024). Third, the development of financial technology and digital finance attracts the nonfinancial firm's involvement in financial markets (Jiang et al., 2022; Wu & Lu, 2023; Zhang et al., 2024).

2.2. Uncertainty and corporate financialization

Economic Policy Uncertainty (EPU) refers to the unpredictability of government policies and regulations, which have a substantial impact on intensively polluted industries' spending, and investment (Farooq et al., 2022; Hong et al., 2024), green growth (Sohail et al., 2022). Bhattacharya et al. (2017) state that policy uncertainty could generate more negative impacts than the policy itself. Extensive literature has studied the theory behind the relationship between uncertainty and financialization. The precautionary saving theory indicates that when uncertainty increases, firms tend to hold more liquid assets and implement more conservative investment policies (Baker et al., 2016; Duong et al., 2020; Liu et al., 2021). Growth option theory suggest that there is a U-shaped relationship between EPU and firms financialization (Zhao & Su, 2022). Moreover, real options theory suggests that when firms face heightened uncertainty, they tend to postpone fixed investments (Baker et al., 2016; Liu & Zhang, 2020), because rising uncertainty enhances the option value of waiting (Bernanke, 1983; Kim et al., 2022). Financial fraction theory suggests that increased uncertainty could raise the costs of debt financing and increase the probability of default (Arellano et al., 2019; Gilchrist et al., 2014; Ottonello & Winberry, 2020).

Policy uncertainty could exacerbate the financialization tendency by raising firms' risk aversion (Saci, 2021; Tran, 2019; Zhang et al., 2021). Monetary policy uncertainty could raise firms' credit risk (Li et al., 2020), cost of debt financing (Xiang & Li, 2022), irreversible assets investment, increases firms' financing constraints (Husted et al., 2020; Lee & Jeon, 2022). Trade policy uncertainty may affect the firms importing and exporting (Handley & Limão, 2022), foreign direct investment (Bao et al., 2022), foreign exchange markets (Huynh et al., 2023). The asymmetric effect of oil price volatility has different effects on corporate dividend policies. Scholars state that a positive oil price change results in an increase in the dividend yield (Chortareas & Noikokyris, 2014). Wong and Hasan (2021) stated that when the oil demand shock rises, firms are inclined to increase their share repurchases while decreasing cash dividends. During times of uncertainty, a good signal, such as share repurchase and dividend pay-out indicating firms have stable cash flow (Grullon et al., 2002; Lotfi, 2019; Michaely et al., 2021), higher financial flexibility (Oded, 2020; Smith & Pennathur, 2019), better earnings management (Bonaimé & Kahle, 2024; Mcnichols & Dravid, 1990; Michaely & Moin, 2022), and lower systematic risks (Grullon et al., 2002). This is meaningful for firms when face heightened policy uncertainty.

The conflicting results and various dimensions of economic policy uncertainty require comprehensive understanding. Lee and Jeon (2022) state the overall EPU may overlap the specific uncertainty, which leads to unprecise results. Therefore, this study considers four kinds of uncertainties, EPU, monetary policy, trade policy, and oil price uncertainty. Moreover, previous studies have mainly focused on financial investment or aggregate investment, neglecting the impact of uncertainty on financialization. In contrast to previous studies mainly connected with real options theory and growth option theory, this study emphasizes the precautionary saving theory, financial friction, and agency theory. This approach could expand the theoretical framework and offer a more comprehensive understanding of the relationship between uncertainty and the financialization of intensively polluting firms. Therefore, we propose the following hypothesis:

H_1: Which uncertainty measures matter to intensively polluted firms' financialization?

2.3. Mechanism analysis – financing constraints

Financing constraints refer to firms facing challenges in accessing external funds (Pascucci et al., 2022) and a lack of sufficient funds to support operating activities and investments. For intensively polluted industries, green investments are risky, costly, and have a longer payback period (Yang & Park, 2020), or even without profits. Therefore, financing constraints may force them to give up the green innovation (Li et al., 2023), uncontrol the pollution emission, eventually affecting long-term sustainable growth.

When policy uncertainty is high, it significantly increases information asymmetry between firms and potential fund providers (Dai & Ngo, 2021). The development of fintech could lower information asymmetry between fund providers and lenders. First, previous studies state that fintech development prompts firms to enhance their reporting quality (Wen et al., 2023). Second, the data analysis technique enables lenders to precisely and timely evaluate borrowers' creditworthiness (Bollaert et al., 2021; Feyen et al., 2023). Moreover, innovative financial technologies, such as peer-to-peer lending, could broaden the financial channels, especially for small and medium firms to access funds (Abbasi et al., 2021). Therefore, high-quality financial reporting and improved information platforms reduce information asymmetry.

Furthermore, during the high uncertainty period, the cost of capital becomes significantly high (Liu & Wang, 2022; Tran, 2021). The rising cost of capital may force firms to seek alternative financial channels, such as increasing holdings of financial assets and reserving more cash to support their pollution control investments (Wu & Huang, 2022; Zhang et al., 2020). Via holding financial assets, digital finance, and the development of fintech could help firms support their green innovation, boost real investments, and decrease financing constraints (Bollaert et al., 2021; Ding et al., 2022; Guo et al., 2023; Wu & Huang, 2022). Compared with existing studies, when they consider firms' financing constraints, they fail to consider the development of financial technology, which increases firms' financialization levels. To fill this gap, this study generates an interaction item to investigate these relationships. Therefore, we make the following hypothesis:

H_2: Financing constraints moderate the relationship between uncertainty and intensively polluted industries' financialization.

2.4. Mechanism analysis – ESG

ESG, encompassing environmental, social, and governance aspects, plays a pivotal role in shaping firms' investment strategies (Nirino et al., 2021; Vural-Yavaş, 2021). Firms with higher ESG ratings are seen as responsible stewards of the environment, society, and corporate governance (Shakil, 2021). Strong ESG practices build trust among stakeholders (Nirino et al., 2021), reducing agency conflicts between managers and stakeholders (Vural-Yavaş, 2021). Moreover, these practices help lower information asymmetry by promoting high-quality financial reporting and transparency regarding both financial and non-financial performance (Bilyay-Erdogan, 2022; Ellili, 2022; Kim & Park, 2023). Enhanced ESG reporting signals efficient investment strategies and a commitment to social responsibility, boosting stakeholder confidence. As a result, firms with strong ESG ratings face less market pressure, enabling managers to allocate funds to sustainable, long-term value-creation investments (Wang et al., 2022).

ESG investment is recognized as a value-enhancing activity (Cornell & Damodaran, 2020), particularly in times of heightened policy uncertainty, where it helps firms mitigate policy-related risks (Vural-Yavaş, 2021). Effective ESG practices can reduce total risks (Shakil, 2021), and firms with high ESG ratings tend to have lower credit risk (Li et al., 2022a), higher investment efficiency (Wang et al., 2022), lower cost of capital, reduced investment risks, enhanced sustainability, and superior financial returns (Cornell, 2021). Furthermore, ESG indices demonstrate greater stability during uncertain periods (Sharma, 2023). Despite these benefits, no study has explored ESG as a moderating factor between uncertainty and financialization. Examining this relationship could shed light on how firms navigate uncertainty while aligning with sustainable development goals. Based on this, we propose the following hypothesis:

H_3: ESG moderates the relationship between uncertainty and pollution-intensive industries financialization.

3. Research methodology

This study applies the panel data, which contains both cross-sectional and time-series data characteristics, enabling enhancing the analytical efficiency and overall reliability (Haque et al., 2022). Our data including eleven years, the time periods is less than the cross-sectional units. Therefore, 'N > T', the datasets are categorized as short-form panel data. To ensure the robustness and applicability of the chosen method, we conducted initial diagnostics, including the Modified Wald test, Wooldridge test (Wooldridge, 2002), and Variance Inflation Factor (VIF), to detect and address heteroskedasticity, autocorrelation, and multicollinearity issues. The Breusch-Pagan-Lagrange multiplier (BPL) test (Breusch & Pagan, 1979) was applied to evaluate the suitability of pooled OLS versus a random effects model. In contrast, the Hausman test confirmed that the fixed effects model was the most appropriate to capture the firm-specific heterogeneity inherent in the data (Hammad Naeem et al., 2023; Kwizera, 2024; Olalere & Mukuddem-Petersen, 2023b).

This study employs a high-dimensional fixed effects model, which was developed by Correia (2017). The following are motivations to apply this method. First, this model is suitable for analysing data with a large number of variables and observations, especially for 'big N and small T' dataset (Correia, 2017; Guimarães & Portugal, 2010; Luo & Lan, 2017). Second, this method could effectively address the unobserved firm-level heterogeneity, in our study, we explore which uncertainty measure matter for intensive polluted firms financialization, the unobserved factors, such as the regional policies or firm-specific practices could result significant bias of the outcomes (Gormley & Matsa, 2014). Moreover, our study may exist the time-varying regional heterogeneity. While the high-dimensional fixed effects model could effectively absorb these unobserved factors, which ensure that the estimation focus on within-firm variables over time (Correia, 2017; Zhu et al., 2022). Therefore, this high-dimensional fixed effect model is specifically tailored to assess the influence of uncertainty measures on financialization in heavily polluted industries, addressing the complex nature of the research problem.

