





ARTICLE



<https://doi.org/10.1057/s41599-025-04483-x>

OPEN

Technology adoption and extreme stock risk: Evidence from digital tax reform in China

Kangqi Jiang¹ , Xiaofeng Chen¹, Jiayun Li¹ & Mengling Zhou² 

The digital reform of tax administration occupies a pivotal role due in enhancing governmental governance capabilities in the digital era. We consider China's "Golden Tax Phase III" project (GTP3P) as a representative digital reform of tax administration. Utilizing a multi-phase DID model, we analyze the impact of GTP3P on the stock market, with a particular focus on corporate stock price crash risk (SPCR). Our findings reveal a significant reduction in SPCR subsequent to the GTP3P implementation. After performing parallel trend test, dealing with endogeneity concerns, and estimating the double machine learning model, we confirm baseline findings again. Heterogeneity analysis indicates that the influences of GTP3P on SPCR is asymmetrical. In the mechanism analysis, we verified that tax administration reform significantly enhances information disclosure, which guarantees a reduction of SPCR. Finally, we perform a further analysis examining investors' holding preferences. Contrary to expectations, we observed a decrease in stock liquidity and the shareholding of long-term and fund investors, attributed to the escalated tax burden and diminishing business benefits post-reform. This study presents an innovative perspective on the corporate implications of digitization.

¹ Business School, Shantou University, Shantou, China. ² School of Credit Management, Guangdong University of Finance, Guangzhou, China. ✉email: july_zml@126.com

Introduction

The stock market, often regarded as the “barometer” of economic activity, constitutes a fundamental component of the financial systems in economies worldwide. It performs critical functions, including optimizing the allocation of capital and risk, transmitting and reflecting market information, and addressing the financing needs of enterprises while catering to the investment demands of individuals (Arestis et al. 2001; Chen et al. 2023b). Traditional financial development theory posits that financial development serves as a catalyst for economic growth. However, global financial development practices have increasingly revealed vulnerabilities in financial systems, accompanied by a notable rise in the frequency and intensity of financial market shocks (Wang et al. 2023).

Over the past decade, abnormal stock market fluctuations have become more frequent (Chen et al. 2023a; Jiang et al. 2022b; Fan and Zhang, 2024). For instance, consider the case of Meta, a leading U.S. technology company. On February 3, 2022, Meta experienced a historic 26.39% decline in market capitalization, representing the largest single-day loss in U.S. market history. Later that year, on October 27, Meta’s market value plummeted by another 24.56%. These substantial declines in the share prices of major corporations have heightened public and governmental awareness of stock price crash risk (SPCR). SPCR refers to the sudden, dramatic, and unpredictable collapse of stock market indices or individual stock prices (Fan and Zhang, 2024).

The efficient functioning of capital markets is critical, as they mobilize, aggregate, and allocate financial resources, thereby serving as a powerful driver of economic development (Afghahi et al. 2024). However, stock price crashes, characterized by their abruptness, speed, and potential for contagion, have far-reaching consequences. Such crashes erode corporate shareholder wealth, reduce social welfare (Chen et al. 2023a), and trigger widespread investor panic and withdrawals. This, in turn, escalates corporate capital costs, disrupts market confidence, and ultimately leads to the misallocation of economic resources. Frequent stock price crashes also amplify the risk of systemic market collapse through cross-contagion, threaten the stability of financial systems, and exacerbate financial risk (Hong and Stein, 2003; Piotroski et al. 2015). Consequently, mitigating SPCR has become an increasingly important area of academic inquiry in recent years (Jiang et al. 2022b; Eugster and Wang, 2023; Pham and Nguyen, 2023). Addressing SPCR is not only essential for safeguarding financial stability but also for ensuring the efficient operation of capital markets and fostering sustainable economic development.

The concentrated release of adverse news has been widely identified as a direct catalyst for corporate SPCR (Jin and Myers, 2006; Hutton et al. 2009; Jiang et al. 2022b). Drawing on agency theory and information asymmetry theory, prior research highlights that managerial hoarding of negative information and financial manipulation are key drivers of extreme stock price risks (Kim et al. 2011; Kim et al. 2014; Hutton et al. 2009). Consequently, efforts to mitigate SPCR have primarily focused on enhancing the quality of information disclosure, curbing managerial opportunistic behavior, and improving the availability and accessibility of information for investors (Afghahi et al. 2024; Yuan et al. 2024).

Scholars have devoted significant attention to accounting-related determinants of SPCR (e.g., Robin and Zhang, 2015; Kim et al. 2022; Richardson et al. 2022; Au et al. 2023; Cho et al. 2023; Liu et al. 2024a), as well as internal governance factors, such as executive characteristics (e.g., Pham and Nguyen, 2023; Choi et al. 2022; Kumar and Mohnot, 2024; Liu et al. 2024b), board characteristics (e.g., Cao et al. 2019; Hu et al. 2020), and internal control mechanisms (e.g., Lobo et al. 2020; Chen et al. 2017; Lee et al. 2024; Zhang et al. 2024). Additionally, an emerging body of

literature has underscored the significance of external governance-related determinants (e.g., Lu and Qiu, 2023; Chen et al. 2022a; Wang and Qiu, 2023; Chen et al. 2023a; Sun, 2023; Gan et al. 2024). Among these external factors, government intervention has been recognized as a particularly effective mechanism for mitigating SPCR (e.g., Chen et al. 2022a; Sun, 2023; Chen and Chen, 2024; Shi et al. 2024). The jurisdictional authority of governments enables regulatory bodies to influence economic incentives and restrict firms’ ability to conceal unfavorable information, thereby reducing extreme stock price risks.

Among government-related factors, the role of tax authorities is especially critical. Tax administration is directly linked to tax revenue, a vital economic resource for governments (Desai et al. 2007; Chen et al. 2022a; Ye et al. 2023). Tax authorities maintain access to detailed corporate tax-related information and, due to the coercive nature of tax regulation, possess a unique ability to influence corporate behavior. Transformations within tax authorities, particularly in terms of digitalization and oversight capabilities, have the potential to reduce information asymmetry at the corporate level. By enhancing the transparency of corporate financial practices, such transformations can serve as a mechanism to mitigate SPCR. Exploring the impact of tax authority reforms on corporate SPCR is therefore of significant academic and practical relevance. It offers critical insights into how government-led initiatives can stabilize capital markets through readily implementable and enforceable measures. Such measures not only contribute to reducing SPCR but also strengthen the broader financial system by fostering transparency and accountability within the corporate sector.

This study aims to investigate corporate SPCR through the lens of the digitization of tax administration. On one hand, the digital economy is increasingly recognized as a key driver of global economic growth (Goldfarb and Tucker, 2019; Verhoef et al. 2021; Jiang et al. 2022b; Zhou et al. 2023). Leveraging digital technologies to enhance governmental governance capabilities has become a central focus of government transformation in the digital era. In the realm of tax collection and administration, governments across the globe are progressively adopting digital technologies to collect and process tax-related information and to monitor taxpayer compliance (Slemrod et al. 2017; Bassey et al. 2022; Almunia and Lopez-Rodriguez, 2018; Okunogbe and Santoro, 2022). Examining digital tax administration provides valuable insights into the governance effectiveness of digital government initiatives. On the other hand, while existing research has explored the economic implications of digital tax administration, it has predominantly focused on areas such as tax compliance (Slemrod et al. 2017; Li et al. 2020; Almunia and Lopez-Rodriguez, 2018; Mascagni et al. 2021; Bellon et al. 2022; Bellon et al. 2023), financial performance (He and Yi, 2023), tax burdens (Okunogbe and Poulquien, 2022), and investment efficiency (Zhang et al. 2023). However, limited attention has been given to how capital markets respond to digital tax administration reforms. This study seeks to address this gap by exploring the impact of digital tax administration on stock market dynamics, particularly focusing on SPCR and stock liquidity. By examining how digitalization in tax administration influences corporate stock behavior, this research provides new insights into the intersection of digital governance and capital markets, thereby contributing to the broader understanding of the economic effects of digital government initiatives.

This study leverages the implementation of China’s “Golden Tax Phase III” project (GTP3P) as a proxy for the digitization of tax administration and examines its impact on corporate SPCR among Chinese public enterprises. Several factors support the suitability of GTP3P as both a research focus and an empirical

instrument. First, China has made substantial efforts to digitize its tax system, with GTP3P representing a major milestone in this transformation. GTP3P integrates advanced technologies, such as Internet-based platforms, cloud computing, and big data analytics, enabling the comprehensive integration and analysis of tax-related data. This upgrade marks a significant leap in the digital modernization of China's tax administration, making GTP3P an ideal proxy for studying the effects of tax digitization. Second, the phased rollout of GTP3P across various provinces and cities since 2013 offers a unique quasi-experimental setting. This staggered implementation allows for the construction of a multi-phase DID model to evaluate the causal effects of tax digitization on SPCR. Third, while digital tax systems have been established in developed economies for some time (Bassey et al. 2022; Almunia and Lopez-Rodriguez, 2018), the digital transformation of taxation in developing countries remains in its early stages (He and Yi, 2023). As the largest developing country, China's experience provides a critical case for understanding the implications of tax digitization in similar emerging market contexts. Fourth, the dominance of individual investors has exacerbated the volatility of the Chinese stock market (Wan et al. 2024), making it particularly susceptible to SPCR. For example, between July and September 2015, the Shanghai Composite Index experienced a sharp decline of 28.63%. Other notable instances, such as the dramatic stock price collapse of Zhangzidao in 2018 and the more than 300 listed companies that saw declines exceeding 30% in 2021, underscore the prevalence of SPCR among Chinese firms. These events highlight the relevance of the Chinese market as a suitable setting for exploring how tax digitization influences SPCR.

Theoretically, the digitization of tax administration holds significant potential to enhance corporate transparency and reduce SPCR. On one hand, digital tax systems employ advanced technologies, such as electronic invoicing and big data analytics, enabling the direct, accurate, and timely transfer of tax-related data from firms to tax authorities. This reduces the ability of companies to engage in tax evasion or financial manipulation. On the other hand, digital tax systems incorporate features such as risk early-warning modules and strengthened internal risk monitoring mechanisms. These capabilities not only improve tax authorities' oversight but also enhance internal corporate governance, thereby increasing the difficulty for managers to hoard negative information or engage in opportunistic behavior. According to information asymmetry theory and agency theory (Jin and Myers, 2006; Hutton et al. 2009; Jiang et al. 2022b), reducing information asymmetry and curbing managerial opportunism are critical factors in mitigating SPCR. By increasing the transparency and accountability of corporate financial practices, the digitization of tax administration systems has the potential to significantly lower the risk of stock price crashes. Thus, this study contributes to the literature by investigating how digital tax reforms influence SPCR, offering new insights into the intersection of tax policy, corporate governance, and financial market stability.

The results of the multi-period DID model strongly support our hypothesis. To ensure the robustness of these findings, we conducted a series of validation tests, including parallel trend tests, the substitution of dependent and independent variables, addressing potential endogeneity concerns, and other complementary analyses. Additionally, we employed the double machine learning model (DMLM) to strengthen causal inference. The observed negative association between digital tax administration and corporate SPCR remains robust across these tests. Moreover, heterogeneity analysis reveals significant asymmetries in the baseline effects, highlighting the differentiated impacts of digital tax reforms across firms. In exploring the underlying mechanisms, we confirm the mediating role of information asymmetry, demonstrating that tax administration reforms

significantly enhance the quality of corporate information disclosure. Finally, we extend our analysis to investor behavior, finding that digital tax reforms reduce stock liquidity and decrease the proportion of long-term investors. This outcome suggests a general aversion among investors to digital tax reforms, offering important insights into how such initiatives are perceived in capital markets.

This study expands the scope of research on the digitization of tax administration by offering novel insights into the economic implications of digital tax regulation. While previous studies have predominantly focused on the relationship between digital taxation and corporate behavior, this research leverages the phased implementation of China's GTP3P as a natural experiment to examine the effects of digital tax administration on stock market dynamics, with a particular emphasis on extreme SPCR and stock liquidity. Importantly, the study not only validates the mediating role of information asymmetry but also conducts a comprehensive heterogeneity analysis, considering key factors such as ownership structure, firm size, institutional investor participation, internal control mechanisms, and financing dependence. This multifaceted approach allows for the derivation of nuanced conclusions and the formulation of refined policy recommendations that address the diverse impacts of digital tax administration across varying corporate contexts. In addition, the integration of machine learning techniques enhances the analytical rigor of this study, offering both methodological innovations and a benchmark for future research on digital tax administration. By doing so, this study makes significant contributions to the growing body of literature on government digitization, while simultaneously providing actionable insights for policymakers seeking to balance the advantages of digital tax reforms against their potential repercussions on capital market stability and investor behavior.

This research also contributes meaningfully to the broader literature on the digital economy. While prior studies have largely focused on enterprise digitization (e.g., Jiang et al. 2022b; Zhou et al. 2023) and industry-level digitization (e.g., Ouyang et al. 2023; Jiang et al. 2022a), this study enriches the empirical evidence on the interaction between capital markets and the digital economy from a digital government perspective. Furthermore, while a substantial body of research suggests that the digital economy fosters value creation, this study provides a counterpoint by demonstrating that the digitization of tax administration can negatively influence stock liquidity and overall financial performance.

Moreover, this research extends the discourse on the relationship between government actions and extreme risks associated with corporate stock prices. The existing literature has primarily explored this relationship through the lenses of policy implementation and equity control. However, the evolution of digital technology and the digital economy necessitates a reevaluation of government digitization, an area that has been underexplored in discussions about the determinants of SPCR. By addressing this gap, this study sheds light on investor sentiment towards digital reforms in governmental functions and provides a critical assessment of how such reforms influence corporate stock price risks and capital market behavior.

The structure of the document is organized in the subsequent manner: The second section encompasses a review of relevant literature, foundational background, and theoretical analysis. The third section delineates the model, outlining its variables and the data utilized. The fourth section details the empirical process, while the final section offers conclusions and policy recommendations.

