Is the unreal world real? Corporate fraud and investment credibility*

Xi Xu†
Department of Accountancy and Finance
Otago Business School, University of Otago
Dunedin 9054, New Zealand
Tim.xu@postgrad.otago.ac.nz

Pakorn Aschakulporn
Department of Accountancy and Finance
Otago Business School, University of Otago
Dunedin 9054, New Zealand
pakorn.aschakulporn@otago.ac.nz

Jing A. Zhang
Department of Management
Otago Business School, University of Otago
Dunedin 9054, New Zealand
Jing.zhang@otago.ac.nz

First Version: 4 April 2024
Current Version: 29th July 2024

Keywords: Metaverse Investments, Information Disclosure Violation, Corporate Governance, Systematic Risk, Idiosyncratic Risk, Chinese Financial Market, Event Study.

JEL Classification Code: G14. G32. G38. M15. M38.

* I would like to extend my heartfelt gratitude to my advisors, Annie Zhang and Pakorn Aschakulporn, for their invaluable guidance, support, and insightful feedback throughout the course of this research. Their expertise and encouragement were crucial to the successful completion of this study. I am also deeply thankful to the University of Otago and the China Scholarship Council for providing the financial support through their scholarship programs, which made this research possible. Their support has been instrumental in enabling me to pursue and complete this project.
† Corresponding author. Tel: +64 277456972.

Abstract

This study explores the impact of penalties for information disclosure violations (IDV) imposed by securities regulators on Chinese firms and their subsequent investments in Metaverse. Analyzing 1,217 investment announcements from 573 firms during 2021-2023, the results indicate that Metaverse investments typically result in higher cumulative abnormal returns (CAR) and increased systematic and idiosyncratic risks. Notably, firms with a history of IDV show smaller CAR increases, lower systematic risk, and higher idiosyncratic risk compared to their non-IDV counterparts. Overall, our findings emphasize the lasting influence of previous corporate misconduct on investment performance and confirm that the market values the effectiveness of regulatory oversight in China's financial market. Additionally, a firm's history of regulatory violations is a significant factor in the valuation of subsequent corporate investment announcements.

Keywords: Metaverse Investments, Information Disclosure Violation, Corporate Fraud, Systematic Risk, Idiosyncratic Risk, Chinese Financial Market, Event Study.

JEL Classification Code: G14. G32. G38. M15. M38.

1. Introduction

In this study, we investigate the impact of administrative sanctions on corporate behavior and financial outcomes, with a particular focus on market reaction to corporate investments in emerging technology. Understanding how regulatory actions influence firm behavior is crucial for policymakers and investors, as it sheds light on the effectiveness of current regulatory frameworks. Previous research has often emphasized the immediate financial penalties of corporate misconduct, but has overlooked the long-term implications of enhanced regulatory scrutiny. Our study addresses this gap by examining not only the direct financial impacts but also the broader corporate governance and market response to regulatory sanctions.

Corporate fraud, defined as a company's illegal actions that violate national laws, regulations, and other relevant rules (Sun et al. 2017), has attracted significant attention from scholars and has been proved that corporate fraud impairs firm value after the securities regulator announced the punishment (Firth et al. 2011; Gong et al. 2021; Liebman and Milhaupt 2008). In 2023, the China Securities Regulatory Commission (CSRC)[1] intensified its crackdown on corporate fraud, penalizing 1,073 parties, a 43% increase from the previous year, and imposing fines totaling 6.389 billion RMB, a 140% rise.[2] Among these, the CSRC delisted and penalized Guangdong Amethystum Information Storage Technology Co., Ltd. (688086.SH) for fraudulent issuance and disclosure violations, requiring intermediaries to pay 1.275 billion RMB and compensate investors 1.086 billion RMB.[3] This enforcement mechanism enhances regulatory efficiency and investor protection, contributing to stock market stability. However, the company's income statement for the fiscal year 2022 shows a total operating revenue of just 176.7 million RMB. Therefore, it raises the question of whether such stringent administrative penalties and fines imposed by the regulatory measures will have a long-term impact on investor confidence in the enterprise.

Other than severe fines and a plummet in the stock price, Karpoff et al. (2008) found the financial costs associated with reputational damage from accounting fraud in listed firms are more than seven times higher than administrative penalties. Numerous studies have demonstrated that such announcements of penalties can severely damage firm's image and reputation, which can be reflexed in increased cost of debt (Gong et al. 2021; Graham et al. 2008), customer sanctions (Johnson et al. 2014), decreased revenue and increased risk (Murphy et al. 2009), and reduced household stock market participation (Giannetti and Wang 2016). More specifically, Gong et al. (2021) reveal that corporate violations highlight deficiencies in legal compliance and transparency, which increase information asymmetry among financiers thereby raising the costs for creditors to

[1] The CSRC, a ministerial-level public institution under the State Council, is responsible for overseeing and regulating the national securities and futures markets. It ensures market order and the lawful operation of these markets in accordance with relevant laws, regulations, and State Council authorizations.
[2] Source: http://www.csrc.gov.cn/csrc/c100200/c7481207/content.shtml.
[3] Source: http://www.csrc.gov.cn/csrc/c100028/c7453700/content.shtml.

obtain essential information and complicating corporate financing and investment. Bonaimé (2012) and Ota et al. (2019) indicate that a firm's reputation is built on its past actions, which can influence market reactions to its subsequent announcements. Autore et al. (2020) found that investors assess the value enhancement of firms based on the credibility of their investments in disruptive technologies. Therefore, it can be inferred that a history of violation has a very far-reaching impact on firms' development and plays an irreplaceable role, especially in its investments involving new technologies that require significant capital and good reputation.

Even many studies explore factors influencing the credibility of corporate announcements such as technical backgrounds, financial stability, ownership (Chen et al. 2022a), social trust (Pevzner et al. 2015), insider stock purchases before announcements (Babenko et al. 2012), CEO optimism (Nguyen et al. 2017), market-to-book ratios, return volatility, insider ownership rates, company performance, dividend yields, being classified in the electronics industry (Hou 2024), and timely detection and disclosure of financial restatements (Hirschey et al. 2015), the effect of announcements of punished corporate fraud on the credibility of subsequent investment announcements is still unclear.

Our research thus aims to assess whether reputation damage caused by IDV affects the credibility of a company's future investment announcements, seeking to fill this gap in the literature. Since signals that decrease information asymmetry are deemed more credible (Connelly et al. 2011), we have reason to believe that subsequent investment announcements from firms with IDV may be perceived as less credible by investors, due to the implied information asymmetry.

Metaverse, embodying a blend of virtual reality, blockchain, and digital avatars, bridging the physical and digital worlds (Lee et al. 2021), has gained significant attention in the tech sector in recent years (Xu et al. 2023). As a component of Metaverse-related investments, blockchain investment announcements typically involve strategic initiatives, recruitment efforts, and research activities without directly affecting cash flow or overall risk (Chen et al. 2022a). In comparison, investments in the broader concept of Metaverse technologies are even more abstract and conceptual. Although the market reaction to sub-technologies within Metaverse Cahill et al. (2020); (Autore et al. 2020; Ho et al. 2022) and Metaverse concept (Huang and Mao 2024; Xu et al. 2023) have been shown to be positive, information asymmetry at the firm level heightens the importance of trust for decision-making when detailed information is scarce (Wei et al. 2017; Pevzner et al. 2015). In this context, compared to other announcements, Metaverse investment announcements provide a cleaner environment to test the market reactions to different credibility signals released by the firm itself, beyond the investment announcements. And because emerging markets often have imperfect information channels, corporate fraud is more common due to legal, accounting, oversight, and governance deficiencies (Murphy and Dacin 2011). Thus, our study selects firms making Metaverse-related investment announcements to

examine the effect of reputation damage caused by IDV on market reaction to firms' future investment announcements.

Our research is based on Chinese public firms over those from developed markets for various reasons. First, a key factor is the notable rise of Metaverse in the Chinese stock market, surpassing even the US in its impact (Xu et al. 2023). China's market is characterized by institutional restrictions that curb stock liquidity, leading investors to favour short-term gains and positive news (Tao et al. 2017). Such conditions are ripe for herd mentality (Chen et al. 2018), exacerbating irrational behaviours and resulting in more pronounced and sustained overreactions in the market (Ho et al. 2022). With an increasing number of Chinese companies leveraging short-term market reactions to Metaverse news for gain (Huang and Mao 2024), the special characteristics of the Chinese market may exacerbate the consequences of disclosure fraud, it provides a unique data set for analysis. Second, although China is the world's largest transitional and major developing economy (Wang et al. 2017; Gong et al. 2021), it continues to struggle with inadequate investor protection, underdeveloped corporate governance, and poor quality of corporate information disclosure (Xiong et al. 2021). Corporate information disclosure fraud has been widespread in China (Hass et al. 2016; Huang and Rice 2012). As the potential benefits of fraud are huge in the Chinese market (Zhou et al. 2018), many Chinese firms struggling with profit maximization often resort to irresponsible practices (Wang and Li 2015; Zhang et al. 2010). Additionally, Chinese firms tend to suffer relatively minor economic repercussions following regulatory violations and display a general reluctance to embrace corporate social responsibilities (Gong et al. 2021). These factors provide a unique backdrop for examining the credibility of corporate disclosures. Given that many developing nations face similar challenges, studying investments in high-tech sectors in these countries using China's Metaverse investment as a case study offers a natural laboratory setting.

We collected and textually analyzed announcements from all Shanghai and Shenzhen A-share listed companies, identifying 1217 Metaverse-related announcements from 573 firms from 2021 to 2023 (of which 796 announcements from 292 firms explicitly involve Metaverse investments, while the rest deny involvement or comment widely). To examine the heterogeneous effects of corporate fraud on market responses to these investment announcements, we focused on disclosure fraud including delayed, omitted, or false disclosures (Liao et al. 2019; Li et al. 2023; Xiong et al. 2021). Based on historical data of corporate fraud in China from 2000 to 2024, we classified 147 out of 292 Metaverse-investing firms as firms with IDV. We then employed an event study methodology with a propensity score matching-difference in differences (PSM-DID) approach to mitigate selection bias and discern whether the market's response varied between firms with past IDV and those without. Our findings indicate that only firms explicitly declaring Metaverse-related investments consistently showed significant positive abnormal returns across multiple time windows, accompanied by notable increases in both idiosyncratic and systematic risks.

By examining the differential impacts of Metaverse-related investments on the stock performance (stock returns and risk changes) of IDV firms and non-IDV firms, it reveals from an investor's perspective that non-IDV companies experience greater value improvement and a smaller increase in idiosyncratic risk, even though the rise in their systematic risk may be relatively more. This suggests that a history of IDV serves as a risk indicator, offering a measure of credibility to Metaverse investment disclosures. The higher idiosyncratic risk associated with IDV firms highlights the need for management to focus on enhancing the credibility of their investments. In contrast, non-IDV companies exhibit higher systemic risk, possibly due to firms with IDV are likely to face a stringent regulatory environment when they announce their investments, which aligns with the findings of Wang et al. (2023), who report administrative sanctions significantly mitigate the recurrence of corporate frauds in China, suggesting an effective enhancement in internal control systems and compliance frameworks within penalized firms. Consequently, investors might perceive that IDV companies, after facing penalties, become more cautious in their information disclosure. As a result, the overall investment credibility of the IDV company group is perceived to be relatively higher.

Our research makes two main contributions. First, it extends the literature on the impact of Metaverse-related investments on the market, offering up-to-date insights into investor behaviour and market reactions to corporate technological investment. Prior studies has examined market reaction to Metaverse concept based on growth in valuation (Huang and Mao 2024; Xu et al. 2023). Our study extends a nuanced understanding of the value of Metaverse investments, not only with comprehensive growth in value, but also idiosyncratic risk, and systematic risk following corporate investment in Metaverse technology, providing references for corporate investment or external investors.

Second, numerous studies have demonstrated that such announcements of penalties can severely damage firm’s image and reputation (Gong et al. 2021; Graham et al. 2008). Building on this perspective, our research explores the extended impact of corporate fraud on subsequent company investment decisions. We provide evidence that corporate fraud can influence market reactions to future announcements, such as those related to investments. Also, the majority of research indicates that the credibility of announcements is typically influenced by a company’s current attributes, our findings suggest that a firm’s reliability is also affected by its past announcements, such as instances of corporate fraud. Therefore, we suggest that future event studies should consider whether a company has a history of penalties for corporate fraud.

The remainder of the paper proceeds as follows: In Section 2, we illustrate the background for Chinese corporate fraud and Metaverse. In Section 3, we review the related literature and propose our hypotheses in Section 4. In Section 5 we explain our sample construction with collecting announcements information and methodology used in our study. Section 6 presents our empirical results about the market reaction to

Metaverse-related investment announcements and the heterogeneous effect of IDV on them. Section 7 conducts a discussion based on our findings, and Section 8 draws a conclusion.

2. Theoretical background

2.1. China Securities Regulatory Commission and Corporate Fraud in China

The CSRC, since 1998, serves as the key overseer of China's securities markets. Empowered by the Securities Law to crack down on corporate fraud. The headquarters of CSRC is organized into 19 functional departments, including the Party Committee and the Discipline Inspection Commission. In addition, there are 36 securities regulatory bureaus established in provinces, autonomous regions, municipalities, and specially designated cities, as well as securities regulatory commissioner offices in Shanghai and Shenzhen, to conduct fraud investigations. These inquiries are the main method of uncovering corporate fraud in China. If violations are substantiated, the CSRC regularly investigates corporations and their financial statements, conducting inquiries in specific instances where there are allegations of misconduct and the findings of the China Securities Regulatory Commission's investigations will be disclosed on its official web portal (Chen et al. 2005). Although given the relatively low levels of penalties for fraudulent activities and the rate of detection in China, violations in the capital market are likely to persist (Wu 2012). Correspondingly, misconduct in corporate finances, when disclosed and sanctioned by regulatory authorities, tends to be viewed with greater severity and influence than similar revelations made through media outlets. Such formal disclosures more effectively draw the attention of stakeholders (Wu et al. 2021). Therefore, identifying companies that have previously engaged in disclosure violations announced by the CSRC holds significant research value.

China’s regulatory framework, particularly in relation to technology and information disclosure, offers a distinct perspective on how firms navigate challenges related to transparency and governance. Financial fraud in Chinese companies has consistently drawn considerable attention from both regulators and scholars (Chen et al. 2020). Defining the scope of such regulatory infractions is crucial to our study. According to Gong et al. (2021) and Wu et al. (2021), the visibility of corporate disclosure issues arises upon their detection and subsequent publication by securities authorities. Also, corporate disclosure violations that are uncovered and sanctioned by regulators carry more weight and have a greater effect than those identified by other sources like the media thereby drawing more attention from stakeholders. Hence, our study focuses on firms penalized for disclosure fraud, which we term as firms with corporate fraud.

