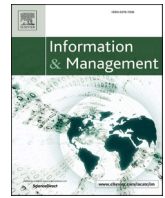




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White knight in dark days? Supply chain finance firms, blockchain, and the COVID-19 pandemic

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ABSTRACT

We investigate the impact of the announcement of the COVID-19 pandemic on the market value and trading volume of supply chain finance (SCF) firms. Using an event study, we observe a significant valuation loss and higher trading volume of SCF firms. However, blockchain-enabled SCF firms are protected from such valuation loss and volatility in trading. We find that higher research and development (R&D) and capital expenditures by firms prevent the loss. Moreover, the firm value of blockchain-enabled SCF firms is impacted by their membership in a blockchain consortium and progress in blockchain implementation. Investors' confidence in blockchain reduces the market uncertainty.

1. Introduction

'Blockchain technology provides the potential that the full transaction flow will be processed in a single technical environment that is secure ... by reducing the number of involved parties and by simplifying the transaction, we also expect that the cost per transaction can be reduced significantly for our suppliers and therefore make the SCF programs more attractive to them.'

Hofmann et al. [1].

1.1. Background and motivation

In the modern global supply chain, supply chain finance (SCF) is responsible for the smooth functioning of business operations. The size of the global SCF market achieved a significant mark of USD 46 billion in 2020.¹ An SCF firm acts as an intermediary between the suppliers and buyers. In other words, the SCF firm enables financing to the suppliers through different financial institutions such as banks, third-party platforms, etc., to deal with the working capital constraint and liquidity of

the suppliers. It also provides credit period-related flexibility to the buyers. The adoption of blockchain in the business operations of SCF firms is an emerging trend.² Currently, the size of the global market for blockchain-enabled SCF is USD 84,540 million, and it is estimated to grow at an annual rate of 33.6% between 2021 and 2026.³ Blockchain technology brings several advantages to the operations of SCF firms. The distributed ledger system in blockchain technology ensures higher transparency and security in transactions. Additionally, blockchain facilitates a faster and cost-effective credit clearing and settlement process [1]. This positivity is often evident in investors' sentiment that reflects in the stock price reaction of the firms. A few blockchain initiatives taken by SCF firms such as JP Morgan Chase, CGI, BBVA, etc., are presented in Table 1. Despite its immense growth potential, the ongoing COVID-19 pandemic poses a major challenge in adopting this technology for maintaining the business operations of SCF firms.

Since the beginning of 2020, the world has been going through the most serious crisis of the century. The COVID-19, first identified at Wuhan of China in January 2020, was declared a global pandemic by the World Health Organization (WHO) on 11th March 2020⁴ [2]. All leading

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¹ Retrieved from: <https://www.pymnts.com/news/2015/supply-chain-finance-market-growing-worldwide/>. Accessed 2nd January 2022.

² Retrieved from: https://www.scmr.com/article/7_supply_chain_financing_trends_to_watch_in_2019. Accessed 2nd January 2022.

³ Retrieved from: <https://www.marketwatch.com/press-release/blockchain-supply-chain-finance-market-size-2021industry-analysis-size-share-trends-market-demand-growth-opportunities-and-forecast-2026-2020-12-09>. Accessed 2nd January 2022.

⁴ The detail of the announcement is provided in Appendix A.1

Table 1
Blockchain initiatives taken by SCF firms.

Organizations	Blockchain initiatives
JP Morgan Chase	Introduced a new blockchain system called Quorum in 2016.
CGI	Implemented a ripple validator node-based blockchain system in 2017.
UniCredit	Implemented a live blockchain-enabled trading platform in 2019
BBVA	Issued a structured, blockchain-enabled green bond in 2019.

Retrieved from: [https://www.jpmorgan.com/solutions/cib/news/digital-coin-payments?utm_source=](https://www.jpmorgan.com/solutions/cib/news/digital-coin-payments?utm_source=email&utm_medium=enl&utm_campaign=briefing&utm_content=20,190,219&utm_term=law)

[email&utm_medium=enl&utm_campaign=briefing&utm_content=20,190,219&utm_term=law](https://www.jpmorgan.com/solutions/cib/news/digital-coin-payments?utm_source=email&utm_medium=enl&utm_campaign=briefing&utm_content=20,190,219&utm_term=law). Accessed 2nd January 2022.