Literature review, background and theoretical analysis

Researches on the determinants of stock price crash risk. The sudden and severe decline in a company's stock price, commonly

referred to as SPCR, has been extensively examined in the academic literature (Chen et al. 2001; Jin and Myers, 2006; Hutton et al. 2009; Jiang et al. 2022b). Existing studies predominantly investigate the determinants of SPCR at the firm level through the theoretical frameworks of agency theory and information asymmetry theory (Jin and Myers, 2006; Hutton et al. 2009). Agency problems often drive managers to withhold unfavorable information for personal or self-serving reasons, while the opaque environment created by information asymmetry enables and exacerbates such concealment. The prolonged suppression of negative information inflates stock prices, which are prone to sharp corrections when adverse information is disclosed in aggregate (Hong and Stein, 2003). These theoretical perspectives form the foundation for much of the existing research on the causes of and potential strategies to mitigate SPCR.

A significant portion of the literature focuses on corporate governance factors, including managerial traits, board composition, and ownership structures. Corporate governance influences agency conflicts, shaping managerial incentives to withhold negative news and impacting internal risk management. The board of directors, for instance, plays a critical role in supervising managerial behavior, while ownership structures determine the alignment of stakeholder interests and the motivation for oversight. Recent studies confirm that specific governance attributes can constrain managerial tendencies to hoard bad news and reduce information asymmetry, thereby affecting SPCR. For example, evidence suggests that internally promoted CEOs (Choi et al. 2022), executives with legal backgrounds (Huang and Ho, 2023), CEO stock gifts (Pham and Nguyen, 2023), CEOs with weaker decision-making power (Al Mamun et al. 2020), academic independent directors (Jin et al. 2022), board feature (Yuan et al. 2024) and financial audit experts (Cho et al. 2023) contribute to mitigating SPCR. Similarly, minority shareholder activism (Wang and Qiu, 2023), institutional cross-ownership (Hou and Liu, 2023) and organization capital (Chen et al. 2024) and controlling shareholders' stock pledges (Ren et al. 2024) have been linked to improved transparency and reduced crash risk.

Operational strategies can also reshape the information environment of firms, alleviating information asymmetry and reducing SPCR. For instance, corporate social responsibility initiatives (Kim et al. 2014; Dumitrescu and Zakriya, 2021), ESG disclosures (Zaman et al. 2021; Yu et al. 2023; Chebbi, 2024; Zhou et al. 2024), human capital quality (Si and Xia, 2023), digitalization (Jiang et al. 2022b), online interactions (Li et al. 2023), customer concentration (Afghahi et al. 2024), supply chain transparency (Zhong et al. 2024) and diversification strategies (Wang et al. 2023) have been found to enhance transparency and mitigate crash risk. The social-ecological characteristics of a firm's headquarters location can trigger strategic choices that affect SPCR, such as local speculative culture (Zuo et al. 2023), local gambling attitudes (Yu et al. 2024) and terrorist attacks (Liu et al. 2024c).

Beyond firm-level factors, government regulation plays a critical role in shaping SPCR by influencing corporate incentives and determining the extent to which negative information can be concealed. Governments, particularly those holding equity stakes in corporations, often act as stakeholders by monitoring or directly influencing internal governance mechanisms. Recent studies underscore the impact of government intervention in enhancing corporate governance and mitigating SPCR. For instance, Sun (2023) found that government-controlled firms in China exhibit stronger governance practices and reduced financial opacity, thereby decreasing the likelihood of stock price crashes. Similarly, Zhang et al. (2023) demonstrated that the involvement of Chinese party and government entities strengthens governance structures and mitigates SPCR. Policy

implementation can also function as a signaling mechanism. Chen et al. (2023a) showed that the enforcement of green credit policies heightened external oversight over highly polluting firms, leading to a reduction in SPCR. Using the issuance of inquiry letters by stock exchanges as a proxy for non-punitive supervision, Lu and Qiu (2023) revealed that such oversight compels firms to disclose more information, alleviating information asymmetry and lowering SPCR. Xu et al. (2023) documented that the consolidation of China's State Administration of Taxation and local tax bureaus significantly reduced SPCR by enhancing tax enforcement. Similarly, Sun et al. (2024) analyzed panel data from Chinese A-share listed firms (2010–2022) and found that government green subsidies reduced SPCR by alleviating financing constraints and improving investor sentiment. Supporting these findings, Li and Huang (2024) reported that the New Asset Management Regulations reduced SPCR by enhancing financial stability.

However, not all government initiatives have a mitigating effect on SPCR. Shi et al. (2024) observed that participation in China's Targeted Poverty Alleviation program increased SPCR, as firms engaged in higher earnings management to maintain favorable reputations. Makrychoriti and Pyrgiotakis (2024), using Brexit as a quasi-natural experiment, identified a positive association between firm-level political risk and SPCR. In contrast, Dong et al. (2024) showed that the centralization of regulated information through national databases effectively reduced SPCR in European Union countries.

While the existing literature provides detailed insights into the relationship between government actions and SPCR, it primarily focuses on policy implementation and equity control. With the advent of digital technology, government oversight has increasingly transitioned from traditional offline methods to big data-driven monitoring. The impact of government digitization on firm behavior has become an unavoidable topic, yet the role of digital tools in addressing SPCR remains underexplored. This study seeks to fill this gap by examining how the digitization of tax collection and administration influences SPCR. Specifically, we investigate whether digital tax reforms reduce SPCR and explore how investors perceive and react to these technological advancements in government oversight. By expanding the discussion on the intersection of government digitization and SPCR, this paper offers new insights into the implications of digital governance for corporate transparency and risk management.

Background. Tax revenue constitutes a vital financial pillar for governments (Pomeranz and Vila-Belda, 2019). Reforms in tax collection and administration are primarily driven by the objective of enhancing efficiency and simplifying compliance, thereby fostering the dual advancement of fiscal revenues and economic development. In China, issues such as tax evasion and avoidance have been particularly pervasive. According to the Chinese State Administration of Taxation, in 2015 alone, 250 anti-tax avoidance investigations were launched, resulting in a substantial increase of nearly 60 billion yuan in tax revenue. To address these challenges, Chinese authorities have significantly augmented investments in human resources for tax enforcement. Between 1994 and 2013, the tax workforce expanded by approximately 150,000 employees. Nonetheless, this growth has struggled to keep pace with the rapid proliferation of enterprises amid China's fast-evolving economy. Consequently, a strategic pivot toward integrating advanced information technology into tax collection and administration has emerged as a critical imperative for enhancing operational capacity.

In this context, the Chinese government initiated the “Golden Tax Project” (GTP) in 1994, aiming to progressively modernize the IT infrastructure supporting its tax system. Officially termed the China Tax Management Information System, the GTP has undergone four developmental phases since its inception. The first phase, implemented between 1994 and 1998 across 50 Chinese cities, prioritized the establishment of systems such as the value-added tax (VAT) anti-counterfeiting tax control system and the VAT special invoice cross-checking system. These measures were instrumental in reinforcing the broader reforms of the industrial and commercial tax framework, particularly in addressing issues like the forgery and fraudulent issuance of VAT invoices.

The subsequent phase, “Golden Tax Phase II,” launched in 1998, sought to rectify limitations in data accuracy, omissions, and inefficiencies identified during the first phase. This phase introduced four core modules: the VAT anti-counterfeiting tax control invoicing subsystem, certification subsystem, VAT audit subsystem, and invoice information management subsystem. While these enhancements improved VAT administration efficiency, they fell short of addressing the increasingly complex demands of tax audits and the comprehensive coverage of tax entities. The escalating intricacies of tax-related data and the expanding scope of tax collection highlighted the limitations of Phase II’s technology and operational framework. To address these challenges, the Chinese government introduced the “Golden Tax Phase III Project” (GTP3P), which represents a transformative leap in tax administration. This phase leverages cutting-edge digital technologies such as big data analytics and cloud computing to optimize the collection, processing, and verification of tax-related data. GTP3P is grounded in three strategic objectives. First, it aims to establish a centralized technical infrastructure integrating network hardware and foundational software to standardize and enhance the quality of national tax data. This unified system facilitates seamless interconnectivity among various tax departments, enabling robust cross-verification, procedural oversight, and centralized data management within both national and local tax agencies. Consequently, the project delivers a consolidated, nationwide perspective on tax data. Second, GTP3P addresses informational asymmetries between central and local government entities by fostering data sharing across diverse institutions, including tax bureaus, statistics agencies, financial institutions, commercial administrations, and social security offices. Third, through automated data verification, matching, and analysis, GTP3P significantly enhances the precision and efficiency of tax risk assessments conducted by tax authorities, thereby improving the effectiveness of tax inspections. By integrating internet technology, big data, and cloud computing, GTP3P achieves comprehensive data synthesis and analysis across the National Tax Bureau, local tax bureaus, and third-party sources. This phase signals a profound digital transformation of China’s tax administration, setting a new benchmark for leveraging technology to streamline and secure fiscal processes.

The implementation of GTP3P has established a unified national tax platform, integrating tax departments across the country through a phased rollout of pilot programs and systematic deployment. Specific timelines for these initiatives will be discussed in subsequent sections. Recent studies have examined the economic ramifications of GTP3P (Ye et al. 2023; He and Yi, 2023; Zhang et al. 2023; Li et al. 2020). Recent studies have extensively explored the economic impacts of the GTP3P, revealing its multifaceted effects on corporate behavior and market outcomes. A significant body of research suggests positive effects: the digital tax administration has enhanced corporate information disclosure quality (Ye et al. 2023), improved ESG

performance (Hai et al. 2024), reduced R&D manipulation (Pang and Hua, 2024), and mitigated inefficient investment (Guo et al. 2024). The system has also shown broader social impacts by narrowing corporate salary disparities (Wei et al. 2024) and promoting job creation (Cheng et al. 2024). However, some studies highlight adverse effects, indicating that the digital overhaul has increased corporate tax burdens (Li et al. 2020) and negatively impacted corporate performance and investment levels (He and Yi, 2023).

While the intersection of the digital economy and capital markets has garnered attention, the specific responses of capital markets to the digitization of China’s tax system remain underexplored. This study seeks to bridge this gap by providing a comprehensive investigation into the implications of tax system digitization on capital market dynamics, thereby contributing to a nuanced understanding of the broader economic impacts of digital tax reforms.

Theoretical analysis: Digital tax administration and stock price crash risk. This paper argues that the transition to digital tax systems transforms corporate information transparency, which subsequently influences financial practices, corporate governance, and the information asymmetry faced by investors.

Digital tax systems enhance financial oversight and curtail tax evasion. First, the adoption of digital tools in tax collection and administration, leveraging technologies such as online invoicing and advanced data analytics, facilitates the seamless transmission of tax-related data from corporations to tax authorities. This enables real-time monitoring of corporate operations and production activities, effectively addressing the deficiencies of traditional manual tax processes. Second, the “Golden Tax Phase III” (GTP3P) system empowers the State Administration of Taxation to centrally manage and archive tax-related data, encompassing detailed records of purchases, production, and sales across diverse industries and regions. Third, utilizing big data technology, tax authorities can precisely identify and monitor electronic invoices by tracking amounts and tax numbers, while cross-referencing discrepancies between VAT input and output invoices through taxpayer identification numbers. Fourth, the GTP3P system enhances commodity tracking using barcode technology, enabling tax authorities to more accurately assess business inventory and financial standing. Collectively, digital tax administration ensures the immediacy, integration, and digitization of tax-related data. By consolidating information from multiple sources, the GTP3P significantly raises barriers for corporations attempting financial manipulation and tax evasion.

Digital tax administration strengthens financial compliance and fortifies corporate governance. The GTP3P system incorporates an early-warning risk module, which employs big data analytics to flag high-risk entities and regions. By benchmarking financial metrics against tax data within similar industries, the system swiftly identifies enterprises with irregularities, compelling them to clarify, report, and rectify questionable practices. Moreover, digital tax administration eliminates the reliance on manual verification by local tax officials. By centralizing tax processing across provincial and national levels, the GTP3P minimizes opportunities for collusion, curbing exploitative behaviors and fraudulent practices. Consequently, the digitization of tax management intensifies internal risk surveillance, reduces financial opportunism, and enhances the overall integrity of corporate governance, making it increasingly difficult for managers to conceal adverse information.

Digital tax administration also improves the quality of information disclosure and mitigates information asymmetry

for investors. First, the GTP3P facilitates data integration and interdepartmental information sharing, enabling tax authorities to comprehensively collect corporate information from diverse sources. This cross-verification capability significantly enhances tax oversight, bolsters corporate transparency, and discourages financial manipulation, thereby improving the authenticity and timeliness of corporate disclosures. Second, the introduction of the “Trial Measures for the Administration of Tax Credit Rating Assessment” in 2002 allows tax authorities to evaluate enterprises based on criteria such as tax compliance, payment history, and avoidance behaviors, assigning ratings (A, B, C, D) accordingly. Publicizing the list of A-rated enterprises under GTP3P enables investors to better assess corporate performance and operational health. Conversely, enterprises with lower ratings or flagged by tax authorities are more likely to be scrutinized, allowing investors to conduct timely and informed analyses of their conditions.

As previously noted, information opacity is a significant driver of extreme SPCR. From an investor’s perspective, opacity impedes access to timely and accurate information on corporate performance, leading to decisions based on incomplete or distorted data. From a corporate perspective, transparency deficits allow managers to obscure negative developments, misleading stakeholders about the true financial health of the firm. Additionally, opacity exacerbates agency problems in poorly governed firms, as executives may intentionally withhold adverse information for personal gain. When such information eventually surfaces, it can result in significant stock price volatility. Furthermore, opacity reduces oversight, fostering behaviors such as tax avoidance, which may initially appear beneficial by preserving internal funds for reinvestment. However, when uncovered, such practices can trigger severe financial penalties and reputational harm.

