Toxic chemical releases and idiosyncratic return volatility: A prospect theory perspective

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RESEARCH ARTICLE

Toxic chemical releases and idiosyncratic return volatility: A prospect theory perspective

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Abstract

We investigated whether and how firms' toxic chemical releases (TCRs) affect idiosyncratic return volatility (IRV) using a prospect theory lens. Utilising a large sample of US public listed firms over the period 2001–2018, we find a significant and positive association between TCRs and IRV, suggesting that firms releasing more toxic chemicals have higher IRV. Additional analyses show that a positive association between TCR and IRV is more evident among firms with (i) high revenue, (ii) lower financial constraints and (iii) fewer environmental violations. A further test also suggests that a positive association between TCRs and IRV is contingent on political leadership ideology and market states. Our results remain consistent with weighted TCRs, IRV based on the Fama–French three-factor model, fixed-effect two-stage least square estimator (FE-2SLS), and other robustness checks. These findings shed light on the role of equity markets as a driver for capital-intensive pollution abatement activities and enhanced compliance with environmental laws, standards and best practices.

KEYWORDS

Fama–French three-factor model, idiosyncratic return volatility, prospect theory, toxic chemical releases

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1 | INTRODUCTION

Pollution is one of the major environmental risks that modern societies face. Emission of pollutant chemical wastage into the environment affects firms' revenues by disrupting their production process, resulting in large environmental penalties, customer boycotts and higher insurance premiums. Studies have shown the volatility for stakeholders of a firm's environmental performance. For instance, the BP oil spill in 2010 not only resulted in substantial stock volatility (Humphrey et al., 2016) but also attracted fines of US$18.7 billion (Robertson et al., 2015; Zaman et al., 2021a). Similarly, the Freedom Industries chemical spill in 2014 into the West Virginia River, which led the firm to file for bankruptcy (Larson, 2014), and most recently the Volkswagen emissions scandal in 2015, which has significantly reduced the firm's stock price, thereby increasing stock volatility (Boston, 2015; Metcalf et al., 2016). These incidents show that the occurrence of pollutant wastage releases not only causes financial uncertainty among investors but also exposes firms to the risk of environmental irresponsibility (Zaman et al., 2021a), which has the potential to wipe out billions of dollars of cash reserves in the form of fines. Therefore, we argue that the presence of environmental concerns, i.e., pollutant chemical waste release, is an enduring risk for firms, irrespective of the occurrence of environmental disasters, and that the severity of this risk is proportionate to the magnitude of toxic chemical releases (TCRs) and chemical-specific toxicity.

Prior literature in this regard has suggested that environmental concerns may cause cash flow volatility and thus require managerial attention to consider it as a 'business risk' (Huang et al., 2019; Zaman et al., 2021b). Nevertheless, the financial market views the uncertainty of cash flow and/or cash volatility due to firm-specific factors as idiosyncratic risk (Campbell et al., 2001; Mishra & Modi, 2013). Idiosyncratic risk accounts for approximately 80 percent of the total stock risk and remains an integral element of stock price fluctuation (Bansal & Clelland, 2004). The association of idiosyncratic risk with firms' management decision-making is well articulated in prior literature (Goyal & Santa-Clara, 2003; Merton, 1974; Panousi & Papanikolaou, 2012). However, the literature fails to account for TCRs as an antecedent of idiosyncratic risk. This study fills this gap by examining the effect of firms' TCRs on their idiosyncratic risk.

We argue that TCRs are relevant to idiosyncratic risk. We base our argument on prospect theory, which starts with the concept of loss aversion (i.e. an asymmetric form of risk aversion) from the observation that individuals react divergently to potential losses and gains (Kahneman & Tversky, 1979). Thus, individuals make decisions based on the potential gains/losses relative to their risk appetite (Barberis et al., 2016; Best & Grauer, 2016). Therefore, the prospect theory framework allows us to evaluate firms' risk-averse attitudes towards idiosyncratic return volatility (IRV) in the event of TCRs. We expect that, under prospect theory, risk-averse firms adopt capital-intensive pollution abatement activities to avoid high TCRs, thereby resulting in their low IRV, whereas risk-seeking firms focus on production escalation and ignore abatement activities, which could result in high TCRs and thus increase the IRV of those firms.

We further examine this relationship using a socially responsible investment (SRI) perspective. We argue that the recent surge in environmental violation incidents has put investors in a vulnerable position. Investors become highly sceptical about investing in stocks that are perceived by the market as environmentally irresponsible (Bahadar et al., 2019; Ivanisevic Hernaus, 2019). This shows that environmental concerns are becoming a driving force for investors' decision making, which is mainly attributable to the rapid growth of SRI capital in the last two decades, exceeding US$30 trillion in total (Bernow & Kehoe, 2019). In parallel, there has also been a marked increase in environmentally sensitive lending that takes into account the environmental impact of borrowers in the lending decision (Chava, 2014). Altogether, the SRI perspective argues that socially responsible investors perform negative screening of firms' stock that is considered a high pollutant (i.e., releases highly toxic chemicals), thereby increasing the return volatility (i.e., IRV).

To test these arguments, we measure firms' environmental liabilities based on TCR, as reported by a firm to the US Environmental Protection Agency (EPA) and examine its impact on IRV based on the capital asset pricing model (CAPM) and Fama–French three-factor (3F) model. Our empirical results support our hypothesis that TCR has a significant positive association with IRV, indicating that investors negatively perceive the environmental liabilities of firms. Additional analysis shows that the positive relationship between TCR and IRV is more pronounced in firms with (a) higher revenues, (b) greater financial flexibility and (c) lower environmental penalties. We further found evidence that the TCR and IRV relationship is also contingent on political leadership ideology. Our baseline results remain robust to nonlinearity assumptions, exogenous shocks and endogeneity concerns. The results support our theoretical predictions that firms with higher TCRs face a higher IRV due to the psychological representation of potential risk by investors and rapidly increasing awareness around SRIs.

We make at least four vital contributions to the literature. First, while prior studies generally concur that firms' environmental performance has a significant association with firm value (Hassel et al., 2005), there is scant literature examining the potential financial-risk implications of firms' involvement in pollution activities in the form of TCR. The exception is Metcalf et al. (2016) who examined the impact of firms' toxic emissions and human exposure to such emissions on firms' idiosyncratic risk.[1] However, our paper does differ in three important respects. First, Metcalf et al. (2016) employ an information processing lens to test the association between TCR and IRV. They suggest that strong external monitoring, i.e., the presence of analyst followings and local population education, weakly influences the documented positive relationship. We employ the prospect theory lens and explore three distinct possible channels that drive the positive association between TCR and IRV. Specifically, our channel analysis suggests that the positive association between TCR and IRV is contingent on companies' financial health (revenue and financial constraints) and environmental violations. Second, as firm TCR reporting to EPA is also contingent on political leadership ideology, we empirically tested the role of politically leadership ideology on the TCR and IRV relationship. Our results suggest that the documented positive relationship between TCR and IRV is more pronounced in the republican presidency period. This might be due to the ineffectiveness of the EPA during the republican presidency period. Finally, in our additional analysis, we also test the role of market states in the TCR and IRV nexus and found that higher TCR triggers bearish sentiments in the market and thus causes higher IRV. Therefore, all the underlying mechanisms in our study remain distinct, compared to Metcalf et al. (2016).

Second, most prior studies examining the relationship between environmental performance and firm value rely on agency or stakeholder theories. Recent literature suggests that prospect theory provides a better lens through which such an association can be analysed (Barberis et al., 2016). However, to the best of our knowledge, none of the prior studies has applied a prospect theory framework to explain the financial implications of corporate irresponsible behaviour. Thus, this is the first study of its kind that uses prospect theory to theorise and explain the association between firms' environmental liabilities (in the form of TCRs) and financial risk measured as IRV. By doing so, this study provides a foundation for future studies to examine such relationships using the prospect theory framework.

Third, we also contribute to the corporate environmentalism literature by documenting that poor environmental performance is not only bad for the environment and society but also

[1]We are thankful to an anonymous reviewer for making us think in this direction.

carries negative implications for firm value in the form of higher IRV. Such a finding holds important implications for regulators, practitioners and managers. For example, firms that ignore their environmental externalities in the race to increase production levels could face severe consequences in the form of investors' reactions and public and media scrutiny. In this way, our study is useful to firms and shareholders who want to manage tail risk in the stock market and to investors who want to incorporate TCR in their portfolio and risk management decisions.

Finally, our study informs the regulatory debate about the effectiveness of political leadership's interest in environmentalism. In this manner, we envision the TCR and IRV relationship by empirically testing for political leadership ideology. We have seen a large number of scholars commenting on the importance of executive values for corporate responsibility (Chin et al., 2013; Woodward et al., 2001). However, it is very unfortunate that the majority of CSR scholarship ignores political leadership ideology/policies (see Zaman et al., 2021b). Our paper considers the role of the top political elites in devising policies and/or shaping business executives' perception of environmentalism, and sheds new light on the interplay between TCR and IRV by documenting those presidential policies that shape the views of investors and regulators as well as those of management on corporate environmental performance (i.e., TCR in our case).

The remainder of the paper proceeds as follows. We review prior literature and develop our hypothesis in Section 2. Section 3 presents our methodology. Section 4 presents and discusses the results. Finally, Section 5 concludes this study.

2 | LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

2.1 | Toxic chemical releases

In the US, the EPA, with the aim of protecting human health and the environment, has enacted various legislative and monitoring mechanisms and/or programmes. The Toxic Release Inventory (TRI) is one of the programmes that was established to monitor the use of toxic chemicals by US firms. It is a mandatory programme that gathers and disseminates firms' TCR information to the public (Kim et al., 2019). The report requirements limit corporate influence on the type and timing of emission information (Connors et al., 2013). Hence, the existing literature supports the argument that TCRs are a value-relevant measure for polluting firms (Chava, 2014; Giudici et al., 2019; Schneider, 2011). TCRs have significant implications for firm decision making due to their relevance to firms' stakeholders (i.e., investors, regulators, society and the environment) and serve as an important basis for stakeholders to capture firms' environmental anomalies (Kim et al., 2019).

TCRs have been an extensively researched topic among environmental management and planning scholars. Interestingly, despite the relevance and/or significance of TCR to finance scholarship, especially investment decisions, the literature seems scared to study the topic. Prior studies examining the financial implications of improved environmental performance indicate that better environmental performance, as measured by the quantity of pollution emissions weighted by toxicity, is associated with high operating performance (Hart & Ahuja, 1996; King & Lenox, 2002; Russo & Fouts, 1997), lower cost of equity (Connors & Silva-Gao, 2008), negative abnormal returns (Hamilton, 1995; Khanna et al., 1998), lower cash holding (Huang et al., 2019) and local institutional ownership (Kim et al., 2019). Of note, although these studies focused on different objectives, they all suggest that the market views TCR as a business risk and firms that proactively manage this risk have superior performance.