Retrieved from: CGI advances blockchain adoption with implementation of Ripple Validator Node | CGI United States. Accessed 2nd January 2022.

Retrieved from: <https://www.unicreditgroup.eu/en/press-media/press-releases/2019/unicredit-esegue-con-successo-la-prima-transazione-commerciale-s.html>. Accessed 2nd January 2022.

Retrieved from: BBVA issues the first blockchain-supported structured green bond for MAPFRE. Accessed 2nd January 2022.

developed countries, such as the USA, Spain, the UK, Germany, France, etc., have been severely affected by this pandemic [3]. The global economy has been experiencing turmoil and is on the verge of shrinkage by 1%, instead of the projected growth of 2.5% [4]. As a result, the world economy witnessed the biggest valuation loss of stock indices (e.g., the Nikkei and the Dow Jones) over the last three decades between January 2020 and March 2020.⁵ In this context, investigation on the financial health of SCF firms during the pandemic is an emerging area of interest. Also, the role of blockchain in maintaining the financial health of SCF firms becomes important. Generally, there exist two opposing viewpoints in this regard. One group of scholars and industry experts believe there will be an increasing reliance on blockchain due to the restriction in business operations and lockdown-related measures, leading to a stable business operation.⁶ This belief is also noticed in the stock price movement of several firms associated with this new disruptive technology. For instance, Cioroianu et al. [5] combine the blockchain “hype” on stock price [6] and the impact of sentiment on equity pricing [7] and show how firms can generate short-term value. On the contrary, another group of researchers opines that blockchain-enabled firms may not always be trustworthy to investors. Rather, implementing blockchain technology can lead to several security risks, such as the Sybil attack, 51% attack, and Double-spending attack [8]. Also, Fedorov et al. [9] point out that quantum computing would make the blockchain technology vulnerable within a decade by breaking the blockchain’s cryptographic codes. In such cases, blockchain-enabled SCF firms may not generate enough trust in investors and enhance their value. Even there is evidence to suggest that the blockchain will not always positively impact the financial health of SCF firms. For instance, fundraising by the Indian fintech companies has come down due to the COVID-19 pandemic [10]. Therefore, the anticipation of security risk or panic among investors may also result in valuation loss. In this context, the investigation on the effectiveness of blockchain to protect the financial health of SCF firms emerges as an interesting topic for research.

1.2. Research questions and contribution

In the domain of SCF, scholars focus on several issues such as trade credit period decisions [11], financing decisions, contract design, coordination [12], etc. However, our in-depth analysis of the literature indicates several interesting research opportunities. First, Xu et al. [13] opine that the scholarly works mostly adopt analytical approaches,

⁵ Retrieved from: https://www.bbc.com/news/business-51706225?intlink_from_url=&. Accessed 2nd January 2022.

⁶ Retrieved from: <https://blog-idx.com/blockchain-help-in-the-covid-19-and-recovery/>. Accessed 2nd January 2022.

whereas empirical analysis based on event study is not paid much attention despite its immense potential to obtain valuable context-specific insights. Second, the works related to the effect of the COVID-19 pandemic on supply chain management mostly focus on logistics operations, demand management, risk mitigation strategies, etc. [14], whereas SCF-related decisions have not received much attention. Third, as mentioned earlier, the rising interest among SCF firms for implementing blockchain highlights the importance of investigating the effectiveness of blockchain in protecting their financial health. Further, McQuinn and Castro [15] highlight the importance of government initiatives in enhancing research and development (R&D) activities related to blockchain. It is known that extensive involvement in R&D activities has played an instrumental role in IBM’s phenomenal progress in blockchain initiatives.⁷ So, it is also crucial to investigate the factors influencing the valuation of blockchain-enabled SCF firms. More specifically, it is interesting to enquire how the investors exhibit their trust about the blockchain activities of the SCF firms. Motivated by these issues, we propose the following research questions:

- RQ 1: What is the impact of the WHO’s announcement of COVID-19 as a pandemic on the market valuation and trading volume of SCF firms?
- RQ 2: Does the adoption of the blockchain allow SCF firms to maintain their market valuation and trading volume during the COVID-19 pandemic?
- RQ 3: What is the effect of different firm-level inputs (e.g., R&D intensity, capital expenditure, and staff expenditure) on the market valuation of the blockchain-enabled SCF firms?
- RQ 4: What is the effect of firm-specific characteristics (e.g., affiliation to a banking group, member of a consortium, and progress in blockchain implementation) on the market valuation of blockchain-enabled SCF firms?