From the lens of principal-agent theory, tax avoidance represents a risky yet ostensibly profitable strategy that management may pursue to increase after-tax cash flows, often at odds with shareholder interests. This behavior typically requires a veil of secrecy, further deepening firm-level information asymmetry. Over time, undisclosed negative information accumulates, reaching a tipping point that can precipitate sudden and severe stock price crashes. Under robust and digitally enforced tax administration, however, the opportunity costs of tax avoidance rise significantly, diminishing its appeal and mitigating principal-agent conflicts over tax-related decisions. This regulatory shift incentivizes more timely disclosure of adverse information, curbing the risk of extreme stock price collapses. Consequently, digital tax systems not only enhance corporate transparency but also align managerial behaviors more closely with shareholder and societal interests.

In sum, digital tax administration reduces information opacity, thereby improving corporate financial practices, strengthening internal governance mechanisms, and enhancing the accessibility of information for investors. Ultimately, these improvements contribute to a reduction in SPCR, fostering greater stability within financial markets.

Methodology, variables, and data

Methodology. We generate a multi-period difference-in-difference model to assess the association between tax administration reform and corporate SPCR. The multi-period DID model is as follows:

$$Crash_{cit} = \alpha + \beta_1 GT_{c,t} + \theta X_{cit} + \gamma_t + \delta_i + \tau_c + \varepsilon_{it} \quad (1)$$

where i , c , t , and j denote the enterprise, city, and year, respectively. $Crash_{cit}$ represents the SPCR of a corporation. $GT_{c,t}$ refers

to the implementation of tax collection and management reform. X_{cit} are vectors of firm-level control variables, respectively. To mitigate possible endogeneity, we include γ_t , δ_i , and τ_c denoting the year, firm, and city fixed effects, respectively. ε_{it} is the error term. The coefficient β_1 measures the effect of tax administration reform on corporate SPCR. A negative and significant β_1 implies that tax administration reform alleviates corporate SPCR. Moreover, our analysis adopts the PSM, placebo test, and DMLM to address endogeneity concerns.

Variable setting

Stock price crash risk. SPCR represents an unexpected extreme decline in stock prices (Jiang et al. 2022b; Hutton et al. 2009; Afghahi et al. 2024). This extreme risk differs from a decline in market indices. This extreme risk is different from the decline in market indices, as it is caused by heterogeneous fluctuations due to the concentrated release of negative news from the company. Therefore, the key to measuring SPCR is to measure the company’s idiosyncratic returns independent of market fluctuations. We run the following model:

$$r_{i,w} = \alpha_0 + \alpha_1 r_{m,w-2} + \alpha_2 r_{m,w-1} + \alpha_3 r_{m,w} + \alpha_4 r_{m,w+1} + \alpha_5 r_{m,w+2} + \varepsilon_{i,w} \quad (2)$$

$r_{i,w}$ is the stock return of corporation i at week w ; $r_{m,w}$ is the market return of corporation i at week w ; $\varepsilon_{i,w}$ is the error term, indicating the portion of stock returns that cannot be correlated with market returns. This study sets the firm-specific weekly return $W_{i,w}$.

$$W_{i,w} = \ln(\varepsilon_{i,w} + 1) \quad (3)$$

The calculation method of market return includes market value weighted average and equal weighted average. The main risk indicator for SPCR in this article is the upper-lower volatility calculated by market value weighted market returns.

$$Crash_{i,t} = \log \frac{(D_{up} - 1) \times \sum_{down} w_{i,w}^2}{(D_{down} - 1) \times \sum_{up} w_{i,w}^2} \quad (4)$$

D_{up} and D_{down} refer to the number of weeks when the weekly stock returns of corporation i are larger and smaller, respectively, than the annual average return. A larger $Crash$ implies the greater SPCR. In the robustness checks, we attempt to use the alternative risk indicators.

Tax administration reform. Building on existing research (Ye et al. 2023; Zhang et al. 2023; Li et al. 2020), this investigation utilizes the “Golden Tax Phase III” project (GT) as a proxy for assessing the digitization of tax collection and administration. Since 2013, the GT project has been incrementally introduced in different provinces and cities. Initially, in 2013, it was deployed in Chongqing, Shanxi, and Shandong. The following year, 2014, saw the rollout in Guangdong (Shenzhen not included), Henan, and Inner Mongolia. By 2015, the project was operational in an additional 14 provinces, including Hainan, and by 2016, it extended to encompass the entire nation. Table 14 details the specific launch dates of the GT project across various regions. The GT serves as a binary indicator; it is set to 1 following the project’s implementation in the enterprise’s region, and 0 otherwise.

Control variables. We include a series of corporate-level control variables, as indicated in previous research (Kim et al. 2011; Jiang et al. 2022b), to account for potential missing variables. We add variables reflecting corporates’ fundamentals, containing the firm-level gross profit margin (Mar), sales revenue

Table 1 Descriptive statistics.

Variables	Obs	Mean	S.D.	Min	P25	P50	P75	Max
<i>Crash</i>	26,394	−0.222	0.486	−2.777	−0.541	−0.222	0.090	2.362
<i>GT</i>	26,394	0.501	0.500	0.000	0.000	1.000	1.000	1.000
<i>Mar</i>	26,392	0.290	0.175	−0.007	0.163	0.257	0.380	0.835
<i>Saleg</i>	26,368	0.418	1.146	−0.691	−0.020	0.141	0.434	8.891
<i>Lev</i>	26,394	0.429	0.207	0.049	0.263	0.422	0.586	0.941
<i>Du</i>	26,359	0.374	0.053	0.308	0.333	0.333	0.429	0.571
<i>Top</i>	26,394	34.950	15.040	8.739	23.140	32.980	45.130	74.820
<i>Size</i>	26,394	22.190	1.298	19.570	21.260	22.010	22.940	26.120
<i>StockM</i>	26,394	0.064	0.026	0.026	0.047	0.059	0.074	0.219
<i>StockV</i>	26,394	0.004	0.011	−0.025	−0.003	0.002	0.009	0.072
<i>Crash2</i>	26,394	−0.428	0.776	−5.173	−0.827	−0.385	0.0130	5.078
<i>Crash3</i>	26,394	−0.326	0.751	−5.250	−0.718	−0.286	0.0960	5.013
<i>Audit</i>	26,394	5.951	0.306	4.000	6.000	6.000	6.000	6.000
<i>Market</i>	23,203	6.972	1.335	1.480	6.120	7.100	8.060	9.520
<i>Deficit</i>	24,541	10.000	1.183	4.057	9.239	10.020	10.790	12.540
<i>Polground</i>	15,820	0.219	0.414	0.000	0.000	0.000	0.000	1.000
<i>Gdp</i>	23,099	10,676	9,336	65.97	3,100	7,401	16,252	38,156
<i>VAT</i>	23,858	0.006	0.129	−4.985	0.001	0.003	0.009	17.750
<i>KV</i>	25,378	0.485	0.192	0.003	0.351	0.460	0.591	1.790
<i>LQ</i>	26,394	0.109	0.854	0.000	0.018	0.036	0.066	57.780
<i>LI</i>	26,019	0.010	0.023	0.000	0.000	0.001	0.011	0.426
<i>FI</i>	25,117	4.092	5.863	0.000	0.315	1.726	5.475	55.560
<i>ROA</i>	26,394	0.038	0.061	−0.279	0.015	0.037	0.067	0.200
<i>TA</i>	22,197	−0.004	0.106	−0.537	−0.029	0.006	0.045	0.245
<i>RT</i>	22,197	0.194	0.119	0.000	0.127	0.163	0.243	0.991

The detailed definitions and explanations of these variables can be found in the Table 13.

growth rate (*Saleg*), the corporate scale (*Size*) and financial leverage (*Lev*). Regarding that internal governance is related to corporate's SPCR (Andreou et al. 2016; Hu et al. 2020), we include two variables, the percentage of independent directors (*Du*) and the shareholding of the largest shareholder (*Top*). Following previous researches (e.g., Jiang et al. 2022b), we controlled for the average return on stocks (*StockM*) and the standard deviation of stock prices (*StockV*) to absorb interference from market changes. Definitions of these variables are provided in Table 13.

Data and description. The dataset employed in this research encompasses annual records from A-share listed corporations in both Shanghai and Shenzhen, China, covering the years from 2009 to 2020. To enhance data integrity, we excluded data points associated with ST and *ST companies as well as those from the financial sector. Furthermore, to reduce the effect of statistical anomalies, all continuous variables were winsorized at the 1% threshold. Verification of the implementation dates for the *GTP3P* was conducted through direct consultations with the tax bureau. Corporate financial metrics were sourced from the CSMAR database, whereas city-specific data were obtained from local statistical annuals and official governmental reports. Descriptive statistics for the studied variables are delineated in Table 1. The mean indicator for *GT* stands at 0.501, suggesting that about half of the enterprises in our sample were impacted by the *GTP3P* during the analysis timeframe. The average value for *Crash* is registered at −0.222, with a standard deviation of 0.486, indicating a considerable divergence in SPCR among the observed firms. A comparative analysis of core variables such as *Saleg*, *Mar*, *Lev*, and *Size* with those documented in previous research (e.g., Jiang et al. 2022b; Zhou et al. 2023) shows negligible discrepancies, thereby affirming the robustness, reliability, and representativeness of our research sample relative to existing studies.

Empirical results

Baseline findings. Based on Eq. (1), we explore the effect of tax administration reform on the SPCR. Table 2 reports benchmark regression results. We have controlled year, firm, and city fixed effects in all columns. In column (1), excluding the firm-level controls, we find that tax administration reform significantly reduces the level of SPCR by 0.037. In columns (2)–(5), we perform similar regression with gradually adding variables that represent corporate business operation, corporate governance, and stock returns. We find the negative effects of tax administration reform on corporate SPCR remains. As revealed as column (5), the negative relationship between *GT* and *Crash* remains significant, and the coefficient estimate is 0.042, taking about 18% of the mean level of all enterprises. Our findings coincide with those of Kim et al. (2011), they confirm that corporate tax avoidance raises the SPCR. In this case, our administration reform as a coercive tax governance policy is expected to combat corporate tax evasion, which in turn reduces corporate SPCR. As for the controls, the large scale of cooperate assets and good stock returns are benefit for the reduction of SPCRs.

Robustness tests. We then conducted a battery of robustness tests to convince our baseline findings. This subsection includes three parts: parallel trend test, replace explained variables, replace explanatory variables, deal with endogeneity concern, and other complementary tests.

Parallel trend test. As Li et al. (2016) noted, an important prerequisite for quasi-natural experimental analysis of policies using DID model is “parallel trends,” which means that the treatment and control groups should exhibit similarity until the time of policy onset, i.e., they should have a common trend, or there should be absence of notable discrepancies in the explanatory variables (*Crash*) between the two groups. However, if the *Crash* of the two groups have significantly different development trends

Table 2 Results for the effect of tax administration reform on stock price crash risk.					
Variables	(1) Crash	(2) Crash	(3) Crash	(4) Crash	(5) Crash
GT	−0.037** (−2.326)	−0.038** (−2.402)	−0.038** (−2.388)	−0.038** (−2.386)	−0.042** (−2.486)
Mar		−0.111** (−2.476)	−0.108** (−2.414)	−0.110** (−2.451)	0.015 (0.356)
Saleg		−0.001 (−0.256)	−0.001 (−0.246)	−0.001 (−0.257)	0.002 (0.719)
Lev		−0.068** (−2.044)	−0.067** (−2.011)	−0.073** (−2.135)	−0.022 (−0.678)
Du			0.128 (1.413)	0.129 (1.426)	0.120 (1.393)
Top			−0.000 (−0.362)	−0.000 (−0.369)	−0.000 (−0.305)
Size				0.004 (0.449)	−0.024*** (−2.754)
StockV					−3.970*** (−13.509)
StockM					−7.117*** (−8.720)
Constant	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓
Firm FE	✓	✓	✓	✓	✓
City FE	✓	✓	✓	✓	✓
R-squared	0.191	0.192	0.192	0.192	0.239
Observations	26173	26147	26113	26113	26113

The dependent variable in all columns is *Crash*, a variable to represent the firm-level SPCR. The estimates of *GT* represent the effects of tax administration reform on SPCR. Column 1 presents the influence of tax administration reform on SPCRs with year, city and firm-level fixed effect; the firm-level gross profit margin (*Mar*), sales revenue growth rate (*Saleg*) and financial leverage(*Lev*) are controlled in column 2; column 3 shows the estimates with additional governance factors like the percentage of independent directors (*Du*), the shareholding of the largest shareholder (*Top*); the corporate scale (*Size*) is also controlled in column 4; column 5 reports the estimates with controlling stock returns factors (*StockV* and *StockM*) and all control variables as above. T-statistics are displayed in parentheses as indicated in the subsequent text. Robust standard errors are clustered to the joint city and year level. ***, and ** respectively symbolize p-values less than 0.01, and less than 0.05.

before the tax administration reform, it will lead to the deviation of the estimation of the treatment effect.

Here, we perform parallel trend test to exclude such concern. Following previous studies (Li et al. 2016; Jiang et al. 2021; Chen et al. 2022b), we perform the event study analysis based on the following model:

$$Crash_{cit} = \alpha_i + \beta_n \sum_{n=-8,+5} T^n_{cit} + \theta X_{it} + \gamma_t + \delta_i + \tau_c + \varepsilon_{it} \tag{5}$$

Here, T^n_{cit} is a series of year dummy variables, it takes the value of 1 if the time period between the fiscal year and the establishment year of tax administration is n , where $-8 = n \leq +5$. It should be noted that $n = +5$ comprises the time period large than 5 to save space. We employ these dummy variables as explanatory variables for the regression, and drop the one year before tax administration reform to reduce collinearity. The coefficients of T^n_{cit} reflect the differences between the treatment and control groups in a given year, that is, the differential trends between these two groups before and after the tax administration reform. X_{it} is a series of control variables. γ_t , δ_i and τ_c are year, enterprise, and city fixed effects, respectively. ε_{it} is the random error as above.

Table 3 reports the estimated coefficients of the T^n_{cit} showing the dynamic effects of tax administration reform in different years. These coefficients are not significantly different from 0 before the tax administration reform although a positive estimate in three before this policy, indicating that no significant difference exists between treat and control groups before the policy point, that is, to meet the hypothesis of the parallel trend. The evidence also illustrates the continuing impact of tax administration reform on SPCR.