To further enhance the reliability of the findings and address potential endogeneity concerns, we incorporated advanced techniques such as Instrument Variables-Two-Stage Least Squares (IV-2SLS) and the two-step Generalized Method of Moments (GMM). Which are widely applied in finance research to address the endogeneity issue (Akron et al., 2020; Jumah et al., 2023; Olalere & Mukuddem-Petersen, 2023a). Two-Stage Least Squares (2SLS) is an econometric method, which could effectively address the endogeneity issues. In the regression, when the explanatory variables are correlated with the error term, it may lead to the biased and inconsistent estimates (Lee et al., 2016; Lenkoski et al., 2014; Wang et al., 2023). There are two steps involves in this approach: in the first stage, using the instrument variables, which is strictly exogenous to the error term, to predict the endogenous variables. In the second stage, the predicted values apply to the primary regression model, to predict the casual relationships (Wang et al., 2023). For two-step Generalized Method of Moments (GMM) model. This method could address the endogeneity via using the lagged values of the internal instruments, which is correlated with the endogenous variables, and uncorrelated with the measurement errors terms (Arif Khan et al., 2020; Chakradhar & Gupta, 2024). Furthermore, previous studies have proved that the GMM model could provide robustness and consistent results even across many specifications. Hence strengthening the reliability of findings about which uncertainty measure matter for intensive polluted industries' financialization (Cheng & Masron, 2024). The relationship between uncertainty and intensive polluted firms financialization are dynamic process, while the two-step GMM model could capture the dynamic nature of the variables (Olalere & Mukuddem-Petersen, 2023b). Moreover, this method could control the endogeneity from the unobserved firm-specific effects or the measurement errors and provide reliable regression results even the dataset have the heteroscedasticity and auto-correlation issues (Olalere & Mukuddem-Petersen, 2023b).

Acknowledging the challenges highlighted by Huang et al. (2022), we excluded year-fixed effects in this analysis to mitigate the risk of multicollinearity introduced by macroeconomic variables (EPU, MPU, TPU, and OPU) that remain constant across firms over time. This methodological framework effectively aligns with the problem at hand, ensuring a rigorous and context-sensitive analysis.

3.1. Model specification

To examine which uncertainty measure matters for the financialization of intensive-polluting firms, we employ a panel regression model with the following specifications:

$$FIN_{i,t} = \alpha_0 + \alpha_1 Uncertainty_{i,t} + \alpha_2 Controls_{i,t} + \varepsilon_{i,t} \quad (1)$$

where $FIN_{i,t}$ is the level of corporate financialization of firm i at time t, uncertainty represents various uncertainties, $Controls_{i,t}$ denotes the control variables, and ε_{it} is the error term.

To further explore the moderating effect of financing constraints and ESG ratings, the following Tao et al. (2021) and Zhao and Su (2022), model (2) (below) and model (3) were used to research the moderating effect of financing constraints and ESG ratings. The interaction terms Uncertainty*FC and Uncertainty*ESG were used in the model:

$$FIN_{i,t} = \beta_0 + \beta_1 Uncertainty_{i,t} + \beta_3 Uncertainty_{i,t} \times FC_{i,t} + \beta_4 Controls_{i,t} + \varepsilon_{i,t} \quad (2)$$

$$FIN_{i,t} = \gamma_0 + \gamma_1 Uncertainty_{i,t} + \gamma_3 Uncertainty_{i,t} \times ESG_{i,t} + \gamma_4 Controls_{i,t} + \varepsilon_{i,t} \quad (3)$$

Models (2) and (3), where $FIN_{i,t}$ is the level of corporate financialization of firm i at time t. $Uncertainty_{i,t}$ denotes the uncertainty faced by firm i at time t. FC represents the financing constraint level faced by firm i at time t. $Uncertainty_{i,t} \times FC_{i,t}$ and $Uncertainty_{i,t} \times ESG_{i,t}$ are the interaction terms. All these variables are explained in detail in Table A1 (refer to Appendix A).

3.2. Data collection and samples

Our sample includes China A-share listed intensively polluted firms for the years 2011–2022. Following Zhou et al. (2021) twenty industries were defined as heavily polluting industries. We collected the data from different databases. First, we collected firm-level data from the China Stock Market and Accounting Research (CSMAR) database. Second, we collected ESG data from third-party rating institutions, the Bloomberg website, and Huazheng ESG ratings. Third, Fintech patent data were manually collected from the China National Intellectual Property Administration (CNIPA). The digital inclusive finance index was obtained from the Digital Finance Research Center of Peking University.

In this study, we mainly use eight kinds of uncertainties including economic policy uncertainty (EPU_DCHN) of China by Davis et al. (2019), US economic policy uncertainty (EPU_BUSA) by Baker et al. (2016), global economic policy uncertainty (GEPU_BBDC) by Baker et al. (2016), monetary policy uncertainty (MPU_BUSA) by Baker et al. (2016), monetary policy uncertainty (MPU_HUSA) by Husted et al. (2020), trade policy uncertainty (TPU_DCHN) by Davis et al. (2019), US trade policy uncertainty proposed (TPU_BUSA) by Baker et al. (2016), and oil price uncertainty(OVX). We then exclude special treatment (ST) firms that have abnormal financial situations or sustained losses for more than two years. We also excluded the samples with missing data. Based on Gulen and Ion (2015), outlier influence was reduced by winsorizing every continuous variable at the 1% and 99% percentiles. The final sample consists of 8953 firm-year observations.

3.3. Variable operationalization

3.3.1. Construction of the corporate financialization measure

This study explores the concept of financialization and introduces a novel method for measuring financialization levels using Principal Component Analysis (PCA), a dimensionality reduction technique (Lamichhane et al., 2021). By leveraging influential studies, we analyse key concepts and employ seven indicators to categorize and quantify financialization levels. These indicators include: the proportion of financial assets to total assets (Jin et al., 2022; Xu & Guo, 2023); the proportion of financial income to total income (Si et al., 2024; Wang & Mao, 2022); fintech patent quantity; digital finance development; debt ratio; share repurchases; and dividend payout ratio. Detailed descriptions of these indicators are provided in Appendix A, Table A2. This comprehensive approach offers a robust framework for capturing financialization dynamics.

Following Si et al. (2024), fin1 excludes cash and cash equivalents, because they can serve multiple purposes, such as payable items. If cash and cash equivalents are treated as financial assets, they may distort the measurement of financialization. However, Davis (2018b) and Cheng and Masron (2024) state that cash holding is the main contributor to firms' financialization, and it is classified as a short-term marketable security; therefore, we construct fin2, which treats cash and cash equivalents as our financial assets for our robustness test.

This study incorporates regional fintech patent quantity as a key indicator of financialization. Fintech innovations introduce diverse financial products and services, enhancing firms' operational efficiency, broadening financing channels, and reducing financing costs (Bollaert et al., 2021; Feyen et al., 2023). This indicator reflects the role of financial market and product development in driving financialization (Orhangazi, 2015). Additionally, digital transformation provides critical infrastructure for the financial industry, contributing to financial system stability (Zeqiraj et al., 2020) and further promoting financialization. To measure digital finance development, we adopt the Digital Finance Index (DIFI) developed by Peking University, following the methodologies of Li et al. (2020), Huang (2022), Wu and Huang (2022), Zhang and Du (2024).

Table 1 presents the summary statistics of financialization from 2011 to 2022 of the sample data. In addition, we conducted principal component analysis (PCA method) with varimax rotation (refer to Table 2), while only preserving factors with eigenvalues greater than 1. This process can preserve the most important features of high-dimensional data, remove noise and unimportant features, and minimize the loss caused by dimensionality reduction. In addition, the retained information was optimized (Farza et al., 2021). Table 2 shows that the PCA application decreases the dimensionality of the data to three components while retaining 52.5% of the original data's information. Moreover, we conducted a Kaiser–Meyer–Olkin (KMO) test of sample adequacy, which has an overall KMO value of 0.531 (see Table 2), which is higher than 0.5, confirming the adequacy of the sample. Following Ofori et al. (2023) this study, we generate our first financialization measure (FIN1) based on the first three components, in which the eigenvalue surpasses 1. Figure 1 demonstrates that these three components meet the Kaiser rule. A higher financialization level indicates a higher financialization level.

3.3.2. Measurement of the second variable of study – economic policy uncertainty

For economic policy uncertainty, firstly, we consider the economic policy uncertainty constructed (EPU_DCHN) by Davis et al. (2019). This measurement is a news-based index, and the author collected data from mainland China. In the second measurement, we consider U.S. economic policy uncertainty, which was developed by Baker et al. (2016) (EPU_BUSA). Third, we consider global economic policy uncertainty (GEPU_BBDC), which is the average of the national Economic Policy Uncertainty (EPU) indices for 21 nations, with each country's index weighted according to its Gross Domestic Product (GDP).

Table 1. Summary statistics of financialization, 2011–2022.

	N	Mean	SD	Min	Max
Fin2	8953	.269	.179	.03	.905
Fin4	8953	.027	.073	−.156	.426
Fintechno	8953	35	80.198	0	603
DFIIC	8953	244.814	84.353	3.39	581.23
R	8953	.343	1.588	0	11.654
D	8953	.409	.202	.05	.899

Note. N = Observations; SD denotes Standard Deviation.

Table 2. Principal component rotation and eigenvalues for financialization (FIN1).

Component	Eigenvalue	Difference	Proportion	Cumulative	KMO statistic	Component
Comp1	**1.512**	**0.319**	**0.252**	**0.252**	**0.530**	**Comp1**
Comp2	**1.193**	**0.187**	**0.199**	**0.451**	**0.483**	**Comp2**
Comp3	**1.006**	**0.044**	**0.168**	**0.619**	**0.525**	**Comp3**
Comp4	0.962	0.294	0.160	0.779	0.536	Comp4
Comp5	0.667	0.007	0.111	0.890	0.575	Comp5
Comp6	0.660	.	0.110	1.000	0.527	Comp6
Overall	0.531					Overall

Source: Authors' computation.*Notes:* Bont font highlights eigenvalues greater than 1, which are the factors retained for analysis.