To the best of our knowledge, this is the first article that incorporates an event-based methodology to investigate the impact of blockchain on the market valuation and trading volume of SCF firms during the COVID-19 pandemic. We first explore the impact of the WHO’s announcement of the COVID-19 pandemic on the stock price of SCF firms by computing the cumulative average abnormal return (CAAR) earned by the listed SCF firms over different event windows. For this purpose, we utilize four expected return models, namely the market model (MM), the MM with exponential generalized autoregressive conditional heteroscedasticity (EGARCH) errors (MMEGE), the Fama-French 3-factor model (FF3F), and the Carhart 4-factor model (C4F). Further, we conduct a volume-based event study measured by the cumulative average abnormal volume (CAAV) of SCF firms to determine their abnormal change in trading volume around the event date. We also check whether firm-level heterogeneity or firm characteristics (e.g., banking or non-banking SCF firms) play an important role in protecting the valuation loss for firms due to the WHO’s announcement of the COVID-19 as a ‘pandemic’. Finally, we perform a regression analysis to study the impact of different firm-level inputs (e.g., R&D intensity, capital expenditure, and staff expenditure) of SCF firms on their valuation during the COVID-19 pandemic. Additionally, for blockchain-enabled SCF firms, we explore whether being a part of a consortium rather than operating standalone or progression from pilot to implementation stage for blockchain implementation leads to value protection from the announcement. Our results suggest that WHO’s announcement of COVID-19 as a ‘pandemic’ generates a significant valuation loss for SCF firms. However, SCF firms that have adopted blockchain experience an insignificant impact of the announcement on their market valuation compared to SCF firms that did not do so. Also,

⁷ Retrieved from <https://www.i-scoop.eu/blockchain-distributed-ledger-technology/>. Accessed 2nd January 2022.

we find that the adoption of blockchain induces stability in the trading volume of SCF firms. Further, we do not find any significant impact of firm characteristics on our results. Finally, we determine that R&D intensity and adequate capital expenditure strengthen the SCF firm's financial position and reduce the loss of their valuation. Especially, these two factors play a more important role for blockchain-enabled SCF firms that are part of any consortium or have progressed from the pilot to the implementation stage of their blockchain initiative. These insights can be beneficial for investors who want to invest in SCF firms.

Our study has several important contributions. First, deviating from existing research works such as production or resource allocation-based activities of the supply chain during the COVID-19 pandemic, our work facilitates a holistic depiction by studying the impact of this pandemic on the valuation of SCF firms across the world. Hence, it presents a new paradigm to explore the effect of uncertainties associated with the ongoing global pandemic. Second, it contributes to the existing literature of economic losses by analyzing the stock price and the volume movement and identifying potential factors leading to such losses in the context of SCF firms. Third, it establishes the effectiveness of the blockchain technology for protecting the market value of the firms and identifying the factors influencing the valuation of blockchain-enabled SCF firms. Fourth, our findings reflect investors' trust in the valuation of the SCF firms. Blockchain technology, admittedly, is effective in building trust across a supply chain with a decentralized 'trustless' network [16]. Our study extends this argument in the context of the SCF firms.

The article is organized as follows. Section 2 describes a summary of the relevant literature. Section 3 presents the proposed hypotheses. Section 4 details the steps of the event study. Section 5 provides the data description. Section 6 discusses the empirical findings obtained from this study. Section 7 discusses the academic and managerial implications of this research, limitations, and future research avenues. The article concludes by discussing the key contributions of this research in Section 8.

2. Literature review

Our exploration of the existing literature leads us to classify relevant research articles into four categories; event studies in supply chain management, uncertainty related to pandemic and economic losses, blockchain applications in supply chain management, and technology adoption in SCF.