Replace variables. In this subsection, we replace the explained and explanatory variable to exclude the concerns about variables definition.

Following Jiang et al. (2022b), we use two alternative indicators (*Crash2* and *Crash3*) to measure corporate SPCR. *Crash2* is the risk of corporate SPCR calculated by negative return skewness coefficient according to the equal-weighted average method of submarkets, and *Crash3* is the SPCR indicator calculated by negative return skewness coefficient using the average method of total market capitalization of the combined market. They are both collected from the CSMAR database. We perform similar regressions as Table 2 and report results in columns (1) and (2) of Table 4. Consistent with the findings in Table 2, we observe a notable mitigating influence of tax administration reform on corporate SPCR. The estimated coefficient is similar to the estimate in our baseline regression.

In the previous section, we defined the policy timing of tax administration by defining the implementation time in the second half of the year (later than June 30) as the next year’s implementation. For example, in Shanxi Province, the tax administration policy was implemented in October 2013, and considering that the time is very close to the next year, we take the implementation time of the tax policy as 2014 in baseline analysis. However, there may be some man-made errors in this practice. Here, we do not adjust the year anymore, and the tax administration implemented in that year is regarded as a policy shock in that year. Thus, the policy time for Shanxi province is 2013 at this point. In this case, we similarly adjust for the timing of tax administration reform in other areas and define a new policy effect variable *GT2*. The robustness result is shown in Column (3) of Table 4. It is evident that the negative effect of tax collection on the SPCR remains.

Table 3 Parallel trend test.

Variables	(1) <i>Crash</i>
T^{-8}	0.278 (1.481)
T^{-7}	0.256 (1.596)
T^{-6}	0.155 (1.160)
T^{-5}	0.134 (1.237)
T^{-4}	0.106 (1.287)
T^{-3}	0.097* (1.735)
T^{-2}	0.051 (1.626)
T^0	-0.059* (-1.936)
T^{+1}	-0.125** (-2.297)
T^{+2}	-0.141* (-1.787)
T^{+3}	-0.186* (-1.788)
T^{+4}	-0.200 (-1.539)
T^{+5}	-0.250 (-1.507)
Constant	✓
Controls	✓
Year FE	✓
Firm FE	✓
City FE	✓
Observations	26113
R-squared	0.239

The explained variable in all columns is *Crash*, a variable to represent the firm-level SPCR. The T^i represents dynamic effects of tax administration reform in different years. All controls and fixed effects are defined as above. **, and * respectively symbolize p-values less than 0.05, and less than 0.1.

Table 4 Replace variables.

Variables	(1) <i>Crash2</i>	(2) <i>Crash3</i>	(3) <i>Crash</i>
GT	-0.053** (-2.091)	-0.062** (-2.537)	
GT2			-0.037** (-2.120)
Constant	✓	✓	✓
Controls	✓	✓	✓
Year FE	✓	✓	✓
Firm FE	✓	✓	✓
City FE	✓	✓	✓
Observations	26113	26113	26,113
R-squared	0.237	0.239	0.239

This Table report robust checks in terms of explained variables. *Crash2* and *Crash3* are two alternative indicators for SPCR. Column (1) is the result of Table 2 and reported here for comparison. Columns (2)-(3) report results with alternative explained variables. The last two columns are for alternative explanatory variables. All controls and fixed effects are defined as above. ** symbolize p-values less than 0.05.

Endogeneity concerns. In this subsection, we discuss possible endogeneity issues because of omitted variables and model-setting problems. Here, regarding omitted variables, we try to control for the interference from potential omitted socioeconomic factors, conducting tests such as adjustment of control variables and change the fixed effects. Regarding model setting, we conducted placebo tests such as PSM, policy randomness, and adjustment of clustering standard errors.

Studies noted that the deterioration of audit quality aggravates the SPCR (Robin and Zhang, 2015; Fan and Xu, 2022). The

independence, scale, expertise, and number of meetings of the audit committee will reduce the earnings management of enterprises. In this case, the audit quality assumes the role of external governance (Abbott et al. 2007), and we anticipate that it may mitigate SPCR to a certain degree. Therefore, our baseline model suffers from omitted variable problems. To cater this concern, we add audit quality (*Audit*) in Eq. (1) and re-perform regression. The coefficient estimate reported in Column (1) of Table 5 reveals a negative association between tax administration reform and SPCR, and a negative effect of audit quality as expected, though statistically insignificant.

In addition, the political connection of directors should also affect SPCR. Previous works like Lee and Wang (2017) found that appointing local government officials as corporate directors would help listed private holding enterprises reduce SPCR. Here, we exclude the omitted variables concerned owned to political connections. We define a dummy variable (*Polground*) based on the political background of the executives, which is defined as 1 when the executive has a history of political office (former and current) and 0 when the executive has no political history. A new baseline regression with *Polground* is conducted and the related result is reported in Column (2) of Table 5. Consistent with Table 2, the negative effects of tax administration reform on SPCR remain significant.

Given that we are using regional-level policy factors as the subject, then regional socioeconomic factors should also influence our interest in tax collection as well as SPCR. After all, firm behavior is influenced by the external macro environment and the industry environment. First, regional economic upswing periods are characterized by more active stock markets and are less likely to experience negative events such as stock price crashes. Second, the government's relationship with the market inevitably affects its tax collection efforts and the performance of corporate behavior. Moreover, the government's aggressiveness in tax collection is also related to its fiscal surplus, and when local finances are tight, officials are more likely to want to alleviate their financial woes through taxation, which may also affect corporate stock price performance in such cases. Therefore, we exclude this contextual factor by adding region GDP calculated as the logarithm of real GDP, marketability Index (*Market*), and the level of fiscal deficit (*Deficit*) based on the difference between fiscal revenue and expenditure. Related results are reported in Columns (3)-(5) respectively. We find the negative effects of tax administration reform on SPCR remain after excluding these factors.

In fact, it is difficult to quantify and exclude all contextual factors. However, considering that the majority of the confounding factors are either at the industry level or at the regional level, we can exclude them by controlling additional fixed effects. Here, apart from the baseline fixed effects specification, the two-way fixed effects by year and industry are also concluded in Eq. (1). Column (1) of Table 6 reveals a negative relationship between tax administration reform and SPCR, consistent with baseline findings.

As Li et al. (2016) pointed out, the use of quasi-natural experimental methods requires that the setting of the treatment object of the policy is random. In other words, the treatment group and the control group need to remain similar in other aspects except for the factor of policy variable, so that the final difference between the two is only caused by the policy object. In the benchmark analysis, we distinguish the treatment group and the control group based on whether the enterprise is subject to tax collection and management in the place of registration. However, the treatment enterprises and control enterprises are not necessarily similar in other aspects. To this end, we conducted an annual propensity score matching method (PSM) to find most

Table 5 Endogeneity robustness checks: Part A.					
Variables	(1) Crash	(2) Crash	(3) Crash	(4) Crash	(5) Crash
GT	−0.042** (−2.493)	−0.035** (−1.983)	−0.038** (−2.296)	−0.038** (−2.271)	−0.042** (−2.438)
Audit	−0.018 (−1.534)				
Polground		−0.009 (−0.906)			
Gdp			−0.000 (−0.177)		
Market				0.002 (0.191)	
Deficit					0.006 (0.814)
Constant	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓
Firm FE	✓	✓	✓	✓	✓
City FE	✓	✓	✓	✓	✓
Observations	26113	15420	22939	23047	24216
R-squared	0.239	0.271	0.244	0.244	0.238

This Table report robust checks in endogeneity (Part A). All controls and fixed effects are defined as above. ** symbolize p-values less than 0.05.

Table 6 Endogeneity robustness checks: Part B.						
Variables	(1) Crash	(2) Crash	(3) Crash2	(4) Crash3	(5) Crash	(6) Crash
GT	−0.033* (−1.932)	−0.071** (−2.379)	−0.163*** (−3.022)	−0.166*** (−3.640)	−0.042** (−2.022)	−0.039** (−2.37)
Constant	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓
Firm FE	✓	✓	✓	✓	✓	✓
City FE	✓	✓	✓	✓	✓	✓
Year#Industry	✓					
Observations	26,053	6688	6688	6688	26,113	23,022
R-squared	0.283	0.429	0.438	0.426	0.239	0.245

This Table report robust checks in endogeneity (Part B). All controls and fixed effects are defined as above. Apart from Column 5 and Column 6, the robust standard errors are clustered to the joint city and year level. ***, **, and * respectively symbolize p-values less than 0.01, less than 0.05, and less than 0.1.

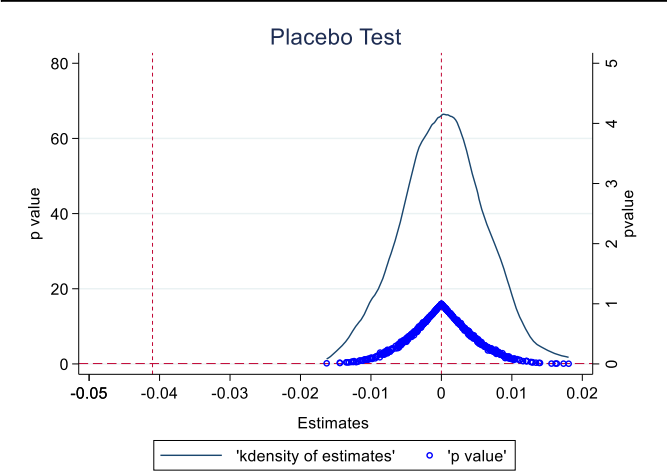


Fig. 1 False grouping test. Distribution of the estimated coefficients.

similar control enterprises for the treatment enterprises and then carry on PSM-DID analysis. Following Deng et al. (2020), the proximity 1:3 matching method is employed and result is reported in Column (2) of Table 6. We find the tax

administration reform significantly reduces corporate SPCRs. We also replace the explained variable with *Crash2*, *Crash3* and perform another test. The result in Column (3)-(4) supports our baseline findings.

To address any lingering doubts regarding the assignment of entities into treatment and control groups and to mitigate the impact of latent variables, we conducted placebo tests as outlined by Li et al. (2016). In these tests, we randomly designated firms for treatment, introduced a fictitious treatment variable, *False-treat*, and recalculated our primary model using this artificially generated explanatory variable. This procedure was replicated 500 times. Figure 1 illustrates the distribution of *Falsetreat*'s regression coefficients across these simulations, along with the associated *P*-values on the vertical axis for each model iteration. The coefficients of *Falsetreat* appear to follow a standard normal distribution, with the majority of *P*-values exceeding 0.1, affirming that our initial results are robust against hidden variable bias and validating the group assignments. Additionally, we assessed the robustness of our findings through a random sample analysis concerning policy implementation dates, creating a hypothetical policy variable, *Falsepolicy*, and applying the same methodological approach. Figure 2 displays the estimated

coefficients and *P*-values for 500 random policy simulations, where the coefficients predominantly cluster around zero, significantly below the actual observed effect of -0.041 . This analysis lends further credence to our baseline assertions.

Moreover, we adjusted the standard errors in the baseline model. Regarding that the research subject of the article is company-level variables, the joint industry-year and the corporate clustering robust standard errors replace the use of city-year clustering standard errors. Findings in Columns (5) and (6) confirm that tax administration reform reduces SPCR remains significant.

Other robust tests. In this subsection, we conduct other robust checks to support our baseline findings. We eliminate the influence of synchronization interference, sample tests, and the impact of control variable changes.

First, although we have eliminated the problem of omitted variables due to social variables in the previous section, there remains the influence of other important factors. In particular, other tax policies in addition to tax administration reform bring disturbances. Essentially, different tax policies will all affect the tax burden of firms and thus their behavior. If this is the case, then our benchmark results are likely to be biased. To rule out this problem, we need to eliminate the effects of other tax policies over the same period. We find that in addition to the tax

administration reform, firms are also affected by the VAT reform¹. Therefore, we need to exclude the role of VAT reform. We use the ratio of total VAT plus business tax to business revenue as a proxy for the VAT policy. We re-run the regression of Eq. (1) with the inclusion of VAT. The relevant results are reported in Column (1) of Table 7. This significant negative estimate of *GT* indicates that the baseline results remain.

Second, considering that tax administration reform fully implemented in China from 2017. At this time, all enterprises will be impacted by policies. There is no policy effect difference between the treatment and the control group. In this case, in order to accurately estimate the policy effect, we reserved the data from 2009 to 2017 for regression analysis. As Column (2) of Table 7 revealed, the negative effects of tax administration reform on SPCR remain significant, consistent with the estimate in Table 2.

Third, in addition to affect the SPCR, our control variables may also be affected by tax administration reform. For example, the *Mar* may be affected by tax administration reform. When the enterprise is faced with strict tax collection and management, it is difficult for the enterprise to evade taxes, and the increase of tax burden will correspondingly reduce the income of the enterprise, thereby reducing the *Mar*. Therefore, we will multiply the control variables and tax administration policies, replace the original control variables *X* in Eq. (1), and conduct analysis again. The estimate in Column (3) of Table 7 support our baseline findings. Here, we also multiply the control variables and year variables to further exclude potential interference. Then, we use these new control variables in Eq. (1). The last column of Table 7 also supports our baseline findings that tax administration reform reduces SPCR.