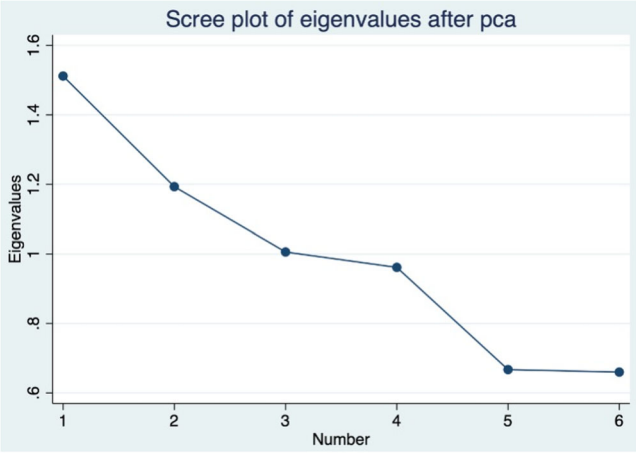

Figure 1. Screen plot of financialization component (FIN1).

3.3.3. Measurement of the second variable of study – monetary policy uncertainty

For monetary policy uncertainty, we first used the monetary policy uncertainty constructed (MPU_BUSA) by Baker-Bloom-Davis (Baker et al., 2016), which is based on world news. Second, we use the uncertainty constructed (MPU_HUSA) by Husted et al. (2020), which is a news-based index that closely follows the Federal Reserve policy activity.

3.3.4. Measurement of the second variable of study – trade policy uncertainty

For the trade policy uncertainty, we also use the uncertainty constructed (TPU_DCHN) by Davis et al. (2019). The second measure was the uncertainty construct (TPU_BUSA) by Baker et al. (2016).

3.3.5. Measurement of the second variable of study – oil price uncertainty

Previous studies have mainly employed three methods to measure oil price uncertainty. The first is realized volatility (Meng & Liu, 2019; Wen et al., 2023; Xiao et al., 2022), the GARCH model (Hamilton, 2003; Sadorsky, 2006; Yoon & Ratti, 2011), and OVX (Wen et al., 2023).

To measure oil price uncertainty, we employ two approaches. First, following Zhu et al. (2022) and Ren et al. (2022), we use the OVX index, the Chicago Board Options Exchange (CBOE) Crude Oil ETF Volatility Index, which provides an annualized measure of oil price volatility. OVX was selected due to its ability to capture both historical and forward-looking information (Liu et al., 2013; Maghyereh & Abdoh, 2020; Zhang et al., 2020) and its widespread use in research on global oil price uncertainty's macro and micro effects (Lu et al., 2020; Wen et al., 2023). A higher OVX value indicates greater oil price uncertainty (Zhang et al., 2020). For robustness checks, we incorporate daily West Texas Intermediate (WTI) crude oil spot prices from the U.S. Energy Information Agency (2011–2021), as WTI futures are globally significant benchmarks for oil pricing and effective information exchange (Chen et al., 2022; Sadorsky, 2008). These dual measures ensure a comprehensive assessment of oil price uncertainty.

First, following Henriques and Sadorsky (2011), and Song and Yang (2022), we apply the standard deviation of the daily oil price:

$$OILVOLWTI_t = \sqrt{\frac{1}{N}\sum_{t=1}^{N}\left(r_t - E(r_t)\right)^2} \times \sqrt{N} \tag{4}$$

where r_t is the daily closing oil price and N is the trading days of the year.

$$r_t = \ln\left(\frac{p_t}{p_{t-1}}\right) \tag{5}$$

The second way to measure oil price via GARCH(1,1) model, following Song and Yang (2022) and Ilyas et al. (2021):

$$\text{OilVARWTI} = \text{GARCH}_t = \frac{1}{N}\sum_{t=1}^{N} \hat{h}^2{}_t \times \sqrt{N} \quad (6)$$

The second Where $\hat{h}^2{}_t$ is the fitted value from GARCH (1,1) model.

4. Empirical results data

4.1. Descriptive statistics

Table 3 presents the statistics for the main variables used in our baseline models. The financialization level of intensive polluting firms, the maximization level of financialization level is 4.163, the minimum level is −0.667, and a relatively large standard deviation of 0.611 indicates considerable differences among firms.

4.2. Baseline results

Table 4 presents the regression results of Eq. (1), analyzing the impact of different measure uncertainty on intensive polluted industry's financialization. Column 1 reports the results without any control variables, column 2 only controls firm-level control variables, and column 3 includes firm-level control variables and macro-level control variables. First, we run the uncertainty separately, and find that all uncertainties in the financialization of intensive polluting firms are statistically significant at the 1% level. From columns 1 to 3, after we add firm- and macro-level control variables, the results remain significant and positive at the 1% level. Second, we find that the global economic policy uncertainty developed by Baker et al. (2016) exhibits the highest coefficient from columns 1 to 3, indicating that global economic policy uncertainty has the most significant impact on intensive polluted industry financialization.

Table 3. Descriptive statistics.

Variables	N	Mean	SD	Min	p25	p50	p75	Max
FIN1	8953	0	0.611	−0.667	−0.415	−0.192	0.213	4.163
EPU_DCHN	8953	5.297	0.524	4.523	4.823	5.627	5.752	5.967
EPU_BUSA	8953	4.713	0.389	4.171	4.464	4.685	4.891	5.631
GEPU_BBDC	8953	5.240	0.333	4.663	4.985	5.245	5.545	5.763
MPU_BUSA	8953	4.357	0.447	3.676	3.934	4.337	4.651	5.049
MPU_HUSA	8953	4.985	0.372	4.431	4.589	5	5.174	5.584
TPU_DCHN	8953	5.247	0.903	3.791	4.554	5.542	6.157	6.533
TPU_BUSA	8953	4.695	1.002	3.572	3.801	4.322	5.438	6.681
OVX	8953	38.69	11.95	22.46	29.71	38.79	44.99	64.89
Size	8953	22.39	1.328	20.06	21.43	22.16	23.18	26.36
Cashflow	8953	0.062	0.066	−0.120	0.022	0.060	0.099	0.256
GrowthRate	8953	0.163	0.397	−0.487	−0.029	0.0980	0.248	2.601
Top10	8953	0.643	0.153	0.287	0.559	0.703	0.754	0.828
HHI	8941	0.167	0.119	0.015	0.078	0.137	0.226	0.588
Lquidity	8953	2.391	2.549	0.255	0.963	1.599	2.750	16.07
GDP	8953	6.383	2.128	2.239	5.951	6.947	7.766	9.551
inflation	8953	2.545	1.957	−0.003	1.287	2.249	3.500	8.076

Notes: This table shows descriptive statistics for the main variables used in our baseline empirical analysis. The statistics provided include the mean, standard deviation, and minimum value (min.), 25th percentile (P25), 50th percentile (P50), 75th percentile (P75), and maximum value (max.). Corporate financialization level (FIN1) is the dependent variable, and the independent variables are uncertainty measures.

Table 4. Baseline results of uncertainty measure and financialization.

	FIN1 (1)	FIN1 (2)	FIN1 (3)
EPU_DCHN	0.4508***	0.4559***	0.5532***
EPU_BUSA	0.3523***	0.3064***	0.2710***
GEPU_BBDC	**0.6447*** **	**0.6118*** **	**0.8373*** **
MPU_BUSA	0.2245***	0.1693***	0.0593***
MPU_HUSA	0.3485***	0.2281***	0.1694***
TPU_DCHN	0.2427***	0.2345***	0.2457***
TPU_BUSA	0.1501***	0.1386***	0.1200***
OVX	0.0087	0.0070***	0.0033***
Firm-level control variables	No	Yes	Yes
Macro-level control variables	No	No	Yes

Notes: This table shows the baseline results of uncertainty regarding the financialization of intensively polluting firms. Statistical significance was denoted by *, **, and *** at the 10%, 5%, and 1% levels, respectively (same for all tables). Bond font highlights the most significant values for emphasis.

4.3. Analysis

4.3.1. Mechanism analysis-financing constraints

Table 5 presents the results derived from Eq. (2), which investigates how financing constraints affect the relationship between uncertainty and the financialization of intensively polluting firms. The interaction term coefficient between economic policy uncertainty, monetary policy uncertainty, and oil price uncertainty is negative and significant at the 1% level, while the interaction term of U.S. trade policy uncertainty constructed by Baker et al. (2016) is the only one that is not significant. The interaction term coefficient of financing constraints (GEPU_BBDC*KZ) is −0.042, and it has a statistically significant effect at the 1% level. This finding indicates that financing constraints mitigate the positive influence of uncertainty on financialization, which supports our hypothesis 2, financing constraints moderate the relationship between economic policy uncertainty and financialization. This suggests that, although there is an increase in global economic policy uncertainty (GEPU_BBDC), firms do not show strong enthusiasm in response to financialization. This lack of enthusiasm is due to the constraints imposed by financing, which limits investment behaviour.

4.3.2. Mechanism analysis-ESG practices

Table 6 presents the regression results of Huazheng ESG for the relationship. The coefficients of uncertainty for economic policy uncertainty, monetary policy uncertainty, and trade policy uncertainty all exhibit positive coefficients. The coefficient of the interaction term for economic policy uncertainty was positive and statistically significant. From the results we can see that ESG plays a moderating role in shaping the relationship between uncertainty and financialization, verifying our hypothesis 3, ESG moderates the relationship between uncertainty and corporate financialization. To obtain precise results, we used Bloomberg ESG to perform a robustness check (see Table 7). For global economic policy uncertainty, the coefficient of the interaction items is positive and significant. This confirms that corporate ESG ratings moderate the relationship between uncertainty and corporate financialization.