2.1. Event studies in supply chain management

Event studies are popular for studying the impact of the various announcements on the market value of firms [17]. Various event studies have been conducted on understanding the impact of announcements related to the adoption of new information technologies on the firms' performance in the stock market [18–20]. The impact of different events on supply chain management has gained the attention of researchers over the years as well. Though most scholars consider a longer duration for their work, there is an emerging interest in the short-term event studies in the supply chain literature [21]. Bose and Pal [22] study the impact of green supply chain initiatives on the stock prices of firms. The extant literature has also analyzed events signifying economic losses in the context of supply chain as well. For example, Hendricks and Singhal [23] document that supply chain glitches resulting in the delay of production and shipment erode 10.28% of the shareholder wealth. Even delay in the launching of new products [24] or product recall announcements [25] lead to a significant loss in the market value of firms. From the perspective of supply chain disruption, Hendricks and Singhal [26] demonstrate the effect of supply chain disruption on the stock price and equity risk of the firms. Jacobs and Singhal [27] investigate the impact of the Rana Plaza Disaster of Bangladesh in 2013 on the sourcing strategies and supply chain governance of the firms. Similarly,

Hendricks et al. [28] explain the stock market reaction to the 2011 earthquake in Japan. In the context of SCF firms, Lam et al. [29] use an event study to investigate the impact of SCF initiatives on the market value of firms.

2.2. Uncertainty related to pandemic and economic losses

A global pandemic like COVID-19 ushers in various types of business uncertainty, such as geopolitical, industry, and firm-level uncertainties [30]. Craighead et al. [31] link established and emergent theories of business with pandemic situations and explain how the uncertainty due to the pandemic affects the supply chain activities. Few studies propose sustainable open-loop and closed-loop supply chain solutions to combat the uncertainty related to the COVID-19 pandemic [32,33]. Sharif et al. [34] argue that the uncertainty emanating from COVID-19 should be perceived differently over the short run and the long run. Stock market volatility has been considered a prominent indicator for such uncertainty [34,35]. Hence, in the context of supply chain, short-term event studies considering stock price movement during a pandemic can yield meaningful insights. Further, dealing with such an uncertainty is a crucial issue for businesses and is often addressed by adopting a new strategy [36]. Automation or technology adoption is a popular way to deal with such a situation [37].

Exploration of economic losses caused by the pandemic situation is a popular theme of research. Analyzing the data from the 2009 H1N1 pandemic, Haimar and Santos [38] identify that the sectors with higher production outputs experience a significant economic loss due to the pandemic. Fan et al. [39] estimate the expected annual loss of USD 500 billion due to the global influenza pandemic. According to Altig et al. [35], the COVID-19 pandemic is responsible for raising the economic uncertainty of the USA by 35% in the first quarter of 2020. Using a natural experiment, Dietrich et al. [40] conclude that the uncertainty associated with the COVID-19 pandemic has amplified recession by a factor of three.

2.3. Blockchain applications in supply chain management

Blockchain, a distributed ledger technology developed for peer-to-peer transactions, first appeared around 2011. In the current era of Industry 4.0, blockchain exhibits immense potential in supply chain operations [41]. The distributed ledger-based operations present in blockchain can be helpful to ensure transparency and visibility in the supply chain by eliminating the information asymmetry among the supply chain members [42]. Recently, there has been a rising interest among academics to explore the use of blockchain in supply chain management. Wamba et al. [43] adopt a survey-based method to investigate the impact of blockchain implementation on supply chain transparency. Martinez et al. [44] apply a simulation-based analysis to demonstrate how blockchain can be useful for customer order management. Lohmer et al. [45] investigate the resilience strategy and the ripple effect of the supply chain with blockchain using agent-based simulation. Kouhizadeh et al. [46] discuss the barriers of blockchain adoption in sustainable supply chain design. Dolgui et al. [47] propose a modeling approach to facilitate the smart contract design for a blockchain-enabled supply chain. Danese et al. [48] explain how blockchain can be helpful to prevent counterfeiting in the supply chain. Toufaily et al. [49] demonstrate how blockchain can facilitate the traceability and transparency of the supply chain. Chod et al. [50] document that blockchain technology can bring supply chain transparency which in turn leads to secure financing with more favorable terms while incurring lower signaling cost. Multiple blockchain service providers often adopted a collaborative approach to develop and maintain a 'blockchain consortium' for providing services to their clients. For instance, IBM food trust, a blockchain consortium initiated by CargoSmart and comprising growers, distributors, manufacturers, wholesalers, etc., provides blockchain-based tracking solutions to the food