2.2 | Idiosyncratic return volatility

Idiosyncratic risk is the component of financial risk that can be affected by firms' actions rather than the market; hence, it not only remains pivotal and central to organisational policies and management decisions but also attracts special attention to investors' and asset managers' portfolio selections (Panousi & Papanikolaou, 2012). Due to its significance to firms and management alike, the relationship between the firm's strategy and/or actions and IRV has been extensively studied across disciplines. Studies in finance scholarship have identified various sources that contribute to IRV, including investment decisions (Panousi & Papanikolaou, 2012), institutional ownership (Chichernea et al., 2015; Jafarinejad et al., 2015), earnings management practices (Alharbi et al., 2021; Chang et al., 2015), limited investor protection (Morck et al., 2000), corporate misconduct (Murphy et al., 2009), earnings smoothing (Chen et al., 2012), corporate governance (Ferreira & Laux, 2007; Nadeem et al., 2019; Sila et al., 2016; Sun & Liu, 2014), ownership structure (Panousi & Papanikolaou, 2012), corporate social performance (Becchetti et al., 2015; Lee & Faff, 2009), security return (Boehme et al., 2009; Fu, 2009; Huang et al., 2010; Wei & Zhang, 2005), growth opportunities (Cao et al., 2008), equity premiums (Cogley, 2002; Lettau, 2002), short selling (Cogley, 2002), corporate human capital (Eiling, 2013), managerial risk taking (Glover & Levine, 2017), dividend policies (Lee & Mauck, 2016), cash holding (Irvine & Pontiff, 2009), religiosity (Adhikari & Agrawal, 2016; Gao et al., 2017), CEO compensation and personal characteristics (Armstrong & Vashishtha, 2012; Neyland, 2020; Serfling, 2014), market competition (Abdoh & Varela, 2017) and insider trading (Gider & Westheide, 2016). Interestingly, none of these studies[2] has considered IRV as an antecedent of corporate emission releases. Considering the increased environment-related pollution (i.e., TCR) and its impact on firm risk, there remains an acute need for a thorough investigation of whether and how TCRs affect IRV.

2.3 | Environmental performance, corporate financial performance and corporate risk

Prior literature shows mixed results on the relationship between environmental and financial performance. For example, several earlier studies, such as Fisher-Vanden and Thorburn (2011) and Jacobs et al. (2010), find that firms involved in polluting activities experience negative abnormal returns. Others find no significant effect of environmental performance on financial performance (e.g., Horváthová, 2010; Renneboog et al., 2008). Studies that use TRI data as a proxy for environmental performance generally find a negative relationship between toxic chemical releases and firm profitability. For example, Khanna et al. (1998) show that the higher toxic chemical releases, potentially due to lower production efficiency, potentially higher pollution control costs and environmental liabilities, have a significant negative effect on the stock return. Prior literature capturing environmental performance, by the quantity of pollution emissions weighted by toxicity, suggests that better environmental performance is positively associated with financial performance such as return on sales (Hart & Ahuja, 1996) or return on assets (Clarkson et al., 2011; Hart & Ahuja, 1996), and stock market performance, i.e., stock return (Klassen & McLaughlin, 1996), Tobin's q (King & Lenox, 2000;

[2]Our study is distinct from other work on CSR. We focus on the negative environment externalities, i.e. TCRs. In the US, reporting TCRs to the EPA is not only mandatory but the EPA also limits corporate influence on the type and timing of TCRs – making it a more objective and unbiased measure. Of note, both of the studies on the CSR–IRV nexus capture CSR either using KLD (Becchetti et al., 2015) or based on firms' self-reported questionnaires (Lee & Faff, 2009), and thus suffer underreporting bias, as they are not subjected to stringent audits/monitoring.

Konar & Cohen, 2001). Scholars also advocate that environmental management initiatives are significantly associated with the firm's cost of capital (Mackelprang & Nair, 2010; Sharfman & Fernando, 2008).

While the number of studies that have examined the impact of environmental performance on financial performance has increased (see Mackelprang & Nair, 2010; Sharfman & Fernando, 2008; Zhu & Sarkis, 2004), the risk implication of the environmental management process has recently received limited academic attention. For instance, the findings of Metcalf et al. (2016) indicate that corporate environmental performance measured as toxic chemical releases significantly increases the idiosyncratic risk of US-listed firms. Accordingly, the findings of Xue et al. (2020) using a sample of 1,632 UK listed firms, indicate that corporate environmental management activities significantly reduce firm risk. A similar finding was observed by Djoutsa Wamba et al. (2020) when investigating the impact of environmental performance on systematic risk for 351 European listed companies. As environmental behaviour might improve the relationship with regulatory authorities and consumers, reduce the risk of penalties and litigation and lower the cost of capital, firms with leading (lagging) environmental performance are less (more) susceptible to the sudden revealing of bad news that can cause stock price crashes. For example, Zaman et al. (2021b) have examined the impact of corporate environmental-related innovation on stock price crash risk. Their results suggest that an increase in corporate environmental-related innovation from the 25th to the 75th percentile is associated with a 17.62 percent reduction in stock price crash risk. Conversely, Cai et al. (2016) find that corporate environmental performance increases the risk for companies operating in the services sector. They argued that cost and inefficiency attributed to environmental commitment increase firm risk. We complement and extend these studies by specifically examining the relationship between toxic chemical release and the idiosyncratic return volatility of the firm.

2.4 | Information processing theory vs. prospect theory

Information processing theory relies mainly on the ‘information availability’ or firm-specific details that are available to the market (Atawnah et al., 2018; Galbraith, 1974; Michael et al., 2022). We applied the prospect theory of Kahneman and Tversky (1979) to explain the relationship between TCR and IRV, as not all firm-specific information is publicly available, some information or disclosures are proprietary and costly (Glaeser, 2018; Indjejikian, 1991), and complex to process by retail investors, and they mostly mimic the investment decisions of the institutional investors. In this way, the findings of several studies imply that a company may restrict the provision of information to the external market. For example, consistent with proprietary cost concerns, Peters and Romi (2013) found that, despite mandatory requirements, companies are less likely to disclose sanctions involving judicial proceedings about environmental incidents. Similarly, Ellis et al. (2012) and Li et al. (2018) also suggest managers provide limited disclosure for mandatory compliance. Therefore, given the controlled narrative (limited information to the external market), the information processing lens may fall short of fully capturing the TCR and IRV relationship.

2.5 | Prospect theory and the TCR–IRV nexus

Kahneman and Tversky (1979) propose prospect theory as an alternative to expected utility theory (also called Morgenstern–von Neumann utility theory) and provide robust evidence that people's actual decision making does not follow rational calculation. The prospect theory argues that people react differently when they are in the domains of potential losses and potential gains. Thus, they make investment decisions based on the potential gains or potential losses relative to their specific situation (or reference point) rather than in absolute terms (Wiseman & Gomez-Mejia, 1998; Zona, 2012). For example: (1) Faced with a risky choice leading to gains, individuals are risk-averse, preferring solutions that lead to a lower expected return but with a higher certainty (concave value function). (2) Faced with a risky choice leading to losses, individuals are risk-seeking, preferring solutions that lead to a lower expected return as long as it has the potential to avoid losses (convex value function). For example, the success criterion for active exchange-traded fund (ETF) managers, is not just making money but beating the underlying target index. Since the rewards from surpassing a target index are not as great as the costs of falling short of it, these managers are risk-averse and overvalue losses relative to comparable gains (Levy, 2003). This helps to explain why many actively managed funds secretly mimic their target index: 'Many fund managers have stopped swinging for the fences. Because they know the penalties for severely underperforming an index are now much greater than the rewards for strongly outperforming it' (New York Times, 1999).

In the context of our study, prospect theory can explain the motivation for firms to meet government-set TCR thresholds. However, the applicability of the prospect theory in explaining corporate irresponsible behaviour in releasing highly toxic pollutants has not been studied extensively in previous studies. We, therefore, propose a framework built on prospect theory whereby firms have asymmetric preferences related to TCR. Risk-averse firms preserve their corporate reputation and prefer to mitigate environmental concerns through abatement activities to keep TCR below the defined threshold. Thus, these risk-averse firms overvalue potential losses relative to comparable potential gains and avoid the risk of exceeding the TCR threshold. Hence, by complying with the cut-off value of TCR, firms may avoid potential consequences of negative media scrutiny, customer boycotts, tighter lending conditions and hefty monetary penalties, and thereby manage the IRV of the firm. On the other hand, risk-seeking firms pursue capital investment projects that maximise shareholder value through increased production and consider abatement projects as detrimental to that value. Thus, these risk-seeking firms overvalue potential gains relative to comparable potential losses at the risk of exceeding the TCR threshold. Consequently, such non-compliance with the government-set TCR threshold may result in negative media scrutiny, customer boycotts, tighter lending conditions and hefty monetary penalties (Karpoff et al., 2005), and thereby increase the IRV of the firm. We, therefore, hypothesise the following relationship:

> **H1:** TCR has a significantly positive effect on the IRV of a firm, ceteris paribus.

3 | RESEARCH DESIGN

3.1 | Dependent variable: idiosyncratic return volatility

We follow Xu and Malkiel (2003) and Chang and Dong (2006) and measure IRV using daily stock returns as a basis for calculating annual estimates and run the CAPM and Fama–French three-factor regressions for each firm in each year. Each annual firm-level IRV is estimated using at least 175 daily observations in a year. We take the natural logarithm of the idiosyncratic volatility measure (IV) to reduce the impact of heteroskedasticity on our results. Specifically, we define our measures of idiosyncratic volatility, IV*i*,*n*FF and IV*i*,*n*M, of firm *i* during fiscal year *n* as follows:

$$R_{i,t} - R_{rf,t} = \beta_{i,0} + \beta_{i,1}(R_{m,t} - R_{rf,t}) + u_{i,t} \tag{1}$$

$$IRV_{i,T}^{CAPM} = \ln\left(\frac{1}{M_T}\sum_{t \in T}(u_{i,t})^2\right) \quad (2)$$

where $R_{i,t}$ is the return on day t for firm i, $R_{m,t}$ is the daily return of a value-weighted market index, $\beta_{i,0}$ is the intercept term, $\beta_{i,1}$ is the coefficient that captures systematic risk, $u_{i,t}$ is an error term, and $IRV_{i,T}^{CAPM}$ represents the IRV on year T for firm i calculated as the standard deviation of the residuals from the CAPM.

$$R_{i,t} - R_{rf,t} = \gamma_{i,0} + \gamma_{i,1}(R_{m,t} - R_{rf,t}) + \gamma_{i,2}SMB_{m,t} + \gamma_{i,3}HML_{m,t} + \upsilon_{i,t} \quad (3)$$

$$IRV_{i,T}^{3F} = \ln\left(\frac{1}{M_T}\sum_{t \in T}(\upsilon_{i,t})^2\right) \quad (4)$$

where $(R_{m,t} - R_{rf,t})$, $SMB_{m,t}$ and $HML_{m,t}$ are the market risk premium, size premium (small minus big) and value premium (high minus low), respectively, collected from Kenneth French's website, and the remaining variables are as presented in Equation (3). $IRV_{i,T}^{3F}$ represents the idiosyncratic return volatility in year T for firm i, calculated as the standard deviation of the residuals from the Fama–French three-factor model.