4.3.3. Mechanism analysis – managerial over-confidence

The characteristics, skills, and practices of executives play a crucial role in guiding corporate strategies (Huang & Kisgen, 2013; Malmendier et al., 2011; Malmendier & Tate, 2005, 2008). Managerial overconfidence has a direct impact on firms' decision-making (Gervais et al., 2011); overconfident managers may implement inefficient investments (He et al., 2019), which could eventually affect firms' earnings performance (Bertrand & Schoar, 2003; Huang & Kisgen, 2013).

Table 5. Mechanism analysis – financing constraints.

	FIN1 (1)	FIN1 (2)	FIN1 (3)	FIN1 (4)	FIN1 (5)	FIN1 (6)	FIN1 (7)	FIN1 (8)
EPU_DCHN	0.5688***							
EPU_DCHN*KZ	−0.0322***							
EPU_BUSA		0.3039***						
EPU_BUSA*KZ		−0.0259***						
GEPU_BBDC			0.8748***					
GEPU_BBDC*KZ			−0.0442***					
MPU_BUSA				0.1216***				
MPU_BUSA*KZ				−0.0281***				
MPU_HUSA					0.1873***			
MPU_HUSA*KZ					−0.0232***			
TPU_DCHN						0.2486***		
TPU_DCHN*KZ						−0.0127***		
TPU_BUSA							0.1153***	
TPU_BUSA*KZ							−0.0017	
OVX								0.0038***
OVX*KZ								−0.0007***
KZIndex	0.1264***	0.0638**	0.1771***	0.0657***	0.0617**	0.0219*	−0.0393***	−0.0289***
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
_cons	−2.2515**	−4.2862***	−4.7867***	−3.1145***	−2.5652***	−1.5948***	−2.8440***	−2.6291***
R^2	0.6229	0.5740	0.6078	0.5593	0.5607	0.6112	0.5774	0.5576
N	8792	8792	8792	8792	8792	8792	8792	8792

Notes: This table reports the moderating effect of financing constraints on the relationship between uncertainty and financialization. The dependent variable is the financialization level of intensively polluting firms, which is constructed using the PCA method. The uncertainty measures were collected from different websites.

Table 6. Mechanism analysis – ESG (Huazheng ESG).

	FIN1 (1)	FIN1 (3)	FIN1 (3)	FIN1 (4)	FIN1 (5)	FIN1 (6)	FIN1 (7)	FIN1 (8)
EPU_DCHN	0.423***							
EPU_DCHN*ESGHuazheng	0.032***							
EPU_BUSA		0.116**						
EPU_BUSA*ESGHuazheng		0.037***						
GEPU_BBDC			0.596***					
GEPU_BBDC*ESGHuazheng			0.060***					
MPU_BUSA				−0.101**				
MPU_BUSA*ESGHuazheng				0.039***				
MPU_HUSA					0.084			
MPU_HUSA*ESGHuazheng					0.023			
TPU_DCHN						0.199***		
TPU_DCHN*ESGHuazheng						0.012**		
TPU_BUSA							0.108***	
TPU_BUSA*ESGHuazheng							0.003	
OVX								−0.002
OVX*ESGHuazheng								0.001***
ESGHuazheng	−0.171***	−0.174***	−0.309***	−0.159***	−0.094	−0.060**	−0.007	−0.043***
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
_cons	−2.005***	−4.259***	−4.092***	−2.946***	−2.795***	−1.899***	−3.508***	−3.182***
R^2	0.613	0.559	0.595	0.545	0.549	0.602	0.569	0.546
N	8684	8684	8684	8684	8684	8684	8684	8684

Notes: This table illustrates the impact of ESG ratings on the relationship between uncertainty and corporate financialization. ESGHuazheng represents firms' ESG rating scores.

Table 7. Mechanism analysis – ESG (Bloomberg ESG).

	FIN1 (1)	FIN1 (2)	FIN1 (3)	FIN1 (4)	FIN1 (5)	FIN1 (6)	FIN1 (7)	FIN1 (8)
EPU_DCHN	0.1933***							
EPU_DCHN*ESGBloomberg	0.0128***							
EPU_BUSA		0.0088						
EPU_BUSA*ESGBloomberg		0.0082***						
GEPU_BBDC			0.2707***					
GEPU_BBDC*ESGBloomberg			0.0182***					
MPU_BUSA				0.1610**				
MPU_BUSA*ESGBloomberg				−0.0025				
MPU_HUSA					0.2334***			
MPU_HUSA*ESGBloomberg					−0.0048**			
TPU_DCHN						−0.0197		
TPU_DCHN*ESGBloomberg						0.0084***		
TPU_BUSA							0.0023	
TPU_BUSA*ESGBloomberg							0.0027***	
OVX								−0.0018
OVX*ESGBloomberg								0.0001
ESGBloomberg	−0.0694***	−0.0256***	−0.0927***	0.0237***	0.0343***	−0.0401***	−0.0005	0.0087***
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
_cons	−0.2366	−1.4288**	−1.8277***	−1.9764***	−2.0310***	0.0558	−1.3933***	−1.1417**
N	3653	3653	3653	3653	3653	3653	3653	3653
R^2	0.6182	0.5813	0.6003	0.5674	0.5667	0.6086	0.5782	0.5658

Notes: This table shows illustrates the impact of ESG ratings on the relationship between uncertainty and corporate financialization. ESG Bloomberg represents firms' ESG rating scores constructed by the Bloomberg third-party agency.

Previous studies have used various methods to measure managerial overconfidence. (1) option-based measure (Andreou et al., 2019; Qiao, 2023; Zhu et al., 2024); (2) executives' compensation ratio; (3) the number of shares held by executives (Kaplan et al., 2022; Malmendier & Tate, 2005); (4) investment rate; (5) executive characteristics (such as sex, age, education, duality, etc.) (Bertrand & Schoar, 2003; Zhu et al., 2024); and (6) corporate earnings forecast (He et al., 2019; Hribar & Yang, 2016).

Table 8 present the results of the mechanism analysis of impact of managerial overconfidence. Following He et al. (2019), we first use the executive shareholding ratio and then the top 1 executive compensation ratio to measure managerial overconfidence. A higher ratio indicates that managers have higher confidence levels. Our results show that managerial with over confidence firms exhibit higher financialization levels. This suggests that overconfident managers have more faith in their ability, when they face heightened uncertainty, they believe they could achieve excessive returns, but underestimate the risks. Therefore, this behaviour led to a higher inefficient investment level

Table 8. Mechanism analysis managerial overconfidence.

Panel A Executive shareholding ratio								
	High (1) FIN1	Low (2) FIN1	High (3) FIN1	Low (4) FIN1	High (5) FIN1	Low (6) FIN1	High (7) FIN1	Low (8) FIN1
EPU_DCHN	0.7284***	0.5270***						
	(17.54)	(31.66)						
EPU_BUSA			0.3073***	0.2721***				
GEPU_BBDC					0.9822***	0.8083***		
MPU_BUSA							0.0978**	0.0656***
_cons	−2.9662***	−2.5212***	−5.5284***	−4.7613***	−6.0375***	−5.1175***	−3.9487***	−3.4428***
N	1665	7006	1665	7006	1665	7006	1665	7006
r2	0.6681	0.6161	0.6076	0.5690	0.6392	0.6011	0.5932	0.5539
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
MPU_HUSA	0.1397***	0.1669***						
TPU_DCHN			0.3040***	0.2353***				
TPU_BUSA					0.1583***	0.1106***		
OVX							0.0009	0.0040***
_cons	−2.3829***	−3.8040***	−1.4463***	−2.7855***	−2.5852***	−4.2247***	−2.5467***	−4.0127***
N	3445	5116	3445	5116	3445	5116	3445	5116
r2	0.6106	0.5771	0.6591	0.6223	0.6271	0.5952	0.6094	0.5742
Panel B Top 1 executive compensation								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
EPU_DCHN	0.5885***	0.5191***						
EPU_BUSA			0.3221***	0.2359***				
GEPU_BBDC					0.8891***	0.7599***		
MPU_BUSA							0.0837***	0.0537***
_cons	−2.2365***	−3.1994***	−4.5692***	−5.3925***	−4.9290***	−5.6824***	−2.9586***	−4.2311***
N	3445	5116	3445	5116	3445	5116	3445	5116
r2	0.6695	0.6311	0.6258	0.5851	0.6543	0.6136	0.6087	0.5736
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
MPU_HUSA	0.1482***	0.1534***						
TPU_DCHN			0.2583***	0.2289***				
TPU_BUSA					0.1185***	0.1137***		
OVX							0.0039***	0.0028***
_cons	−2.3829***	−3.8040***	−1.4463***	−2.7855***	−2.5852***	−4.2247***	−2.5467***	−4.0127***
N	3445	5116	3445	5116	3445	5116	3445	5116
r2	0.6106	0.5771	0.6591	0.6223	0.6271	0.5952	0.6094	0.5742

Notes: Panel A uses the Executive shareholding ratio to represent the managerial over-confidence; panel B uses the top 1 executive compensation.

(Malmendier & Tate, 2005). This highlights the importance that firms should build systems to monitor managerial behaviour, and in turn, to mitigate the negative effects of managerial overconfidence on firms' investment.