suppliers, manufacturers, and retailers.⁸ Similarly, Global Shipping Business Network, a blockchain consortium initiated by CargoSmart and comprising nine terminal operators and ocean carriers, offers blockchain-based logistics solutions to the shippers, logistics service providers, etc.⁹

Blockchain technology also plays a crucial role in building trust in the system by using a decentralized ‘trustless’ network. Trust is one of the most influential factors influencing blockchain adoption [51]. Weber et al. [52] highlight that blockchain can generate enough trust within the network of untrusted participants, thus facilitating the integration of business processes. Chen et al. [53] point out three issues of centralized trust-building that can be potentially addressed by blockchain: self-interest of supply chain participants, cost of supply chain quality inspection, and the information asymmetry in the production process. Although few studies raise concerns related to the high visibility of sensitive data in the blockchain platform [54], others report an extremely strong relationship between trust and blockchain [16]. In the context of supply chain management, Dujak and Sajter [55] conclude that blockchain builds trust, which, in turn, builds value for a firm.

2.4. Technology adoption in supply chain finance

In recent times, technology adoption in supply chain financing activities has attracted the attention of scholars. Byrd and Davidson [56] demonstrate the positive impact of information technology on supply chain performance. Wang et al. [57] discuss how the Internet of Things (IoT) can be useful to devise proper supply chain risk management strategies. Zhu et al. [58] describe the use of machine learning techniques to forecast the credit risk for SCF firms. Hoffman et al. [1] explain the important role of blockchain in different supply chain activities such as smooth transaction of the payments, maintaining buyer-lender relationships, auditing, etc. Similarly, Du et al. [59] discuss the improvement of efficiency and transparency of SCF firms that use blockchain. Chod et al. [50] adopt an analytical modeling approach to depict the role of blockchain in ensuring supply chain transparency. Choi et al. [60] propose a game-theoretic model to devise a proper supply chain financing mechanism with blockchain.

The studies related to the impact of the COVID-19 pandemic on the supply chain activities focus on logistics operations, demand management, risk mitigation, etc., whereas supply chain financing has not been paid enough attention [14]. Hence, exploring the role of technology such as blockchain to protect the market value of SCF firms during the COVID-19 pandemic can be an interesting research avenue. In this context, it is important to investigate the investor’s trust on the blockchain activities of SCF firms. From the perspective of methodology, on a similar line as Xu et al. [13], our exploration of the relevant literature highlights the absence of a substantial number of empirical works in the context of SCF. To fulfill the extant gap in research, we investigate the role of a financial innovation such as blockchain for SCF firms to protect their market value in the onset of the COVID-19 pandemic. The summary of the relevant literature that highlights the contributions of our work is presented in Table 2.

3. Hypotheses development

Investors’ decision-making under uncertainty remains an area of interest for researchers, practitioners, and policymakers. The stock market often reflects investors’ reactions to uncertainties [61]. Fig. 1 depicts the market price movement of major stock indices across the globe for the period of 1st January 2020 to 31st December 2021, which

⁸ Retrieved from: <https://www.ibm.com/products/food-trust>. Accessed 2nd January 2022.

⁹ Retrieved from: <https://101blockchains.com/blockchain-consortium/>. Accessed 2nd January 2022.

Table 2
Summary of the extant literature.