Drawing on the findings of prior research (Liao et al. 2019; Li et al. 2023; Wu et al. 2021; Xiong et al. 2021), instances of corporate disclosure infractions have been systematically categorized into three primary types: disclosure fraud, accounting fraud and other frauds. Focusing on disclosure fraud, this category is characterized by

instances of delayed disclosure, significant omissions, and fraudulent disclosure (Liao et al. 2019; Li et al. 2023; Xiong et al. 2021). As for the realm of accounting fraud, it is defined by the creation of fictitious revenue, fictitious assets, false statements and general accounting irregularities (Li et al. 2023; Liao et al. 2019; Xiong et al. 2021). Meanwhile, other frauds encompass frauds such as initial public offering (IPO) fraud, appropriation of assets, embezzlement, illegal share trading, market manipulation and illegal loan guarantees (Xiong et al. 2021; Liao et al. 2019). In this research, our central interest lies in disclosure fraud and assessing how it influences the market reaction to Metaverse-related investment.

2.2. Metaverse

The concept of Metaverse, a term originated from a cyberpunk science fiction "Snow Crash" by Stephenson (1992), envisioned a three-dimensional virtual space populated by avatars representing individuals. Today, Metaverse, was defined as a network of immersive, interconnected spaces (Mystakidis 2022), represents a convergence of virtual reality, blockchain technology, and digital avatars, creating a new nexus between the physical and digital realms (Lee et al. 2021). In March 2021, the success of (38.26 billion USD market capitalization) Roblox Corporation's IPO on the Nasdaq signalled a watershed moment for Metaverse,[4] elevating it to a topic of public intrigue and speculative interest. This event not only signalled Metaverse's burgeoning relevance but also amplified its potential as a fertile ground for digital innovation and economic transactions. Furthermore, the speculative nature of Metaverse, with its potential as a medium of exchange, is drawing significant attention (Vidal-Tomás 2023b). Citi Bank forecasts that Metaverse could represent a market opportunity ranging from 8 trillion to 13 trillion USD by the year 2030, with the potential user base reaching approximately five billion individuals.[5]

As a part of the broader information technology (IT) landscape, Metaverse involves advanced IT infrastructure and technologies such as virtual reality (VR), augmented reality (AR), blockchain, and cloud computing to create immersive digital environments (Lee et al. 2021), this enables firms to efficiently convey their dedication to resource generation and the establishment of a competitive edge for stakeholders and investors. However, although this novel technology presents potential opportunities, it also introduces challenges that need to be navigated to forge valuable experiences within Metaverse. Among these challenges is the proliferation of new virtual spaces, which could give rise to legal and privacy concerns, as noted by Dwivedi et al. (2022). Such issues might lead to limitations on the real-time, multisensory, and social interactions that are essential for delivering satisfactory and immersive experiences, as discussed by (Hennig-Thurau et al. 2023).

Metaverse surge in popularity is mirrored in the stock market within China, even more than in the U.S., and is one of the key roles in the future development of science and

[4] Source: https://www.cnbc.com/2021/03/10/roblox-rblx-starts-trading-at-64point50-after-direct-listing.html.
[5] Source: https://www.citigroup.com/global/insights/citigps/Metaverse-and-money_20220330.

technology (Xu et al. 2023), as reflected by the Hang Seng China Metaverse Index,[6] with levels hovering around 6,000 throughout 2021. Under the mania of Metaverse-related investment, many listed firms were prompted to explore opportunities in emerging digital technologies (Cioroianu et al. 2021), but their readiness to actualize these virtual environments remains in question.

Previous research has suggested the possibility of financial, business and banking value arising from Metaverse (Dwivedi et al. 2022; Koohang et al. 2023; Tan et al. 2023). The multifaceted nature of Metaverse suggests that it has the potential to extend across all industries. Yet, with the current lack of technology and infrastructure to facilitate the development of immersive virtual worlds on a grand scale (Dwivedi et al. 2022), this still affords many companies the opportunity to engage in speculative behaviour by inaccurately announcing Metaverse-related developments, thus leveraging the excitement to inflate their value artificially. In other words, there are companies that are speculative investments and not necessarily real investments in the release of the investment announcement (Cahill et al. 2020; Cioroianu et al. 2021). Corporate fraud is more prevalent in emerging markets due to flawed legal frameworks, inadequate accounting standards, weak financial oversight, and insufficient corporate governance. (Murphy and Dacin 2011). Thus, it is interesting to explore the market reaction to Metaverse and the connection between Metaverse-related investment and corporate fraud.

3. Literature Review

3.1. Disclosure of Fraud

Following the announcement of accounting fraud or after the announcements of penalties by the securities regulatory agencies, public condemnation exerts a notable adverse effect on the stock prices of the fraudulent firms (Firth et al. 2011; Gong et al. 2021; Liebman and Milhaupt 2008). Apart from the negative detrimental impact on stock price, the academic and business communities have shown great interest in the spillover effects of corporate fraud. Wen et al. (2023) found that corporate fraud influences the stock price crash risk of interconnected firms. Files and Gurun (2018) suggest that lenders charge higher loan spreads to hedge against financial misconduct in the supplier industry. Beatty et al. (2013) indicate that significant financial misstatements by companies during a fraudulent period can trigger excessive investment among industry peers. Additionally，Li (2016) notes that distortion effects can also occur in a broader range of fraudulent activities such as restatements and extend to research and development (R&D), advertising, and pricing policies. Corporate fraud significantly impacts suppliers' investment decisions, leading to overinvestment during fraudulent activities and poorer future performance (Yin et al. 2021).

[6] Source: https://www.hsi.com.hk/eng/indexes/all-indexes/hscmi.

Beyond the spillover effects, the manifestations of reputational damage from corporate fraud is well-documented. Johnson et al. (2014) observed that sanctions from customers, such as the cessation of business relationships and a downturn in purchases, lead to both operational declines and adverse financial outcomes for the fraudulent firms as well as their customers. After financial fraud, restatements of financial reports followed by negative stock returns, higher capital costs, wider bid-ask spreads, more frequent audit revisions, and increased CEO turnover rates (Firth et al. 2011). Karpoff et al. (2008) articulate reputational loss as a foreseeable decrease in future cash flows' present value due to lower sales and heightened costs for contracts and financing, quantified as exceeding by over sevenfold of the sum of all penalties levied by legal and regulatory entities. Murphy et al. (2009) describe the reputational impact from allegations of misconduct as a combination of reduced revenues (reported earnings) and escalated risks (stock return volatility and concordance among analysts' forecasts). Additionally, Graham et al. (2008) discovered that for firms implicated in fraudulent re-signings, the loan spreads are considerably greater in contrast to those of their counterparts engaging in standard re-signings. In the research investigating reputation's impact on announcement credibility, Ota et al. (2019) and Bonaimé (2012) discovered that a company's history of completed buybacks and a consistent record of earnings forecasts build its reputation, subsequently affecting the credibility of its repurchase announcements, which supports that firms' past behaviour builds its reputation, subsequently affecting the credibility of its announcements in the future. However, literature on how reputational damage from corporate fraud influences the credibility of subsequent announcements is scarce.

Autore et al. (2020) found that stock reactions to corporate investments in disruptive technologies (like blockchain) are based on their investment credibility. Thus, it is also important to find out what factors impact the credibility of investment announcements. After reviewing prior studies about announcement credibility, most studies have examined factors that influence the credibility of corporate announcements but not corporate fraud. For instance, Chen et al. (2022b) note that similar technical backgrounds, stable financial conditions, and being a state-owned enterprise are factors that can strengthen the credibility of an announcement. Pevzner et al. (2015) discovered that more trusting societies bolster the perceived trustworthiness of corporate financial reporting, especially when a country's average education level is lower. Babenko et al. (2012) indicated that executives purchasing the stock before an announcement can also signal undervaluation and boost credibility. Nguyen et al. (2017) pointed out that buyback announcements made by optimistic CEOs tend to be more credible than those from their less optimistic counterparts. Hou (2024) identifies several indicators of a credible signal to investors, including a lower market-to-book ratio, less volatile returns, higher insider ownership rates, strong company performance, low dividend yields, and categorization within the electronics sector. Hirschey et al. (2015) demonstrate that the prompt detection and reporting of earnings restatements contribute to heightened credibility in post-restatement financial reports. Influential factors include robust corporate governance, turnover of executives or auditors, and the duration of the

detection period. The heterogeneous effect of corporate fraud on investment announcements (i.e. the Metaverse) has not been studied and this is what makes our research meaningful. Given the substantial research value of Metaverse, building on our research into the market's response to the concept of Metaverse, including its potential returns and risks, our research aims to investigate whether investors' decision-making is influenced by a company's observable history of IDV.

3.2. Market reaction to Metaverse

In recent years, multiple listed companies, even some companies whose businesses are utterly unrelated to Metaverse, have been attracted to follow suit and foray into building immersive worlds.[7] In fact, with the popularization of many new technologies related to Metaverse, such as 'blockchain' and 'cryptocurrency', plenty of firms involved false disclosures that mislead investors to manipulate prices were investigated by national regulatory authorities (Cheng et al. 2019; Cioroianu et al. 2021; Cahill et al. 2020). Metaverse is seen as an expansive, though somewhat undefined, opportunity for entrepreneurship (Wang et al. 2022; Oh et al. 2023). A strand of prior relevant research has predominantly focused on the study of Metaverse-related financial assets such as Non-Fungible Tokens (NFTs) and cryptocurrencies in the finance literature (Vidal-Tomás 2022; Yencha 2023; Vidal-Tomás 2023a; Aslanidis et al. 2022; Tong et al. 2022; Ghosh et al. 2023), even in-game Metaverse economy (Bai et al. 2023). Although a lot of literature (Cheng et al. 2019; Cahill et al. 2020; Klöckner et al. 2022) reveals the effectiveness of information disclosure of innovative technology and revolutionary knowledge in responding to a firm's value and how investors react to Metaverse investment concept has not yet received much attention.

Another strand of studies has investigated and found a positive market reaction to various sub-technologies involved in Metaverse. For instance, (Chen et al. 2022a) discovered investors reacted positively to blockchain-related announcements, Cahill et al. (2020) found more positive market reaction to smaller firms, and those announcements with speculative commitment in the U.S. market. Qin (2022) observed that the investment environment of the VR industry in the stock market was positive. Autore et al. (2020) revealed that investors initially showed a significant positive reaction to blockchain investment, but this trend reversed after three months. Vidal-Tomás (2023b) highlighted the observation that Metaverse tokens exhibit greater volatility compared to Metaverse-related stocks, suggesting that the relationship between Metaverse tokens and stocks remains to be rigorously examined. Consequently, in contrast to examining Metaverse-related sub-technologies, investigating the stock market's response to the relatively nascent concept of Metaverse, which gained prominence in 2021, holds considerable value.

The Chinese capital market is drawing more academic focus due to its increasing global impact, ongoing regulatory updates, and unique institutional setup (Luo et al. 2020). An increasing number of Chinese firms exploit transient investor overreactions to

[7] Source: https://kr-asia.com/Metaverse-hype-renews-suspicion-of-market-manipulation-in-china.

Metaverse-related announcements for personal gain (Huang and Mao 2024). However, we found that very limited literature has focused on the stock reaction to the concept of Metaverse. Specifically, Huang and Mao (2024) and Xu et al. (2023) discovered that Metaverse exerts a significantly positive influence on China's stock market. Such announcements do not significantly influence stock prices if the company is unprepared to fully engage with Metaverse infrastructure (Xu et al. 2023). Besides, Aysan et al. (2023) posited that investing in Metaverse stocks may not constitute a steadfast option for mitigating risk in the face of economic uncertainties or instabilities, which emphases that risk is also of considerable research value. Despite these insights, academic research in this field is still in its nascent stages, often characterized by short-term data spanning only a year or a few months, with limited focus on the variation in risks.

Given the substantial research value of Metaverse, our study uses event study methodology for capturing the market reaction to Metaverse investment based on the signalling theory from Connelly et al. (2011) as shown in Figure 1. According to relevant research (Rego et al. 2009; Dewan and Ren 2007; Wai Kong Cheung 2010), research using event study methodologies typically assesses two dimensions as shown by Figure 2: (1) equity return; or (2) equity risk. The return can reflect investors' expectations of a firm's future cash flow. Another term, equity risk, represented by stock volatility, indicates the volatility of a company's cash flows.

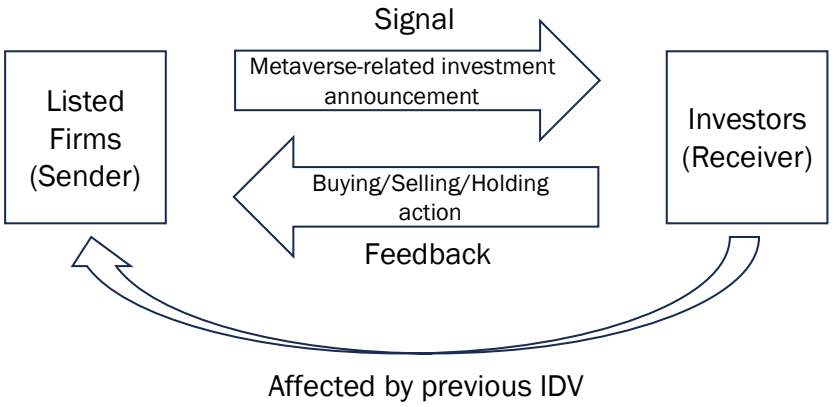

Figure 1: Signal Theory with IDV. Note: The signal is sent to investors by firms and then receivers decide to conduct trade of the firms' stock or not, which directly influencing firms' market valuation.

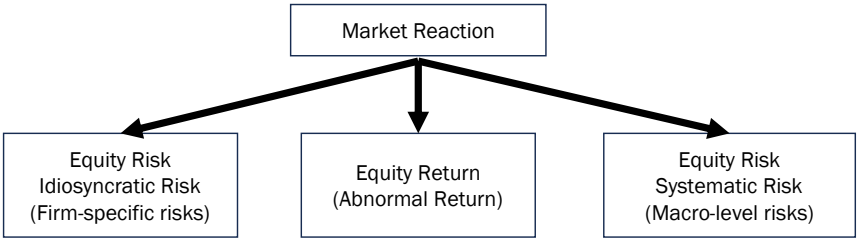

Figure 2: The composition of market reaction. Note: The abnormal returns can reflect investors' expectations of a firm's future cash flow. Idiosyncratic equity risk represents the unique volatility of a firm's equity due to specific internal factors, not linked to overall market movements while systematic risk involves exposure to widespread economic risks that affect the entire industry, like changes in market demand (Rego et al. 2009).