4.4. Robustness tests

4.4.1. Alternative measure of uncertainties

For economic policy uncertainty, monetary policy uncertainty and trade policy uncertainty, following Vural-Yavaş (2021) and Bonaime et al. (2018), first, we use the average of natural logarithm of the weighted average in the last 3 months' policy uncertainty as follows: 1/6 for the uncertainty of December, 1/3 for the uncertainty of November, 1/2 for the uncertainty of October, for example EPU_DCHN_3. Second, we use the natural logarithm of the weighted average in December's policy uncertainty index, for example EPU_DCHN_12th. For oil price uncertainty, we first used the standard deviation of the daily oil price (OIL_VOL_WTI), which has been widely used in previous research (Henriques & Sadorsky, 2011; Phan et al., 2019; Song & Yang, 2022). Second, following Song and Yang (2022) we use the GARCH (1,1) model to calculate oil price uncertainty (OIL_VAR_WTI).

Table 9 presents the results of the alternative measure of the independent variables, where FIN1 is the dependent variable. These results confirm that global economic policy uncertainty could generate the most significant impact on intensively polluted firms financialization.

Table 9. Robustness check: alternative measure of independent variables.

	FIN1 (1)	FIN1 (2)	FIN1 (3)		FIN1 (4)	FIN1 (5)	FIN1 (6)
EPU_DCHN_3	0.4068***	0.3943***	0.5107***	**EPU_DCHN_12th**	0.3881***	0.3666***	0.4196***
EPU_BUSA_3	0.2733***	0.2421***	0.1701***	**EPU_BUSA_12th**	0.3212***	0.2845***	0.2305***
GEPU_BBDC_3	0.5558***	0.4956***	0.5410***	**GEPU_BBDC_12th**	0.5735***	0.5123***	0.5115***
MPU_BUSA_3	0.1599***	0.1118***	0.0474***	**MPU_BUSA_12th**	0.1433***	0.0976***	0.0847***
MPU_HUSA_3	0.2068***	0.1229***	0.1386***	**MPU_HUSA_12th**	0.1107***	0.0497***	0.0932***
TPU_DCHN_3	0.2518***	0.2431***	0.2575***	**TPU_DCHN_12th**	0.2052***	0.1950***	0.1996***
TPU_BUSA_3	0.1095***	0.0945***	0.0804***	**TPU_BUSA_12th**	0.0774***	0.0724***	0.0670***
OIL_VOL_WTI	0.5996***	0.5020***	0.4052***	**OIL_VAR_WTI**	6.9036***	5.9172***	5.1306***
Firm-level CV	No	Yes	Yes	**Firm-level CV**	No	Yes	Yes
Macro-level CV	No	No	Yes	**Macro-level CV**	No	No	Yes

Notes: Table 9 reports the reports the robustness check for replacing the independent variable measure. Fin1 was constructed by the PCA.

Table 10. Robustness check: Potential Endogeneity Issues.

	IV-2SLS estimation							
	First stage (1)	Second stage (2)	First stage (3)	Second stage (4)	First stage (5)	Second stage (6)	First stage (7)	Second stage (8)
	EPU_DCHN	FIN1	EPU_BUSA	FIN1	GEPU_BBDC	FIN1	MPU_BUSA	FIN1
lag_uncertainty	0.1166***		0.0972***		0.0860***		0.0509***	
VIX	−0.0105***		0.0456***		0.0021***		0.0397***	
EPU_DCHN		0.4333***						
EPU_BUSA				0.2788***				
GEPU_BBDC						0.6387***		
MPU_BUSA								0.3211***
_cons	2.0510***		6.8251***		4.3473***		6.5013***	
N	8792	8792	8792	8792	8792	8792	8792	8792
R^2	0.7759	0.2492	0.7907	0.1545	0.8710	0.2151	0.6511	0.0923
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
	MPU_HUSA	FIN1	TPU_DCHN	FIN1	TPU_BUSA	FIN1	OVX	FIN1
lag_uncertainty	0.0459***		0.1771***		−0.072***		1.1288***	
VIX	−0.0199***		−0.0524***		−0.0870***		1.5282***	
MPU_HUSA		0.2998***						
TPU_DCHN				0.1490***				
TPU_BUSA						−0.1376***		
OVX								0.0077***
_cons	1.6999***		1.4645***		4.2807***		13.9833***	
N	8792	8792	8792	8792	8792	8792	8792	8792
R^2	0.5556	0.1283	0.6488	0.2185	0.4702	−0.0489	0.8132	0.1215

Notes: Table 10 reports presents the results of the robustness check, which addresses possible endogeneity concerns.

4.4.2. Addressing endogeneity issue

To mitigate potential endogeneity concerns, such as omitted variables (Zhu et al., 2022), reverse causality (Gulen & Ion, 2015), and measurement error issues (Vural-Yavaş, 2021). In our study, we explore the relationship between economic policy uncertainty and corporate financialization, while the market conditions, firm-specific characteristics, and some other external economic shocks may be the potential sources of endogeneity. IV-2SLS (Instrumental Variables – Two-Stage Least Squares) estimation is commonly employed to tackle endogeneity issues (Gulen & Ion, 2015; Li et al., 2022b; Ndikumana, 1999; Si et al., 2024; Vural-Yavaş, 2021). In this study, we first utilized the one-year lagged weighted average of overall uncertainty as our first instrument variable; specifically, the weighted average of the sum of the eight uncertainties was calculated. Previous study have verified that the lagged value as instruments could effectively addressing the endogeneity issue (Kwizera, 2024). In addition, we used the VIX as the instrument variable. The following are the reasons for using the VIX as our instrument variable. First, the VIX acts as a representative of overall market risk sentiment (Li et al., 2022c; Whaley, 2000), which can reflect fluctuations in financial markets and investor sentiment (Akin & Akin, 2024; Bekaert et al., 2013). A higher VIX may also be associated with higher risk aversion (Bams & Honarvar, 2021; Bekaert et al., 2013), and the heightened global economic policy uncertainty also shifts firms' risk-taking levels (Zhang et al., 2023). When the volatility of financial market risk is high, the VIX normally exhibits a higher value (Chen & Sun, 2022). This can effectively reflect the overall market risk attitude (Akin & Akin, 2024; Bekaert et al., 2013). In addition, the factors influencing global economic policy uncertainty may also indirectly affect the VIX, and the VIX does not directly impact the financialization behaviour of intensively polluting Chinese firms. Therefore, we use the VIX as an instrumental variable.

Table 10 presents the results of the IV-2SLS. The coefficient in the first stage indicates the impact of lag_uncertainty and the VIX as instrument variables on uncertainty. In the second stage, the result still indicates a significant and positive association between global economic policy uncertainty and financialization of intensive polluting firms.

Given the advantages of GMM estimation techniques in dealing with fixed effects (Arellano & Bond, 1991), this method can capture omitted firm-specific characteristics (Abdul-Haque & Shaoping, 2008; Barros et al., 2020; Orhangazi, 2008), as well as addressing the unobserved heterogeneity and potential endogeneity issues (Kwizera, 2024). In this study, we employed a two-step GMM estimation. We use a one-period lag of uncertainty as the instrument variable. Table 11 presents the results of the two-step GMM estimation method. Column5, the coefficient for the one-period lag of global economic policy uncertainty (L.GEPU_BBDC) is 0.5762, indicating that the previous result is still statistically significant and positively related at the 1% significance level. The results provide empirical support for the hypothesis that the instrument variables one-year lagged uncertainty (lag_uncertainty), and VIX are effective. In addition, the results suggest that global economic policy uncertainty has the most pronounced influence on intensive polluted firms' financialization levels.

4.4.3. Alternative measure of financialization measure

As an alternative measure of financialization, we use the PCA method to create different financialization levels. First, we consider firm-level factors to construct the second measurement of financialization (FIN2), which includes fin2, fin4, fin7, Div, R, and D (see detail in Table A2). Then consider the financial technology and development of financial inclusion to create the third measure (FIN3), which includes fin1, fin5, FinTechNo, DFIIC, R, and D (see detail in Table A2). The overall KMO values are higher than 0.5, which means sample adequacy is acceptable. (1) financial assets to total assets (fin2), (2) financial income to total income (fin4), (3) financial assets to total fixed assets (fin7), (4) dividend payout ratio (Div), (5) the proportion of the repurchase ratio (R), and (6) total debt to total assets (D). We then employ the Principal Component Analysis (PCA) technique to construct our second measure of financialization (FIN2). We also selected components with eigenvalues that exceeded 1. The overall KMO value was 0.5919, which was higher than 0.5, indicating that sample adequacy was acceptable. A higher level of financialization signifies a more significant degree of financialization.

Table 11. Two Step-GMM Estimation.

	Two step-GMM estimation							
	First stage	Second stage	First stage	Second stage	First stage	Second stage	First stage	Second stage
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	EPU_DCHN	FIN1	EPU_BUSA	FIN1	GEPU_BBDC	FIN1	MPU_BUSA	FIN1
L.EPU_DCHN	0.6726***							
EPU_DCHN		0.6780***						
L.EPU_BUSA			0.5310***					
EPU_BUSA				0.2397***				
L.GEPU_BBDC					0.5762***			
GEPU_BBDC						1.2760***		
L.MPU_BUSA							0.2975***	
MPU_BUSA								0.2558***
_cons	2.3729***		3.3378***		2.8383***		4.2532***	
N	7483	7359	7483	7359	7483	7359	7483	7359
R^2	0.8954	0.2687	0.6617	0.1632	0.8462	0.2028	0.6344	0.1261
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
	MPU_HUSA	FIN1	TPU_DCHN	FIN1	TPU_BUSA	FIN1	OVX	FIN1
L.MPU_HUSA	−0.083***							
MPU_HUSA		−2.19***						
L.TPU_DCHN			0.653***					
TPU_DCHN				0.392***				
L.TPU_BUSA					0.518***			
TPU_BUSA						0.3679***		
L.OVX							0.723***	
OVX								0.0063***
_cons	5.7030***		2.5155***		3.6465***		43.3706***	
R^2	0.3134	−1.7983	0.8000	0.2281	0.4764	−0.0260	0.8715	0.1395

Notes: This table reports the results of the two-step GMM. A one-period lag for each uncertainty was applied as an instrument variable.