Theme	Objectives	Research avenues
Event studies in supply chain management	Examine the effect of innovation on the stock prices of firms [22] Study the impact of supply chain disruption on the stock prices of firms [23–28] Study the impact of SCF initiatives on the market valuation of firms [29]	Investigate the impact of a disruption such as the COVID-19 pandemic on the supply chain financing activities
Uncertainty related to pandemic and economic losses	Allocate resource efficiently for a supply chain network under the uncertainty caused by the COVID-19 pandemic [32,33] Study the impact of the COVID-19 pandemic on the stock market volatility [34, 35] Examine the role of technology in reducing economic losses caused by the COVID-19 pandemic [37] Measure economic losses caused by the COVID-19 pandemic [35,39,40]	Explore the impact of uncertainties due to the COVID-19 pandemic on SCF firms
Blockchain applications in supply chain management	Analyze the impact of blockchain implementation on: Supply chain transparency [42,43,49] Customer order management [44] Resilience strategy [45] Sustainable supply chain design [46] Smart contract design [47] Prevention of counterfeiting [41,48]	Investigate investor’s trust on blockchain activities of a firm during the COVID-19 pandemic
Technology adoption by the SCF firms	Study the impact of technologies such as IoT, machine learning, etc., on the risk management strategies of SCF firms [56–58] Examine the impact of blockchain on the transparency [50], efficiency and effectiveness [59], and proper mechanism design for financing [60]	Explore the role of technology to protect the market value of SCF firms during the COVID-19 pandemic

encompasses the uncertainty related to the COVID-19 pandemic. Although there is a substantial plunge in market prices on the event of WHO’s declaration of COVID-19 as a pandemic, this has been followed by a widespread recovery of global stock markets toward the end of the year. The extant literature often explores the relationship between uncertainty and stock price movement. While Anderson et al. [62] explore the association between uncertainty and stock price returns, Andrei and Hasler [63] establish uncertainty and investors’ attention as driving factors of asset prices. The substantial increase in the unsystematic risk due to the COVID-19 pandemic causes a decrease in revenue, leading to a valuation loss. For example, external private finance activities are projected to decrease by USD 700 billion compared to 2019 [64]. Also, there is a substantial increase in the percentage of firms with a market capitalization less than the book value of equity, i.e., from 15.1% to 42.8% between 31st December 2019 and 16th March 2020.¹⁰ In the context of supply chain, Li et al. [65] examine the propagation of disruption caused by the COVID-19 pandemic across the supply chain

¹⁰ Retrieved from: <http://cdn.hl.com/pdf/2020/covid-19-impact-on-impairment.pdf>. Accessed 2nd January 2022.