4. Hypothesis development

Metaverse complements the real world in numerous ways by facilitating tasks that are difficult to achieve in reality. It simplifies complex tasks and is highly beneficial for simulating social phenomena and marketing strategies. Given that the analysis of actual user experiences is more precise than the analysis of surveys based on user opinions, Metaverse holds substantial commercial value (Dwivedi et al. 2022). Pástor and Veronesi (2009) show evidence that stock prices of innovative companies experience an upsurge following favourable reports on the productivity enhancements brought about by their new technologies. Therefore, firms can benefit from Metaverse investment. The following hypothesis is proposed:

Hypothesis 1. Firms' abnormal return increases after Metaverse investment.

Idiosyncratic equity risk represents the unique volatility of a firm's equity due to specific internal factors, not linked to overall market movements. (Rego et al. 2009). As a high-tech concept for business, investment in Metaverse means a certain level of increase in R&D expenditure. Firms with higher R&D intensity, which also means advanced innovation, are found to have greater uncertainty and come with higher idiosyncratic risk (Mazzucato and Tancioni 2008). The uncertainty of firms' future profitability matches the high volatility of stock prices (Pastor and Veronesi 2006). It is assumed that higher idiosyncratic risk exists in new and high-tech industries due to increased profit uncertainty (Pástor and Pietro 2003). Thus, the idiosyncratic risk of firms that invest in Metaverse is more likely to increase as proposed by the following hypothesis.

Hypothesis 2. Firms' idiosyncratic risk increases after Metaverse investment.

Systematic risk involves exposure to widespread economic risks that affect the entire industry, like changes in market demand. (Rego et al. 2009). Firms that operate a data-related business are exposed to greater economic risks (Yu et al. 2017). Also, Center for Countering Digital Hate (CCDH) found that gaming platforms like VRChat reveals issues such as online harassment, sexual deviance, loneliness, and depression,[8] which can affect user engagement, the reputation of Metaverse platforms, and ultimately investment returns. These findings suggest that systemic risks for companies investing in Metaverse could increase, necessitating careful risk assessment and management strategies to mitigate potential negative impacts on corporate investments in Metaverse (Ortiz 2022). Thus, the following hypothesis is proposed:

Hypothesis 3. Firms' systematic risk increases after Metaverse investment.

[8] Source: https://counterhate.com/blog/new-research-shows-Metaverse-is-not-safe-for-kids/.

Huang and Mao (2024) suggest that initial Metaverse-related announcements tend to incite an overly enthusiastic response from investors. Additionally, it seems that this opportunity is sometimes seized by managers for self-enrichment by capitalizing on the overreaction, which may lead to short-term investor deception. This pattern of hype may influence investor behaviour, with different reactions observed between companies that engage in hyping their Metaverse investments and those that abstain, highlighting the need for discernment in distinguishing between genuine investment potential and mere hype. According to prior studies, investment announcements in blockchain deemed credible are associated with stronger announcement reactions (Autore et al. 2020). Likewise, Liu et al. (2021) found that the stock market reacts negatively to news of firms' corporate social irresponsibility behaviours. Consequently, firms with a history of IDV may be perceived by investors as more likely to engage in potential stock price manipulation. This perception could lead to a preferential bias among investors towards companies that have maintained a record of compliance with disclosure regulations as proposed:

Hypothesis 4. The abnormal return of firms with IDV increases less than non-IDV firms after Metaverse investment.

As indicated in hypothesis 2, in terms of risks to a firm, equity risk gauges the fluctuations in a company's stock performance. This metric is theoretically indicative of investor sentiment regarding the firm's prospective cash flows, as informed by publicly disseminated announcements, such as those of investments in Metaverse. Specifically, IT implementation is inherently risky because of technological complexity and implementation challenges (Maruping et al. 2009), with the simultaneous announcement of Metaverse and false disclosure, differences in costs may arise from the varying degrees of investment implementation, reflecting a predisposition among participants to speculate on potential economic gains derived from the involved concept, rather than the efficacy of actual operational activities. Therefore, Metaverse investment by firms with previous fault disclosure is associated with higher uncertainty in implementation risk compared to firms without. Higher uncertainty leads to higher volatility of stock returns from Metaverse investment. Therefore, the following hypothesis is proposed:

Hypothesis 5. IDV firms' idiosyncratic risk increases more than non-IDV firms after Metaverse investment.

Consistent with the literature previously summarized (Firth et al. 2011; Gong et al. 2021; Liebman and Milhaupt 2008), it has been observed that incidents of IDV exert a significant adverse effect on firms' stock prices. Consequently, it is plausible to infer that investors may exhibit lower trust towards firms with a history of IDV compared to those without such incidents. Furthermore, with the increasing utilization of Metaverse for speculative purposes, as noted by Huang and Mao (2024), investor confidence in the entire industry related to Metaverse investments could likely be less optimistic.

Autore et al. (2020) highlight that blockchain investment announcements viewed as untrustworthy are generally associated with greater risk in later periods. During the development of Metaverse, the prevalence of bullying, pornographic content, racism, and threats of violence within virtual environments has been widely noted, as highlighted in reports by the CCDH. Such issues underline the social and content moderation challenges that Metaverse faces. Furthermore, as Metaverse technology is still evolving and stabilizing, the systemic risk to the entire industry increases, according to Yu et al. (2017). This rise in systemic risk is not only attributed to the nascent state of Metaverse technology and the uncertainty surrounding its regulatory frameworks but is also potentially exacerbated by IDV firms, which introduce additional layers of uncertainty. Given their history of IDV, IDV firms could be facing greater skepticism about their use and governance of emerging technologies, contributing to an overall higher systemic risk in comparison to non-IDV firms. These concerns stem from the uncharted implications these virtual spaces have on user behavior and society at large, magnified by the possibility of misuse by firms with questionable track records. Therefore, we hypothesize that the systematic risk associated with Metaverse investments by firms with IDV could be perceived as larger.

Hypothesis 6. IDV firms' systematic risk increases more than non-IDV firms after Metaverse investment.

5. Data and methodology

The event study methodology, which evaluates the influence of specific events on the value of firms, is a widely accepted approach for gauging investors' immediate reaction to various announcements. This method is broadly applied across multiple fields, including information systems, finance, marketing, and management, and it is instrumental in quantifying how stock market prices are affected by corporate announcements (Rego et al. 2009; Dewan and Ren 2007; Wai Kong Cheung 2010; Firth et al. 2011; Gong et al. 2021; Liebman and Milhaupt 2008).

In our research, we use the event study method to analyze the impact on returns and risks associated with announcements regarding Metaverse investments. Considering that the choice to undertake Metaverse investments is made at the discretion of the firm, there exists a strong potential for selection bias that may set these firms apart on a systemic level from their counterparts that do not engage in Metaverse investments. To mitigate the self-selection bias, we implemented the PSM method to match a comparable control group for our treatment group. This approach in our data analysis enhances our ability to draw more reliable causal inferences and to estimate the effect of investing more accurately in Metaverse with reduced selection bias (Li 2013).

5.1. Data

The primary subject of our study is the corporate announcements of a Metaverse investment made by a firm. We obtained the announcements from 2002 from the China Stock Market and Accounting Research Database (CSMAR). Our study focuses on

Chinese firms that are listed in four major stock markets in China: the Shanghai A-share market, the Shenzhen-share market, the Chinese Growth Enterprise market, and the Chinese Science and Technology Innovation market. We first retrieved the data with the Chinese search term “Metaverse” in both titles and contents of the data set, which returned 3,728 announcements about Metaverse from 2021 to 2023 (Table 1). Notably, we checked the titles and contents of all Metaverse-related announcements and excluded the plethora of information available that extends beyond mere announcements issued by individual firms, such as news compilations consisting of many types of announcements, duplicated announcements issued by other news agencies, and financial analysis reports or irrelevant news with content that only mentions Metaverse literally. After this step, 1,792 Metaverse-related announcements remained. In order to eliminate the confounding effect from other events, we followed McWilliams and Siegel (1997) and dropped Metaverse-related announcements that had a board of shareholders, change of administrator, and earnings call within the two days around the focal announcements, leaving 1,561 Metaverse-related announcements. Next, we exclude the repetitive events or the adjacent events with opposite effects around the focal announcements, remaining 1,339 announcements. After, we excluded the announcements without enough historical stock data for estimation. Finally, remained 1,217 announcements were classified into three groups: 796 announcements that firms claimed their Metaverse initiatives or acted as practically involved in Metaverse, 130 announcements that firms simply commented widely on Metaverse, and 291 announcements that firms claimed no intention to get involved in Metaverse. The main dataset was comprised of 796 announcements about Metaverse investment, originating from 292 companies. The chronologically earliest announcement occurred on June 4, 2021, with the most recent on November 9, 2023. For specific instances of these announcements, please see
Appendix.

Table 1. Date filtering procedure.

Procedure	Change in number of the announcements	Retained number of the announcements
Step 1: Search events with keywords("Metaverse") and are in the period from 2002 to 2023 in the Chinese A-share market (i.e., Shanghai A-share, Shenzhen A-share, Chinese Growth Enterprise Market and Chinese Science and Technology Innovation Market).	+3728	3728
Step 2: Exclude events Compilation (events content with previous event date).	-408	3320
Step 3: Exclude events with the same title or content announced before.	-160	3160
Step 4: Exclude events of Stock Market performance or technical analysis.	-927	2233
Step 5: Exclude irrelevant events with content that only mentions Metaverse literally.	-441	1792
Step 6: Exclude events with confounding events (e.g., board of shareholders, change of administrator, earnings call) in the event window [-2,2].	-231	1561
Step 7: Exclude duplicated events with the same classification announced on the same day or the next day.	-198	1363

Step 7: Exclude all events that occurred on the same day but was of a different classification.	-24	1339
Step 8: Exclude events without sufficient stock data	-122	1217
Step 9: Events classification:	1. Firms claimed their Metaverse initiatives or acted as practically involved in Metaverse: 796 2. Firms simply commented widely on Metaverse: 130 3. Firms claimed no intention to get involved in Metaverse: 291	

To pinpoint firms with IDV, our search targeted enforcement reports of disclosure fraud, characterized by delayed reporting, significant omissions, or fraudulent disclosures, as delineated in studies by Li et al. (2023), Liao et al. (2019), and Xiong et al. (2021). Enforcement reports from Chinese governmental agencies, including the Ministry of Finance, the Shanghai and Shenzhen stock exchanges, and notably the CSRC, highlight instances of corporate misconduct. The CSRC, has instituted committees for disciplinary inspection and administrative sanctions to address and discipline fraudulent activities within corporations, tasked with the enforcement of securities laws and regulations, demands ethical behaviour and transparent information disclosure from listed companies, following legal mandates (Du 2015). If violations are substantiated, the findings of the CSRC's investigations will be disclosed on its official web portal (Chen et al. 2005).[9] Because this set of data has been collected and collated by the CSMAR database, we can directly collect all the Enforcement reports data from there. This search returned 9,025 instances (8,542 nonredundant samples) involving 2,481 companies from 2000 to 2024. For specific examples of IDV announcements, refer to
Appendix. Ultimately, we identified 147 of the 292 firms invested in Metaverse as IDV firms, due to at least one violation of information disclosure that occurred before Metaverse-related announcements within the search timeframe.

5.2. Event study methodology

In this study, we employed the event study methodology to capture the market reaction to investments related to Metaverse. Researchers frequently use stock return and risk as key metrics to assess the value of a company when applying this methodology (Rego et al. 2009; Dewan and Ren 2007; Wai Kong Cheung 2010). Consequently, we have calculated three dependent variables: Cumulative abnormal return, idiosyncratic risk, and systematic risk as DV_{it} using the event study method to facilitate our empirical analysis. This approach allows us to systematically quantify and interpret the impact of Metaverse investments on firm value, aligning our research with established practices in the field.

In our methodology, the asset pricing models commonly employed in the context of the Chinese market include the Fama-French five-factor (FF5F) and other models. A significant portion of the literature suggests that the FF5F model tends to outperform

[9] The CSRS website: http://www.csrc.gov.cn/pub/newsite.

other models in terms of stock pricing efficiency (Lin 2017; Wang 2023; Chen et al. 2022b; Sha and Gao 2019; Guo et al. 2017; Wang et al. 2021). For instance, many researchers conducted a comparative analysis of the Chinese market and revealed a superior explanatory capability of the FF5F model over the Fama-French three-factor (FF3F) model (Lin 2017; Chen et al. 2022b; Guo et al. 2017). Besides, comparing with the CAPM, FF3F, Fama-French-Carhart, and Fama-French six-factor models, it is found that the FF5F model surpasses the others in explaining returns within the Chinese mutual fund industry and across various fund categories (Sha and Gao 2019).

Wang et al. (2021) indicates that in the face of explosive price movements, the FF5F model is notably adept at clarifying the observed variances in cross-sectional stock returns. Given that announcements related to Metaverse investment inherently exhibit such price volatility, it becomes increasingly pertinent for our study to employ the FF5F model to capture these dynamics accurately. The daily stock returns for all firms are based on Daily Dividend-Reinvested Stock Returns and the market indexes were all collected from the CSMAR database.

5.2.1. Equity return

To evaluate the effect of specific events on stock prices, we utilized the CAR over the event window around Metaverse-related investment events as our first dependent variable. Our analysis was grounded in the FF5F (Fama and French 2015), as outlined in Equation (1), which was employed to calculate the abnormal returns of stocks. This model integrates five key factors: market return, size, book-to-market value, profitability, and investment patterns.

$$R_{it} - R_{ft} = \beta_{0i} + \beta_{1i}(R_{mt} - R_{ft}) + \beta_{2i}SMB_t + \beta_{3i}HML_t + \beta_{4i}RMW_t + \beta_{5i}CMA_t + \varepsilon_{it} \quad (1)$$

In Equation (1), R_{it} represents the daily return of company i on day t, while R_{mt} denotes the daily return of the market portfolio m on day t. R_{ft} is the daily risk-free return on day t, SMB_t highlights the return differential between small-cap and large-cap firms, HML_t captures the return disparity between stocks with high and low book-to-market ratios, RMW_t signifies the return difference between diversified stock portfolios characterized by strong versus weak profitability. CMA_t indicates the return variance between diversified portfolios from firms with low versus high investment levels, termed as conservative versus aggressive and ε_t is a zero-mean residual error. The data for the FF5F ($R_{mt}, R_{ft}, SMB_t, HML_t, RMW_t$, and CMA_t) were collected from the CSMAR database, and we employed a 2-by-3 portfolio approach where data is weighted according to total market capitalization.