Table 12 reports the results of alternative measures of financialization, the results remain statistically significant at a significance level of 5%, which suggests that there is a strong relationship between uncertainty and corporate financialization. Furthermore, the results reveal that global economic policy uncertainty, as measured by Baker et al. (2016), remain displays the largest coefficient throughout column 1 to column 12. This indicates that intensively polluted firms' financialization in China is significantly influenced by global economic policy uncertainty. These highly polluted firms should pay more attention to global economic policy uncertainty.

4.4.4. Dynamic effect of uncertainty

Following Lee and Jeon (2022), we measure each uncertainty variable and financialization across different time horizons, aiming to determine the duration of uncertainty. Our analysis extends over four years. Table 13 shows the results of the dynamic effect of uncertainty. Prior studies have identified that MPU can exert the longest and most substantial impact on physical investment (Husted et al., 2020; Lee & Jeon, 2022). Our findings further reveal that MPUs constructed by Husted et al. (2020) also has a positive and significant impact on intensive polluting firms' financialization, lasting for four years. In addition, the global economic policy uncertainty developed by Baker et al. (2016) shows a positive and significant impact on financialization for three years. Similarly, trade policy uncertainty and economic policy uncertainty Davis et al. (2019) exhibit positive effects that last for three years.

Table 12. Alternative measure of financialization level.

	(1) FIN2	(2) FIN2	(3) FIN3	(4) FIN3	(5) FIN4	(6) FIN4
EPU_DCHN	0.3261***	0.3436***	0.4748***	0.5929***	0.4556***	0.5839***
EPU_BUSA	0.2750***	0.1692***	0.4186***	0.3442***	0.3325***	0.2698***
GEPU_BBDC	0.5100***	0.6264***	0.6840***	0.8981***	0.6325***	0.8226***
MPU_BUSA	0.2659***	0.1972***	0.2256***	0.0247	0.1513***	−0.0623***
MPU_HUSA	0.3374***	0.2741***	0.3099***	0.1054***	0.3256***	0.0942***
TPU_DCHN	0.1582***	0.1244***	0.2552***	0.2634***	0.2491***	0.2719***
TPU_BUSA	0.0724***	0.0342***	0.1507***	0.1215***	0.1622***	0.1445***
OVX	0.0073***	0.0030***	0.0103***	0.0054***	0.0092***	0.0039***
Firm-level control	No	Yes	No	Yes	No	Yes
Macro-level control	No	Yes	No	Yes	No	Yes
	(7) fin1	(8) fin1	(9) fin2	(10) fin2	(11) fin6	(12) fin6
EPU_DCHN	0.0235***	0.0253***	0.0539***	0.0537***	0.2232***	0.2134***
EPU_BUSA	0.0130***	0.0054**	0.0596***	0.0404***	0.0984***	0.0163
GEPU_BBDC	0.0354***	0.0405***	0.0898***	0.1096***	0.3310***	0.3325***
MPU_BUSA	0.0114***	0.0023	0.0514***	0.0382***	0.0803***	−0.0266
MPU_HUSA	0.0286***	0.0193***	0.0495***	0.0415***	0.2770***	0.1653***
TPU_DCHN	0.0110***	0.0098***	0.0243***	0.0164***	0.1113***	0.0910***
TPU_BUSA	0.0054***	0.0040***	0.0064***	−0.0009	0.0645***	0.0457***
OVX	0.0006***	0.0002***	0.0016***	0.0011***	0.0055***	0.0025***
Firm-level control	No	Yes	No	Yes	No	Yes
Macro-level control	No	Yes	No	Yes	No	Yes

Notes: This table reports FIN2, FIN3, and FIN4 represent different measures of corporate financialization and are constructed using the PCA method. Table A2 provides the details of the measurements of financialization level.

Table 13. Dynamic effect of uncertainty.

	(1)	(2)	(3)	(4)
Lag=	1	2	3	4
EPU_DCHN	0.4306***	0.2102***	0.0435**	−0.2176***
GEPU_BBDC	0.6681***	0.1442***	0.1309***	−0.1706***
MPU_HUSA	0.3948***	0.6840***	0.1038***	0.8398***
TPU_DCHN	0.2418***	0.1424***	0.0346***	−0.1039***
TPU_BUSA	0.1724***	0.1722***	0.0421***	−0.0413***
OVX	0.0044***	−0.0145***	0.0085***	0.0363***
Firm-level control variables	Yes	Yes	Yes	Yes
Macro-level control variables	Yes	Yes	Yes	Yes

Notes: Table 13 present the dynamic effects of uncertainty on intensive polluted firms financialization. Statistical significance is denoted by *, **, and *** at the 10%, 5%, and 1% levels, respectively.

4.5. Further discussion

4.5.1. The role of environmental protection payment

In this section, we discuss whether environmental protection payments alter firms' financialization in response to global economic policy uncertainty. The strict environment protection law associated with the environmental protection fees imposes a cost burden on Intensive polluted industries (Mao et al., 2023; Xie et al., 2022). Meanwhile, strict laws indirectly reduce firms' access to commercial credit financing (Allen et al., 2005). Consequently, companies may turn to financialized channels to obtain external funding (Zhang et al., 2021).

A previous study regards environmental protection fees as a cost burden for firms (Greenstone et al., 2012; Mao et al., 2023). Xie et al. (2022) found that after China implemented a stricter environmental protection law, highly polluting firms tended to increase their financialization level. The reasons for this are as follows: First, strict environmental protection laws force firms to pay higher taxes and environmental protection fees (Xie et al., 2022). These increased costs can motivate firms to engage in financialization to mitigate the adverse financial costs resulting from stringent laws. Second, strict laws indirectly reduce firms' access to commercial credit financing (Allen et al., 2005). During periods of heightened policy uncertainty, it is difficult for firms to access external loans. Meanwhile, traditional commercial banks or financial institutions may become more cautious about financing for firms with intense pollution (Brandt & Li, 2003). Consequently, companies may turn to financialized channels to obtain external or internal funding (Zhang et al., 2021).

To verify our hypothesis, we utilize the environmental protection tax and environmental protection fees of intensively polluted firms to investigate whether the financialization level varies between high and low environmental protection fees. In 2015, China implemented the new Environmental Protection Law, and removed the environmental protection fee from the environmental protection tax. Therefore, we considered both items. Specifically, we first categorize firms into two sub-groups: if the environmental protection tax (ETax) is greater than the median values of their respective industries, then we set to 1; otherwise, we set to 0. Similarly, we categorize firms that fall below the industry median as having a lower environmental protection fee (EPF), set as 0. We then set dummy variables; when firms pay higher environmental protection fees and taxes, we assign them a value of 1, otherwise 0.

Table 14 presents the results of heterogeneous results of environmental protection payments. We find that the global economic policy uncertainty remains generating the most significant impact on pollution intensive industries, with the coefficients in the high and low group are 0.8072 and 0.6697, respectively (as shown in column 5 and 6), especially for firms with higher environmental protection tax and environmental protection fee.

Table 14. The role of environmental protection payments.

	Environmental protection payments							
	FIN High (1)	FIN Low (2)	FIN High (3)	FIN Low (4)	FIN High (5)	FIN Low (6)	FIN High (7)	FIN Low (8)
EPU_DCHN	0.5583***	0.4257***						
EPU_BUSA			0.2803***	0.2134***				
GEPU_BBDC					**0.8072*** **	**0.6697*** **		
MPU_BUSA							0.0545***	0.0733**
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
_cons	−2.5391***	−3.6315***	−4.8789***	−5.1681***	−5.0930***	−5.6231***	−3.3563***	−4.2971***
N	6815	1826	6815	1826	6815	1826	6815	1826
R^2	0.6274	0.7155	0.5793	0.6958	0.6079	0.7105	0.5640	0.6879
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
MPU_HUSA	0.1435***	0.0774**						
TPU_DCHN			0.2485***	0.1797***				
TPU_BUSA					0.1238***	0.0835***		
OVX							0.0029***	0.0040***
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
_cons	−2.9378***	−3.8401***	−1.8703***	−3.3294***	−3.1662***	−4.3456***	−3.1011***	−4.0619***
R^2	0.5668	0.6878	0.6185	0.7110	0.5878	0.6981	0.5647	0.6888

Notes: Table 14 present the This table reports the results of heterogeneous results an additional analysis of the impacts of environmental protection payments on which uncertainty measures matter for intensive firms' financialization. Bond text is used to mark the key values of greatest significance.

4.5.2. The role of ownership structure

Previous research demonstrates that state-owned (SOEs) and non-state-owned (non-SOEs) companies have significantly different investment strategies (Feng et al., 2022) and financial resources (Zhang, 2022). SOEs, with a government background, can easily access low-cost financial resources and bank loans (Cai et al., 2020; Zhang, 2022), and faceless financing constraints (Cai et al., 2020), better ability against policy uncertainty. In contrast, non-SOEs frequently receive discrimination in capital allocation, facing stricter lending standards (Brandt & Li, 2003), and less investment opportunity. As a result, non-SOEs are forced to increase financialization levels as precautionary saving (Li et al., 2022d), alleviate financing constraints, mitigate policy uncertainty risks, moreover, via fintech searching the new investment opportunities (Abbasi et al., 2021; Bollaert et al., 2021). Table 15, Columns 5 and 6 show that there is a strong correlation between global economic policy uncertainty remain generating the most significant impact on Intensive polluted industries financialization, and it varies between SOEs and non-SOEs. During heightened uncertainty times, with sufficient funds and cash flow, it is easier for them to resist unforeseen uncertainties and adjust investment strategies (Xie et al., 2022). Therefore, they pay less attention to financial activities.