3.2 | Independent variable: Toxic chemical releases

We use the chemical releases from the TRI database following prior studies (Berrone et al., 2010; Bui & Kapon, 2012; Chatterji & Toffel, 2010; King & Lenox, 2000; King & Shaver, 2001). The TRI, created by the US Emergency Planning and Community Right-to-Know Act of 1986, requires establishments (i.e., facilities, factories) to report waste, transfers and releases of certain toxic chemicals on an annual basis. Since the financial statement data in the Bloomberg database is not available at the establishment (i.e., facility) level, we sum the TCRs in pounds for all establishments (i.e., facilities) at the parent company level, and then merge the chemical releases dataset with the financial statement data from the Bloomberg database. Consistent with prior research (Chatterji & Toffel, 2010; Doshi et al., 2013; Konar & Cohen, 2001), we use the natural logarithm of the total pounds of chemical releases adjusted by firm size (i.e., total firm assets) at the parent company level.

However, an important data issue arises when measuring the TCR at the firm level, as the TRI databases only include pollution information for facilities in the United States. Therefore, firms that have plants outside of US territory may have lower or no effect on firm's idiosyncratic risk. For example, a firm may have static financial performance for several years, but at the same time be moving their manufacturing facilities from the US to other countries. Therefore, the reported TCR levels in the US may be lower as well as the financial performance of firms may also be static due to their moving of manufacturing facilities from the US to other countries. Thus, the relation between TCR and IRV would be spurious. For this reason, we limited our sample to those firms that only have manufacturing facilities in the US (firms with US-only facilities were identified through the Mergent Online database). This ensures that the financial and pollution measures for each firm are derived from the same set of facilities. We use the Compustat segments database to identify firms operating in the US. For any reporting year, if the firm reports data only for domestic segments and has foreign sales equal to zero in that year, it is identified as a non-multinational company (MNC) (i.e., a firm with manufacturing facilities in the US only).

We use two alternative measures of chemical releases in this additional test. Next, we standardise TCR by firm size. We also adjust TCR with the industry average value of TCR to control for the industry effect for each year based on two-digit SIC codes. In line with the process adopted by Eisenberg et al. (1998), we transform TCR using the logarithmic transformation of the difference between each firm's TCR and the corresponding industry average TCR as follows:

$$TCR_{i,t} = sign\left(\Delta TCR_{i,t}\right) \times \log\left(\left|\Delta TCR_{i,t}\right|\right) \tag{5}$$

$$\Delta TCR_{i,t} = \frac{\sum_{j=1}^{n} Chemical_{j,i,t}}{Total\ Asset_{i,t}} - \frac{\left(\overline{\sum_{j=1}^{n} Chemical_{j}}\right)_{i,t}}{Total\ Asset_{i,t}} \tag{6}$$

Our second measure captures the industry-adjusted amount of chemical releases based on chemical-specific toxicity. Cong and Freedman (2011) argue that simply summing chemical releases is not an appropriate approach, although many related studies use this approach and assume all chemicals are equally toxic. Because some chemicals are more toxic than others, researchers using TRI's chemical releases should adjust the raw amounts based on the chemical-specific toxicity (Toffel & Marshall, 2004). Hence, we calculate the adjusted total amount of chemical releases based on toxicity. Consistent with prior research (Cong & Freedman, 2011; King & Lenox, 2000), we use the following formula to calculate the weighted amount of chemical releases.

$$WTCR_{i,t} = sign(\Delta WTCR_{i,t}) \times \log\left(\left|\Delta WTCR_{i,t}\right|\right) \tag{7}$$

where:

$$\Delta WTCR_{i,t} = \frac{\sum_{j=1}^{n} Chemical_{j,i,t} \times Weight_{j,i,t}}{Total\ assets_{i,t}} - \frac{\overline{\sum_{j=1}^{n} Chemical_{j,i,t} \times Weight_{j,i,t}}}{Total\ assets_{i,t}} \tag{8}$$

where *Chemical* refers to a specific chemical and *Weight* refers to the toxicity weight attached to the specific chemical.

3.3 | Control variables

We control for several variables affecting IRV. Firm size (*SIZE*) is expected to relate negatively to idiosyncratic volatility because (1) small firms experience higher return volatility (Pástor & Veronesi, 2003a; Rajgopal & Venkatachalam, 2011) and (2) large firms tend to diversify their businesses more efficiently and are less prone to bankruptcy (Titman & Wessels, 1988) and experience lower return volatility (Pástor & Veronesi, 2003b). Hence, we control for firm size (*SIZE*) in the regression model, which is measured as the natural log of total assets. Campbell et al. (2001) and Rajgopal and Venkatachalam (2011) suggest that leverage (*LEV*) increases stockholder risk associated with firm cash flow, indicating a positive relation between stock return volatility and financial leverage. Prior studies argue that (1) higher profitability, stock returns and dividend payout, and (2) lower volatility in profit can enhance companies' ability to lower financial instability and thus reduce IVOL (Brown & Kapadia, 2007; Pástor & Veronesi, 2003a). Therefore, in the regression models, we control for firm profitability (*ROA*), stock return (*RET*) and dividend payout (*DIV*).

Firms with more growth opportunities are likely to experience higher stock return volatility (Cao et al., 2008; Rajgopal & Venkatachalam, 2011; Xu & Malkiel, 2003). We control for firm growth by using (1) rate of change in sales (*SG*) and (2) market-to-book (*MTB*) ratio as the proxies for firm growth. Gaspar and Massa (2006) and Irvine and Pontiff (2009) suggest that competition among firms has important implications for idiosyncratic risk. Therefore, we control for market competition using the Herfindahl index (*HINDEX*). Cao et al. (2008) argue that future cash flows of younger firms are more uncertain than those of older firms, indicating that firm age (*AGE*) affects firm-specific volatility. Rajgopal and Venkatachalam (2011) show that financial reporting quality (*FRQ*) is associated with IRV. We estimate *FRQ* using the model developed by Kothari et al. (2005), and use the absolute value of accruals so that a lower value indicates better financial reporting quality. Appendix I provides the definitions and measurements of all the variables used in this study.

3.4 | Data and methodology

We start the sample selection process by obtaining all available data on TCRs from 2001 to 2018 on the TRI website. For each year, we aggregate the chemical data of all facilities (i.e., factories) at the parent company level. For example, if parent company ABC has six facilities in 2018, each reporting 5,000 pounds of total TCRs to the TRI, then we consider that company ABC releases 30,000 pounds of chemicals in 2018. Next, we obtain financial statement data from the Bloomberg database and merge the two datasets by unique firm identification number and fiscal year. After removing the missing data, the final sample consists of 2,734 firm-year observations from 2001 to 2018, representing 286 individual firms. We winsorise all variables at the 1st and 99th percentiles to account for data outliers. We follow Jain and Zaman (2020) and Köster and Pelster (2017) and apply dynamic generalised method of moments (GMM) to estimate Equation (9).

We specify the following empirical model to examine the effect of chemical releases on the idiosyncratic risk of the firm:

$$IRV_{i,t} = \varphi_0 + \varphi_1 IRV_{i,t-1} + \sum_{j=1}^{n} \theta_j X_{j,i,t} + \sum_{k=1}^{m} \delta_k C_{k,i,t} + \varepsilon_{i,t} \quad (9)$$

where i represents the firm and t represents time (i.e. year); $IRV_{i,t}$ represents two dependent variables (i.e. $IRV_{i,T}^{CAPM}$ and $IRV_{i,t}^{3F}$) for firm i at year t; $X_{j,i,t}$ represents the two independent variables for firm i at year t; $C_{k,i,t}$ represents the control variables for firm i at year t; φ_0 is a constant and φ_1, θ_j and δ_k are the estimated coefficients for $IRV_{i,t-1}$, explanatory variables and control variables, respectively, whereas $\varepsilon_{i,t}$ is the residual of the model.

4 | RESULTS

4.1 | Descriptive statistics

The descriptive statistics are reported in Table 1. The mean (logged) TCR in our sample is 4.65 pounds with a standard deviation of 14.60. Firms in our sample have an average debt-to-total assets ratio of 0.25 and an average MTB value of 3.64. The average sales growth rate is 0.07,

TABLE 1 Descriptive statistics

Variables	Observations	Mean	SD	Minimum	Maximum
$IRV_{i,t}^{CAPM}$	2,734	2.47	1.09	0.00	10.04
$IRV_{i,t}^{3F}$	2,734	2.10	0.97	0.00	8.95
$TCR_{i,t}$	2,734	4.65	14.60	0.00	372.00
$LEV_{i,t}$	2,734	0.25	0.14	0.00	0.75
$SG_{i,t}$	2,734	0.07	0.2	−0.56	1.48
$MTB_{i,t}$	2,715	3.64	7.97	0.08	200.79
$FRQ_{i,t}$	2,734	0.00	0.71	−3.28	2.93
$HHI_{i,t}$	2,734	12.03	75.15	0.00	2772.93
$EPU_{i,t}$	2,734	116.92	30.84	71.33	172.25
$FCDISP_{i,t}$	2,725	0.00	0.10	−1.52	2.34
$SIZE_{i,t}$	2,734	8.58	1.53	4.54	12.56
$ROA_{i,t}$	2,734	0.05	0.06	−0.54	0.31
$GDP_{i,t}$	2,734	1.89	1.45	−2.54	3.80
$DIV_{i,t}$	2,722	44.63	85.31	0.00	1342.86
$RET_{i,t}$	2,707	0.07	0.38	−2.64	2.20
$AGE_{i,t}$	2,734	35.11	31.31	0.00	212

Note: This table reports the summary statistics of all the variables. The definitions and measurements of the variables are given in Appendix I.

whereas the average market competition based on the Herfindahl–Hirschman index is 12.03. The average value of economic policy uncertainty is 116.92. Firms in our sample have an average size of 8.58 and average profitability of 0.05. Finally, the average age of a typical firm in our sample is 35 years.

We also perform a correlation analysis of our dependent and independent variables, and the results presented in Table 2 suggest no issues with multicollinearity (i.e., values are less than the threshold limit of 0.8).

4.2 | Main results

Table 3 reports the system GMM results for Equation (9). The results for TCR with both proxies of IRV, i.e., IRV^{CAPM} and IRV^{3F}, are presented in Models (1) and (3), while the results for weighted TCRs (WTCR) with IRV are shown in Models (2) and (4), respectively. At the outset, we found that both proxies of TCR, i.e., TCR ($\beta = 0.059$, $p < 0.001$) and weighted TCR (WTCR) ($\beta = 0.025$, $p < 0.001$), are positive and significantly associated with IRV (i.e., IRV^{CAPM}) – supporting our study's hypothesis that polluting firms face higher idiosyncratic risk. The positive association between TCR and IRV is not only statistically significant, but it also holds economic significance as a one-standard-deviation increase in TCR is associated with 35.50 percent and a 27.11 percent increase in IRV, respectively.[3] These results remain consistent using an alternative measure of IRV (i.e., IRV^{3F}). Taken together, our results complement the prospect theory perspective and illustrate that investors will incorporate TCR while assigning prospect theory value to stocks, and stocks with higher TCR

[3]We followed Zaman et al. (2021c) to calculate economic significance.