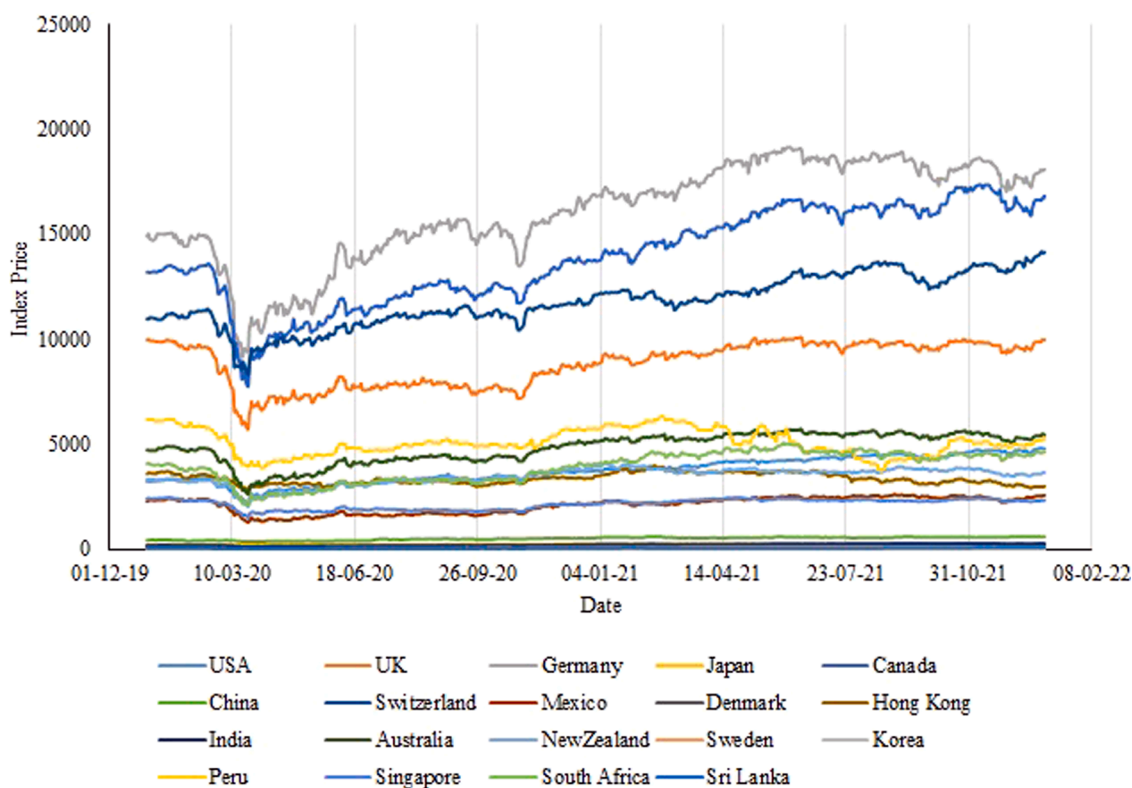


Fig. 1. Price (in USD) movement of the global stock indices during the COVID-19 pandemic.

network. The forward and backward propagation of disruption termed as 'ripple effect' can be attributed to the supply shortage and demand reduction across the global supply chain [66]. We expect that this ripple effect may disrupt the functions of SCF firms as well. Hence, we posit that the uncertainty created due to the WHO's announcement of COVID-19 as a 'pandemic' will negatively impact the stock prices of SCF firms. Hence, we propose the following hypothesis:

H1. *The WHO's announcement of COVID-19 as a 'pandemic' generates a significant loss of valuation for SCF firms.*

The decentralized distribution of blockchain-based applications overcomes certain shortcomings of the centralized technology, such as data tampering attacks. However, as discussed earlier, certain security risks have emerged from the blockchain technology itself. For instance, the reentrancy attack of 2016 on the Ethereum blockchain-based smart contracts of a venture capital fund named the decentralized autonomous organization (DAO) showcases this risk. In this attack, almost USD 60 million worth of Ethers was siphoned off [67,68]. Based on such instances, one may argue that blockchain-enabled firms may not always be trusted by an investor. Therefore, it is quite unlikely that during the COVID-19 pandemic, the blockchain-enabled firms can restore valuation.

Despite such security threats, numerous studies identify the implementation of blockchain as a positive change toward a better and more transparent economic system [69]. Moreover, various studies recognize the potential of blockchain in financial inclusion and poverty alleviation [70,71], as well as in building economic resilience and reducing the risk of a disaster [72]. Similarly, scholars such as Wang et al. [73] and Centobelli et al. [74] opine that blockchain technology facilitates higher traceability and transparency in supply chain operations. Also, Wang et al. [75] demonstrate the immense potential for value creation by blockchain-enabled SCF firms. Recent initiatives undertaken by SCF

firms are consistent with this insight. For instance, SCF firms such as Tencent, Dianrong, and FnConn experience a significant rise in funding after implementing a blockchain platform.¹¹ Such initiatives attract stakeholders' attention and subsequently increase the market value of these firms. Also, the initiatives such as digital lending platforms developed by several USA-based financial service companies such as nCino, Unqork, Numerated, etc., under the CARES Act, highlight the rising interest among the financial service firms to incorporate financial technology for enhancing their financing decision-making during the COVID-19 pandemic [76]. The pandemic has already raised the cost of operations of the financial service firms. In this context, blockchain can be helpful to improve their operations and reduce information asymmetry. For this reason, we posit that SCF firms that have adopted blockchain will be less affected by the WHO's announcement about COVID-19 as a 'pandemic.' Hence, we propose the next hypotheses:

H2. *The WHO's announcement of COVID-19 as a 'pandemic' generates a lower valuation loss for blockchain-enabled SCF firms compared to other SCF firms.*

H3. *Due to the WHO's announcement of COVID-19 as a 'pandemic,' a lower percentage of blockchain-enabled SCF firms incur valuation loss compared to other SCF firms.*