4.5.3. The impact of regional economy (east, west, Middle)

Chinese economy exhibits significant differences among eastern, middle, and western region (Zhao et al., 2021). Firms located in eastern China area with developed economy and financial markets, inclined

Table 15. The role of ownership structure.

	SOEs (1) FIN1	Non-SOEs (2) FIN1	SOEs (3) FIN1	Non-SOEs (4) FIN1	SOEs (5) FIN1	Non-SOEs (6) FIN1	SOEs (7) FIN1	Non-SOEs (8) FIN1
EPU_DCHN	0.4580***	0.6402***						
EPU_BUSA			0.2590***	0.2840***				
GEPU_BBDC					0.6868***	0.9595***		
MPU_BUSA							0.0289	0.0950***
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
_cons	−1.4982***	−3.6043***	−3.7892***	−5.8212***	−3.8417***	−6.4396***	−2.2394***	−4.6092***
N	3647	5125	3647	5125	3647	5125	3647	5125
R^2	0.6105	0.6153	0.5737	0.5524	0.5965	0.5936	0.5574	0.5384
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
MPU_HUSA	0.1056***	0.2026***						
TPU_DCHN			0.2058***	0.2734***				
TPU_BUSA					0.0944***	0.1317***		
OVX							0.0044***	0.0024***
_cons	−2.0203***	−3.9450***	−0.9653**	−2.9151***	−2.1730***	−4.3256***	−2.3060***	−4.0775***
R^2	0.5595	0.5428	0.6008	0.6029	0.5722	0.5671	0.5610	0.5372

Notes: This table reports the results of an additional analysis of the impacts of ownership structure on which uncertainty measures matter for intensive firms' financialization.

Table 16. Uncertainties, Financialization, Regional Effect.

	East (1) FIN1	Middle (2) FIN1	West (3) FIN1	East (4) FIN1	Middle (5) FIN1	West (6) FIN1	East (7) FIN1	Middle (8) FIN1	West (9) FIN1
EPU_DCHN	0.7848***	0.2754***	0.1965***						
EPU_BUSA				0.4059***	0.1020***	0.0683***			
GEPU_BBDC							**1.1775*** **	**0.4355*** **	**0.3119*** **
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
_cons	−3.3366***	−2.5144***	−1.9571***	−6.9762***	−3.4604***	−2.2798***	−7.0758***	−3.9210***	−2.8829***
N	5165	1800	1746	5165	1800	1746	5165	1800	1746
R^2	0.6267	0.5415	0.5893	0.5490	0.5077	0.5732	0.5972	0.5341	0.5859
	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
MPU_BUSA	0.0454*	0.1021***	0.0584***						
MPU_HUSA				0.1680***	0.1855***	0.1244***			
TPU_DCHN							0.3422***	0.1182***	0.0828***
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
_cons	−4.6456***	−3.4995***	−2.2381***	−4.2438***	−2.7592***	−1.9798***	−2.7406***	−2.2253***	−1.6403***
N	5165	1800	1746	5165	1800	1746	5165	1800	1746
r2	0.5211	0.5089	0.5730	0.5246	0.5168	0.5771	0.6109	0.5325	0.5844

Notes: This table reports the results of an additional analysis of the impact of regional effects on which uncertainty measures matter for intensive firms' financialization. Bold font in Table 16 indicates the values of highest significance.

to adopt new technology and embrace fintech, with broaden channel to access funds and financial instruments (Wen et al., 2023), which could help them better against the policy uncertainty. Table 16 present the results of heterogeneous among firms' locations. The findings show that the global economic policy uncertainty consistently leads to the strongest impact on pollution intensive industries across different regions. The coefficients for east, middle, and west are 1.1775, 0.4355, and 0.3119, respectively.

4.5.4. From the perspective of firms' diversification

Uncertainty can affect a firm's risk exposure. Policy-related or economic uncertainty increases the risks faced by firms, while diversification business models can mitigate these adverse effects (Hassan et al., 2023), and diversified firms may benefit from diversified businesses (Hoang et al., 2021). Jumah et al. (2023) demonstrate that diversification plays a moderating role in the relationship between EPU and US firms' investment; diversification could lessen firms' financing constraints during the economic policy uncertainty period, thereby mitigating the negative effect of EPU on firms' investment. Feng et al. (2022) find a positive relationship between nonfinancial firms' diversification and financialization, indicating that firms implementing diversified investment strategies tend to allocate a greater proportion of their funds to financial assets. Chen et al. (2024) stated that when firms face heightened trade policy uncertainty, they may enter a new market to diversify risks. Hoang et al. (2021) found a positive relationship between economic policy uncertainty and diversification.

Table 17 reports the regression results of firms with different levels of diversification. We use the Herfindahl-Hirschman Index to represent the diversification level. We generate an interaction item between uncertainty and diversification levels. The results show that diversification could strengthen the positive relationship between uncertainty and financialization. Further, the coefficient for GEPU is 0.7947, and the interaction item is 0.1805 (see column 3). Both coefficients are positive and statistically significant, as shown in column 3. These results confirm our previous view that GPUE has the most influence on firms' financialization.

4.5.5. From the perspective of external monitoring

According to agency theory Jensen and Meckling (1976), managers tend to make decisions that maximize their interests. We anticipate that higher external monitoring can effectively curb management opportunism, especially during periods of high uncertainty.

We use PCA method to construct external monitoring proxy (ETM) by combining four indicators, including (1) whether firms cross-listing in the Hong Kong stock exchange issued H-shares and B-shares

Table 17. From the perspective of firms' diversification.

	(1) FIN1	(2) FIN1	(3) FIN1	(4) FIN1	(5) FIN1	(6) FIN1	(7) FIN1	(8) FIN1
EPU_DCHN	0.5286***							
EPU_DCHN*HHIA	0.1181**							
EPU_BUSA		0.2408***						
EPU_BUSA*HHIA		0.1333*						
GEPU_BBDC			0.7947***					
GEPU_BBDC*HHIA			0.1805**					
MPU_BUSA				0.0095				
MPU_BUSA*HHIA				0.2252***				
MPU_HUSA					0.1131***			
MPU_HUSA*HHIA					0.2451***			
TPU_DCHN						0.2334***		
TPU_DCHN*HHIA						0.0594*		
TPU_BUSA							0.1108***	
TPU_BUSA*HHIA							0.0423	
OVX								0.0023***
OVX*HHIA								0.0048*
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
_cons	−2.6912***	−4.8089***	−5.1996***	−3.3826***	−2.9149***	−2.1334***	−3.4086***	−3.2730***
R^2	0.6135	0.5610	0.5952	0.5466	0.5506	0.6033	0.5701	0.5471
N	8792	8792	8792	8792	8792	8792	8792	8792

Notes: This table reports the results of an additional analysis of the impact of firms' diversification on which uncertainty measures matter for intensive firms' financialization.

Table 18. The impact of external monitoring.

	(1) FIN1	(2) FIN1	(3) FIN1	(4) FIN1	(5) FIN1	(6) FIN1	(7) FIN1	(8) FIN1
EPU_DCHN	0.5506***							
EPU_DCHN*ETM	0.0598***							
EPU_BUSA		0.2751***						
EPU_BUSA*ETM		0.0487***						
GEPU_BBDC			**0.8343*** **					
GEPU_BBDC*ETM			0.1001***					
MPU_BUSA				0.0617***				
MPU_BUSA*ETM				0.0385***				
MPU_HUSA					0.1613***			
MPU_HUSA*ETM					0.0406**			
TPU_DCHN						0.2441***		
TPU_DCHN*ETM						0.0264***		
TPU_BUSA							0.1197***	
TPU_BUSA*ETM							0.0135**	
OVX								0.0032***
OVX*ETM								0.0014***
ETM	−0.3570***	−0.3098***	−0.5739***	−0.2387***	−0.2582***	−0.1943***	−0.1334***	−0.1203***
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
_cons	−2.7017***	−5.1870***	−5.3541***	−3.7900***	−3.2961***	−2.2116***	−3.6816***	−3.4983***
r2	0.6147	0.5636	0.5972	0.5483	0.5517	0.6047	0.5720	0.5489
N	8792	8792	8792	8792	8792	8792	8792	8792

Notes: Table 18 illustrates the impact of external monitoring on the relationship between uncertainty and financialization of intensively polluting firms. Columns 1–8 analyze whether the effect of external monitoring on firms' financialization varies across uncertainties. External monitoring is constructed using the PCA method, which includes four dummy variables (1) analyst following level, whether companies are audited by BIG 4 audit firms, and research report coverage degree to represent the external monitoring level. The bolded values in Table 18 represent the most significant data value.

(Zuo et al., 2022), (2) analyst following level (Zuo et al., 2022), (3) whether companies audited by BIG 4 audit firms (Feng et al., 2022), and (4) research report coverage degree to represent the external monitoring level (Cheng et al., 2021).