Following McWilliams and Siegel (1997), to accommodate potential pre-announcement information leaks and post-announcement news dissemination delays, we selected a three-day event window [−1, 1] surrounding the event date. To ensure that our time window does not significantly diverge from the actual event and thus compromise the accuracy of our event impact estimation, we decided that events would

be discarded if the trading days with data within the 3-day event window extend more than 7 days from the event date. Moreover, according to the research from Zhang et al. (2021), parameter estimation for our model can be conducted via ordinary least squares regression across a 180-trading-day period, concluding 10 days before the event to mitigate any announcement-related impacts and prevent estimated non-stationarity; thus we set [-190, -11] for our estimation windows. Additionally, we stipulated that each firm must present at least 50 days of stock return data within the estimation timeframe. The event study methodology isolates returns that are theoretically expected in the absence of the event under investigation. Therefore, we computed abnormal returns (AR_{it}) for firm i on day t by calculating the deviation between actual and anticipated returns, following the formula presented in Equation (2). After that, we calculated the cumulative abnormal return $CAR_{i(T_1,T_2)}$ for firm i over the period [T1,T2] by adding up all the AR_{it} in the period as shown in Equation (3).

$$AR_{it} = (R_{it} - R_{ft}) - [\hat{\beta}_{0i} + \hat{\beta}_{1i}(R_{mt} - R_{ft}) + \hat{\beta}_{2i}SMB_t + \hat{\beta}_{3i}HML_t + \hat{\beta}_{4i}RMW_t + \hat{\beta}_{5i}CMA_t] \quad (2)$$

$$CAR_{i(T_1,T_2)} = \sum_{t=T_1}^{T_2} AR_{it} \quad (3)$$

5.2.2. Equity risk

Through event study methodology, we are able to calculate the total risk and then decompose it into systematic and idiosyncratic risk components by examining the variance in the equation of the FF5F model (1):

$$Var(R_i - R_f) = \beta_i{}^2(R_m - R_f) + Var(\varepsilon_i) \quad (4)$$

In Equation (4), $Var(R_i - R_f)$ is the total risk, which can be divided into the systematic risk β_i and the idiosyncratic risk $Var(\varepsilon_i)$. We estimated the change in idiosyncratic risk and systematic risk before Metaverse-related investment event and after them following the model used in Dewan and Ren (2007) and Zhang et al. (2021). We set the market index β_m from the FF5F model as the systematic risk and the standard deviation of residuals of the FF5F model as the idiosyncratic risk. Then, we furthermore followed their model and measured the change in both types of risks by subtracting the pre-event risks from the post-event risks as shown by Figure 3.

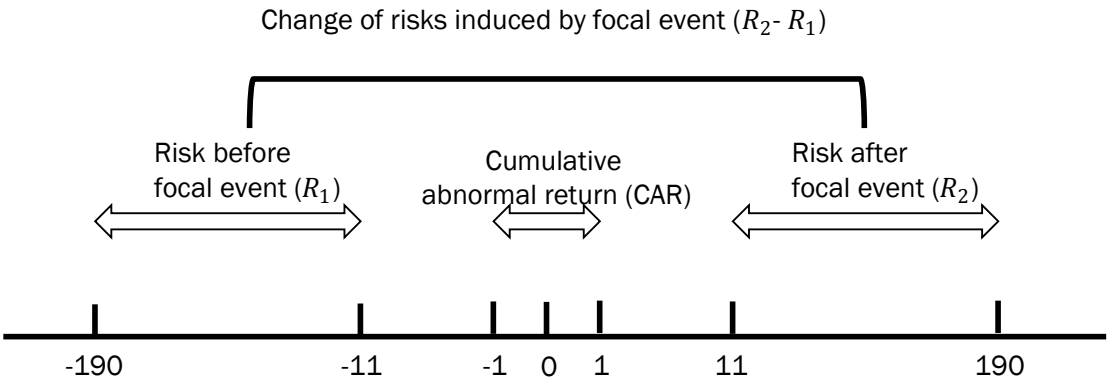

Figure 3: The time window to compute pre-event and post-event risks. Note: We calculated idiosyncratic and systematic risks for the periods before (-190 to -11 trading days) and after (11 to 190 trading days) the events, respectively. a positive value indicates an increase in firm risk after Metaverse-related investment, whereas a negative value signifies a decrease in risk after the adoption.

5.3. PSM-DID methodology

Our research aims to explore the causal relationship between Metaverse investment announcement and firm valuation, as well as the heterogeneous effects of a firm's information disclosure violation history (IDV). Endogeneity is a key concern in such studies. Previous research has discussed how corporate social responsibility performance moderates the financial impact of subsequent announcements, indicating that financial performance is less likely to have endogeneity problems when being a main dependent variable (Flammer 2013; Masulis and Reza 2015). In our event study, it is evident that reverse causality between Metaverse investment announcements and firm valuation changes is not credible. This would imply that companies would need to wait for their stock price to rise before making an announcement instantly, which is impractical (Wang and Li 2015). Additionally, changes in stock price cannot affect a firm's past violation history. Therefore, our study has less concerns about endogeneity issues. Despite this, to mitigate endogeneity concerns, we follow the guidance of Roberts and Whited (2013) and investigate the causal impact of Metaverse-related investment announcements on firm financial performance using DID and matching methods. The DID approach offers several advantages over previous methods (Roberts and Whited 2013). It effectively addresses the issue of overlooked trends related to Metaverse investments and firm financial performance over time in both the treatment and control groups. By minimizing the impact of unobserved differences between these groups, it helps mitigate endogeneity concerns, making it a robust method for our analysis. Thus, we analyze whether the observed firm financial performance remains consistent after controlling for firm differences besides the investment announcements by conducting a DID estimation of an average effect, incorporating an exogenous shock (IDV history) to Metaverse-related investments.

The DID approach relies on the parallel trends assumption (Roberts and Whited 2013), which means that any trends in outcomes for the treatment and control groups before the treatment must be the same. This is why the introduction of PSM is necessary. When integrating PSM with DID, following (He et al. 2024; Cheng et al. 2024; Wu et al.

2021),researchers initially employ PSM to ensure the treatment and control groups are comparable. Subsequently, they apply the DID approach to these well-matched groups to pinpoint the actual impact of the intervention. This dual-method strategy is adept at accounting for both unobservable factors that do not change over time (handled by DID) and imbalances in observed characteristics (addressed by PSM). Such a methodological fusion strengthens the estimation of causal effects in scenarios where randomized treatment assignment is not feasible, bolstering the credibility of the findings in a quasi-experimental context. This approach is particularly valuable in financial research, providing a more rigorous analysis where experimental conditions are challenging to replicate (Wu et al. 2021).

5.3.1. Propensity score matching

We designated firms with Metaverse-related investments as the treatment group and employed PSM (Rosenbaum and Rubin 1983) to pair each company in this group with a control group benchmark firms that DID not engage in Metaverse-related investment but shared similarities with the sample firms in primary areas of characteristics.

After reviewing several studies (Corbett et al., 2005; Dewan & Ren, 2007; Zhang et al., 2021), to ensure the similarity in stock performance and firms' characteristics, we ultimately matched each event-firm observation in our dataset with a corresponding control observation in the same date and selected the following criteria for matching: (1) the average daily stock return over the 500 trading days before the event (At least 50 trading days available), (2) the average daily number of shares traded over the 500 trading days prior to Metaverse-related event (At least 50 trading days available), (3) whether the firm is a IDV-firm before Metaverse-related event, and (4) the initial letter standard industrial classification (SIC) code of the firm as industry fixed effect. As for the technical parameter setting of PSM, we applied the nearest neighbour as 1 and the calliper of the propensity score's standard deviation as 0.05, thereby excluding 53 deficient observations that might contaminate the later comparison analysis. Eventually, we got 1,486 event-firm observations (743 as the treatment group and 743 as the control group) and conducted a kernel density distribution plots for a balance test to see the effect of the PSM method on the balance of the key criteria between these two groups (Figure 4).

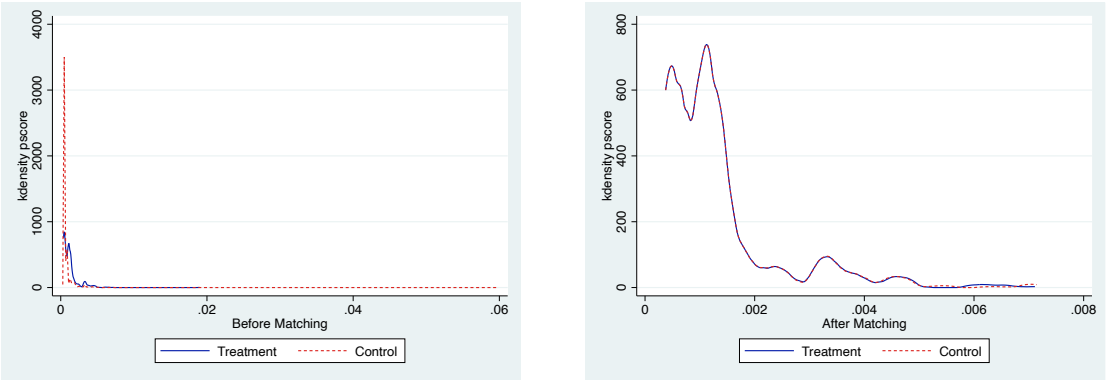

Figure 4. Distribution of propensity score before (left) and after (right) matching. Note: The balance test is used to see the effect of the PSM method on the balance of the key criteria between these two groups, examines the similarity in stock performance and firms' characteristics between event-firm observations and their corresponding control observations. The nearest neighbour method with a caliper of 0.05 was applied for matching.

5.3.2. Difference-In-Differences regression

After producing the corresponding control group from the PSM process, we calculated CARs and risks for every sample of the control group, the same as we calculated for the treatment group with the FF5F model.

$$DV_i = \beta_0 + \beta_1 Treatment_i + \beta_2 IDV_i + \beta_3 Treatment_i \times IDV_i + \beta_i Control_i + YEARs + \varepsilon_i \quad (5)$$

Based on DID method (Card and Krueger 2000), we analyzed how firms with IDV and other factors affect equity returns and risks through the regression model shown in Equation (5), specifically, the dependent variables (DV_i) can be the CAR, change in idiosyncratic risk or change in systematic risk for a Metaverse-related investment announcement. $Treatment_i$ is a binary indicator set to 1 for firms with Metaverse-related investments and 0 for matched firms without. IDV indicates IDV firms with 1 and non-IDV firms with 0. $Treatment_i \times IDV_i$ is the interaction term and its coefficient β_3 indicates the heterogeneous effect in our research. $Control_i$ includes various control variables. $YEARs$ comprises all year dummy variables, and ε_i represents the error term.

Many literatures study the effect of information disclosure. Specifically, various studies have highlighted how certain structural factors like earnings quality (Francis et al. 2008), financial reporting frequency (Fu et al. 2012), voluntary disclosure (Gordon et al. 2010), and foreseeability (Hwang et al. 2008) differentially influence market reactions. In our study, we followed (Zhang et al. 2021), integrated both firm-specific and environmental variables as control variables to mitigate extraneous influences as summarized in Table 2. Finally, only 583 pairs from the treatment-control group combinations had enough historical stock data and comparative data available.

The firm-specific variables we considered include annual R&D, advertising expenditures, firm size, financial performance, and previous engagements with Metaverse-related investments, all of which were obtained from the CSMAR database according to the fiscal year preceding the year of Metaverse-related investment event.

- **R&D**

A firm's investment in R&D expenditure may serve as an indicator of its technological capabilities (Ravichandran et al. 2017). R&D intensity has a detrimental impact on short-term profitability but exerts a beneficial influence on long-term firm value (Leung and Sharma 2021). Thus, our study used R&D intensity as a control variable and measured it by dividing a company's R&D expenditures by its total sales (Honoré et al. 2015; Leung and Sharma 2021).

- **Advertising**

Advertising enhances a firm's value by increasing its visibility among investors (Lou 2014). In China, firms do not individually disclose their advertising costs. As a substitute, selling expenses, which encompass advertising costs, sales salaries, and commissions, are all associated with efforts to boost sales (Ye and Zhang 2011). Consequently, selling expenses serve as a suitable indicator for assessing the advertising strength of a company (Zhang et al. 2010). Therefore, our study measured the advertising intensity by dividing the selling expense of a firm by its total assets as a control variable.

- **Firm size**

Cash flow sensitivity to investment tends to be higher in larger firms and lower in smaller firms (Kadapakkam et al. 1998). Investment in R&D grows as firm size increases (Dosi 1988; Acs and Audretsch 1988), especially for companies within the high-tech industries (Kleinknecht 1991). In our study, we initially measured firm size using the natural logarithm of total assets as a control variable. However, after encountering multicollinearity in the later regression analysis, we opted to standardize this measurement to address the issue of multicollinearity.

- **Financial performance**

Return on Assets (ROA) is commonly used to assess financial performance (Rego et al. 2009). Wang et al. (2010) observed that larger companies tend to garner more attention from investors. ROA, which stands for ROA, is defined as the ratio of net income to total assets. Zhang et al. (2021) also discovered a statistically significant impact of ROA on the risk changes associated with IT investment. Consequently, our study also utilizes ROA to measure financial performance.

- **Previous engagement**

Following the research from Zhang et al. (2021), firms' history with Metaverse-related investment was determined by the total number of Metaverse-related investment announcements it made before the focal event.

Regarding environmental factors, we controlled investor attention and industry classification to mitigate the extraneous influence of our regression model.