As previously mentioned, the digital economy affects various sectors including production, governance, and consumption (Verhoef et al. 2021; Wang et al. 2024). It involves the digitization of traditional industries as well as purely digital sectors. The adoption of digital technologies is not limited to government entities; enterprises are a significant force in the economic transition to digital (Du et al. 2024). The digitization of means of production helps businesses to timely understand, analyze, and visualize internal operational conditions, thereby reducing information asymmetry (Chen and Jiang, 2024). Consequently, digital transformation has a substantial direct impact on stock price fluctuations. In the digital economy era, it is common and logical for multiple sectors to develop their digital capabilities concurrently. The similar upward trends in both tax digitization and corporate digitization can undermine the reliability of

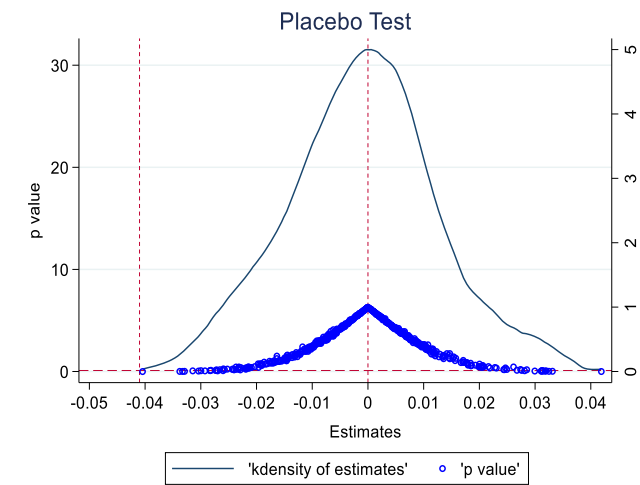


Fig. 2 False policy Test. Distribution of the estimated coefficients.

Table 7 Other robustness checks.						
Variables	(1) Crash	(2) Crash	(3) Crash	(4) Crash	(5) Crash	(6) Crash
GT	−0.046*** (−2.677)	−0.036** (−2.131)	−0.635*** (−3.725)	−0.041*** (−2.593)	−0.038** (−2.28)	−0.054*** (−2.83)
VAT	0.354* (0.210)					
CD					−0.004 (−0.41)	
Constant	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓
Firm FE	✓	✓	✓	✓	✓	✓
City FE	✓	✓	✓	✓	✓	✓
Observations	23,828	16,879	26,113	26,332	22,743	19,719
R-squared	0.240	0.269	0.223	0.285	0.245	0.276

This Table reports other robust checks. In Columns (1)–(2), the controls and fixed effects are defined as above. In Column (3), we used the interaction terms between original controls and tax administration policy variables as new controls. In Column (6), we exclude financial crisis samples. ***, **, and * respectively symbolize p-values less than 0.01, less than 0.05, and less than 0.1.

Table 8 Double machine learning.					
	(1)	(2)	(3)	(4)	(5)
	Partial linear model				Interactive model
Variables	Crash	Crash	Crash	Crash	Crash
GT	−0.015* (−1.844)	−0.038** (−2.397)	−0.039** (−2.379)	−0.043** (−2.482)	−0.043*** (−5.926)
Covariate type	None	I	II	III	III
Observations	26,394	26,394	26,332	26,332	26,332

This Table report the estimates of the DMLM. In Columns (1)–(4), the partial linear models are adopted as above. In Columns (5), the interactive model is adopted as above. In Column (1), we do not add any covariates. Covariate I refers to year dummies and city dummies. Covariate II refers to the control variables we used above. Covariate III refers to year dummies, city dummies and control variables we used above. ***, **, and * respectively symbolize p-values less than 0.01, less than 0.05, and less than 0.1.

baseline conclusions. This paper seeks to eliminate this uncertainty by incorporating the variable of corporate digitization into the baseline regression model. Following contemporary scholarly practices (Jiang et al. 2025), we utilized textual analysis to depict the extent of enterprises’ digital transformation. Column (5) of Table 7 displays the corresponding results. It is encouraging that the estimated coefficient for *GT* remains significant, and the change in its absolute value provides further corroboration of our concerns.

Finally, stock volatility is easily influenced by the market. The emergence of a financial crisis can temporarily disrupt the supply-demand dynamics that determine stock prices, leading to a significant impact on the stability of financial markets (Jiang et al. 2024). Considering that the dependent variable in this study is extreme stock price volatility, which is susceptible to the effects of financial crises, we have excluded samples from financial crises in our regression analysis. Column (6) of Table 7 shows that the stock price effect of *GT* still holds.

Double machine learning. This section introduces the DMLM as a robust methodological approach for enhancing predictive accuracy in causal inference. Traditional techniques, such as difference-in-differences and regression discontinuity, rely heavily on rigid theoretical assumptions and predefined linear relationships between independent and dependent variables. These limitations constrain their practical applicability, particularly in empirical predictions. Accurate estimation of policy effects requires minimizing the influence of extraneous variables on SPCR; however, addressing high-dimensional control variables poses challenges for conventional regression methods, often resulting in the “curse of dimensionality.” To overcome these limitations, Chernozhukov et al. (2018) developed the DMLM, which accommodates high-dimensional covariates and relaxes the restrictive linearity assumptions inherent in traditional models. This approach enables precise estimation of treatment effects without explicitly specifying the functional relationships among covariates, between covariates and primary explanatory variables, or between these and the outcome variable. By leveraging “instrumental variables,” DML corrects for the biases commonly associated with machine learning algorithms while mitigating the dimensionality issues of linear models. DMLM has increasingly been applied in causal inference across various domains (Yang et al. 2020; Bodory et al. 2022; Farbmacher et al. 2022). Following the methodologies proposed by Chernozhukov et al. (2018), this investigation employs both the partial linear model and the interactive model to assess the impact of event shocks on SPCR. Detailed descriptions of the models and their configurations are available in Chernozhukov et al. (2018).

Table 8, columns (1)–(4), displays predictions from the partial linear model. Regardless of covariate combinations, it consistently forecasts a significant reduction in SPCR by *GT*. Moreover, the

interactive model corroborates this effect. Thus, the robustness of the foundational conclusions is confirmed.

Heterogeneous effects. Having established the negative relationship between tax administration reform and SPCR, we now investigate whether this effect varies across corporate ownership structures, industry characteristics, and regional features.

We begin by examining the heterogeneity of corporate ownership. Huang and Liu (2021) observe that SOEs are generally larger than non-SOEs, showing that SOEs are better equipped to withstand SPCR during periods of crisis. Similar findings are reported by Jiang et al. (2022b), who argue that SOEs exhibit greater resilience to risk due to their closer alignment with government oversight and the policy incentives they receive. In contrast, non-SOEs face lower levels of government intervention and protection, making them more vulnerable to SPCR. Consequently, if tax administration reform mitigates the risk of stock price crashes, this positive effect is expected to be more pronounced in non-SOEs. To test this hypothesis, we categorize the sample into state-owned and non-state-owned firms based on the effective controller of each enterprise and conduct subsample regressions using Eq. (1). The coefficient estimates for the tax administration reform variable (*GT*) are presented in Fig. 3. The results align with our conjecture, showing that tax administration reform significantly reduces SPCR among non-state-owned firms, while the effect on SOEs is less pronounced.

We next discuss whether the relationship between tax administration and SPCR varies across enterprises of different sizes. Large enterprises are usually well-capitalized and have more management experience to balance the returns and risks of the enterprise. Consistent with our benchmark analysis, we find that firm size is negatively correlated with SPCR. To investigate this further, we divide the sample into large-scale and small-scale firms based on the mean value of total assets across all enterprises and conduct a subsample analysis using Eq. (1). As illustrated in Fig. 3, the effect of tax administration reform on reducing SPCR is more pronounced among small-scale firms, suggesting that smaller enterprises benefit disproportionately from the reform’s stabilizing effects.

We also discuss if there is a heterogeneous response in industry attributes, such as whether it is a high-tech firm. Prior research indicates that firms in high-tech industries tend to invest heavily in R&D and are more engaged in the development of innovative technologies (Stam and Wennberg, 2009). These activities enhance productivity and R&D intensity, which have been linked to lower SPCR (Bai et al. 2022). In contrast, firms in non-high-tech industries face higher SPCR due to their relatively lower innovation capacities, suggesting that the effects of tax reform should be more pronounced for these firms. To test this hypothesis, we categorize the sample into high-tech and non-

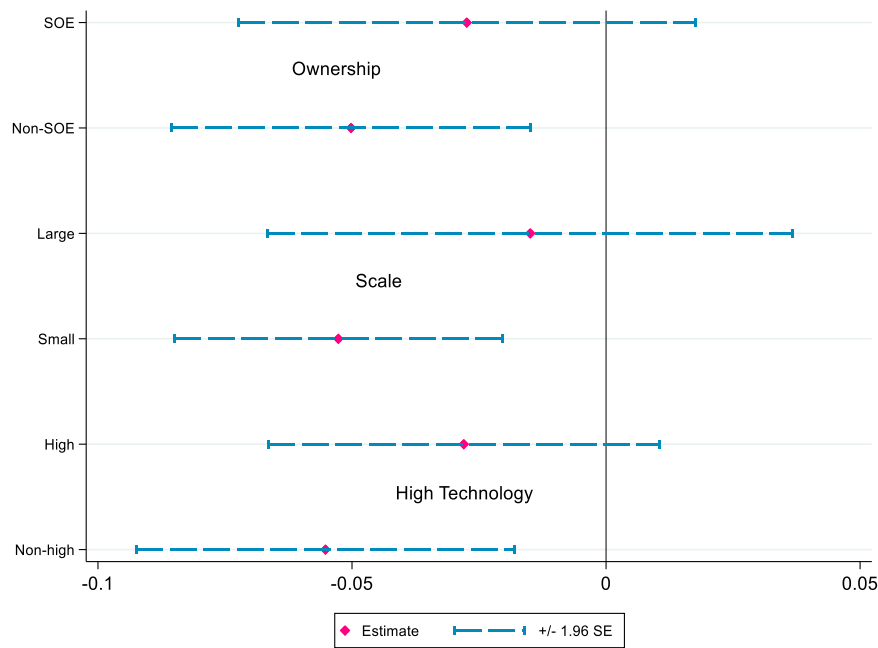


Fig. 3 Heterogeneity analysis. Based on ownership, scale, and industry.

Table 9 Heterogeneity analysis by internal control and financing.				
Variables	(1)	(2)	(3)	(4)
	Internal Control	Internal Control	Financing Cost	Financing Cost
	Crash	Crash	Crash	Crash
GT	−0.038*	−0.037	−0.040*	−0.041
	(−1.749)	(−1.369)	(−1.849)	(−1.554)
Constant	✓	✓	✓	✓
Controls	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
Firm FE	✓	✓	✓	✓
City FE	✓	✓	✓	✓
Observations	15,929	9493	13,521	12,143
R-squared	0.293	0.360	0.289	0.289

This Table report the heterogeneity analysis in terms of internal control and financing cost. The controls and fixed effects are defined as above. * symbolize p-values less than 0.1.

high-tech firms based on industry classification and conduct a subsample analysis. As shown in Fig. 3, the results reveal that the significant reduction in SPCR is concentrated among non-high-tech firms, while the effect is less pronounced in high-tech enterprises.

We investigate the variability attributed to internal control mechanisms. Chen et al. (2017) present empirical findings demonstrating a significant inverse relationship between the strength of internal controls and the probability of future stock price declines. Utilizing the average scores of internal control from a collective dataset of corporations, we divide the sample into two categories: those with robust internal controls and those with weak internal controls. The outcomes from our segmented regression analysis are detailed in Table 9. Columns (1) and (2) contrast firms based on their internal control capacities. The analysis indicates a more pronounced adverse effect of tax administration reforms on SPCR in companies with less stringent internal controls, underscoring the essential influence of governance quality in reducing the likelihood of stock price crashes.

Lamont et al. (2001) established that companies facing financial constraints tend to have lower stock returns and exhibit greater vulnerability to external economic disturbances, thereby highlighting the significant influence of financial limitations on stock market volatility. In a similar vein, Bae et al. (2021) explored how ESG factors intersect with SPCR, particularly focusing on the mediating effect of financial constraints. Their research suggests that although elevated ESG scores generally diminish SPCR, this positive impact is notably diminished in entities burdened by more substantial financial constraints. In our research, we categorize companies according to their financial constraint index (SA), as sourced from the CSMAR database. Entities with SA scores surpassing the mean are deemed highly constrained, whereas those below are considered less constrained. Columns (3) and (4) of Table 9 delineate the comparative analysis of SPCR among firms with different levels of financial constraints. The findings reveal that the marked negative influence of tax enforcement policies on SPCR predominantly affects firms with lower financial constraints, with no significant impact observed within highly constrained firms.

Institutional investors play a pivotal role in corporate governance by performing a crucial oversight function (Ni et al. 2020). Their significant stock ownership and extended investment duration provide them with a strong incentive to oversee company operations. This monitoring by institutions helps curb the accumulation of undisclosed negative information by management, which, when eventually disclosed, can lead to sudden and severe price corrections (SPCR). To investigate this further, we categorize our sample into two groups: one with institutional holdings above or equal to the average across all firms, and another with holdings below this threshold. We then apply the initial model separately to each group. Figure 4's upper section highlights how tax administration reforms impact SPCR more distinctly in companies with fewer institutional investors.

There is no shortage of scholars discussing the response of investor sentiment in the stock market and finding that such sentiment does affect SPCR (Qadan and Nama, 2018), and there are also studies finding that investor sentiment affects stock returns (Paudel et al. 2022). In general, both high and low

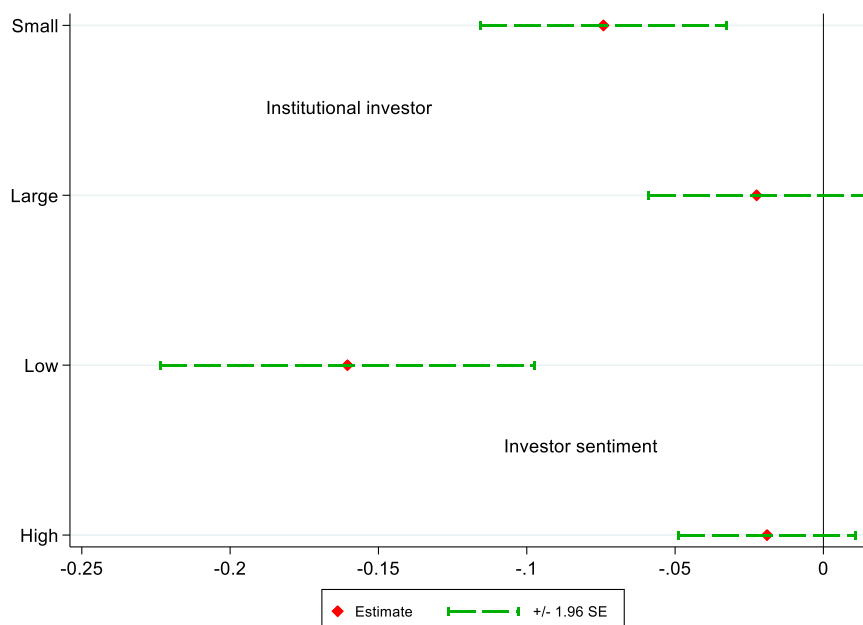


Fig. 4 Heterogeneity analysis. Based on institutional investors and investor sentiment.

investment sentiment affect stock market performance. For the purposes of our analysis, we classify firms into two groups based on investor sentiment—high and low—using the average score of the CSMAR investor sentiment index as the benchmark. The lower section of Fig. 4 highlights the differences in coefficients between these groups. Our results reveal that the negative effects of tax administration reform on the likelihood of corporate SPCR are more pronounced among firms characterized by low investor sentiment, suggesting that sentiment plays a critical role in moderating the relationship between tax reforms and SPCR.