TABLE 2 Pairwise correlations

S#	Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1)	$TCR_{i,t}$	1.00													
(2)	$LEV_{i,t}$	0.06*	1.00												
(3)	$SG_{i,t}$	0.06*	−0.04	1.00											
(4)	$MTB_{i,t}$	0.02	0.18*	0.00	1.00										
(5)	$FRQ_{i,t}$	0.00	−0.06*	0.16*	0.01	1.00									
(6)	$HHI_{i,t}$	0.04	−0.02	0.01	−0.02	−0.04	1.00								
(7)	$EPU_{i,t}$	0.04	−0.01	−0.03	−0.04	−0.01	−0.04	1.00							
(8)	$FCDISP_{i,t}$	0.04	0.03	0.04	0.00	−0.01	0.00	0.01	1.00						
(9)	$SIZE_{i,t}$	−0.16*	0.09*	−0.09*	0.02	0.03	0.23*	0.03	0.01	1.00					
(10)	$ROA_{i,t}$	−0.04	−0.31*	0.17*	0.11*	0.47*	0.02	−0.06*	0.03	0.04	1.00				
(11)	$GDP_{i,t}$	0.01	0.02	−0.01	0.02	0.04	0.00	−0.41*	−0.03	−0.01	0.08*	1.00			
(12)	$DIV_{i,t}$	−0.06*	0.06*	−0.11*	−0.02	−0.12*	0.03	0.05*	0.03	0.09*	−0.13*	−0.03	1.00		
(13)	$RET_{i,t}$	−0.02	−0.06*	0.11*	0.08*	0.16*	−0.04	−0.13*	−0.01	−0.05	0.28*	0.42*	−0.10*	1.00	
(14)	$AGE_{i,t}$	−0.04	0.08*	−0.07*	−0.03	0.02	0.03	0.02	−0.01	0.17*	0.01	−0.02	0.04	−0.03	1.00

Note: This table reports the results of Pearson's pairwise correlation test. * Shows significance at the 0.01 level. The definitions and measurements of the variables are given in Appendix I.

TABLE 3 Effect of toxic chemical release on idiosyncratic risk – Baseline results.

	Dependent variable: Idiosyncratic return volatility			
	$IRV_{i,t}^{CAPM}$		$IRV_{i,t}^{3F}$	
	(1)	(2)	(3)	(4)
$TCR_{i,t}$	0.059*** (0.012)		0.040*** (0.007)	
$WTCR_{i,t}$		0.025*** (0.003)		0.019*** (0.003)
$IRV_{i,t-1}$	0.080*** (0.028)	0.038 (0.027)	0.051** (0.023)	0.024 (0.025)
$LEV_{i,t}$	2.266*** (0.375)	2.906*** (0.432)	2.298*** (0.320)	2.683*** (0.315)
$SG_{i,t}$	0.386* (0.200)	0.146 (0.201)	0.812*** (0.187)	0.519*** (0.176)
$MTB_{i,t}$	0.591*** (0.081)	0.616*** (0.084)	0.274*** (0.060)	0.304*** (0.066)
$FRQ_{i,t}$	0.338*** (0.046)	0.327*** (0.046)	0.232*** (0.034)	0.253*** (0.037)
$HHI_{i,t}$	0.261*** (0.059)	0.285*** (0.060)	0.128*** (0.028)	0.102*** (0.027)
$EPU_{i,t}$	0.164*** (0.051)	0.254*** (0.053)	0.248*** (0.045)	0.275*** (0.045)
$FCDISP_{i,t}$	0.968* (0.517)	0.548 (0.535)	−0.908** (0.426)	−0.649 (0.443)
$SIZE_{i,t}$	0.145*** (0.032)	0.109*** (0.037)	−0.069*** (0.025)	−0.076*** (0.027)
$ROA_{i,t}$	−0.088*** (0.010)	−0.100*** (0.011)	−0.064*** (0.011)	−0.071*** (0.010)
$GDP_{i,t}$	−0.290*** (0.014)	−0.295*** (0.015)	−0.203*** (0.012)	−0.211*** (0.012)
$DIV_{i,t}$	−0.265*** (0.045)	−0.340*** (0.043)	−0.005 (0.033)	−0.041 (0.034)
$RET_{i,t}$	−0.172*** (0.063)	−0.195*** (0.066)	−0.197*** (0.048)	−0.189*** (0.048)
$AGE_{i,t}$	0.192 (0.120)	0.164 (0.125)	−0.359*** (0.118)	−0.316*** (0.117)
Observations	1,498	1,511	1,498	1,511
Number of firms	222	222	222	222
Number of instruments	113	113	117	117
AR1 (*p*-value)	0.000	0.000	0.000	0.000
AR2 (*p*-value)	0.797	0.789	0.455	0.632
Hansent test (*p*-value)	0.233	0.466	0.271	0.329
Diff. in Hansen test (*p*-value)	0.307	0.197	0.962	0.944
F-stat (*p*-value)	0.000	0.000	0.000	0.000

Note: This table reports the system GMM regression results for the association between toxic chemical release and idiosyncratic risk. The results for TCR with both proxies of IRV, i.e., IRVCAPM and IRV3F, are presented in Models (1) and (3), while the results for weighted TCRs (WTCR) with IRV are shown in Models (2) and (4), respectively. Standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. The definitions and measurements of the variables are presented in Appendix I.

(representing poor environmental performance) are more likely to have lower prospect theory value. Thus, stocks with higher levels of TCRs will have negative reactions, resulting in higher IRV costs.

Looking at the control variables, we found that large (*Firm Size*) and growing firms (*SG* and *MTB*) with low liquidity (i.e., *LEV*) and poor reporting quality increase stock return volatility. These findings support the prospect theory view that risk-averse investors abstain from investing in risky firms, as high growth, low liquidity and high earning management practices (*FRQ*) expose the firm to added risk. We also found that older firms (*AGE*) operating in a less competitive market (*HHI*) with high income (i.e., *ROA*) and with less volatile market return (i.e. *RET*) enhance companies' financial stability and thus lower IRV. Finally, consistent with the literature, we found that firms operating in a more turbulent environment (*EPU*) and with lower economic growth (*GDP*) are more prone to IRV.

4.3 | Channel analysis

Recent environmentalism scholarship suggests that the corporate environment and business performance relationship is contingent on certain channels (Broadstock et al., 2018; Brooks & Oikonomou, 2018; Chava, 2014; Zaman et al., 2021b). These channels can be internally related to organisational production/revenue generation and/or externally related to the regulatory environment and political leadership ideology. These channels have the potential to influence the TCR and IRV relationship, and therefore it is imperative to consider these channels to develop a better understanding of the TCR and IRV nexus. We have identified four possible channels – revenue generation, financial flexibility, environmental penalties and political leadership ideology – by which TCR may affect IRV. The mechanism of these four channels can also be comprehended through production-based and abatement-based views and are discussed in detail in subsequent sections.

4.3.1 | TCR and IRV: Does revenue generation matter?

The profit-maximisation drive has brought enormous challenges to the environment. This is well evident from the Bhopal tragedy in 1984 (Connors et al., 2013) and the extent of damage caused by the BP oil spill in the Gulf of Mexico in 2010 (Cherry & Sneirson, 2012). Unfortunately, corporations, especially those with a higher level of greenhouse gas (GHG) emissions, still lack a holistic approach towards environmental management and instead are highly driven by profit-maximisation objectives (Broadstock et al., 2018). Although the causal effect of environmental catastrophes on long-run economic growth is irrecoverable even for a significantly longer period (Hsiang et al., 2014), there remains an inherent tension between firms' goals of profit-maximisation and the normative stakeholders' perspective that views the goal of stakeholders as an end in itself, which results in much of the ambiguity underlying environmental sustainability (Joseph, 2012).

Despite the enduring benefits of pollution abatement (i.e., lower business risk, competitive advantage and lower cost of capital, among others) (Gray & Shadbegian, 2004), firms generally prefer reinvestment in capital projects over investing in pollution-reduction projects. Such firms only address the profit-maximisation concerns of specific stakeholders (i.e., shareholders) and fail to address the interest of all other stakeholders (Jain & Zaman, 2020; Zaman et al., 2022b). The reinvestment of revenues in capital projects results in increased production, and thus increases the TCR. On the other hand, the firms that give equal weight to the concerns of all their stakeholders, including the environment and society, invest in abatement activities that result in the reduction of emissions (Cifuentes & Lave, 1993; Zaman et al., 2022b).

Moreover, under the profit-maximisation motive, firms would pursue those projects that have maximum value for shareholders. Since environmental projects are generally considered detrimental to shareholder value, managers have more incentives to focus on financial returns only rather than investing in projects that improve the environment (Zaman et al., 2021b, 2022b). However, prior studies also document a positive relationship between environmental performance and financial performance, suggesting that corporate environmental investments increase shareholder value (Hassel et al., 2005). Thus, under the profit-maximisation perspective, we expect the relationship between TCR and IRV to be more pronounced in firms with higher revenues.

To test the impact of revenue generation on the relationship between TCR and IRV, we split our sample into two subsamples: firms with high and low revenues based on the median values and run our baseline model.

The results are presented in Table 4. Models (1) and (3) confirm our conjecture that a positive association between TCR and IRV is more pronounced ($\beta = 0.033$, $p < 0.001$ and $\beta = 0.031$, $p < 0.01$, respectively) in high revenue-generating firms compared with firms earning lower revenue ($\beta = 0.020$, $p < 0.10$ and $\beta = 0.022$, $p < 0.10$, respectively). This suggests that revenue generation has detrimental effects on the TCR–IRV relationship. Our results remain qualitatively similar using an alternative measure of TCR, i.e. weighted measure of TCR (WTCR) (see Appendix S1).

4.3.2 | TCR and IRV: Does financial flexibility matter?

Whether a reduction in financing costs affects toxic emissions is theoretically ambiguous. Cheaper financing may spur investments and increase production, and increased production without any changes in the production process also augment emissions (Fazzari et al., 1988). Investments to reduce pollution and save energy tend to be large and offer little cost-savings potential (Fowlie et al., 2015), rendering these investments suboptimal for firms. The debt-payment obligation especially restricts firms' financial flexibility, while activities such as GHG emissions reduction tend to be long-term projects that require consistent financing during the course of the project (Myers, 1977). Therefore, a firm with a tight debt-repayment obligation may be unable or may face constraints to acquire additional financing that may help the firm reduce its level of pollution emissions. This is well evident from the findings of Hatakeda et al. (2012), who argue that firms with restricted financial flexibility are likely to refrain from projects that reduce GHG emission.