Table 18 presents the impact of external monitoring on the relationship between uncertainty and the financialization of intensively polluting firms. The global economic policy uncertainty exhibits the highest value of 0.8343, and the coefficient for interaction item GEPU_BBDC*ETM in Column 3 exhibits a substantial positive relationship, with a coefficient of 0.1001. and has the most significant impact on financialization. The regression results provide robust evidence that global economic policy uncertainty strongest influence on financialization. various types of policy uncertainties can significantly affect intensive polluting firms' financialization, and effective external monitoring can mitigate this effect. The opposite is true before we expect that firms with higher levels of external monitoring may curb managers' short-termism. Higher-level external monitoring is accompanied by higher financialization. This aligns with previous studies showing that external pressure from institutional investors forces firms to maximize short-term interests, rather than long-term equity appreciation (Bushee, 2001).

5. Conclusion

5.1. Findings

This study investigates the impact of different types of uncertainty on corporate financialization in China's intensively polluting industries. Addressing the first research question, our results reveal that global EPU significantly drives financialization in these industries, aligning with the precautionary savings theory. Among the uncertainty measures examined i.e. economic, monetary, trade, and oil price uncertainties and global economic policy uncertainty exert the strongest influence. In response to the second question, the findings highlight the moderating roles of financing constraints and ESG practices. Financing constraints reduce the positive effect of uncertainty on financialization, suggesting that firms with limited funding options are less likely to engage in financialization under uncertain conditions. Conversely, ESG ratings positively moderate the uncertainty-financialization relationship, indicating that firms with higher ESG scores are better equipped to manage uncertainties, likely due to enhanced stakeholder trust and transparency. While managerial overconfidence, addressed in the third research question, is not explicitly covered in this analysis, it represents an important avenue for future research to

better understand its influence on financialization behaviour under uncertainty. These findings emphasize the nuanced roles of uncertainty, financing constraints, and ESG practices in shaping financialization, offering valuable implications for policymakers and stakeholders in heavily polluting industries.

5.2. Study implications

The results offer valuable implications for companies, policymakers, and stakeholders striving to balance financialization with sustainable practices:

1. **Policy Stability and Transparency:** Policymakers should focus on creating a stable, transparent business environment that reduces policy uncertainty. Clear communication between market participants and policymakers is crucial for minimizing information asymmetry, allowing firms to plan their investments with greater predictability rather than resorting to higher levels of financialization to hedge against uncertainty (Bernanke, 2010).
2. **Support for Green Financing:** To reduce financialization driven by funding constraints, governments should consider providing low-interest loans or subsidies specifically for green development initiatives. This could mitigate firms' reliance on financial assets by supporting sustainable, long-term investment.
3. R**egulation of Financialization Practices:** Policymakers should regulate excessive financialization, particularly speculative investments and share repurchases, to ensure firms are not prioritizing short-term gains over long-term sustainability.
4. **Strengthening ESG Standards:** The Chinese government could establish comprehensive Environmental, Social, and Governance (ESG) standards to incentivize firms toward sustainable business practices. This could enhance firms' resilience to policy uncertainty and foster sustainable growth.
5. **Leveraging Financial Technology for Sustainable Growth:** Intensively polluted firms can leverage advancements in financial technology to improve access to sustainable financing options, thereby supporting green innovation. This focus on sustainable financing over short-term financialization can bolster their resilience against global economic policy uncertainty.
6. **International Cooperation:** Enhanced international collaboration, aided by financial technology, can contribute to a stable business and investment environment, which supports firms in achieving long-term sustainable development goals.

5.3. Contributions

This study contributes to the literature in several ways. First, it introduces a multidimensional measure of corporate financialization using Principal Component Analysis (PCA), which includes financial assets, payout ratios, debt levels, technology adoption, and share repurchases. Second, unlike previous studies focusing on broad economic policy uncertainty, this research disaggregates uncertainty measures to investigate their individual impacts. Finally, it focuses on intensively polluted industries, highlighting the sustainability challenges specific to these sectors.

5.4. Limitations and future research

This study has certain limitations. First, it only addresses intensively polluted industries in China, which may limit the generalizability of the findings. Second, while the study covers the period from 2011 to 2022, it may not fully capture extreme events such as the economic effects of COVID-19. Third, the financialization measure does not include mergers and acquisitions or other significant factors that future research might explore to capture financialization more accurately. Future studies should also investigate cross-industry responses to policy uncertainty and explore whether mergers and acquisitions could be included as components of financialization.

Additionally, we found that environmental protection fees and taxes impose significant cost burdens, leading firms to increase financialization to offset these costs. State-owned firms, with better access to

external funding, demonstrate lower financialization levels in response to uncertainty than non-state-owned firms. Interestingly, firms with higher external monitoring pressures from financial markets tend to increase financialization to boost short-term financial performance, consistent with findings by Bushee (2001). Future research should explore why certain types of uncertainty exert more influence on firms in intensively polluted sectors and further investigate the roles of regional economic effects, ownership structures, and external monitoring on financialization practices.

Author contribution

Mingyao Wang: Conceptualization; Methodology; Formal analysis; Investigation; Software; Data curation; Writing – original draft; Writing – review & editing.

Normaziah Mohd Nor: Conceptualization; Methodology; Project administration; Supervision; Validation; Visualization; Writing – review & editing.

Norhuda Bt Abdul Rahim: Conceptualization; Methodology; Project administration; Supervision; Validation; Visualization; Writing – review & editing.

Faisal Khan: Writing – review & editing.

Yuxiang Cheng: Writing – review & editing.

All the authors agreed to be accountable for all aspects of the work.

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Data availability statement

The data for this study were sourced from the CSMAR and different websites. The data are available from the authors upon request.

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Appendix A

Table A1. Definitions and constructions of study variables.

Variables	Description
FIN	Corporate financialization constructed by PCA.
EPU_DCHN	Economic policy uncertainty – the natural logarithm arithmetic mean of the monthly China EPU data constructed by Davis et al. (2019).
EPU_BUSA	Economic policy uncertainty – the natural logarithm arithmetic mean of the monthly US EPU data from Baker et al. (2016).
GEPU_BBDC	Global economic policy uncertainty – the natural logarithm arithmetic mean of the monthly global EPU data from Baker et al. (2016).
MPU_BUSA	Monetary policy uncertainty – the natural logarithm arithmetic mean of the monthly US MPU data from Baker et al. (2016).
MPU_HUSA	Monetary policy uncertainty – the natural logarithm arithmetic mean of the monthly US MPU data from Davis et al. (2019).
TPU_DCHN	Trade policy uncertainty – the natural logarithm arithmetic mean of the monthly China TPU data from Davis et al. (2019).
TPU_BUSA	Trade policy uncertainty – the natural logarithm arithmetic mean of the monthly US TPU data from Baker et al. (2016).
OVX	Oil price uncertainty – the Chicago Board options exchange (CBOE) crude oil ETF volatility index.
FC	Financial constraints – KZ index developed by Kaplan and Zingales (1997).
ESG	ESG ratings (Huazheng ESG rating; Bloomberg ESG disclosure scores).
ExecShares Held	Managerial over-confidence – Executive shareholding ratio.
Top1ExecCompR	Managerial over-confidence – top 1 executive compensation ratio.
Size	Corporate size – the natural logarithm of total assets.
Cash flow	Operating cash flow to total assets ratio – net cash flow from operating activities to the total assets.
Growth_rate	Growth rate of operating revenue.
Top10	Ownership concentration – sum of shareholding percentage of top ten shareholders
HHI	Corporate diversification – Herfindahl-Hirschman Index
Liquidity	The liquidity ratio is calculated as current assets to current liabilities.
GDP	GDP annual growth rate – year-over-year percentage change in a country's economic output.
Inflation	It is the rate of annual percentage change in the overall price level of goods and services.

Table A2. Definition of variables in financialization level.

Variables	Description
fin 1 (Si et al., 2024)	The proportion of book value of financial assets (e.g. hold-for-trading assets, derivative assets, net interest receivables, net divided receivables, net other receivables, hold-to-maturity investments, available-for-sale financial assets, net long-term account receivables, investment properties, long-term equity investments) to total assets.
fin 2 (Davis, 2018b; Huang et al., 2022)	Same as fin 1, but financial assets including cash and cash equivalents.
fin 3 (Tang & Zhang, 2019)	Financial assets divided by the total assets. Financial assets equal to total current assets minus net accounts receivable minus net inventories plus net long-term investments.
fin 4 (Jin et al., 2022)	The proportion of financial income to total income – return on financial assets, financial income equal to investment gains, income from changes in fair value, other comprehensive income (loss). Financial assets including cash and cash equivalents, trading financial assets, derivative financial assets, available-for-sale financial assets, held-to-maturity investments, net long-term equity investment, net investment properties.
fin 5 (Wang et al., 2023)	Ratio of profit from financial activities (investment gains + income from changes in fair value + foreign exchange gains)/total profit.
fin 6 (Si et al., 2024)	Financial assets to net fixed assets, fin 1/net fixed assets.
fin 7 (Si et al., 2024)	Financial assets to net fixed assets, fin 2/net fixed assets.
FinTechNo (Wen et al., 2023)	Fintech patent number – regional fintech development refers to the accumulation of fintech patents falling under categories G06Q40/08 (insurance) within a province by the conclusion of the year.
DFIIC (Wu & Huang, 2022)	Digital finance development level – Peking University digital financial inclusion index of China (PKU-DFIIC) within a city of the year.
R (Davis, 2016)	Share repurchase ratio – the proportion of accumulative share repurchased in total share capital of each year.
D (Davis, 2016)	Debt level – total liabilities to total assets.
Div (Bradford et al., 2013; Wei et al., 2024)	Dividend distribution ratio – the proportion of accumulative share repurchased in total share capital of each year.