- **Investor attention**

There is a strong correlation between Stock Market Volatility and Internet search volume (Dimpfl and Jank 2016). We factored in investor attention in Metaverse through the Google Trends Index in China.[10] This index offers a standardized way to track the rise or fall of internet searches related to specific terms over time (Wu and Brynjolfsson 2015). This approach has been previously employed to represent as a proxy for investor attention (Aslanidis et al. 2022; Tong et al. 2022; Urquhart 2018). For our analysis, we compiled weekly Google Trends data spanning from 2020 to 2023, focusing on "Metaverse" in both English and Chinese, conducted within the territorial boundaries of China as the search term. Considering the data's comparative aspect, we employ the methodology described by Dimpfl and Jank (2016), which involves standardizing search frequencies such that the average frequency over the analyzed period equates to one thereby ensuring a uniform measurement scale. Thus, we collected and averaged

[10] The Google Trend website: https://trends.google.com/trends

the Google Trends index for "Metaverse" in both English and Chinese during the same week as the focal Metaverse-related announcements and subsequently standardized this measure to serve as one of our control variables.

- **Industry**

Similar to the research approach from Zhang et al. (2021), to account for variations attributable to industry-specific traits, we identified companies operating within data-centric sectors by SIC codes as a means of controlling for industry-level fixed effects. The SIC data were collated by the CSMAR database, with the original data sourced from the industry classification documents announced by the CSRC in 2012.[11] Specifically, those within the ranges of J and K (covering Finance, Insurance, and Real Estate) and I, L, M, P, and R (services covering IT, Renting and business, Science & Technology, Education and Culture & Recreation).

Table 2. Variable definition.

Variables	Definitions
1.Equity return - CAR	The cumulative abnormal returns (CAR) of each Metaverse-related announcements in the event window of [− 1,1], are calculated based on the FF5F model.
2. Equity risk - Idiosyncratic risk	Idiosyncratic risk is the standard deviation of residuals of the FF5F model. It is computed by comparing the pre-event and post-event values of residuals derived from the FF5F model. The negative value means that firms' risk decreases after Metaverse adoption, and the positive value means that firms' risk increases after Metaverse adoption.
3. Equity risk - Systematic risk	In the FF5F model, systematic risk is represented by β_m which is the beta of the market index. This risk is computed by comparing the values before and after a specific event. Specifically, a negative value of β_m indicates that a firm's risk decreases after the adoption of Metaverse (Dividend Per Share), whereas a positive value suggests an increase in the firm's risk following Metaverse adoption.
4. IDV	The IDV variable is set as 1 indicating a firm was punished for false disclosure and 0 otherwise.
5. Size	The total assets (RMB) of firm i in year t-1 in natural logarithm before standardized.
6. ROA	The return on assets (RMB) of firm i in year t-1.
7. Advertising	The selling expense (including advertising, exhibition and other expenses) of firm i in year t-1 standardized by total assets.
8. R&D	The proportion of R&D investment to operating income is disclosed directly of firm i in year t-1.
9. Metaverse experience	The number of prior Metaverse-related announcements by firm i before the focal Metaverse-related announcements.
10. Google_Metaverse	The standardized Google trends index of "Metaverse" in the same week of the focal Metaverse-related announcements (average of Chinese and English words).
11. Industry	Set as 1 if the firm belongs to Finance, Insurance and Real Estate Sector or Services Sector (I, J, K, L, M, P, R), otherwise 0.
12. Year	Dummy variables for the year.
13. Treatment	The Treatment variable is set as 1 indicating a firm invests in Metaverse and 0 for its matched firm without Metaverse investment.

Note: The unit of total assets in the measurement of size, and the unit of assets in the measurement of ROA are both RMB.

[11] SIC classification document: http://www.csrc.gov.cn/csrc/c100103/c1452024/content.shtml.

6. Results

6.1. The market reaction to Metaverse-related investment

We examined if the abnormal returns from 1,217 Metaverse-related investment announcements were significantly different from zero using t-tests on the CARs. To ensure the robustness of the results, we refer to the methodology from Baum et al. (2007) to control for heteroskedasticity and autocorrelation issues in the data via calculating robust standard errors similar to Newey-West standard errors (Newey and West 1987). The overall CAR for these Metaverse-related investments and the separate CARs for IDV and non-IDV firms are listed in Table 3. Across all event windows, we observed a significantly positive overall effect of CARs for all events, which includes explicit mentions of Metaverse investment, mere commentary on Metaverse, and clarifications of non-involvement with Metaverse. Upon further categorizing the events, we found that firms with clear involvement in Metaverse exhibited a consistently positive effect in all event windows, regardless of whether they were firms with IDV or not. However, for those events merely commenting on Metaverse or clarifying their non-involvement, CARs across all windows DID not show a significant effect. Therefore, we concentrate our research on the announcements having explicit mentions of Metaverse investment. Table 4 presents the descriptive statistics for the 796 Metaverse-related events and associated firms, while Table 5 displays the correlation matrix for all variables related to these firms at each specific event time.

Table 3. Cumulative abnormal return of Metaverse-related investment.

	Sample size	CAR (%) t = [-1,0]	Newey-West t-test	CAR (%) t = [-1,1]	Newey-West t-test
Overall	1,217	1.06888	6.71***	1.27008	6.36***
Involved firms	796	1.31458	6.76***	1.63946	6.71***
IDV	428	1.49661	5.14***	1.78151	5.05***
Non-IDV	368	1.10288	4.42***	1.47426	4.44***
Ambiguous firms	130	1.09604	1.85*	1.22864	1.62
IDV	54	0.46186	1.25	0.96996	0.83
Non-IDV	76	1.54664	2.04*	1.41243	1.43
Denied firms	291	0.38466	1.29	0.27817	0.76
IDV	161	0.31849	0.80	0.27509	0.52
Non-IDV	130	0.4666	1.03	0.28198	0.58

Table 4. Descriptive statistics.

Variable	Obs	Firms	Mean	Std. Dev.	Min	Max	Median
1.CAR(-1,1)	796	292	0.01638	0.06897	-0.20868	0.43017	0.00593
2.Idiosyncratic risk	796	292	0.00001	0.00052	-0.00388	0.00383	0.00008
3.Systematic risk	796	292	-0.00016	0.00079	-0.01388	0.00228	-0.00000
4.IDV	796	292	0.53769	0.49889	0.00000	1.00000	1.00000
5.Size	796	292	0.14809	1.07041	-1.92691	5.37654	-0.05396
6.ROA	796	292	0.01288	0.10603	-0.54830	0.37700	0.02950
7.Selling	790	286	0.05711	0.08560	0.00019	0.63207	0.03244

8.R&D	769	273	9.64377	13.41226	0.05000	217.46000	6.03000
9.Metaverse_Experience	796	292	2.80402	3.34051	0.00000	17.00000	2.00000
10.Google_Metaverse	796	292	0.00000	1.00000	-1.30302	1.917497	-0.13640
11.Industry	796	292	0.18342	0.38725	0.00000	1.00000	0.00000

Note: N =796 Involved-Metaverse-related announcements in the sample. The table describe all the variables we used in our regression model based on their observation number (Obs), firms number (Firms), mean value (Mean), standard deviation (Std. Dev.), minimal value (Min), maximum value (Max) and median value (Median).

Table 5. Correlation matrix of variables.

CAR	1	2	3	4	5	6	7	8	9	10	11
1. CAR(-1 1)	1										
2.Idiosyncratic risk	-0.0282	1									
3. Systematic risk	0.0107	-0.00790	1								
4. IDV	0.0222	0.0329	-0.0673	1							
5. SIZE	-0.1401*	0.1346*	-0.0206	-0.0568	1						
6. ROA	0.00860	-0.00750	-0.00680	-0.1703*	0.1193*	1					
7. Selling expense	0.0332	-0.0584	-0.1217*	-0.00250	-0.1531*	0.0641	1				
8. R&D	-0.00680	-0.0293	0.0106	-0.1485*	-0.1708*	-0.1459*	0.0792*	1			
9. Metaverse exp	-0.0500	-0.0856*	0.0391	0.0860*	-0.00370	-0.0709*	0.2189*	-0.0228	1		
10.Google_Metaverse	0.1594*	0.0207	-0.00690	0.0119	-0.0941*	0.0836*	-0.0180	-0.0989*	-0.3928*	1	
11.Industry	0.1253*	-0.1736*	-0.0247	0.1036*	-0.0636	-0.1021*	0.0458	-0.1218*	0.0980*	-0.00200	1

Note: *p <.05. N =796 Involved-Metaverse-related announcements in the sample.

6.2. PSM-DID analysis

Our dataset comprises a panel data structure, encapsulating a collection of companies over time, each characterised by a set of control variables that represent various features. Due to missing data from both the treatment group and the matched control group, the total number of samples we were able to use was 1,166. To find a suitable regression model for our panel data, we performed the Modified Wald test from Wooldridge (2010) for groupwise heteroskedasticity in our panel model thereby examining whether the variance of the error term differs across panels. Based on the random effect model using CAR [-1,1], idiosyncratic risk, and systematic risk as our dependent variables, all of the Lagrange Multiplier test results suggest heterogeneity in variance across different variables and time, highlighting the importance of employing heteroskedasticity-consistent estimation techniques in our further analyses to ensure robust and reliable model estimations.

We also applied Wooldridge (2010) and conduct test for autocorrelation to ascertain the presence of first-order autocorrelation within our panel data regression model. Based on the fixed effect model using CAR [-1,1], idiosyncratic risk, and systematic risk as our dependent variables, all of the results are significantly below the conventional significance levels, strongly indicating the presence of first-order autocorrelation in our panel data. This autocorrelation suggests the necessity of

adopting appropriate methods to address potential autocorrelation issues in subsequent model estimations.

According to the introduction of various regression models from Hoechle (2007), to accurately model our panel data, we utilized the feasible generalized least squares (FGLS) approach for all estimations. The FGLS method is preferred over ordinary least squares (OLS) due to its ability to adjust for heteroskedasticity, serial correlation, and cross-sectional dependencies. And FGLS method necessitates that each panel have more than one observation to estimate the autocorrelation parameter accurately, which requires sufficient data points within each panel to estimate the autocorrelation effect. To address this issue, we allowed the command to execute by excluding panels with only a single observation automatically. Eventually, the number of our observations remained at 723.

Additionally, our models incorporated year-dummy variables to further refine the estimations. To assess multicollinearity, we calculated the variance inflation factors (VIFs) for each model, with the highest VIF across models (4), (5), and (6) reaching 3.96 and the average VIF reaching 2.30, meaning there is no multicollinearity problem (Neter et al. 1996). The results of our analysis on the effect of treatment, specifically investment in Metaverse, are detailed in columns (1) to (3). For a more comprehensive understanding, columns (4) to (6) display the complete models including both the effects of treatment and its interactions with IDV.

As shown in Table 6, the positive impacts of Metaverse investment on equity return were averagely significant in both the basic model (1) and the full model (4), which aligns with the results presented in Table 3 and supports our hypothesis 1. Moreover, the influence of Metaverse investment on idiosyncratic risk and systematic risk was significantly positive across the models (2), (3), (5), and (6), suggesting that, on average, Metaverse investment notably heightens both a firm's idiosyncratic and systematic risks. Therefore, hypothesis 2 and hypothesis 3 were supported.

In terms of the interaction terms of Metaverse investment and IDV, Metaverse investment shows a significant interaction effect in model (4) ($\beta = -0.014, \mathrm{p} < 0.001$). This indicates that the equity return of non-IDV firms was more likely to benefit from Metaverse-related investment than IDV firms, which highly supports our hypothesis 4. In contrast, the significant coefficient effect in model (5) ($\beta = 0.00018, \mathrm{p} < 0.001$) signifies that IDV firms increase more idiosyncratic risk than non-IDV firms after Metaverse-related investment, which also supports our hypothesis 5. Non-IDV firms were less likely to increase systematic risk than IDV firms based on model (6) ($\beta = -0.073, \mathrm{p} < 0.001$). Therefore, this is the exact opposite of what we assumed in hypothesis

Table 6. Results of DID analysis (Metaverse investment as treatment).

Event window	[-1,1]			[-1,1]		
	(1)	(2)	(3)	(4)	(5)	(6)
Model	CAR	Idiosyncratic_risk	Systematic_risk	CAR	Idiosyncratic_risk	Systematic_risk
Treatment	0.02764***	0.00019***	0.06048***	0.01783***	0.00009**	0.08640***
	(0.00177)	(0.00003)	(0.00832)	(0.00270)	(0.00003)	(0.00450)
IDV	0.00090	-0.00003	0.00274	0.00820***	-0.00019***	0.07216***
	(0.00151)	(0.00002)	(0.00328)	(0.00240)	(0.00004)	(0.00382)
Treatment * IDV				-0.01393***	0.00018***	-0.07276***
				(0.00381)	(0.00004)	(0.00443)
Control Variables						
Size	-0.01111***	0.00005***	0.00023	-0.00643***	0.00005***	-0.00165**
	(0.00063)	(0.00001)	(0.00152)	(0.00094)	(0.00001)	(0.00084)
ROA	-0.00103	-0.00022**	0.00649	0.01027	-0.00027***	0.01278*
	(0.01265)	(0.00010)	(0.01287)	(0.01178)	(0.00008)	(0.00678)
Selling	-0.01207	-0.00023	0.01283	-0.00310	-0.00010	0.03316**
	(0.01475)	(0.00017)	(0.02905)	(0.01401)	(0.00011)	(0.01546)
R & D	-0.00029***	0.00001***	-0.00005	-0.00007	0.00001***	-0.00010
	(0.00007)	(0.00000)	(0.00017)	(0.00010)	(0.00000)	(0.00007)
Metaverse Experience	-0.00103	0.00002***	-0.00089	0.00099*	0.00001***	-0.00099**
	(0.00068)	(0.00000)	(0.00064)	(0.00057)	(0.00000)	(0.00043)
Google Metaverse	0.00602***	0.00005***	-0.00109	0.00477***	0.00005***	-0.00512*
	(0.00148)	(0.00002)	(0.00172)	(0.00174)	(0.00001)	(0.00281)
Industry	0.01762***	-0.00007**	0.00710	0.00924***	0.00000	-0.00002
	(0.00257)	(0.00003)	(0.00797)	(0.00255)	(0.00003)	(0.00327)
Year Dummy	YES	YES	YES	YES	YES	YES
Intercepts	0.00577**	-0.00017***	-0.06209***	0.00749**	-0.00003	-0.08370***
	(0.00285)	(0.00004)	(0.00906)	(0.00322)	(0.00004)	(0.00479)
# Observation	723	723	723	723	723	723
# Firm	213	213	213	213	213	213
Wald chi-squared	3241.6990***	999.6781***	55.95371***	355.4328***	330.9548***	651.5481***

Note: This table presents the results of regressions of announcement-day abnormal returns (1,4) and equity risks (2,3,5,6) using the Fama–French Five Factors model on the explanatory and control variables. *p <0.1. **p <0.05. ***p <0.01. Standard errors in parentheses.