Firms may also optimally choose not to change harmful behaviour if they expect that the detection probability is low (Shapira & Zingales, 2017). Accordingly, firms facing tighter credit conditions might choose to economise on non-core business functions, such as pollution abatement, to cushion the effects of tighter credit on profits, thereby increasing toxic emissions. There may, however, be countervailing influences. Effective regulatory systems might prevent firms from increasing pollution, and tighter credit might stifle investment and production, reducing toxic emissions. Nonetheless, we expect the TCR–IRV relationship to be more pronounced in financially constrained firms. To test the above contentions, we split our sample into two subsamples: a financial constraint sample and a financial flexibility sample and run our baseline model.

Our results in Table 5 show that the positive association between TCR and IRV is more pronounced ($\beta = 0.044$, $p < 0.001$ and $\beta = 0.060$, $p < 0.01$, respectively) in financially flexible firms compared with financially constrained firms ($\beta = 0.021$, $p < 0.10$ and $\beta = 0.003$, $p < 0.10$, respectively). These results are consistent with the hypothesised argument that financial flexibility may spur additional production without altering production processes, resulting in increased emissions. More specifically, financially flexible firms are more likely to take environmental

TABLE 4 Toxic chemical release and idiosyncratic risk – Results of revenue channel.

	Dependent variable: Idiosyncratic return volatility			
	$IRV_{i,t}^{CAPM}$		$IRV_{i,t}^{3F}$	
	High revenue	**Low revenue**	**High revenue**	**Low revenue**
$TCR_{i,t}$	0.033***	0.020*	0.031***	0.022*
	(0.007)	(0.011)	(0.006)	(0.012)
$IRV_{i,t-1}$	0.139***	0.060*	0.144***	0.112***
	(0.038)	(0.033)	(0.038)	(0.027)
$LEV_{i,t}$	2.368***	−1.741***	1.982***	0.136
	(0.330)	(0.426)	(0.347)	(0.383)
$SG_{i,t}$	0.814***	−0.865***	0.580***	−1.436***
	(0.091)	(0.225)	(0.121)	(0.226)
$MTB_{i,t}$	0.717***	0.605***	0.532***	0.513***
	(0.077)	(0.058)	(0.081)	(0.086)
$FRQ_{i,t}$	0.093**	0.032	0.093	0.090*
	(0.037)	(0.045)	(0.058)	(0.050)
$HHI_{i,t}$	0.120***	0.294***	0.139***	0.500***
	(0.034)	(0.087)	(0.034)	(0.086)
$EPU_{i,t}$	0.119**	0.253***	0.260***	0.259***
	(0.057)	(0.095)	(0.057)	(0.094)
$FCDISP_{i,t}$	4.537***	−1.247	2.529	−2.025***
	(1.299)	(0.862)	(2.035)	(0.589)
$SIZE_{i,t}$	0.059	0.083	−0.087**	0.051
	(0.037)	(0.060)	(0.036)	(0.058)
$ROA_{i,t}$	0.009	−0.006	−0.046***	0.031*
	(0.012)	(0.017)	(0.018)	(0.018)
$GDP_{i,t}$	−0.251***	−0.181***	−0.205***	−0.194***
	(0.015)	(0.025)	(0.020)	(0.021)
$DIV_{i,t}$	0.024	0.054*	0.097***	0.063
	(0.031)	(0.030)	(0.032)	(0.041)
$RET_{i,t}$	−0.134*	−0.548***	−0.195*	−0.436***
	(0.078)	(0.085)	(0.100)	(0.091)
$AGE_{i,t}$	0.178	0.007	0.068	−0.006
	(0.108)	(0.196)	(0.106)	(0.223)
Observations	546	952	546	952
Number of firms	175	205	175	205
Number of instruments	91	88	79	90
AR1 (*p*-value)	0.000	0.000	0.000	0.000
AR2 (*p*-value)	0.726	0.215	0.320	0.308
Hansent test (*p*-value)	0.407	0.320	0.471	0.521
Diff. in Hansen test (*p*-value)	0.829	0.484	0.945	0.880
F-stat (*p*-value)	0.000	0.000	0.000	0.000

Note: This table reports the system GMM regression results for the association between toxic chemical release and idiosyncratic risk across revenue channels, i.e. High revenue vs Low revenue. Models (1) and (2) document the results for the relationship between toxic chemical release and idiosyncratic risk across high (low) revenue, respectively, by capturing idiosyncratic risk via the CAPM model. Models (3) and (4) results are based on an alternative proxy of idiosyncratic risk, i.e. $IRV_{i,t}^{3F}$ calculated as the standard deviation of the residuals from the Fama–French three-factor model. Standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. The definitions and measurements of the variables are presented in Appendix I.

TABLE 5 Toxic chemical release and idiosyncratic risk – Results of financial flexibility channel

	Dependent variable: Idiosyncratic return volatility			
	$IRV_{i,t}^{CAPM}$		$IRV_{i,t}^{3F}$	
	Financial constraint	**Financial flexibility**	**Financial constraint**	**Financial flexibility**
$TCR_{i,t}$	0.021*	0.044***	0.003*	0.060***
	(0.010)	(0.014)	(0.002)	(0.010)
$IRV_{i,t-1}$	0.134***	0.120***	0.111***	0.084**
	(0.038)	(0.045)	(0.003)	(0.041)
$LEV_{i,t}$	2.090***	1.883***	2.153***	0.684*
	(0.493)	(0.607)	(0.055)	(0.389)
$SG_{i,t}$	0.824***	0.696**	0.292***	0.410*
	(0.239)	(0.298)	(0.018)	(0.229)
$MTB_{i,t}$	0.322***	0.859***	0.026***	0.553***
	(0.093)	(0.159)	(0.008)	(0.110)
$FRQ_{i,t}$	0.125*	0.401***	0.187***	0.124**
	(0.073)	(0.084)	(0.004)	(0.057)
$HHI_{i,t}$	0.091**	0.146**	0.057***	0.209***
	(0.040)	(0.063)	(0.007)	(0.052)
$EPU_{i,t}$	0.213**	0.289***	0.024***	0.323***
	(0.084)	(0.097)	(0.005)	(0.069)
$FCDISP_{i,t}$	0.571	−1.019**	1.142***	−0.831**
	(1.481)	(0.479)	(0.082)	(0.332)
$SIZE_{i,t}$	−0.109**	−0.002	0.162***	−0.106*
	(0.054)	(0.073)	(0.003)	(0.063)
$ROA_{i,t}$	−0.081***	−0.140***	−0.011***	−0.101***
	(0.014)	(0.022)	(0.001)	(0.022)
$GDP_{i,t}$	−0.205***	−0.179***	−0.217***	−0.183***
	(0.015)	(0.019)	(0.001)	(0.016)
$DIV_{i,t}$	−0.074	−0.281***	−0.183***	−0.035
	(0.089)	(0.075)	(0.004)	(0.055)
$RET_{i,t}$	−0.664***	−0.242*	−0.488***	0.010
	(0.070)	(0.145)	(0.008)	(0.093)
$AGE_{i,t}$	−1.001***	−0.174	−0.455***	−0.285
	(0.210)	(0.405)	(0.010)	(0.366)
Observations	591	907	591	907
Number of firms	136	178	136	178
Number of instruments	76	80	127	91
AR1 (*p*-value)	0.000	0.000	0.000	0.000
AR2 (*p*-value)	0.213	0.751	0.250	0.758
Hansent test (*p*-value)	0.610	0.447	0.364	0.226
Diff. in Hansen test (*p*-value)	0.241	0.579	0.243	0.522
F-stat (*p*-value)	0.000	0.000	0.000	0.000

Note: This table reports the system GMM regression results for the association between toxic chemical release and idiosyncratic risk across financial flexibility channels, i.e. Financial constraint vs Financial flexibility. Models (1) and (2) document the results for the relationship between toxic chemical release and idiosyncratic risk across Financial constraint (flexibility), respectively, by capturing idiosyncratic risk via the CAPM model. Models (3) and (4) results are based on an alternative proxy of idiosyncratic risk, i.e. $IRV_{i,t}^{3F}$ calculated as the standard deviation of the residuals from the Fama–French three-factor model. Standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. The definitions and measurements of the variables are presented in Appendix I.

initiatives which will then be incorporated by investors while making investment decisions. Our results remain consistent on an alternative measure of TCR, i.e. weighted TCR (WTCR) (see Appendix S1).

4.3.3 | TCR and IRV: Does environmental irresponsibility matter?

Companies are well aware of the fact that better environmental performance can lead to better corporate reputation, which in turn leads to better financial performance (Tang et al., 2018). That is why companies strive hard to establish a reputational advantage by implementing environmentally responsible measures. The consideration of CSR in formulating a business strategy has helped corporations to minimise the tendency to resort to environmentally irresponsible behaviour (Belal et al., 2015; Jain & Zaman, 2020; Zaman et al., 2022b). However, big corporations never fall short of giving credible reasons for societies or the general public to criticise them for their environmental misconduct or irresponsibility (Jain & Zaman, 2020). The BP oil spill in the Gulf of Mexico in 2010, Shell in the Niger Delta, and Volkswagen's cheating on pollution emissions in 2015 are obvious examples of environmental irresponsibility. Such environmentally irresponsible events have a considerable negative impact not only on the reputation of a firm but also have a considerable negative impact on firm cash flows and market value (Lin et al., 2016; Zaman et al., 2021a, 2021c).

Moreover, large fines due to the companies' violation of environmental regulations reduce firm value (Karpoff et al., 2005; Köster & Pelster, 2017). This may encourage firms to invest in pollution control. Furthermore, investors may pressure firms to reduce toxic emissions due to their preference for a cleaner environment (Chava, 2014; Heinkel et al., 2001; Zaman et al., 2021b, 2021c). Identifying a causal link running from a firm's financing conditions to its toxic emissions is empirically challenging, particularly since unobservable heterogeneity across firms, such as the expansion of output (Fazzari et al., 1988), managers' focus on CSR (Cheng et al., 2013) or regulators' ability to enforce and monitor regulation (Evans & Stafford, 2019), shape a firm's release of toxic chemicals and its financing condition (Kubik et al., 2011). Causality may even be reversed and heavy polluting firms could become financially constrained in the case of large monetary fines due to violations of environmental laws (Cohn & Deryugina, 2018). Therefore, we expect the TCR–IRV relationship to be more pronounced in firms with higher environmental penalties. To test the foregoing contention, we split our sample into two subsamples: a high environmental penalties sample and a low environmental penalties sample (based on median penalty amounts) and run our baseline model.

The results are presented in Table 6. We find that the TCR–IRV relationship is positive and significant in both subsamples, indicating that higher IRV exhibits investors' reaction to the awarding the penalties to pollutant firms irrespective of the size of the penalty. We also employ weighted TCR (WTCR) and the results, presented in Appendix S1, provide consistent evidence.

4.4 | Additional analysis

4.4.1 | TCR and IRV: Does political leadership ideology matter?

A CNN Business report suggests that stock market performance is conditioned on political ideology across US presidencies (Egan et al., 2019). We have seen a stronger stock market performance (i.e. +64%) during the first 743 days of Democratic presidents' tenure compared with (i.e. −16%) during the Republican period (Egan et al., 2019; Zaman et al., 2021b).