A robust rule of law environment is crucial in curbing managerial opportunism, safeguarding investor interests, and fostering the development of capital markets (La Porta et al. 1997). The regional rule of law environment exerts a binding influence on the comparability of corporate accounting information. In regions with stronger rule of law, firms exhibit lower levels of discretionary earnings management, and the quality of information disclosure for locally listed firms is significantly enhanced. Consequently, a favorable rule of law environment reduces the extent of earnings manipulation, ensures that stock prices more accurately reflect a firm's true operational performance, and mitigates the risk of future stock price crashes. To empirically test this relationship, we adopt the marketization index employed by Liu et al. (2023) as a proxy for the regional rule of law environment, dividing the sample into two groups: high-marketization and low-marketization regions. Firms in the high-marketization group operate in regions where the legal system level meets or exceeds the national average. Subsample coefficient estimates are presented in Fig. 5. The results indicate that tax administration reform significantly reduces SPCR for enterprises located in low-marketization regions, suggesting that the reform's impact is more pronounced in areas with weaker institutional frameworks.

Vo (2020) examines the relationship between international equity holdings and SPCR, employing various panel data analysis techniques. The study identifies a positive correlation between foreign investments and the likelihood of future SPCR. Similarly, Huang et al. (2020) explore the impact of international investors on firm-specific crash risk within the Chinese market, finding that foreign investments significantly increase SPCR. Building on

these insights, our research investigates whether the effect of tax administration reforms on firm-specific SPCR varies with differing levels of reliance on foreign capital. To test this, we classify firms into two groups—high and low reliance on foreign capital—based on the average level of foreign capital dependence. Subsample analyses are conducted to evaluate the heterogeneity in effects. As illustrated in Fig. 5, our results reveal that tax administration reforms significantly reduce SPCR for firms with high dependency on foreign investments. This finding suggests that the stabilizing effects of tax reforms are particularly impactful for companies with greater exposure to international capital flows.

Potential channels of Tax administration on stock price crash risk. Having found the negative effects of tax administration on SPCR, we now aim to investigate the potential channels between them. According to the theoretical discussion in Section 2, we will analyze the mechanism from the perspective of information asymmetry.

Within the framework where ownership is distinct from management, it is observed that company executives, serving as agents, tend to conceal adverse details rather than disclose them, driven by personal gain or other benefits. Furthermore, to preserve the value of the company, these managers often accumulate unfavorable news to maintain stability in the stock market, especially when the company's results are unsatisfactory or fall short of expectations. Managers have a potent incentive to suppress information that they believe would be disadvantageous for investors to discover. This creates a disparity in information between investors and the corporation. Though these practices might seem inconsequential in the short run, they can lead to severe repercussions over time. Accumulating too much hidden negative information can eventually lead to a crisis point where a sudden release of this accumulated bad news can cause a drastic plummet in the company's stock prices, or in extreme cases, lead to a complete market collapse. Based on information asymmetry theory, it has been found in the literature that the lower the information transparency of a firm and the higher the degree of surplus management, the higher the risk of a firm's stock price

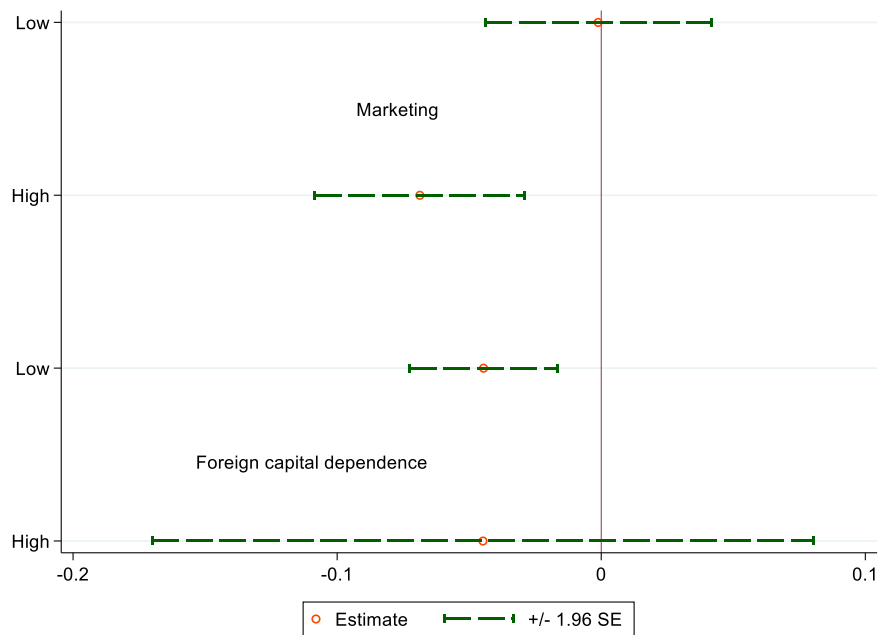


Fig. 5 Heterogeneity analysis. Based on marketing and foreign capital dependence.

crash. To this end, we discuss whether tax administration reform is beneficial in mitigating the degree of information asymmetry and thus reducing SPCR.

Here, we use the quality of information disclosure of enterprises to reflect the degree of information asymmetry. With reference to Kim and Verrecchia (2001), the calculation method is as follows:

$$\ln \left| \frac{P_t - P_{t-1}}{P_{t-1}} \right| = \lambda_0 + \lambda \left(\frac{Vol_t}{Vol_o} - 1 \right) + \varepsilon \tag{6}$$

$$KV = \lambda \times 10^6 \tag{7}$$

We take *KV* as the proxy variable of information disclosure quality, in which the higher *KV* value represents the lower information disclosure quality. As shown in Columns (1) and (2) of Table 10, we find that tax administration reform significantly reduces *KV*, which indicates an improvement in information asymmetry and a high level of information transparency. We also provide the estimates of the parallel trend test. We re-run Eq. (5) by replacing *Crash* with *KV*. T^{+5} had been dropped because of collinearity. Column (3) of Table 10 reports the estimated coefficients of the T^n_{cit} , showing the dynamic effects of tax administration reform on *KV* in different years. These coefficients are not significantly different from 0 before the tax administration reform, indicating that no significant difference exists between treat and control groups before the policy point, that is, to meet the hypothesis of the parallel trend.

We next run a mediation effects model to verify the pivotal role played by information asymmetry in the tax reform’s impact on stock price risk. We perform the following designs.

$$Crash_{cit} = \alpha + \beta_1 GT_{c,t} + \theta X_{it} + \gamma_t + \delta_i + \tau_c + \varepsilon_{it} \tag{8}$$

$$KV_{cit} = \alpha + \delta GT_{c,t} + \theta X_{it} + \gamma_t + \delta_i + \tau_c + \varepsilon_{it} \tag{9}$$

$$Crash_{cit} = \alpha + \beta_2 GT_{c,t} + \rho KV_{cit} + \theta X_{it} + \gamma_t + \delta_i + \tau_c + \varepsilon_{it} \tag{10}$$

Tables 2 and 10 have shown the estimates of Eq. (8) and Eq. (9), respectively. Based on the theoretical analysis, information asymmetry increases SPCR, which predicts that

Table 10 Mechanism analysis.			
Variables	(1) KV	(2) KV	(3) KV
GT	−0.015** (−2.162)	−0.015** (−2.141)	
T−8			−0.158 (−1.342)
T−7			−0.134 (−1.239)
T−6			−0.136 (−1.371)
T−5			−0.118 (−1.307)
T−4			−0.108 (−1.323)
T−3			−0.098 (−1.339)
T−2			−0.088 (−1.361)
T−1			−0.075 (−1.354)
T0			−0.077 (−1.639)
T+1			−0.070* (−1.839)
T+2			−0.049* (−1.665)
T+3			−0.033 (−1.570)
T+4			−0.029** (−2.185)
Constant	✓	✓	✓
Controls	×	✓	✓
Year FE	✓	✓	✓
Firm FE	✓	✓	✓
City FE	✓	✓	✓
Observations	26,268	26,182	26,185
R-squared	0.380	0.425	0.395
This Table report results of mechanism analysis. Other control variables are defined as Table 2. **, and * respectively symbolize p-values less than 0.05, and less than 0.1.			

Table 11 Mediating effect of information asymmetry.			
Variables	(1) Crash	(2) KV	(3) Crash
GT	−0.042** (−2.486)	−0.015** (−2.141)	−0.034** (−2.053)
KV			0.409*** (15.609)
Constant	✓	✓	✓
Controls	✓	✓	✓
Year FE	✓	✓	✓
Firm FE	✓	✓	✓
City FE	✓	✓	✓
Observations	26,113	26,182	25,138
R-squared	0.239	0.395	0.263

This Table report results of mechanism analysis. Other control variables are defined as Table 2. ***, and ** respectively symbolize p-values less than 0.01, and less than 0.05.

the coefficient ρ will be positive. If the mediating effect of information asymmetry KV holds, then the absolute value of the coefficient β_2 will be less than the absolute value of the coefficient β_1 . Table 11 displays findings in accordance with our expectations. In this case, the increased information transparency can mitigate information asymmetry and thus reduces the SPCR (Hutton et al. 2009).

Further analyses: Is tax administration reform good news for investors? The above discussion centers on the relationship between tax administration reform and corporate SPCR. Indeed, the information environment does not fully determine investors’ holding preferences. Whether improvements in the information environment can enhance stock liquidity depends critically on investor returns (Chen et al. 2023b). As mentioned earlier, tax administration reforms reduce corporate information asymmetries and further curb corporate tax avoidance and financial manipulation. Other things being equal, tax administration reforms have instead resulted in firms losing some of their earnings (He and Yi, 2023), which can be derived from legal tax avoidance and financial manipulation. Thus, while tax administration reform reduces information asymmetry, it undermines investors’ returns to ownership. Tax administration reform may be bad news for investor. We test the above scenario.

We use the following variables to characterize investor concerns and holdings: *LQ*, *LI*, and *FI*. *LQ* is a variable measuring stock liquidity. We use the illiquidity indices proposed by Amihud (2002). *FI* is the shareholding of fund investors. *LI* is the shareholding of long-term investors.

Building on prior research (Jiang et al. 2024), this study classifies institutional investors based on their turnover rates. The analysis primarily centers on the trading activities of equity funds and hybrid funds, given the availability and reliability of relevant data. Specifically, the study aggregates the total stock assets purchased and sold by each institutional investor over the period from 2007 to 2020, providing a comprehensive view of institutional trading behavior. The following are the calculation formulae for the institutional investor s ’s total assets of equities purchased and sold each half year:

$$Buy_{s,h} = \sum_{i=1}^N |SN_{s,h,i}P_{h,i} - SN_{s,h-1,i}P_{h-1,i} - SN_{s,h-1,i}\Delta P_{h,i}|,$$
$$SN_{s,h,i} \geq SN_{s,h-1,i}$$

(11)

$$Short_{s,h} = \sum_{i=1}^N |SN_{s,h,i}P_{h,i} - SN_{s,h-1,i}P_{h-1,i} - SN_{s,h-1,i}\Delta P_{h,i}|,$$
$$SN_{s,h,i} < SN_{s,h-1,i}$$

(12)

In the model, the investor index and the semi-annual index are represented by the letters s and h . The overall number of shares is N . $Buy_{s,h}$ and $Short_{s,h}$ refer to the total market value of stocks that investor s has purchased or sold during the period h , respectively. $SN_{s,h,i}$ and $SN_{s,h-1,i}$ indicate the number of shares of corporate i held by investor s in the period h and the previous period $h - 1$, respectively. $P_{h,i}$ and $P_{h-1,i}$ is the stock price of firm i in the period h or in the period $h - 1$, respectively. Then, the turnover rate of investor s during the period h is defined as:

$$TR_{s,h} = \frac{2 \min(Buy_{s,h}, Short_{s,h})}{\sum_i^{SN_s} (SN_{s,h,i}P_{h,i} + SN_{s,h-1,i}P_{h-1,i})}$$

(13)

SN_s is the share number that the investor s hold. $TR_{s,h}$ is the metric used to gauge the turnover rate of investor s during the period h . Then, to compute the average turnover rate of institutional investor s over the past two years, the following calculation is undertaken:

$$AVR_{TR_{s,h}} = \frac{1}{4} \sum_k^3 TR_{s,h-k}$$

(14)

An institutional investor is generally associated with long-term investments when exhibiting a lower average turnover rate, while a higher average turnover rate often signals a propensity for short-term investment strategies. Contrary to general expectations, a cohort of investors characterized by a high turnover rate is classified as long-term investors for the purposes of this study. Institutional investors are segmented into three distinct categories based on their average turnover rate. Subsequently, for each stock i in year t , the shareholding ratio of long-term investors (*LI*) is calculated according to the type of investor.

We replace *Crash* of Eq. (1) with *LQ*, *LI*, and *FI*, respectively. Columns (1)-(2) of Table 12 confirm that tax reform decreases stock liquidity and the percentage of investors who own shares, showing that investors do not prefer *GT*.