6.3. Robustness check

To confirm the reliability of our findings, we conducted multiple additional analyses. These included employing different event windows and an alternative market model.

6.3.1. Alternative event windows

Following previous studies, the day before the announcement is necessary to be included into the event windows as information leakage (Jacobs and Singhal 2017; Kim and Chae 2022) although Liu et al. (2018) considered the possibility of information leak by comparing the results between event widows [0, n] and [-1, n]. Many event studies

have employed unnecessarily long event windows, failing to account for contaminating events or noise around the announcement period, resulting in biased estimates (Nelson 2006; Haleblian et al. 2009). Therefore, we limit the event window to no more than two trading days around the event itself. Other than 3-day CAR [-1,1] in our main empirical models, we use different event windows as Afrin et al. (2021) DID, including a shorter one [-1,0] and a little longer one [−1,2]. The outcomes related to our primary variables of interest remained in alignment with those observed in our original model, as detailed in Table 7.

Table 7. Using alternative event windows [-1,0] and [-1,2].

Event window	(1)	(2)	(3)	(4)	(5)	(6)
Model	CAR [-1,0]	CAR [-1,0]	CAR [-1,2]	CAR [-1,2]	Idiosyncratic risk	Systematic risk
Treatment	0.01121**	0.01407**	0.03464**	0.02090**	0.00009**	0.08640**
	(0.00220)	(0.00257)	(0.00312)	(0.00218)	(0.00003)	(0.00450)
IDV	0.00271	0.00643**	0.00383	-0.00395**	-0.00019**	0.07216**
	(0.00193)	(0.00229)	(0.00281)	(0.00190)	(0.00004)	(0.00382)
Treatment × IDV		-0.00553*		-0.00465*	0.00018**	-0.07276**
		(0.00331)		(0.00247)	(0.00004)	(0.00443)
Control Variables						
Size	-0.00280**	-0.00305**	-0.01741**	-0.00853**	0.00005**	-0.00165**
	(0.00102)	(0.00090)	(0.00156)	(0.00066)	(0.00001)	(0.00084)
ROA	-0.01015	-0.01021	-0.05460**	-0.00614	-0.00027**	0.01278*
	(0.00938)	(0.00796)	(0.01563)	(0.00991)	(0.00008)	(0.00678)
Selling	-0.00673	-0.00494	-0.02577	0.00779	-0.00010	0.03316**
	(0.01112)	(0.00964)	(0.02482)	(0.01008)	(0.00011)	(0.01546)
R&D	0.00020*	0.00011	-0.00053**	-0.00022**	0.00001**	-0.00010
	(0.00012)	(0.00010)	(0.00023)	(0.00007)	(0.00000)	(0.00007)
Metaverse	-0.00040	-0.00016	-0.00164	-0.00063	0.00001**	-0.00099**
Experience						
	(0.00057)	(0.00047)	(0.00112)	(0.00045)	(0.00000)	(0.00043)
Google Metaverse	0.00188	0.00182	0.01198**	-0.00320*	0.00005**	-0.00512*
	(0.00194)	(0.00197)	(0.00182)	(0.00182)	(0.00001)	(0.00281)
Industry	0.00426	0.00418	0.03283**	0.01730**	0.00000	-0.00002
	(0.00308)	(0.00259)	(0.00420)	(0.00219)	(0.00003)	(0.00327)
Year Dummy	YES	YES	YES	YES	YES	YES
Intercepts	0.00187	0.00292	-0.00304	0.03244**	-0.00003	-0.08370**
	(0.00334)	(0.00327)	(0.00380)	(0.00354)	(0.00004)	(0.00479)
# Observation	723	723	723	723	723	723
# Firm	213	213	213	213	213	213
Wald chi2	117.0685***	168.1569***	793.3733***	1364.934***	330.9548***	651.5481***

Note: This table presents the results of regressions of announcement-day cumulative abnormal returns (1,2,3,4) and equity risks (5,6) using the Fama–French Five Factors model on the explanatory and control variables. *p <0.1. **p <0.05. ***p <0.01. Standard errors are reported in the parentheses.

6.3.2. Alternative asset pricing model

To verify that our findings were robust and not merely a result of the particular asset pricing model chosen for calculating cumulative abnormal returns, idiosyncratic risk, and systematic risk using the market model (Sharpe 1964). This model posits a linear relationship between a firm's return rate and the market's return rate. According to Table 8, employing this alternative market model DID not alter our core conclusions. Investments related to Metaverse lead to an increase in both equity returns and risks. However, the magnitudes of the increases in both returns and idiosyncratic risk are more pronounced for firms not engaged in non-IDV firms compared to those firms with IDV. In contrast, the effect on systematic risk shows the opposite trend.

Table 8. Using the market model to measure equity performance.

Event window	[-1,1]			[-1,1]		
	(1)	(2)	(3)	(4)	(5)	(6)
Model	CAR	Idiosyncratic_risk	Systematic_risk	CAR	Idiosyncratic_risk	Systematic_risk
Treatment	0.01474***	0.00011***	0.02712**	0.02070***	0.00006***	0.05222***
	(0.00219)	(0.00002)	(0.01118)	(0.00325)	(0.00002)	(0.01781)
IDV	0.00258	0.00010***	-0.02465	0.01144***	0.00004*	0.01280
	(0.00183)	(0.00002)	(0.01539)	(0.00339)	(0.00002)	(0.02008)
Treatment * IDV				-0.01786***	0.00013***	-0.06274**
				(0.00479)	(0.00004)	(0.02556)
Control Variables						
Size	-0.00700***	0.00004***	0.05875***	-0.00763***	0.00004***	0.05708***
	(0.00072)	(0.00001)	(0.00952)	(0.00093)	(0.00001)	(0.00787)
ROA	0.00696	-0.00032**	0.32566***	0.00532	-0.00039***	0.35908***
	(0.01448)	(0.00013)	(0.08126)	(0.01788)	(0.00013)	(0.07469)
Selling	-0.01191	-0.00052*	-0.09063	-0.00078	-0.00048*	0.02001
	(0.01558)	(0.00028)	(0.13581)	(0.02031)	(0.00025)	(0.13855)
R & D	0.00004	-0.00000	0.00353***	-0.00003	-0.00000	0.00304***
	(0.00012)	(0.00000)	(0.00072)	(0.00013)	(0.00000)	(0.00054)
Metaverse Experience	0.00071	-0.00002***	0.00854**	0.00100	-0.00003***	0.00155
	(0.00065)	(0.00001)	(0.00409)	(0.00075)	(0.00001)	(0.00393)
Google Metaverse	0.00854***	0.00009***	-0.05737***	0.00851***	0.00006***	-0.06097***
	(0.00107)	(0.00001)	(0.01042)	(0.00117)	(0.00002)	(0.01099)
If_data_intensive	0.00579*	0.00013***	0.04008	0.00655*	0.00013***	0.04496*
	(0.00330)	(0.00002)	(0.03132)	(0.00387)	(0.00003)	(0.02389)
Year Dummy	YES	YES	YES	YES	YES	YES
Intercepts	0.01091***	0.00017***	-0.34671***	0.00715**	0.00027***	-0.36772***
	(0.00277)	(0.00003)	(0.01838)	(0.00326)	(0.00003)	(0.02100)
# Observation	753	753	753	753	753	753
# Firm	219	219	219	219	219	219
Wald chi2	1148.366***	646.971***	843.461***	861.4092***	502.4596***	796.8114***

Note: This table presents the results of regressions of announcement-day abnormal returns (1,4) and equity risks (2,3,5,6) using the market model on the explanatory and control variables. *p <0.1. **p <0.05. ***p <0.01. Standard errors are reported in the parentheses.

7. Discussion

In this paper, we assess the impact of Metaverse-related investments on firm value and whether there's a differential effect on IDV firms versus non-IDV firms by employing the PSM-DID approach and event study methodology. As assumed, we find that investments in Metaverse significantly lead to an increase in firm value, idiosyncratic risk, and systematic risk. Furthermore, following Metaverse-related investments, IDV firms experience a greater increase in idiosyncratic risk but a lesser increase in systematic risk and value enhancement compared to non-IDV firms. The main findings will be discussed as follows:

7.1. Market reaction to Metaverse-related investment

Firstly, drawing from all available data on the Metaverse concept in China to date, our paper provides relatively comprehensive evidence for the field of research on the firms' valuation associated with direct Metaverse-related investments. Our results are consistent with prior relevant studies, showing that Metaverse-related investment can be considered a potent initiative for enhancing firm value (Dwivedi et al. 2022; Xu et al. 2023; Huang and Mao 2024). This indicates that the financial market is generally very optimistic about the Metaverse concept. As listed by Dwivedi et al. (2022), Metaverse can serve as a dynamic expansion of the marketplace, allowing businesses to not only explore untapped opportunities but also to revolutionize their revenue generation and advertising strategies. In this digital landscape, companies can increase their value by producing virtual products with significantly lower overhead compared to physical manufacturing. This virtual economy empowers young consumers to become active economic agents and provides senior customers with simplified, intuitive interfaces akin to kiosk systems, thereby broadening market reach and enhancing customer engagement — key factors in driving business value upward. Therefore, investment in Metaverse technology can be seen as a powerful promotion tool for firms' business value.

However, when investors positively reacted to Metaverse technology, at the same time, the risk changes after investing in Metaverse is also remarkable. What we found is also consistent with the studies about risks of high-tech fields (Ortiz 2022; Rego et al. 2009; Yu et al. 2017), both idiosyncratic risk and systematic risk rose significantly. The main reason is that high-tech companies often invest heavily in research and development, leading to uncertain outcomes and potentially large swings in profitability. This unpredictability affects individual firms differently, hence contributing to their unique, idiosyncratic risk profile (Pástor and Pietro 2003). Moreover, firms' managers began to utilize this blooming to hype their firms' stock prices (Huang and Mao 2024). The hype surrounding Metaverse technology can inflate a firm's stock prices beyond its intrinsic value, which heightens idiosyncratic risk due to the eventual market correction and resulting volatility specific to the firm. Should this trend of hyping Metaverse technology become widespread among multiple firms within the same sector, the collective overvaluation could inflate industry-wide valuations, thereby increasing systematic risk. A subsequent revelation that the technology fails to fulfil its anticipated

potential might precipitate a sector-wide sell-off, further exemplifying the systemic implications of such overhyped investments. Also, the reports from CCDH show that bullying, presentation of graphic sexual content, racism, and threats of violence pervade the Metaverse environment.[12] These challenges remain difficult to manage within the rapidly evolving environment of this emerging industry. Any widespread issue within the data industry can have ripple effects throughout the entire market. Hence, systematic risk is elevated as the stability of Metaverse technology is still developing (Yu et al. 2017).

7.2. Firms' announcements and IDV history

Second, the majority of financial studies concentrate on event study methodology focused on isolated events. Our contribution lies in the deployment of a dual-event study approach, which enhances the evaluation by integrating events related to IDV and Metaverse-related investments. Our research assesses the interaction effects between the investment in Metaverse and the perceived credibility associated with it. Specifically, we find that investors differentiate in their perception of Metaverse investments made by IDV firms compared to those by non-IDV firms.

In detail, we found that non-IDV firms not only gain more value from Metaverse investments than IDV firms but also experience a smaller increase in idiosyncratic risk. This nuanced difference in risk elevation is informed by the market's perception of credibility and corporate responsibility. Drawing on research by Autore et al. (2020) and Liu et al. (2021), the market is inclined to reward firms that have demonstrated credible behaviour and to penalize those with histories of irresponsibility. Hence, non-IDV firms, with their untarnished record of disclosures, command greater investor trust when they explore new territories like Metaverse. This trust manifests in both an enhancement in value and a comparatively modest uptick in idiosyncratic risk, considering that these firms are viewed as having stable and predictable management practices. On the flip side, IDV firms are perceived as carrying higher operational uncertainties due to their past disclosure infractions, leading to investor caution. Such scepticism arises from the potential for future governance issues or deceptive tactics, thereby injecting additional volatility into the firm's stock. Thus, when IDV firms announce investments in technologically advanced and speculative areas like Metaverse, the investor apprehension not only tempers the positive valuation response but also portends a relatively greater increase in idiosyncratic risk, reflective of the firm's perceived propensity for riskier behaviour and less transparent operations.

Moreover, the finding that IDV firms experience a smaller increase in systematic risk compared to non-IDV firms appears counterintuitive when contrasted with our initial hypothesis. This unexpected result could be attributed to the enhanced rigour in regulatory enforcement within the Chinese securities market, which compels affected companies to adopt more stringent and cautious approaches in their information

[12]See more details: a. https://counterhate.com/blog/new-research-shows-Metaverse-is-not-safe-for-kids/. b. https://counterhate.com/research/facebooks-Metaverse/.

disclosure practices. According to the findings of Wang et al. (2023), administrative sanctions significantly mitigate the recurrence of corporate frauds in China, suggesting an effective enhancement in internal control systems and compliance frameworks within penalized firms. This reduction in recidivism not only reflects an immediate response to regulatory penalties but also indicates a sustained improvement in corporate governance practices. Cao et al. (2021) also suggest that in China, significant strides have been made in the realm of information disclosure and investor protection, implying a more robust regulatory environment. Between 2019 and 2023, the China Securities Regulatory Commission (CSRC) issued 1,940 administrative penalties, marking a 77.98% year-on-year increase, imposed market bans on 442 individuals, a 140.22% year-on-year rise, and collected fines totaling 23.1 billion RMB. [13] Consequently, this transformation potentially lowers the systemic risk associated with these enterprises, as a more robust compliance environment substantially decreases the likelihood of future infractions, thereby stabilizing the firm's operational integrity and restoring market confidence in its financial health and management quality. This could temper the rise in systematic risk associated with their future investments.

8. Conclusion

In conclusion, our research comprehensively examined the Chinese market's response to Metaverse investments from their inception in 2021 through 2023, validating the significant enthusiasm they sparked. Companies that indicated involvement in the Metaverse, even through vague or general statements without disclaiming their participation, consistently saw an increase in stock prices. Nevertheless, this market volatility was coupled with an escalation in investment risks.