TABLE 6 Toxic chemical release and idiosyncratic risk – Results of environmental penalties channel

	Dependent variable: Idiosyncratic return volatility			
	$IRV_{i,t}^{CAPM}$		$IRV_{i,t}^{3F}$	
	High environmental penalties	**Low environmental penalties**	**High environmental penalties**	**Low environmental penalties**
$TCR_{i,t}$	0.007***	0.073***	0.005***	0.070***
	(0.002)	(0.008)	(0.002)	(0.008)
$IRV_{i,t-1}$	0.122***	0.147***	0.122***	0.108***
	(0.018)	(0.036)	(0.023)	(0.031)
$LEV_{i,t}$	1.484***	1.409***	1.564***	0.571
	(0.188)	(0.418)	(0.230)	(0.391)
$SG_{i,t}$	0.359***	0.473**	0.644***	0.599***
	(0.051)	(0.213)	(0.075)	(0.215)
$MTB_{i,t}$	0.074***	0.678***	0.157***	0.364***
	(0.025)	(0.087)	(0.055)	(0.072)
$FRQ_{i,t}$	0.249***	0.034	0.215***	0.115***
	(0.015)	(0.043)	(0.025)	(0.037)
$HHI_{i,t}$	0.081***	0.217***	0.114***	0.162***
	(0.018)	(0.040)	(0.030)	(0.031)
$EPU_{i,t}$	0.538***	0.047	0.414***	0.053
	(0.034)	(0.050)	(0.053)	(0.056)
$FCDISP_{i,t}$	0.910**	2.076***	1.494**	2.265***
	(0.437)	(0.637)	(0.699)	(0.639)
$SIZE_{i,t}$	−0.044*	0.062*	−0.093***	0.055
	(0.025)	(0.035)	(0.035)	(0.035)
$ROA_{i,t}$	0.056***	−0.078***	−0.000	−0.068***
	(0.014)	(0.011)	(0.016)	(0.012)
$GDP_{i,t}$	−0.190***	−0.283***	−0.214***	−0.232***
	(0.010)	(0.020)	(0.013)	(0.016)
$DIV_{i,t}$	−0.074**	−0.040	0.037	−0.041
	(0.028)	(0.036)	(0.026)	(0.032)
$RET_{i,t}$	−0.324***	−0.347***	−0.258***	−0.434***
	(0.046)	(0.076)	(0.043)	(0.061)
$AGE_{i,t}$	−0.118**	−0.137	−0.229**	−0.328***
	(0.048)	(0.140)	(0.087)	(0.123)
Observations	134	1,364	134	1,364
Number of firms	65	221	65	221
Number of instruments	86	103	76	103
AR1 (*p*-value)	0.000	0.000	0.000	0.000
AR2 (*p*-value)	0.944	0.753	0.696	0.273
Hansent test (*p*-value)	0.277	0.206	0.222	0.257
Diff. in Hansen test (*p*-value)	0.390	0.639	0.503	0.772
F-stat (*p*-value)	0.000	0.000	0.000	0.000

Note: This table reports the system GMM regression results for the association between toxic chemical release and idiosyncratic risk across environmental penalties channels, i.e. High environmental penalties vs Low environmental penalties. Models (1) and (2) document the results for the relationship between toxic chemical release and idiosyncratic risk across High (Low) environmental penalties, respectively, by capturing idiosyncratic risk via the CAPM model. Models (3) and (4) results are based on an alternative proxy of idiosyncratic risk, i.e. $IRV_{i,t}^{3F}$ calculated as the standard deviation of the residuals from the Fama–French three-factor model. Standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. The definitions and measurements of the variables are presented in Appendix I.

The difference in stock market performance can be attributed to the heterogeneity among the political ideologies of the US presidents that drives key changes in federal institutions' policies during the initial days of their presidency (Gizzi, 2012; Ozymy & Jarrell, 2015). For example, in the US, the EPA has the power to monitor firms' environmental compliance and to impose penalties for environmental irregularities. Despite having a consistent set of regulations and policies across EPA operations, we have witnessed very different philosophies on managing the EPA during Democratic and Republican administrations (Westmoreland, 2010; Zaman et al., 2021b). Some scholars have also suggested that enforcement of environmental laws is dependent on political pressure (Buttel & Flinn, 1978; Holland et al., 2009; Zaman et al., 2021b). On one hand, the Republican-led EPA was characterised as ineffective and vigilantly protective of business interests over the environment (Goldenberg, 2009). In contrast, the Democratic-led EPA was branded as a supporter of the extreme anti-industry agenda, in which 'environmental violations' were dealt with through severe enforcement (Ozymy & Jarrell, 2015). Concomitantly, the Democratic administration was focused on a 'Green America' concept and promoted policies and rules to deter environmental anomalies (e.g., the incorporation of a GHG emissions standard under the Clean Air Act 2010 and the Clean Power Plan).

We argue that heterogeneity in political leadership ideology promotes compliance related to environmental policies. More specifically, political leadership's interest in environmentalism inspires companies' leadership to adopt environmentally friendly processes which result in low TCR. Subsequently, the lower TCR reduces litigation risk and sends a positive signal to the market – making it less prone to IRV. We expect the positive association between TCR and IRV to be more pronounced during a Republican presidency compared with a Democratic presidency. To examine this, we split our sample into two: Republican presidency tenure (2001–2008 and 2017–2018) and Democratic presidency tenure (2009–2016).

Our results in Table 7 confirm this conjecture. As we see in Models (1) and (3), the TCR–IRV nexus is more pronounced ($\beta = 0.058$, $p < 0.001$ and $\beta = 0.069$, $p < 0.01$, respectively) for firms during a Republican presidency compared with firms during a Democratic presidency ($\beta = 0.016$ $p > 0.05$ and $\beta = 0.014$, $p > 0.05$, respectively). These results suggest that political leadership ideology matters for companies in reducing TCR.

4.4.2 | TCR and IRV: Do market states matter?

Finally, we examine how the reaction of buy-and-hold investors in the market affects the causal relation between TCR and IRV.[4] To capture the buy-and-hold investors' reaction, we measure market states as proposed by Cooper et al. (2004). The market is in a 'UP' state when the lagged three-year market return is positive, while a 'DOWN' state occurs when the three-year lagged market return is negative.

Environmentally irresponsible events impede firm cash flows and market value (Lin et al., 2016; Zaman et al., 2022a) and investors, especially the buy-and-hold investors, react to higher TCR reporting, considering it detrimental to their investment, by causing a DOWN trend in the market and thus increasing IRV; whereas the lower TCR reporting results in an UP market trend and results in lower IRV of the firm. According to our results, as reported in Table 8, the relation between TCR and IRV is more pronounced in the DOWN market state ($\beta = 0.015$, $p < 0.05$ and $\beta = 0.015$, $p < 0.05$, respectively). These results suggest that higher TCR triggers bearish sentiments in the market and thus causes higher IRV.

[4]We are thankful to an anonymous reviewer for making us think in this direction.

4.5 | Sensitivity analyses

4.5.1 | Exogenous shock and nonlinearity in the TCR–IRV nexus

Prior studies have reported a shift in investors' opinions during the global financial crisis period (2008) due to the increased level of risk (Köster & Pelster, 2017; Zaman et al., 2021b). During financial crises, pessimistic investors sell their stock, which causes diminishing stock prices, loss of capital and depletion in firm market value (Bartram & Bodnar, 2009; Wang et al., 2009). However, studies in finance scholarship hold divergent opinions regarding the impact of the financial crisis on stock returns. On one hand, Bartram and Bodnar (2009) documented a significant decline in firm value during the financial crisis. On the other hand, Zaman et al. (2021c) found no effect of the financial crisis on corporate misconduct and the stock price–crash nexus. Taken together, there might be a probability that the global financial crisis affected the TCR–IRV nexus. Therefore, following Jain and Zaman (2020), we excluded 2008 from our sample and re-estimated Equation (9).

The results reported in Models (1)–(4) of Table 9 show qualitatively similar results to our baseline, suggesting our results are not driven by the financial crisis.

Similarly, some studies in CSR–firm performance scholarship have documented a nonlinear relationship (Uotila et al., 2009). Accordingly, we checked for a nonlinear relationship, especially a U-shaped relationship. Models (1)–(4) in Table 10 report an insignificant result for the quadratic value of TCR (i.e., TCR and WTCR) and suggests that the relationship between TRC and idiosyncratic risk is linear.

4.6 | Endogeneity concerns

The TCR–IRV relationship may suffer from endogeneity problems from at least two sources. First, although we have included a list of control variables that prior studies have identified to have effects on both TCR and IRV, we still acknowledge that this might not be an exhaustive list of all potential control variables. Thus, our study might have omitted variables bias. Second, the TCR–IRV relationship might well be bidirectional – meaning that current IRV might also determine future environmental performance. For example, current or past IRV might pose financial constraints and leave such firms with more incentives to ignore environmentalism in the future. This might cause reverse causality in our estimations.

Although we have estimated our baseline model using the dynamic GMM estimator that accounts for endogeneity arising out of omitted variables and reverse causality (Nadeem et al., 2019), Wintoki et al. (2012) argue that finding a valid and exogenous instrument remains a gold standard in dealing with endogeneity. To check the robustness of our results, we follow Zaman et al. (2021c) and employ an alternate instrumental variable (IV) estimator, namely a two-stage least square fixed effect estimator (FE-2SLS). The challenge with any IV estimator is to find the suitable instrumental variable(s) that satisfy (1) the relevance criteria, which means correlated with the independent variable, and (2) the exclusion restriction, which means uncorrelated with the error terms (Larcker & Rusticus, 2010). Due to a lack of suitable instruments, the use of industry averages is quite common (Larcker & Rusticus, 2010). Therefore, we use the industry average TCR as the valid instrumental variable. The results are presented in Table 11. Once again, we find a significant positive relationship between TCR and IRV, indicating that our results are robust to endogeneity concerns. The instrument validity tests presented at the bottom of Table 11 confirm that our instrument was valid and correctly identified.

TABLE 7 Toxic chemical release and idiosyncratic risk – Does political leadership ideology matter?