Additionally, we looked at whether tax reform actually hurts the company’s financial performance. We generate three variables: *TA*, *RT*, and *ROA*. We use the difference between the nominal income tax rate minus the effective income tax rate (*RT*) to capture the degree of corporate tax avoidance (*TA*). *ROA* is the return on assets. We use themes to replace the explanatory variable in Eq. (1) and perform a regression analysis. Obviously, from Table 12, we find the implementation of tax administration significantly decreases the level of tax avoidance, as expected. Furthermore, following the tax management reform, the tax burden and benefits for businesses have dramatically deteriorated.

In conclusion, the tax management reform lowers the information asymmetry of businesses but is unable to reverse the decline in financial performance brought on by the tax reform, which lowers stock liquidity and investor involvement.

Conclusions

Drawing on panel data from non-financial listed companies spanning 2009 to 2020, this investigation assesses the repercussions of tax administration reform on SPCR. We utilize the phased rollout of the GTP3P, initiated in 2013, as an exogenous digital tax administration policy shock and employ a multi-period DID model to evaluate its effects on SPCR. The findings reveal that the enactment of this tax reform correlates with a reduction in SPCR by 0.042, which represents approximately 18% of the

Table 12 Further analysis.

Variables	(1) LQ	(2) LI	(3) FI	(4) TA	(5) RT	(6) ROA
GT	0.054** (2.470)	−0.001** (−2.472)	−0.293** (−2.200)	−0.009** (−2.353)	0.009** (2.467)	−0.004** (−2.573)
Constant	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓
Firm FE	✓	✓	✓	✓	✓	✓
City FE	✓	✓	✓	✓	✓	✓
Observations	27,600	27,166	25,828	23,074	23,074	27,600
R-squared	0.421	0.391	0.528	0.387	0.473	0.566

This Table reports the results of the mechanism analysis. Other control variables are defined in Table 2. ** symbolize p-values less than 0.05.

average SPCR value across all firms. To validate our results and address potential biases stemming from the empirical design's subjectivity, a comprehensive series of robustness tests was conducted. These included parallel trend tests, substitution of dependent and independent variables, addressing endogeneity issues, and other supplementary tests. To overcome the limitations associated with using linear models for empirical predictions, we incorporated the DMLM to enhance prediction accuracy. Our core findings are consistent, suggesting that advancements in tax collection and management contribute to mitigating SPCR. Further heterogeneity analysis shows that the adverse impacts of tax administration reform on SPCR are more pronounced in enterprises characterized by non-state ownership, smaller size, minimal institutional holdings, weaker internal controls, and greater foreign dependence. Additionally, we discovered that tax administration reform substantially reduces SPCR in enterprises located in less-marketed regions, outside the high-tech sector, and during periods of low investment sentiment. To explore how the tax administration reduces SPCR, we built the potential mechanism framework from the perspective of information asymmetry. We find that tax administration reform significantly enhances the quality of information disclosure. The increased information transparency can mitigate information asymmetry and guarantee a reduction in SPCR. Finally, we provide a further analysis examining investors' holding preferences. Tax reform decreases stock liquidity and the percentage of investors who own shares, showing that investors do not prefer tax reform, for the reason that the tax burden and benefits for businesses have dramatically deteriorated.

Our work has the following implications. First, the findings demonstrate that the Golden Tax III Project, a digitalization initiative in tax administration, has significantly improved the tax collection and payment environment, served as an effective external governance mechanism, curbed opportunistic behaviors such as information concealment by corporate executives, ensured greater transparency in corporate disclosures, and consequently reduced the likelihood of stock price crashes. These results underscore the importance of tax policy not only as a tool for income redistribution but also as an instrument for leveraging its indirect governance effects to enhance market efficiency and stability. Second, the study highlights the critical role of tax administration as an external governance mechanism in mitigating corporate SPCR. This provides valuable evidence for financial market regulators to further explore the application of big data technologies in regulating microeconomic activities, preventing financial risks, and promoting stability in capital markets. Additionally, it supports the state's continued efforts to

advance the digital transformation of tax collection systems, thereby contributing to the broader strategy of modernizing national tax governance. Third, the evidence in this paper indicates that improving tax administration is more effective in curbing corporate SPCR in regions with low marketization, non-high-tech industries, and when foreign dependence is high. Fourth, considering that corporate performance may face short-term decline, the government should advocate for companies to establish a healthy financial system and attract investors with long-term performance growth. Finally, China, as the largest developing country, faces the social reality of how to improve government governance, and corporate governance capacity and achieve quality economic development. The evidence on the role of tax administration on stock markets can be generalized and adapted to other developing countries similar to China, and even to developed economies.

However, there are some limitations of this paper. First, we currently quantify the tax administration with a dummy variable, an approach that only reflects the differential impact of whether the reform is imposed or not, and does not quantify the impact of different strengths of the reform. Second, we examine the corporate behavior of listed enterprises and ignore the impact of tax administration reform on unlisted enterprises. Further, even though the use of quasi-natural experimental methods and robustness tests can alleviate some degree of endogeneity, there may still be problems of omitted variables and measurement errors. Finally, it is crucial to not only understand the implications of SPCR but also to elucidate the role of tax administration on other corporate behaviors. These issues need to be refined in future studies.

Data availability

The datasets generated during and/or analyzed during the current study are available in the Harvard Dataverse repository, <https://doi.org/10.7910/DVN/TCIODW>.

Received: 21 August 2024; Accepted: 29 January 2025;

Published online: 06 February 2025

Note

1 After the pilot implementation in different periods, VAT has been fully implemented in China since 2016.

Appendix

Tables 13 and 14

Table 13 Variables Definition.	
Variables	Definitions
<i>Crash</i>	The upper-lower volatility calculated by market value weighted market returns.
$r_{i,w}$	The stock return of corporation <i>i</i> at week <i>w</i>
$r_{m,w}$	The market return of corporation <i>i</i> at week <i>w</i>
$W_{i,w}$	The firm-specific weekly return
<i>GT</i>	Once the “Golden Tax Phase III” project is initiated in the region of the enterprise, <i>GT</i> is assigned a value of 1; if not, it remains at 0.
<i>Mar</i>	The firm-level gross profit margin of corporation <i>i</i>
<i>Saleg</i>	The revenue growth rate of corporation <i>i</i>
<i>Size</i>	The natural logarithm of total assets of corporation <i>i</i>
<i>Lev</i>	The financial leverage of corporation <i>i</i>
<i>Du</i>	The percentage of independent directors of corporation <i>i</i>
<i>Top</i>	The shareholding of the largest shareholder of corporation <i>i</i>
<i>StockM</i>	The average return on stocks
<i>StockV</i>	The standard deviation of stock return
T^n_{cit}	A series of year dummy variables, it takes the value of 1 if the time period between the fiscal year and the establishment year of tax administration is <i>n</i> , where $-8 \leq n \leq +5$.
<i>Crash2</i>	The negative return skewness coefficient according to the equal-weighted average method of submarkets
<i>Crash3</i>	The negative return skewness coefficient using the average method of total market capitalization of the combined market
<i>Audit</i>	If the company’s audit opinion is standard and unreserved, the variable value is 1, otherwise it is 0
<i>Polground</i>	The political background of the executives, which is defined as 1 when the executive has a history of political office (former and current) and 0 when the executive has no political history.
<i>Market</i>	The marketability Index
<i>Deficit</i>	The difference between fiscal revenue and expenditure <i>t</i>
<i>Gdp</i>	The logarithm of real GDP
<i>VAT</i>	The ratio of total VAT plus business tax to business revenue
<i>KV</i>	The KV index
<i>LQ</i>	The illiquidity indices proposed by Amihud (2002)
<i>LI</i>	The shareholding of long-term investors
<i>FI</i>	The shareholding of fund investors
<i>TA</i>	The difference between the nominal income tax rate minus the effective income tax rate
<i>RT</i>	The effective income tax rate
<i>ROA</i>	The return on assets
<i>CD</i>	The natural logarithm of the frequency of digital-related keywords plus one, where the keywords are sourced from Jiang et al. (2025).
Notes: This table shows the variables definition in this paper.	

Table 14 The specific online time of the “Golden Tax Phase III” project.	
2013	Shanxi, Chongqing, Shandong
2014	Guangdong (except Shenzhen), Henan, Inner Mongolia
2015	Hebei, Ningxia, Guizhou, Yunnan, Guangxi, Hunan, Qinghai, Hainan, Xizang, Gansu, Anhui, Xinjiang, Sichuan, Jilin
2016	Remaining provinces and cities

References

Abbott LJ, Parker S, Peters GF, Rama DV (2007) Corporate governance, audit quality, and the Sarbanes-Oxley Act: Evidence from internal audit outsourcing. *Account Rev* 82(4):803–835

Afghahi M, Nassirzadeh F, Askarany D (2024) Exploring the impact of customer concentration on stock price crash risk. *Humanit Soc Sci Commun* 11(1):1–15

Al Mamun M, Balachandran B, Duong HN (2020) Powerful CEOs and stock price crash risk. *J Corp Financ* 62:101582

Almunia M, Lopez-Rodriguez D (2018) Under the radar: The effects of monitoring firms on tax compliance. *Am Econ J: Econ Policy* 10(1):1–38

Amihud Y (2002) Illiquidity and stock returns: cross-section and time-series effects. *J Financ Mark* 5(1):31–56

Arestis P, Demetriades PO, Luintel KB (2001) Financial development and economic growth: the role of stock markets. *J Money Credit Bank*, 16–41

Au SY, Qiu B, Wu SY (2023) Do mandatory risk factor disclosures reduce stock price crash risk. *J Account Public Policy*, 107077

Bae J, Yang X, Kim MI (2021) ESG and stock price crash risk: role of financial constraints. *Asia-Pac J Financ Stud* 50(5):556–581

Bai M, Li S, Lien D, Yu CFJ (2022) The winner’s curse in high-tech enterprise certification: Evidence from stock price crash risk. *Int Rev Financ Anal* 82:102175

Bassey E, Mulligan E, Ojo A (2022) A conceptual framework for digital tax administration-A systematic review. *Gov Inf Q* 39(4):101754

Bellon M, Dabla-Norris E, Khalid S (2023) Technology and tax compliance spillovers: Evidence from a VAT e-invoicing reform in Peru. *J Econ Behav Organ* 212:756–777

Bellon M, Dabla-Norris E, Khalid S, Lima F (2022) Digitalization to improve tax compliance: Evidence from VAT e-Invoicing in Peru. *J Public Econ* 210:104661

Bodory H, Huber M, Laffers L (2022) Evaluating (weighted) dynamic treatment effects by double machine learning. *Econ J* 25(3):628–648

Cao F, Sun J, Yuan R (2019) Board directors with foreign experience and stock price crash risk: Evidence from China. *J Bus Financ Account* 46(9–10):1144–1170

Chebbi K (2024) Examining the interplay of sustainable development, corporate governance, and stock Price crash risk: Insights from ESG practices. *Sustain Dev* 32(1):1291–1309

Cheng Q, Chen B, Luo J (2024) The impact of digital tax administration on local government debt: Based on the revision of the tax collection and administration law. *Financ Res Lett* 67:105938

Chen J, Chan KC, Dong W, Zhang F (2017) Internal control and stock price crash risk: Evidence from China. *Eur Account Rev* 26(1):125–152

Chen J, Hong H, Stein JC (2001) Forecasting crashes: Trading volume, past returns, and conditional skewness in stock prices. *J Financ Econ* 61(3):345–381

Chen J, Liu X, Ou F, Lu M, Wang P (2023a) Green lending and stock price crash risk: Evidence from the green credit reform in China. *J Int Money Financ* 130:102770

Chen L, Lei ACH, Song C (2024) Organization capital and stock price crash risk. *Pac-Basin Financ J* 88:102587