More importantly, we conducted an empirical analysis of the impact of IDV history on the market reaction to these investments. Our findings contribute valuable insights to the existing literature on the profound effects of corporate fraud, revealing that non-IDV firms benefited more from Metaverse investments, both in terms of value gains and reduced incremental specific risks. This distinction highlights the significance of a company's history with disclosure as a critical risk factor, highlighting the necessity of strategic investment management. It suggests that companies, especially those with prior IDV concerns, should aim for greater transparency in their Metaverse investment endeavours. Clear and regular communication can help enhance a firm's credibility. Firms with IDV may experience a smaller increase in systemic risk compared to firms without IDV. This also affirms the effective past regulation of the Chinese financial market and we advocate that studies on corporate investment events should account for the historical violations of companies to ensure more robust results.
Moreover, this paper highlights the importance

Looking forward, a future extension could be based on our study as follows: 1. Other than IDV, other types of corporate fraud are also related to investment and can be influential, future research could delve into different classifications and compare their

[13] Source: https://www.stcn.com/article/detail/1137864.html.

respective impacts. ; 2. Due to our inability to ascertain whether firms are genuinely investing in Metaverse or merely speculating on such projects, we classify companies with a history of IDV as a proxy to study the credibility of Metaverse investments. Future research could seek alternative metrics capable of measuring the credibility of Metaverse investment to further investigate this issue; 3. Delving into the specifics of Metaverse investment also holds significant research value. Future studies could employ qualitative methods to define and categorize firms engaging in Metaverse investment before analyzing the associated returns and risks; 4. Our study focuses on the short-term return and risks while with increasing data on Metaverse technology, further research could explore more studies on the long-term return and risks of Metaverse investment.

References

Acs, Z. J., and D. B. Audretsch. 1988. Innovation in large and small firms: an empirical analysis. *American Economic Review* 678-690.

Afrin, R., N. Peng, and F. Bowen. 2021. The Wealth Effect of Corporate Water Actions: How Past Corporate Responsibility and Irresponsibility Influence Stock Market Reactions. *Journal of Business Ethics* 180 (1):105-124.

Aslanidis, N., A. F. Bariviera, and Ó. G. López. 2022. The link between cryptocurrencies and Google Trends attention. *Finance Research Letters* 47:102654.

Autore, D. M., N. Clarke, and D. Jiang. 2020. Blockchain speculation or value creation? Evidence from corporate investments. *Financial Management* 50 (3):727-746.

Aysan, A. F., J. A. Batten, G. Gozgor, R. Khalfaoui, and Z. Nanaeva. 2023. Twitter matters for metaverse stocks amid economic uncertainty. *Finance Research Letters* 56.

Babenko, I., Y. Tserlukevich, and A. Vedrashko. 2012. The Credibility of Open Market Share Repurchase Signaling. *Journal of Financial and Quantitative Analysis* 47 (5):1059-1088.

Bai, Y., B. Zhang, and L. Xue. 2023. DSGE on the metaverse. *Finance Research Letters* 56.

Baum, C. F., M. E. Schaffer, and S. Stillman. 2007. Enhanced routines for instrumental variables/generalized method of moments estimation and testing. *The stata journal* 7 (4):465-506.

Beatty, A., S. Liao, and J. J. Yu. 2013. The spillover effect of fraudulent financial reporting on peer firms' investments. *Journal of accounting and economics* 55 (2-3):183-205.

Bonaimé, A. A. 2012. Repurchases, reputation, and returns. *Journal of Financial and Quantitative Analysis* 47 (2):469-491.

Cahill, D., D. G. Baur, Z. Liu, and J. W. Yang. 2020. I am a blockchain too: How does the market respond to companies' interest in blockchain? *Journal of Banking & Finance* 113.

Cao, N., P. B. McGuinness, and C. Xi. 2021. Does securities enforcement improve disclosure quality? An examination of Chinese listed companies' restatement activities. *Journal of Corporate Finance* 67.

Card, D., and A. B. Krueger. 2000. Minimum wages and employment: a case study of the fast-food industry in New Jersey and Pennsylvania: reply. *American Economic Review* 90 (5):1397-1420.

Chen, G., M. Firth, D. N. Gao, and O. M. Rui. 2005. Is China's securities regulatory agency a toothless tiger? Evidence from enforcement actions. *Journal of Accounting and Public Policy* 24 (6):451-488.

Chen, J., W. Dong, Y. Tong, and F. Zhang. 2020. Corporate philanthropy and corporate misconduct: Evidence from China. *International Review of Economics & Finance* 65:17-31.

Chen, K., T. Lai, Q. Liu, and C. Wang. 2022a. Beyond the blockchain announcement: Signaling credibility and market reaction. *International Review of Financial Analysis* 82.

Chen, K.-H., T. L. Lai, Q. Liu, and C. Wang. 2022b. Beyond the blockchain announcement: Signaling credibility and market reaction. *International Review of Financial Analysis* 82.

Chen, Q., X. Hua, and Y. Jiang. 2018. Contrarian strategy and herding behaviour in the Chinese stock market. *European Journal of Finance* 24 (16):1552-1568.

Cheng, S. F., G. De Franco, H. Jiang, and P. Lin. 2019. Riding the blockchain mania: Public firms' speculative 8-K disclosures. *Management Science* 65 (12):5901-5913.

Cheng, X., X. Jiang, D. Kong, and S. Vigne. 2024. Shifting Stakeholders Logics: Foreign Institutional Ownership and Corporate Social Responsibility. *Journal of Business Ethics*.

Cioroianu, I., S. Corbet, and C. Larkin. 2021. The differential impact of corporate blockchain-development as conditioned by sentiment and financial desperation. *Journal of Corporate Finance* 66:101814.

Connelly, B. L., S. T. Certo, R. D. Ireland, and C. R. Reutzel. 2011. Signaling theory: A review and assessment. *Journal of management* 37 (1):39-67.

Dewan, S., and F. Ren. 2007. Risk and Return of Information Technology Initiatives: Evidence from Electronic Commerce Announcements. *Information Systems Research* 18 (4):370-394.

Dimpfl, T., and S. Jank. 2016. Can internet search queries help to predict stock market volatility? *European Financial Management* 22 (2):171-192.

Dosi, G. 1988. Sources, procedures, and microeconomic effects of innovation. *Journal of Economic Literature* 1120-1171.

Du, X. 2015. Is corporate philanthropy used as environmental misconduct dressing? Evidence from Chinese family-owned firms. *Journal of Business Ethics* 129:341-361.

Dwivedi, Y. K., L. Hughes, A. M. Baabdullah, S. Ribeiro-Navarrete, M. Giannakis, M. M. Al-Debei, D. Dennehy, B. Metri, D. Buhalis, C. M. K. Cheung, K. Conboy, R. Doyle, R. Dubey, V. Dutot, R. Felix, D. P. Goyal, A. Gustafsson, C. Hinsch, I. Jebabli, M. Janssen, Y.-G. Kim, J. Kim, S. Koos, D. Kreps, N. Kshetri, V. Kumar, K.-B. Ooi, S. Papagiannidis, I. O. Pappas, A. Polyviou, S.-M. Park, N. Pandey, M. M. Queiroz, R. Raman, P. A. Rauschnabel, A. Shirish, M. Sigala, K. Spanaki, G. Wei-Han Tan, M. K. Tiwari, G. Viglia, and S. F. Wamba. 2022. Metaverse beyond the hype: Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. *International Journal of Information Management* 66.

Fama, E. F., and K. R. French. 2015. A five-factor asset pricing model. *Journal of Financial Economics* 116 (1):1-22.

Files, R., and U. G. Gurun. 2018. Lenders' response to peer and customer restatements. *Contemporary Accounting Research* 35 (1):464-493.

Firth, M., O. M. Rui, and W. Wu. 2011. Cooking the books: Recipes and costs of falsified financial statements in China. *Journal of Corporate Finance* 17 (2):371-390.

Flammer, C. 2013. Corporate social responsibility and shareholder reaction: The environmental awareness of investors. *Academy of Management Journal* 56 (3):758-781.

Francis, J., D. Nanda, and P. Olsson. 2008. Voluntary disclosure, earnings quality, and cost of capital. *Journal of Accounting Research* 46 (1):53-99.

Fu, R., A. Kraft, and H. Zhang. 2012. Financial reporting frequency, information asymmetry, and the cost of equity. *Journal of Accounting and Economics* 54 (2-3):132-149.

Ghosh, I., E. Alfaro-Cortés, M. Gámez, and N. García. 2023. Do travel uncertainty and invasion rhetoric spur Metaverse financial asset? – Gauging the role of media influence. *Finance Research Letters* 51:103434.

Giannetti, M., and T. Y. Wang. 2016. Corporate scandals and household stock market participation. *Journal of Finance* 71 (6):2591-2636.

Gong, G., X. Huang, S. Wu, H. Tian, and W. Li. 2021. Punishment by securities regulators, corporate social responsibility and the cost of debt. *Journal of Business Ethics* 171:337-

356.

Gordon, L. A., M. P. Loeb, and T. Sohail. 2010. Market value of voluntary disclosures concerning information security. *MIS Quarterly*:567-594.

Graham, J. R., S. Li, and J. Qiu. 2008. Corporate misreporting and bank loan contracting. *Journal of Financial Economics* 89 (1):44-61.

Guo, B., W. Zhang, Y. Zhang, and H. Zhang. 2017. The five-factor asset pricing model tests for the Chinese stock market. *Pacific-Basin Finance Journal* 43:84-106.

Haleblian, J., C. E. Devers, G. McNamara, M. A. Carpenter, and R. B. Davison. 2009. Taking stock of what we know about mergers and acquisitions: A review and research agenda. *Journal of Management* 35 (3):469-502.

Hass, L. H., M. Tarsalewska, and F. Zhan. 2016. Equity incentives and corporate fraud in China. *Journal of Business Ethics* 138:723-742.

He, F., X. Huang, G. Liu, and Z. Wang. 2024. Does CSR Engagement Deter Corporate Misconduct? Quasi-natural Experimental Evidence from Firms Joining a Government-Initiated Social Program in China. *Journal of Business Ethics*.

Hennig-Thurau, T., D. N. Aliman, A. M. Herting, G. P. Cziehso, M. Linder, and R. V. Kübler. 2023. Social interactions in the metaverse: Framework, initial evidence, and research roadmap. *Journal of the Academy of Marketing Science* 51 (4):889-913.

Hirschey, M., K. R. Smith, and W. M. Wilson. 2015. The Timeliness of Restatement Disclosures and Financial Reporting Credibility. *Journal of Business Finance & Accounting* 42 (7-8):826-859.

Ho, K.-C., L. Yang, and S. Luo. 2022. Information disclosure ratings and continuing overreaction: Evidence from the Chinese capital market. *Journal of Business Research* 140:638-656.

Hoechle, D. 2007. Robust standard errors for panel regressions with cross-sectional dependence. *The Stata Journal* 7 (3):281-312.

Honoré, F., F. Munari, and B. van Pottelsberghe de La Potterie. 2015. Corporate governance practices and companies' R&D intensity: Evidence from European countries. *Research Policy* 44 (2):533-543.

Hou, H. 2024. Does the credibility of open market share repurchase matter? *International Review of Economics & Finance* 93:280-297.

Huang, F., and J. Rice. 2012. Firm networking and bribery in China: Assessing some potential negative consequences of firm openness. *Journal of Business Ethics* 107:533-545.

Huang, L., and R. Mao. 2024. Cryptic excitement: unveiling market reactions to Facebook's Metaverse and potential manipulation in China's stock market. *Finance Research Letters* 60.

Hwang, S., A. Keswani, and M. B. Shackleton. 2008. Surprise vs anticipated information announcements: Are prices affected differently? An investigation in the context of stock splits. *Journal of Banking & Finance* 32 (5):643-653.

Jacobs, B. W., and V. R. Singhal. 2017. The effect of the Rana Plaza disaster on shareholder wealth of retailers: Implications for sourcing strategies and supply chain governance. *Journal of Operations Management* 49:52-66.

Johnson, W. C., W. Xie, and S. Yi. 2014. Corporate fraud and the value of reputations in the product market. *Journal of Corporate Finance* 25:16-39.

Kadapakkam, P.-R., P. Kumar, and L. A. Riddick. 1998. The impact of cash flows and firm size on

investment: The international evidence. *Journal of Banking & Finance* 22 (3):293-320.

Karpoff, J. M., D. S. Lee, and G. S. Martin. 2008. The cost to firms of cooking the books. *Journal of Financial and Quantitative Analysis* 43 (3):581-611.

Kim, S., and S. Chae. 2022. Shareholder value effects of ethical sourcing: comparing reactive and proactive initiatives. *Journal of Business Ethics* 179 (3):887-906.

Kleinknecht, A. 1991. Firm size and innovation: Reply to Scheirer. *Small Business Economics* 3:157-158.

Klöckner, M., C. G. Schmidt, and S. M. Wagner. 2022. When blockchain creates shareholder value: Empirical evidence from international firm announcements. *Production and Operations Management* 31 (1):46-64.

Koohang, A., J. H. Nord, K.-B. Ooi, G. W.-H. Tan, M. Al-Emran, E. C.-X. Aw, A. M. Baabdullah, D. Buhalis, T.-H. Cham, and C. Dennis. 2023. Shaping the metaverse into reality: a holistic multidisciplinary understanding of opportunities, challenges, and avenues for future investigation. *Journal of Computer Information Systems* 63 (3):735-765.

Lee, L.-H., T. Braud, P. Zhou, L. Wang, D. Xu, Z. Lin, A. Kumar, C. Bermejo, and P. Hui. 2021. All one needs to know about metaverse: A complete survey on technological singularity, virtual ecosystem, and research agenda. *arXiv preprint arXiv:2110.05352*.

Leung, T. Y., and P. Sharma. 2021. Differences in the impact of R&D intensity and R&D internationalization on firm performance – Mediating role of innovation performance. *Journal of Business Research* 131:81-91.

Li, J., Y. Chang, Y. Wang, and X. Zhu. 2023. Tracking down financial statement fraud by analyzing the supplier-customer relationship network. *Computers & Industrial Engineering* 178:109118.

Li, M. 2013. Using the propensity score method to estimate causal effects: A review and practical guide. *Organizational Research Methods* 16 (2):188-226.

Li, V. 2016. Do false financial statements distort peer firms' decisions? *Accounting Review* 91 (1):251-278.

Liao, L., G. Chen, and D. Zheng. 2019. Corporate social responsibility and financial fraud: Evidence from China. *Accounting & Finance* 59 (5):3133-3169.

Liebman, B. L., and C. J. Milhaupt. 2008. Reputational sanctions in China's securities market. *Columbia Law Review*:929-983.

Lin, Q. 2017. Noisy prices and the Fama–French five-factor asset pricing model in China. *Emerging Markets Review* 31:141-163.