	Dependent variable: Idiosyncratic return volatility			
	$IRV_{i,t}^{CAPM}$		$IRV_{i,t}^{3F}$	
	Democratic president	Republican president	Democratic president	Republican president
$TCR_{i,t}$	0.016**	0.058***	0.014**	0.069***
	(0.006)	(0.021)	(0.007)	(0.026)
$IRV_{i,t-1}$	0.067**	0.451***	0.054***	0.518***
	(0.028)	(0.080)	(0.018)	(0.095)
$LEV_{i,t}$	2.090***	1.883***	2.153***	0.684*
	(0.493)	(0.607)	(0.055)	(0.389)
$SG_{i,t}$	0.824***	0.696**	0.292***	0.410*
	(0.239)	(0.298)	(0.018)	(0.229)
$MTB_{i,t}$	0.322***	0.859***	0.026***	0.553***
	(0.093)	(0.159)	(0.008)	(0.110)
$FRQ_{i,t}$	0.125*	0.401***	0.187***	0.124**
	(0.073)	(0.084)	(0.004)	(0.057)
$HHI_{i,t}$	−0.051	0.117**	−0.103***	0.100
	(0.037)	(0.058)	(0.035)	(0.067)
$EPU_{i,t}$	0.043	0.783***	0.158***	0.792***
	(0.054)	(0.180)	(0.045)	(0.199)
$FCDISP_{i,t}$	−1.179***	−10.336***	−0.831***	−11.772***
	(0.358)	(3.472)	(0.255)	(3.077)
$SIZE_{i,t}$	0.101**	−0.223***	0.028	−0.246***
	(0.039)	(0.075)	(0.038)	(0.088)
$ROA_{i,t}$	−0.040***	−0.028	−0.037***	−0.196***
	(0.008)	(0.022)	(0.008)	(0.038)
$GDP_{i,t}$	−0.166***	−0.284***	−0.179***	−0.227***
	(0.015)	(0.029)	(0.012)	(0.043)
$DIV_{i,t}$	0.069	0.225**	0.123***	0.074
	(0.054)	(0.091)	(0.029)	(0.152)
$RET_{i,t}$	−0.539***	0.145	−0.385***	−0.640**
	(0.054)	(0.165)	(0.045)	(0.258)
$AGE_{i,t}$	−0.580**	0.323**	−0.511***	0.357*
	(0.225)	(0.136)	(0.171)	(0.204)
Observations	848	650	848	650
Number of firms	199	184	199	184
Number of instruments	119	65	121	54
$AR1$ (p-value)	0.000	0.000	0.000	0.000
$AR2$ (p-value)	0.214	0.164	0.433	0.120
Hansent test (p-value)	0.569	0.229	0.535	0.465
Diff. in Hansen test (p-value)	0.818	0.180	0.508	0.557
F-stat (p-value)	0.000	0.000	0.000	0.000

Note: This table reports the system GMM regression results for the association between toxic chemical release and idiosyncratic risk across political leadership ideologies, i.e. Democratic president vs Republican president. Models (1) and (2) document the results for the relationship between toxic chemical release and idiosyncratic risk across Democratic (Republican) presidents' periods, respectively, by capturing idiosyncratic risk via the CAPM model. Models (3) and (4) results are based on an alternative proxy of idiosyncratic risk, i.e. $IRV_{i,t}^{3F}$ calculated as the standard deviation of the residuals from the Fama–French three-factor model. Standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. The definitions and measurements of the variables are presented in Appendix I.

TABLE 8 Toxic chemical release and idiosyncratic risk – Do market states matter?

	Dependent variable: Idiosyncratic return volatility			
	$IRV^{CAPM}_{i,t}$		$IRV^{3F}_{i,t}$	
	UP market	**DOWN market**	**UP market**	**DOWN market**
$TCR_{i,t}$	0.015**	0.057***	0.015**	0.070***
	(0.006)	(0.021)	(0.007)	(0.026)
$IRV_{i,t-1}$	0.065**	0.452***	0.056***	0.520***
	(0.028)	(0.080)	(0.018)	(0.095)
$LEV_{i,t}$	−0.046	−5.567***	0.580*	−4.850***
	(0.497)	(0.596)	(0.320)	(0.984)
$SG_{i,t}$	−0.537***	2.558***	−0.322***	2.014***
	(0.142)	(0.411)	(0.085)	(0.569)
$MTB_{i,t}$	0.121**	0.338***	−0.071	0.131*
	(0.059)	(0.046)	(0.045)	(0.070)
$FRQ_{i,t}$	0.103**	0.097	0.040**	−0.035
	(0.046)	(0.111)	(0.016)	(0.148)
$HHI_{i,t}$	−0.051	0.117**	−0.103***	0.100
	(0.037)	(0.058)	(0.035)	(0.067)
$EPU_{i,t}$	0.043	0.783***	0.158***	0.792***
	(0.054)	(0.180)	(0.045)	(0.199)
$FCDISP_{i,t}$	−1.179***	−10.336***	−0.831***	−11.772***
	(0.358)	(3.472)	(0.255)	(3.077)
$SIZE_{i,t}$	0.101**	−0.223***	0.028	−0.246***
	(0.039)	(0.075)	(0.038)	(0.088)
$ROA_{i,t}$	−0.088***	−0.100***	−0.064***	−0.071***
	(0.010)	(0.011)	(0.011)	(0.010)
$GDP_{i,t}$	−0.290***	−0.295***	−0.203***	−0.211***
	(0.014)	(0.015)	(0.012)	(0.012)
$DIV_{i,t}$	−0.265***	−0.340***	−0.005	−0.041
	(0.045)	(0.043)	(0.033)	(0.034)
$RET_{i,t}$	−0.172***	−0.195***	−0.197***	−0.189***
	(0.063)	(0.066)	(0.048)	(0.048)
$AGE_{i,t}$	0.192	0.164	−0.359***	−0.316***
	(0.120)	(0.125)	(0.118)	(0.117)
Observations	750	748	750	748
Number of firms	190	193	190	193
Number of instruments	119	65	121	54
$AR1$ (p-value)	0.000	0.000	0.000	0.000
$AR2$ (p-value)	0.214	0.164	0.433	0.120
Hansent test (p-value)	0.569	0.229	0.535	0.465
Diff. in Hansen test (p-value)	0.818	0.180	0.508	0.557
F-stat (p-value)	0.000	0.000	0.000	0.000

Note: This table reports the system GMM regression results for the association between toxic chemical release and idiosyncratic risk across market conditions, i.e. UP market vs DOWN market. Models (1) and (2) document the results for the relationship between toxic chemical release and idiosyncratic risk across the UP (DOWN) market, respectively, by capturing idiosyncratic risk via the CAPM model. Models (3) and (4) results are based on an alternative proxy of idiosyncratic risk, i.e. $IRV^{3F}_{i,t}$ calculated as the standard deviation of the residuals from the Fama–French three-factor model. Standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. The definitions and measurements of the variables are presented in Appendix I.

TABLE 9 Toxic chemical release and idiosyncratic risk – Excluding the global financial crisis (GFC) 2008.

	Dependent variable: Idiosyncratic return volatility			
	$IRV_{i,t}^{CAPM}$		$IRV_{i,t}^{3F}$	
	Global financial crisis (GFC) period – 2008 exclusion			
	(1)	(2)	(3)	(4)
$TCR_{i,t}$	0.025**		0.027***	
	(0.012)		(0.008)	
$WTCP_{i,t}$		0.013***		0.014***
		(0.004)		(0.003)
$IRV_{i,t-1}$	0.266***	0.257***	0.160***	0.134***
	(0.031)	(0.028)	(0.030)	(0.031)
$LEV_{i,t}$	1.623***	1.340***	1.876***	2.728***
	(0.383)	(0.412)	(0.393)	(0.418)
$SG_{i,t}$	0.452**	0.115	0.405**	0.354*
	(0.195)	(0.188)	(0.186)	(0.195)
$MTB_{i,t}$	0.126*	0.253***	0.115*	0.160***
	(0.066)	(0.063)	(0.060)	(0.059)
$FRQ_{i,t}$	0.151***	0.232***	0.255***	0.220***
	(0.044)	(0.040)	(0.029)	(0.036)
$HHI_{i,t}$	0.024	0.064	0.091**	0.075**
	(0.050)	(0.043)	(0.045)	(0.038)
$EPU_{i,t}$	−0.120*	−0.077	0.052	0.162***
	(0.069)	(0.057)	(0.059)	(0.057)
$FCDISP_{i,t}$	−1.193*	−0.868	−1.324**	−2.072***
	(0.653)	(0.549)	(0.616)	(0.603)
$SIZE_{i,t}$	0.093***	0.127***	0.119***	0.016
	(0.033)	(0.028)	(0.029)	(0.031)
$ROA_{i,t}$	−0.046***	−0.063***	−0.088***	−0.089***
	(0.014)	(0.012)	(0.011)	(0.011)
$GDP_{i,t}$	−0.073***	−0.109***	−0.098***	−0.097***
	(0.016)	(0.012)	(0.013)	(0.013)
$DIV_{i,t}$	0.073	−0.049	−0.116***	−0.092***
	(0.048)	(0.035)	(0.033)	(0.034)
$RET_{i,t}$	−0.693***	−0.640***	−0.703***	−0.641***
	(0.064)	(0.047)	(0.051)	(0.053)
$AGE_{i,t}$	−0.378***	−0.262**	0.062	0.023
	(0.145)	(0.128)	(0.102)	(0.103)
Observations	1,396	1,409	1,396	1,409
Number of firms	220	220	220	220
Number of instruments	91	103	99	100
AR1 (*p*-value)	0.000	0.000	0.000	0.000
AR2 (*p*-value)	0.981	0.863	0.108	0.177
Hansent test (*p*-value)	0.402	0.394	0.370	0.367
Diff. in Hansen test (*p*-value)	0.479	0.445	0.152	0.904
F-stat (*p*-value)	0.000	0.000	0.000	0.000

Note: This table reports the system GMM regression results for the association between toxic chemical release and idiosyncratic risk by excluding the global financial crisis (GFC) 2008 period. The results for TCR with both proxies of IRV, i.e., IRVCAPM and IRV3F, are presented in Models (1) and (3), while the results for weighted TCRs (WTCR) with IRV are shown in Models (2) and (4), respectively. Standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. The definitions and measurements of the variables are presented in Appendix I.

TABLE 10 Toxic chemical release and idiosyncratic risk – Results of nonlinearity test

	Dependent variable: Idiosyncratic return volatility			
	$IRV_{i,t}^{CAPM}$		$IRV_{i,t}^{3F}$	
	(1)	**(2)**	**(3)**	**(4)**
$TCR_{i,t}$	0.050***		0.038***	
	(0.010)		(0.007)	
$TCR_{i,t}^2$	0.000		0.000	
	(0.000)		(0.000)	
$WTCR_{i,t}$		0.026***		0.018***
		(0.003)		(0.003)
$WTCR_{i,t}^2$		0.000		0.000
		(0.000)		(0.000)
$IRV_{i,t-1}$	0.036	0.009	0.025	0.002
	(0.032)	(0.032)	(0.027)	(0.027)
$LEV_{i,t}$	3.328***	3.949***	2.386***	2.685***
	(0.451)	(0.492)	(0.330)	(0.323)
$SG_{i,t}$	0.700***	0.575***	0.835***	0.488***
	(0.197)	(0.202)	(0.195)	(0.183)
$MTB_{i,t}$	0.630***	0.559***	0.271***	0.303***
	(0.083)	(0.086)	(0.063)	(0.069)
$FRQ_{i,t}$	0.309***	0.318***	0.254***	0.275***
	(0.054)	(0.060)	(0.035)	(0.039)
$HHI_{i,t}$	0.208***	0.197***	0.131***	0.105***
	(0.044)	(0.042)	(0.029)	(0.028)
$EPU_{i,t}$	0.302***	0.377***	0.274***	0.305***
	(0.050)	(0.055)	(0.051)	(0.049)
$FCDISP_{i,t}$	−1.637***	−0.446	−0.914**	−0.688
	(0.591)	(0.491)	(0.449)	(0.468)
$SIZE_{i,t}$	−0.104***	−0.128***	−0.077***	−0.085***
	(0.035)	(0.038)	(0.027)	(0.027)
$ROA_{i,t}$	−0.065***	−0.115***	−0.061***	−0.073***
	(0.013)	(0.014)	(0.011)	(0.010)
$GDP_{i,t}$	−0.255***	−0.264***	−0.197***	−0.205***
	(0.014)	(0.015)	(0.012)	(0.013)
$DIV_{i,t}$	0.015	−0.176***	−0.007	−0.042
	(0.035)	(0.041)	(0.037)	(0.035)
$RET_{i,t}$	−0.012	−0.146*	−0.248***	−0.242***
	(0.092)	(0.085)	(0.076)	(0.069)
$AGE_{i,t}$	−0.200	−0.425***	−0.359***	−0.299**
	(0.136)	(0.142)	(0.124)	(0.121)
Observations	1,498	1,511	1,498	1,511
Number of firms	222	222	222	222
Number of instruments	111	111	112	112
AR1 (*p*-value)	0.000	0.000	0.000	0.000
AR2 (*p*-value)	0.306	0.821	0.428	0.565
Hansent test (*p*-value)	0.209	0.222	0.230	0.335
Diff. in Hansen test (*p*-value)	0.826	0.342	0.959	0.964
F-stat (*p*-value)	0.000	0.000	0.000	0.000