- Chen R, Chen Y (2024) Government accounting supervision and risk of stock price crashes of listed companies: Evidence from the ministry of finance in China. *Financ Res Lett* 69:106248
- Chen S, Ye Y, Jebran K (2022a) Tax enforcement efforts and stock price crash risk: Evidence from China. *J Int Financ Manag Account* 33(2):193–218
- Chen Z, Jiang K (2024) Digitalization and corporate investment efficiency: Evidence from China. *J Int Financ Mark, Inst Money* 91:101915
- Chen Z, Xiao Y, Jiang K (2023b) Corporate green innovation and stock liquidity in China. *Account Financ* 63:1381–1415
- Chen Z, Zhou M, Ma C (2022b) Anti-corruption and corporate environmental responsibility: Evidence from China's anti-corruption campaign. *Glob Environ Change* 72:102449
- Chernozhukov V, Chetverikov D, Demirer M, Duflo E, Hansen C, Newey W, Robins J (2018) Double/debiased machine learning for treatment and structural parameters: Double/debiased machine learning. *Econ J* 21(1):C1–C68
- Cho M, Kim HD, Kim Y (2023) Audit committee accounting financial expertise and stock price crash risk. *Int Rev Financ Anal*, 102848
- Choi H, Karim K, Tao A (2022) CEO origin and stock price crash risk: Insider versus outsider CEOs. *Corporate Governance: Int Rev*
- Deng Y, Wu Y, Xu H (2020) Political connections and firm pollution behaviour: an empirical study. *Environ Resour Econ* 75:867–898
- Desai MA, Dyck A, Zingales L (2007) Theft and taxes. *J Financ Econ* 84(3):591–623
- Dong W, Gao X, Li D, Yang S (2024) Information centralization and stock price crash risk: Cross-country evidence. *Int Rev Financ Anal* 96:103585
- Du X, Jiang K, Zheng X (2024) Reducing asymmetric cost behaviors: Evidence from digital innovation. *Humanit Soc Sci Commun* 11(1):1–18
- Dumitrescu A, Zakriya M (2021) Stakeholders and the stock price crash risk: What matters in corporate social performance? *J Corp Financ* 67:101871
- Eugster N, Wang Q (2023) Large blockholders and stock price crash risk: An international study. *Glob Financ J* 55:100799
- Fan Y, Xu Z (2022) Audit firm's Confucianism and stock price crash risk: Evidence from China. *Int Rev Financ Anal* 79:101995
- Fan Y, Zhang Y (2024) Consequences of firm-specific stock price crashes on analyst forecasts: Evidence from China. *Humanit Soc Sci Commun* 11(1):1–15
- Farbmacher H, Huber M, Laffers L, Langen H, Spindler M (2022) Causal mediation analysis with double machine learning. *Econ J* 25(2):277–300
- Gan K, Li R, Zhou Q (2024) Climate transition risk, environmental news coverage, and stock price crash risk. *Int Rev Financ Anal* 96:103657
- Goldfarb A, Tucker C (2019) Digital economics. *J Econ Lit* 57(1):3–43
- Guo Y, Wang J, Wang H, Zhang F (2024) The impact of big data tax collection and management on inefficient investment of enterprises—A quasi-natural experiment based on the golden tax project III. *Int Rev Econ Finance* 92:678–689
- Hai B, Shi H, Piao T, Dou Z (2024) Digitalization of tax administration and its impact on corporate ESG performance. *Financ Res Lett* 68:105791
- He Y, Yi Y (2023) Digitalization of tax administration and corporate performance: Evidence from China. *Int Rev Financ Anal*, 102859
- Hong H, Stein JC (2003) Differences of opinion, short-sales constraints, and market crashes. *Rev Financ Stud* 16(2):487–525
- Hou C, Liu H (2023) Institutional cross-ownership and stock price crash risk. *Res Int Bus Financ* 65:101906
- Hu J, Li S, Taboada AG, Zhang F (2020) Corporate board reforms around the world and stock price crash risk. *J Corp Financ* 62:101557
- Huang C, Ho KC (2023) Does the presence of executives with a legal background affect stock price crash risk? *Corp Gov: Int Rev* 31(1):55–82
- Huang S, Liu H (2021) Impact of COVID-19 on stock price crash risk: Evidence from Chinese energy firms. *Energy Econ* 101:105431
- Huang ZX, Tang Q, Huang S (2020) Foreign investors and stock price crash risk: Evidence from China. *Econ Anal Policy* 68:210–223
- Hutton AP, Marcus AJ, Tehranian H (2009) Opaque financial reports, R2, and crash risk. *J Financ Econ* 94(1):67–86
- Jiang K, Chen Z, Chen F (2021) Green creates value: Evidence from China. *J Asian Econ* 78:101425
- Jiang K, Chen Z, Rugho A, Zhou M (2022a) Internet finance and corporate investment: Evidence from China. *J Int Financ Mark Inst Money* 77:101535
- Jiang K, Du X, Chen Z (2022b) Firms' digitalization and stock price crash risk. *Int Rev Financ Anal* 82:102196
- Jiang K, Xie X, Xiao Y, Ashraf BN (2025) The value of corporate digital transformation: evidence from bond pricing. *China Finance Rev Int*
- Jiang K, Zhou M, Chen Z (2024) Digitalization and firms' systematic risk in China. *Int J Finance Econ*
- Jin HM, Su ZQ, Wang L, Xiao Z (2022) Do academic independent directors matter? Evidence from stock price crash risk. *J Bus Res* 144:1129–1148
- Jin L, Myers SC (2006) R2 around the world: New theory and new tests. *J Financ Econ* 79(2):257–292
- Kim JB, Si Y, Xia C, Zhang L (2022) Corporate derivatives usage, information environment, and stock price crash risk. *Eur Account Rev* 31(5):1263–1297
- Kim O, Verrecchia RE (2001) The relation among disclosure, returns, and trading volume information. *Account Rev* 76(4):633–654
- Kim JB, Li Y, Zhang L (2011) Corporate tax avoidance and stock price crash risk: Firm-level analysis. *J Financ Econ* 100(3):639–662
- Kim Y, Li H, Li S (2014) Corporate social responsibility and stock price crash risk. *J Bank Financ* 43:1–13
- Kumar NN, Mohnot R (2024) Nonlinear effect of CEO tenure on stock price crash risk. *Financ Res Lett* 68:105969
- La Porta R, Lopez-de-Silanes F, Shleifer A, Vishny RW (1997) Legal determinants of external finance. *J Financ* 52(3):1131–1150
- Lamont O, Polk C, Saaá-Requejo J (2001) Financial constraints and stock returns. *Rev Financ Stud* 14(2):529–554
- Lee G, Bae M, Sohn J, Han C, Cho J (2024) Does voluntary environmental information disclosure prevent stock price crash risk? – Comparative analysis of chaebol and non-chaebol in Korea. *Energy Econ* 131:107394
- Lee W, Wang L (2017) Do political connections affect stock price crash risk? Firm-level evidence from China. *Rev Quant Financ Account* 48:643–676
- Li M, Huang Y (2024) Financial regulation and financial market stability: Evidence from stock price crash risk. *Financ Res Lett*, 69:106196
- Li J, Wang X, Wu Y (2020) Can government improve tax compliance by adopting advanced information technology? Evidence from the Golden Tax Project III in China. *Econ Model* 93:384–397
- Li P, Lu Y, Wang J (2016) Does flattening government improve economic performance? Evidence from China. *J Dev Econ* 123:18–37
- Li Y, Wang P, Zhang W (2023) Does online interaction between firms and investors reduce stock price crash risk? *Br Account Rev* 55(4):101168
- Liu G, Xie Z, Liu X, Zhang S (2024a) How does finance and accounting supervision affect stock price crash risk? *Int Rev Financ Anal* 96:103672
- Liu X, Liao J, Young M (2024b) Living through an influential socio-political event: Early-life experiences and stock price crash risk. *Financ Res Lett* 68:106015
- Liu X, Wei Z, Zhao S (2024c) Do managers have more incentives to hoard bad news during panic? A study of terrorist attacks and stock price crash risk. *Int Rev Financ Anal* 96:103554
- Liu Y, Dong J, Mei L, Shen R (2023) Digital innovation and performance of manufacturing firms: An affordance perspective. *Technovation* 119:102458
- Lobo G, Wang C, Yu X, Zhao Y (2020) Material weakness in internal controls and stock price crash risk. *J Account, Audit Financ* 35(1):106–138
- Lu J, Qiu Y (2023) Does non-punitive regulation diminish stock price crash risk? *J Bank Financ* 148:106731
- Makrychoriti P, Pyrgiotakis EG (2024) Firm-level political risk and stock price crashes. *J Financ Stab* 74:101303
- Mascagni G, Mengistu AT, Woldeyes FB (2021) Can ICTs increase tax compliance? Evidence on taxpayer responses to technological innovation in Ethiopia. *J Econ Behav Organ* 189:172–193
- Ni X, Peng Q, Yin S, Zhang T (2020) Attention! Distracted institutional investors and stock price crash. *J Corp Financ* 64:101701
- Okunogbe O, Pouliquen V (2022) Technology, taxation, and corruption: evidence from the introduction of electronic tax filing. *Am Econ J: Econ Policy* 14(1):341–372
- Okunogbe O, Santoro F (2022) The Promise and Limitations of Information Technology for Tax Mobilization. *World Bank Res Obs* 1kac:008
- Ouyang J, Liu S, Li H (2023) How does the development of digital finance affect small business tax compliance? Empirical evidence from China. *China Econ Rev*, 101971
- Paudel S, Silveri SD, Wu M (2022) Investor sentiment and asset prices: Evidence from the ex-day. *J Bank Financ* 139:106492
- Pang S, Hua G (2024) How does digital tax administration affect R&D manipulation? Evidence from dual machine learning. *Technol Forecast Soc Change* 208:123691
- Pham MDM, Nguyen TH (2023) When a gift resembles a trojan horse: CEO stock gift and stock price crash risk. *Br Account Rev*, 101235
- Piotroski JD, Wong TJ, Zhang T (2015) Political incentives to suppress negative information: Evidence from Chinese listed firms. *J Account Res* 53(2):405–459
- Pomeranz D, Vila-Belda J (2019) Taking state-capacity research to the field: Insights from collaborations with tax authorities. *Annu Rev Econ* 11:755–781
- Qadan M, Nama H (2018) Investor sentiment and the price of oil. *Energy Econ* 69:42–58
- Ren X, Zhong Y, Cheng X, Yan C, Gozgor G (2024) Does carbon price uncertainty affect stock price crash risk? Evidence from China. *Energy Econ* 122:106689
- Richardson G, Obaydin I, Liu C (2022) The effect of accounting fraud on future stock price crash risk. *Econ Model* 117:106072
- Robin AJ, Zhang H (2015) Do industry-specialist auditors influence stock price crash risk? Auditing: J Pract Theory 34(3):47–79
- Shi X, Lin Y, Wang Y (2024) Targeting poverty alleviation and stock price crash risk. *Financ Res Lett* 69:106159

- Si Y, Xia C (2023) The effect of human capital on stock price crash risk. *J Bus Ethics* 187(3):589–609
- Slemrod J, Collins B, Hoopes JL, Reck D, Sebastiani M (2017) Does credit-card information reporting improve small-business tax compliance? *J Public Econ* 149:1–19
- Stam E, Wennberg K (2009) The roles of R&D in new firm growth. *Small Bus Econ* 33:77–89
- Sun L (2023) Ultimate government control and stock price crash risk: Evidence from China. *Emerg Mark Rev* 55:100970
- Sun G, Wang J, Ai Y (2024) The impact of government green subsidies on stock price crash risk. *Energy Econ* 134:107573
- Verhoef PC, Broekhuizen T, Bart Y, Bhattacharya A, Dong JQ, Fabian N, Haenlein M (2021) Digital transformation: A multidisciplinary reflection and research agenda. *J Bus Res* 122:889–901
- Vo XV (2020) Foreign investors and stock price crash risk: Evidence from Vietnam. *Int Rev Financ* 20(4):993–1004
- Wan P, Xu M, Yang Y, Chen X (2024) CSR decoupling and stock price crash risk: Evidence from China. *Humanit Soc Sci Commun* 11(1):1–12
- Wang H, Yang L, Feng Y (2024) How does digital economy affect the industry chain resilience in China? *Humanit Soc Sci Commun* 11(1):1–14
- Wang Q, Qiu M (2023) Minority shareholders' activism and stock price crash risk: Evidence from China. *Int Rev Financ Anal* 87:102594
- Wang Q, Shen J, Ngai EW (2023) Does corporate diversification strategy affect stock price crash risk? *Int J Prod Econ* 258:108794
- Wei W, Song Y, Jin R (2024) The impact of tax digitalization on corporate salary structures. *Financ Res Lett* 64:105408
- Xu L, Huang X, Liu G, Liu Y (2023) Tax authority enforcement and stock price crash risk: Evidence from China. *Finance Res Lett*, 103831
- Yang JC, Chuang HC, Kuan CM (2020) Double machine learning with gradient boosting and its application to the Big N audit quality effect. *J Econ* 216(1):268–283
- Ye Y, Zeng L, Tao Y, Yun F (2023) Tax authority monitoring and corporate information disclosure quality in China. *Int Rev Financ Ana*, 102872
- Yu D, Wang C, Cai G, Qiang H (2024) Local gambling attitudes and firms' financing strategies: New insights from the geographic structure in China. *Pac-Basin Financ J* 85:102384
- Yu H, Liang C, Liu Z, Wang H (2023) News-based ESG sentiment and stock price crash risk. *Int Rev Financ Anal* 88:102646
- Yuan D, Shang D, Wu X (2024) Board diversity and stock price crash risk: exacerbate or mitigate. *Humanit Soc Sci Commun* 11(1):1–11
- Zaman R, Atawnah N, Haseeb M, Nadeem M, Irfan S (2021) Does corporate eco-innovation affect stock price crash risk? *Br Account Rev* 53(5):101031
- Zhang L, Chen W, Peng L (2023) The impact of tax enforcement on corporate investment efficiency: Evidence from the tax administration information system. *Account Financ* 63(2):1635–1669
- Zhang L, Liu C, Zhang J, Ke J, Yuan J (2023) Party leadership, corporate governance and stock price crash risk: Evidence from China. *Int Rev Financ Anal* 88:102632
- Zhang X, Kong L, Hu X (2024) Shades of green: The impact of greenwashing on stock price crash risk. *Financ Res Lett* 70:106285
- Zhong Q, Song Q, Lee C-C (2024) Managing crash risks through supply chain transparency: Evidence from China. *Financ Innov* 10(1):126
- Zhou K, Jin X, Li X, Tao Y (2024) Enhancing sustainable development through effective disclosure: Corporate environmental performance and readability. *Corp Soc Responsib Environ Manag* 31(1):274–291
- Zhou M, Jiang K, Zhang J (2023) Environmental benefits of enterprise digitalization in China. *Resour Conserv Recycl* 197:107082
- Zuo J, Qiu B, Zhu G, Lei G (2023) Local speculative culture and stock price crash risk. *Res Int Bus Financ* 64:101851

Acknowledgements

We thank the support provided by the STU Scientific Research Initiation Grant (Grant no. STF24004T) and the National Natural Science Foundation of China (Grant no. 72403150; 72203047).

Author contributions

Kangqi Jiang: Conceptualization, Funding acquisition, Methodology, Formal Analysis, Writing - Original Draft, Writing-review & editing, Supervision, Project administration. Xiaofeng Chen: Software, Data curation, Visualization, Writing-review & editing. Jiayun Li: Validation, Methodology, Supervision, Writing - Original Draft, Mengling Zhou: Conceptualization, Software, Software, Methodology, Software, Data curation, Writing - Original Draft, Funding acquisition. All authors have read and agreed to the published version of the manuscript.

Competing interests

The authors declare no competing interests.

Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors. The data used in this paper is based on secondary data, which is available in the public domain for research purposes.

Informed consent

This article does not contain any studies with human participants performed by any of the authors.

Additional information

Correspondence and requests for materials should be addressed to Mengling Zhou.

Reprints and permission information is available at <http://www.nature.com/reprints>

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Open Access This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by-nc-nd/4.0/>.

© The Author(s) 2025