Liu, C., S. L. Wang, and D. Li. 2021. Hidden in a group? Market reactions to multi-violator corporate social irresponsibility disclosures. *Strategic Management Journal* 43 (1):160-179.

Liu, F., H. Lin, and H. Wu. 2018. Political connections and firm value in China: An event study. *Journal of Business Ethics* 152 (2):551-571.

Lou, D. 2014. Attracting Investor Attention through Advertising. *Review of Financial Studies* 27 (6):1797-1829.

Luo, J.-h., C. Peng, and X. Zhang. 2020. The impact of CFO gender on corporate fraud: Evidence from China. *Pacific-Basin Finance Journal* 63.

Maruping, L. M., V. Venkatesh, and R. Agarwal. 2009. A Control Theory Perspective on Agile Methodology Use and Changing User Requirements. *Information Systems Research* 20

(3):377-399.

Masulis, R. W., and S. W. Reza. 2015. Agency problems of corporate philanthropy. *Review of Financial Studies* 28 (2):592-636.

Mazzucato, M., and M. Tancioni. 2008. Innovation and idiosyncratic risk: an industry- and firm-level analysis. *Industrial and Corporate Change* 17 (4):779-811.

McWilliams, A., and D. Siegel. 1997. Event studies in management research: Theoretical and empirical issues. *Academy of Management Journal* 40 (3):626-657.

Murphy, D. L., R. E. Shrieves, and S. L. Tibbs. 2009. Understanding the penalties associated with corporate misconduct: An empirical examination of earnings and risk. *Journal of Financial and Quantitative Analysis* 44 (1):55-83.

Murphy, P. R., and M. T. Dacin. 2011. Psychological pathways to fraud: Understanding and preventing fraud in organizations. *Journal of Business Ethics* 101:601-618.

Mystakidis, S. 2022. Metaverse. Encyclopedia, 2 (1), 486–497.

Nelson, J. M. 2006. The "CalPERS effect" revisited again. *Journal of Corporate Finance* 12 (2):187-213.

Neter, J., M. H. Kutner, C. J. Nachtsheim, and W. Wasserman. 1996. *Applied linear statistical models*. 4th ed. Chicago: McGraw-Hill/Irwin.

Newey, W. K., and K. D. West. 1987. A Simple, Positive Semi-Definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix. *Econometrica* 55 (3):703.

Nguyen, T., L. T. Nguyen, A. D. Ngo, and H. Adhikari. 2017. CEO Optimism and the Credibility of Open-Market Stock Repurchase Announcements. *Journal of Behavioral Finance* 19 (1):49-61.

Oh, H. J., J. Kim, J. J. Chang, N. Park, and S. Lee. 2023. Social benefits of living in the metaverse: The relationships among social presence, supportive interaction, social self-efficacy, and feelings of loneliness. *Computers in Human Behavior* 139:107498.

Ortiz, L. 2022. Risks of the Metaverse: A VRChat Study Case. *Journal of Intelligence, Conflict, and Warfare* 5 (2):53-128.

Ota, K., H. Kawase, and D. Lau. 2019. Does reputation matter? Evidence from share repurchases. *Journal of Corporate Finance* 58:287-306.

Pástor, Ľ., and V. Pietro. 2003. Stock Valuation and Learning about Profitability. *The Journal of Finance* 58 (5):1749-1789.

Pástor, Ľ., and P. Veronesi. 2009. Technological revolutions and stock prices. *American Economic Review* 99 (4):1451-1483.

Pastor, L., and P. Veronesi. 2006. Was there a Nasdaq bubble in the late 1990s? *Journal of Financial Economics* 81 (1):61-100.

Pevzner, M., F. Xie, and X. Xin. 2015. When firms talk, do investors listen? The role of trust in stock market reactions to corporate earnings announcements. *Journal of Financial Economics* 117 (1):190-223.

Qin, Y. 2022. Investment potential analysis on Chinese stock market in Metaverse-take VR industry as a sample. Paper read at 2022 7th International Conference on Financial Innovation and Economic Development (ICFIED 2022).

Ravichandran, T., S. Han, and S. Mithas. 2017. Mitigating Diminishing Returns to R&D: The Role of Information Technology in Innovation. *Information Systems Research* 28 (4):812-827.

Rego, L. L., M. T. Billett, and N. A. Morgan. 2009. Consumer-based brand equity and firm risk.

Journal of Marketing 73 (6):47-60.

Roberts, M. R., and T. M. Whited. 2013. Endogeneity in Empirical Corporate Finance. In *Handbook of the Economics of Finance*: Elsevier, 493-572.

Rosenbaum, P. R., and D. B. Rubin. 1983. The central role of the propensity score in observational studies for causal effects. *Biometrika* 70 (1):41-55.

Sha, Y., and R. Gao. 2019. Which is the best: A comparison of asset pricing factor models in Chinese mutual fund industry. *Economic Modelling* 83:8-16.

Sharpe, W. F. 1964. Capital asset prices: A theory of market equilibrium under conditions of risk. *The Journal of Finance* 19 (3):425-442.

Stephenson, N. 1992. *Snow crash*: Bantam Spectra.

Sun, J., P. Kent, B. Qi, and J. Wang. 2017. Chief financial officer demographic characteristics and fraudulent financial reporting in China. *Accounting & Finance* 59 (4):2705-2734.

Tan, G. W.-H., E. C.-X. Aw, T.-H. Cham, K.-B. Ooi, Y. K. Dwivedi, A. A. Alalwan, J. Balakrishnan, H. K. Chan, J.-J. Hew, and L. Hughes. 2023. Metaverse in marketing and logistics: the state of the art and the path forward. *Asia Pacific Journal of Marketing and Logistics* 35 (12):2932-2946.

Tao, F., X. Liu, L. Gao, and E. Xia. 2017. Do cross-border mergers and acquisitions increase short-term market performance? The case of Chinese firms. *International Business Review* 26 (1):189-202.

Tong, Z., J. W. Goodell, and D. Shen. 2022. Assessing causal relationships between cryptocurrencies and investor attention: New results from transfer entropy methodology. *Finance Research Letters* 50:103351.

Urquhart, A. 2018. What causes the attention of Bitcoin? *Economics Letters* 166:40-44.

Vidal-Tomás, D. 2022. The new crypto niche: NFTs, play-to-earn, and metaverse tokens. *Finance Research Letters* 47.

———. 2023a. The illusion of the metaverse and meta-economy. *International Review of Financial Analysis* 86:102560.

———. 2023b. The illusion of the metaverse and meta-economy. *International Review of Financial Analysis* 86.

Wai Kong Cheung, A. 2010. Do Stock Investors Value Corporate Sustainability? Evidence from an Event Study. *Journal of Business Ethics* 99 (2):145-165.

Wang, F.-Y., R. Qin, X. Wang, and B. Hu. 2022. Metasocieties in metaverse: Metaeconomics and metamanagement for metaenterprises and metacities. *IEEE Transactions on Computational Social Systems* 9 (1):2-7.

Wang, K. T., and D. Li. 2015. Market Reactions to the First-Time Disclosure of Corporate Social Responsibility Reports: Evidence from China. *Journal of Business Ethics* 138 (4):661-682.

Wang, R. 2023. An empirical analysis of the applicability of the Fama-French five-factor model and the three-factor model to China's stock market–Based on validated evidence from listed Chinese Internet companies. Paper read at SHS Web of Conferences.

Wang, S., L. Yu, and Q. Zhao. 2021. Do factor models explain stock returns when prices behave explosively? Evidence from China. *Pacific-Basin Finance Journal* 67.

Wang, T. Y., A. Winton, and X. Yu. 2010. Corporate fraud and business conditions: Evidence from IPOs. *Journal of Finance* 65 (6):2255-2292.

Wang, Y., J. K. Ashton, and A. Jaafar. 2023. Financial statement fraud, recidivism and punishment.

Emerging Markets Review 56:101033.

Wang, Z., M.-H. Chen, C. L. Chin, and Q. Zheng. 2017. Managerial ability, political connections, and fraudulent financial reporting in China. *Journal of Accounting and Public Policy* 36 (2):141-162.

Wei, J., Z. Ouyang, and H. Chen. 2017. Well Known or Well Liked? The Effects of Corporate Reputation on Firm Value at the Onset of a Corporate Crisis. *Strategic Management Journal* 38 (10):2103-2120.

Wen, F., D. Lin, L. Hu, S. He, and Z. Cao. 2023. The spillover effect of corporate frauds and stock price crash risk. *Finance Research Letters* 57.

Wooldridge, J. M. 2010. *Econometric analysis of cross section and panel data*: MIT press.

Wu, L., and E. Brynjolfsson. 2015. The future of prediction: How Google searches foreshadow housing prices and sales. In *Economic analysis of the digital economy*: University of Chicago Press, 89-118.

Wu, S., G. Gong, X. Huang, and H. Tian. 2021. The interaction between suppliers and fraudulent customer firms: Evidence from trade credit financing of Chinese listed firms. *Journal of Business Ethics*:1-20.

Wu, Y. 2012. Information infrastructure, reputation mechanism and the optimization of law enforcement: A new view of food safety management. *Social Sciences in China* 6 (115):133,207.

Xiong, J., C. Ouyang, J. Y. Tong, and F. F. Zhang. 2021. Fraud commitment in a smaller world: Evidence from a natural experiment. *Journal of Corporate Finance* 70.

Xu, Y., W. Liu, T. He, and S.-B. Tsai. 2023. Buzzword or fuzzword: an event study of the metaverse in the Chinese stock market. *Internet Research* 34 (1):174-194.

Ye, K., and R. Zhang. 2011. Do lenders value corporate social responsibility? Evidence from China. *Journal of Business Ethics* 104:197-206.

Yencha, C. 2023. Spatial heterogeneity and non-fungible token sales: Evidence from Decentraland LAND sales. *Finance Research Letters* 58.

Yin, C., X. Cheng, Y. Yang, and D. Palmon. 2021. Do corporate frauds distort suppliers' investment decisions? *Journal of Business Ethics* 172:115-132.

Yu, S., P. Muller, and A. Zomaya. 2017. Editorial: special issue on "big data security and privacy". *Digital Communications and Networks* 3 (4):211-212.

Zhang, R., J. Zhu, H. Yue, and C. Zhu. 2010. Corporate philanthropic giving, advertising intensity, and industry competition level. *Journal of Business Ethics* 94:39-52.

Zhang, Y., C. Zhang, and Y. Xu. 2021. Effect of data privacy and security investment on the value of big data firms. *Decision Support Systems* 146:113543.

Zhou, F., Z. Zhang, J. Yang, Y. Su, and Y. An. 2018. Delisting pressure, executive compensation, and corporate fraud: Evidence from China. *Pacific-Basin Finance Journal* 48:17-34.

Appendix

Examples of Metaverse-related and IDV announcements. The main information of Metaverse-related announcements include firm name, the title and content of the announcement and the main information of IDV announcements include violation type and activities contents.

Part A: Metaverse-related announcements:		
Firm name	Title	Content
Shenzhen SED Industry Co., Ltd.	Shen Sangda A in-depth cooperation and exchanges with Huangling County	[2023/7/13] On July 12, Sangda carried out in-depth cooperation and exchanges with Huangling County, Shaanxi Province. The two sides reached cooperation directions in the areas of county-level global data governance, metacosmic scenario application, rural revitalization of digital economy empowerment, and digital transformation of the coal industry. Set up a project promotion leading group headed by the head of Huangling County and the deputy leader of China Electronics Cloud, and jointly accelerate the project by setting up a joint venture company "CLP Huangling" and strive to build Huangling into a domestic county-wide digital economy and meta-universe scene application "double benchmark".
Shenzhen Desay Battery Technology Co., Ltd.	The company's products are widely used in AR/VR and other smart wearable hardware devices	[2021/9/30] An investor asked on the investor interactive platform: Does the company have a meta-universe concept? Can the company's products be used in the hardware side of Metaverse? Desay Battery (000049.SZ) replied on the investor interactive platform on August 31 that the company's products are widely used in intelligent wearable hardware devices such as AR/VR.
Shenzhen Overseas Chinese Town Co., Ltd.	We are actively considering the relevant layout of the meta-universe and introducing relevant technologies for research and development	[2022/1/17] On the evening of January 17, A record of investor relations activities disclosed by Shenzhen Overseas Chinese Town Co., Ltd. shows that on January 13, members of the working group of information disclosure and investment Customs said in an investor conference call that tourists can break the restrictions of time and space in the meta-universe and obtain different life experiences that break through the physiological limits of human beings. Shenzhen Overseas Chinese Town Co., Ltd. is actively considering the layout of the meta-universe, and carrying out the introduction and research and development of related technologies. Its scenic spots will also strengthen the application of science and technology in the future to bring better play experience to tourists.
Part B: IDV announcements:		
Firm name	Violation type	Activities
Fujian Mindong Electric Power Co., Ltd.	Delayed disclosure, misrepresentation (misleading statement), etc.	[2005-03-24] It has been found that your company has repaid bank loans with raised funds totaling 324.608 million yuan since April 2004, and your company has not fulfilled the relevant decision-making procedures and information disclosure obligations in a timely manner, and the raised funds disclosed by your company in the semi-annual report of 2004 are seriously inconsistent with the above facts. In addition, your company used the raised funds of RMB 100 million for the settlement of securities transactions in 2000, and your company neither fulfilled the obligation of

		information disclosure in a timely manner nor truthfully disclosed it in the relevant periodic reports.
Yuan Longping High-tech Agriculture Co.,Ltd.	Delayed disclosure	[2012-09-26] On February 15, 2011, SHKP and Changsha SHKP Agricultural Co., LTD. signed an agreement to absorb and merge SHKP, and after the merger, SHKP will directly hold 17.24% of the shares of the listed company Yuan Longping Agricultural High-tech Co., LTD. On December 28, 2011, the merger of SMU and SMW was approved by the industry and Commerce Department. However, XinDaxin DID not disclose the detailed equity change report until March 20, 2012.
Hongda Xingye Co., Ltd.	Delayed disclosure, illegal stock trading	[2020-08-13] On July 10, 2020, your company passively reduced its holdings of 4.701 million shares of Hongda Xingye Co., Ltd. by means of centralized bidding trading, accounting for 0.18% of the total share capital of Hongda Xingye Co., Ltd. On July 11, your company disclosed the "Pre-Disclosure Announcement on Passive Reduction of Company Shares by Shareholders and Possible passive Reduction Risks" through Hongda Industrial. Your company, as the controlling shareholder of Hongda Industrial, failed to disclose the reduction plan 15 trading days before the first sale in accordance with relevant regulations.