Note: This table reports the nonlinearity test results for the association between toxic chemical release and idiosyncratic risk. The results for TCR with both proxies of IRV, i.e., IRVCAPM and IRV3F, are presented in Models (1) and (3), while the results for weighted TCRs (WTCR) with IRV are shown in Models (2) and (4), respectively. Standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. The definitions and measurements of the variables are presented in Appendix I.

TABLE 11 Toxic chemical release and idiosyncratic risk – Results of fixed-effect two-stage least square

	Dependent variable: Idiosyncratic return volatility			
	$IRV^{CAPM}_{i,t}$		$IRV^{3F}_{i,t}$	
	(1)	(2)	(3)	(4)
$TCR_{i,t}$	0.010*** (0.003)		0.009*** (0.002)	
$WTCR_{i,t}$		0.107*** (0.037)		0.092*** (0.033)
$IRV_{i,t-1}$	0.039 (0.033)	0.039 (0.031)	0.011 (0.027)	0.009 (0.027)
$LEV_{i,t}$	1.137** (0.512)	0.998** (0.493)	1.445*** (0.540)	1.481*** (0.510)
$SG_{i,t}$	0.001 (0.130)	0.044 (0.131)	0.118 (0.137)	0.126 (0.136)
$MTB_{i,t}$	−0.198 (0.180)	−0.139 (0.168)	−0.399* (0.222)	−0.465** (0.219)
$FRQ_{i,t}$	0.136*** (0.048)	0.136*** (0.045)	0.076* (0.040)	0.078* (0.040)
$HHI_{i,t}$	0.136** (0.069)	0.072 (0.061)	0.065 (0.065)	0.025 (0.063)
$EPU_{i,t}$	−0.230** (0.098)	−0.212** (0.099)	−0.137 (0.096)	−0.158 (0.098)
$FCDISP_{i,t}$	1.370 (1.348)	1.370 (1.300)	0.250** (0.113)	0.254** (0.109)
$SIZE_{i,t}$	−0.427*** (0.099)	−0.359*** (0.096)	−0.386*** (0.084)	−0.345*** (0.081)
$ROA_{i,t}$	0.050*** (0.018)	0.045** (0.018)	0.038** (0.017)	0.036** (0.017)
$GDP_{i,t}$	−0.286*** (0.053)	−0.262*** (0.047)	−0.203*** (0.044)	−0.210*** (0.041)
$DIV_{i,t}$	0.002 (0.053)	−0.026 (0.048)	−0.037 (0.049)	−0.047 (0.047)
$RET_{i,t}$	0.186 (0.449)	−0.082 (0.392)	−0.177 (0.401)	−0.107 (0.354)
$AGE_{i,t}$	−0.017 (0.088)	−0.057 (0.093)	0.017 (0.091)	−0.011 (0.096)
Observations	1,475	1,488	1,475	1,488
Centred R^2	0.115	0.130	0.192	0.182
Number of firms	199	199	199	199
Number of instruments	35	35	35	35
F-stat (p-value)	0.000	0.000	0.000	0.000
VALIDITY OF INSTRUMENTS				
(i) F-test for excluded instruments in first stage				
Sanderson-Sindmeijer	4.710 (0.000)	4.930 (0.000)	6.860 (0.000)	6.650 (0.000)

TABLE 11 (Continued)

	Dependent variable: Idiosyncratic return volatility			
	$IRV_{i,t}^{CAPM}$		$IRV_{i,t}^{3F}$	
	(1)	**(2)**	**(3)**	**(4)**
(ii) Under-identification test				
Kleibergen-Paap rk LM statistics	3.680 (0.961)	3.336 (0.972)	5.070 (0.886)	4.318 (0.932)
(iii) Week identification test				
Cragg-Donald Wald *F*-stat	2.210	4.413	2.322	5.229
Stock-Yogo Weak ID test				
10% max IV size	31.11	31.11	31.11	31.11
15% max IV size	17.06	17.06	17.06	17.06
20% max IV size	12.25	12.25	12.25	12.25
25% max IV size	9.77	9.77	9.77	9.77
VALIDITY OF THE OVER-IDENTIFYING RESTRICTIONS				
(iv) Over-identification test				
Hansen J statistic	27.187 (0.000)	27.038 (0.000)	26.287 (0.000)	23.435 (0.000)

Note: This table reports the fixed-effect two-stage least square (FE-2SLS) estimator results for the association between toxic chemical release and idiosyncratic risk. The results for TCR with both proxies of IRV, i.e., IRVCAPM and IRV3F, are presented in Models (1) and (3), while the results for weighted TCRs (WTCR) with IRV are shown in Models (2) and (4), respectively. Standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. The definitions and measurements of the variables are presented in Appendix I.

5 | CONCLUSION

There is growing stakeholder pressure and consumer awareness around socially responsible business activities, particularly related to firms' adverse impacts on the environment that could threaten their reputation and, at the worst, cause them to lose their licence to operate (Zaman et al., 2022b). As a result, corporate environmentalism has become the main agenda item for many businesses worldwide. Prior studies have well documented evidence that firms' better environmental performance has positive effects on their financial performance. However, there is scant evidence on how firms' poor environmental performance or environmental liabilities are detrimental to firm value, especially their impacts on idiosyncratic return volatility (IRV). We fill this gap by examining the direct relationship between environmental liabilities, measured as firms' toxic chemical release (TCR), and IRV. Based on prospect theory, we find a significant positive relationship between TCR and IRV, suggesting that environmental liabilities significantly increase IRV. We also find three possible channels by which TCR might affect IRV, namely revenue generation, financial flexibility and environmental irresponsibility. Our results are robust to additional analyses and endogeneity concerns. The results have important implications for different stakeholders, including management and shareholders, that firms' TCR is not only detrimental to firm value through wastage and inefficient use of resources but also increases IRV, which has significant implications for shareholder value.

Our study has important policy implications. As corporate environmentalism has gained momentous pressure from various stakeholders worldwide, firms are under strict media scrutiny and public pressure to manage their environmental impacts. Not only this, but if environmental impacts go unnoticed, they could have adverse financial implications – one such implication is higher IRV. Thus, a significant positive relationship between TCR and IRV would inform managers regarding corporate environmental policies in the sense that reduced TCR could result in lower financial risk.

We also acknowledge some limitations of our study that provide worthwhile avenues for future research. First, our study is limited to the US context and, considering the context-dependency of TCR and IRV, we recommend that future studies explore this relationship beyond the US setting. Second, although we have focused on a more objective measure of environmental performance, i.e., TCR, considering the recent trend of corporate environmental innovation to reduce TCR, we recommend that future studies empirically test the environmental innovation and IRV nexus to explore whether and how investors react to environmental innovation. Finally, although we have identified and explored four possible channels that affect the TCR–IRV nexus, our analysis fell short in capturing the cost of finance. Cost of finance is the key implication of the TCR–IRV nexus, as the stigma associated with high TCR significantly increases the cost of finance. Hence, firms under pressure from lenders might adopt environmentalism strategies to keep TCR in check, resulting in lower IRV. Therefore, it is worthwhile for future researchers to unlock this important channel.

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SUPPORTING INFORMATION

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APPENDIX I

Definitions and measurements of variables

Variable	Symbol	Definition/Measurement
Toxic chemical releases	$TCR_{i,t}$	The sum of toxic chemical releases by firm *i* in year *t* scaled by the firm's total assets, adjusted by the corresponding industry-year average value and standardised using the logarithmic transformation
Weighted toxic chemical releases	$WTCR_{i,t}$	The sum of toxic chemical releases by firm *i* in year *t* scaled by the firm's total assets, multiplied by the weight of the toxicity of each chemical, adjusted by the corresponding industry-year average value and standardised using the logarithmic transformation
Leverage	$LEV_{i,t}$	Total debt to total asset ratio for firm *i* in year *t*
Sales growth	$SG_{i,t}$	The rate of change in sales of firm *i* in year *t*
Market-to-book value	$MTB_{i,t}$	Market-to-book value of firm *i* in year *t*
Financial reporting quality	$FRQ_{i,t}$	We use the model in Kothari et al. (2005) to estimate the financial reporting quality for firm *i* in year *t* and use the absolute value of accruals, so that a lower value indicates better financial reporting quality
Market competition	$HHI_{i,t}$	Herfindahl-Hirschman Index, a measure of market share of firm *i* in relation to its corresponding industry in year *t*.
Economic policy uncertainty	$EPU_{i,t}$	The annualised values of the US economic policy uncertainty index downloaded from the following website: https://www.policyuncertainty.com/index.html
Analyst forecast dispersion	$FCDISP_{i,t}$	Analyst forecast dispersion is the standard deviation of analysts' earnings per share (EPS) forecasts for the currently unreported fiscal year (referred to as FY1 by I/B/E/S) scaled by the absolute value of mean EPS forecast for the same fiscal year, measured during the last month of calendar quarter Q0 – to be exact, on the Thursday before the third Friday of that month, termed 'Statistical Period Date' by I/B/E/S. The data are obtained from I/B/E/S.
Firm size	$SIZE_{i,t}$	The log of total assets for firm *i* in year *t*.
Firm profitability	$ROA_{i,t}$	Return on assets of firm *i* in year *t*.

Variable	Symbol	Definition/Measurement
Gross domestic product growth	$GDP_{i,t}$	The annual growth in gross domestic product of the US, downloaded from the World Bank database: https://data.worldbank.org/
Dividend payout	$DIV_{i,t}$	Dividend payout by firm *i* in year *t*.
Stock return	$RET_{i,t}$	Annualised stock return of firm *i* in year *t*.
Firm age	$AGE_{i,t}$	The age of firm *i* from its founding year to year *t*.