A complementary indicator of the impact of an event is a significant and persistent increase in trading volume. Although abnormal returns (ARs) may be sensitive to the factors embedded in expected return models, estimates of abnormal trading volume are model free. Thus, the trading volume may increase due to high volatility, despite the short-lived movement of stock prices. Chen [77] finds a negative correlation between stock price return and trading volume in bear stock markets. Panic overselling at the time of market decline emerges as one of the instrumental factors for this low price and high-volume relationship. The panic overselling on 9th, 12th, 16th, and 23rd March 2020, due to

¹¹ Retrieved from: <https://www.bankingtech.com/2017/03/chinas-chained-financebrings-blockchain-boost-to-sme-funding/>. Accessed 2nd January 2022.

the fear and uncertainty of the COVID-19 pandemic, brought down the Dow Jones Industrial Average (DJIA) by 26% [78]. Based on this phenomenon, we propose the following two hypotheses to examine the impact of the WHO's announcement about COVID-19 as a 'pandemic' on the trading volume of stocks for SCF firms. Hence, we posit the following hypotheses:

H4. *The WHO's announcement of COVID-19 as a 'pandemic' generates significantly higher trading volume for SCF firms.*

H5. *The WHO's announcement of COVID-19 as a 'pandemic' generates significantly lower trading volume for blockchain-enabled SCF firms than that for other SCF firms.*

Lam et al. [29] explore the role of firm characteristics in determining the market value of SCF firms where firms are either banks or non-banks. They show that the stock price reactions are higher for non-banking SCF initiatives compared to their banking counterparts. This finding is supported by the reasons that the banks are bureaucratic [79], and non-banks maintain productive networks as well as understand the needs of other supply chain members better [80]. Therefore, we posit the following hypothesis related to the valuation loss encountered by SCF firms due to the announcement by the WHO.

H6. *The WHO's announcement of COVID-19 as a 'pandemic' generates significantly different valuation loss for banking and non-banking SCF firms that are blockchain-enabled and for those that are not.*

Knott [81] considers three inputs, namely capital, labor, and R&D investments, that determine a firm's output. Following this idea, Coluccia et al. [82] develop a research and development (R&D) innovation indicator based on a firm's R&D, capital, and staff expenditures. The extant literature related to digital innovation indicates the importance of R&D activities in determining the firm's performance [83–85]. As per the report of Reuters, the capital expenditure of multi-national companies has been rising since the pre-COVID period and has achieved the highest level of this decade in the first quarter of 2021.¹² At the same time, despite the potential of revenue loss, "the majority of organizations have already moved forward with or are planning to move forward with salary increases and bonus payouts for 2020, and only a handful of organizations have decided to cancel salary increases or bonus payouts."¹³ Hence, we may expect that SCF firms investing heavily in R&D, capital expenditure, and staff expenditure in the pre-COVID period would be positioned better to combat the disruption caused due to COVID-19. Since 2017, Chinese blockchain firms have maintained a leadership position in R&D activities related to blockchain.¹⁴ Organizations, such as Alphabet, Volkswagen, Samsung, etc., have invested more than USD 15 billion in 2018 to foster their growth through innovation.¹⁵ In 2019, the rising interest of SCF firms in blockchain-based innovation has been described as one of the seven major trends in the corresponding industry.¹⁶ The financial innovation in the form of blockchain will reduce the adverse impact of the WHO's announcement of COVID-19 as a 'pandemic,' and the ARs earned by SCF firms will be closely associated with their investments in capital, labor, and R&D. This leads us to the following hypotheses:

H7a. *The WHO's announcement of COVID-19 as a 'pandemic' will lead*

to a lower valuation loss for SCF firms that adopt blockchain and are more R&D intensive than other SCF firms.

H7b. *The WHO's announcement of COVID-19 as a 'pandemic' will lead to a lower valuation loss for SCF firms that adopt blockchain and are more capital intensive than other SCF firms.*

H7c. *The WHO's announcement of COVID-19 as a 'pandemic' will lead to a lower valuation loss for SCF firms that adopt blockchain and are more labor intensive than other SCF firms.*

The consortium mode of blockchain benefits from the leadership of multiple entities. Hence, it is expected to develop more innovative business models due to collaborative business transformation [86]. In 2019, around 20% of Italian blockchain companies started collaborative ventures with local universities, especially in R&D-related activities.¹⁷ On the other hand, any standalone blockchain system is often criticized for privacy and security-related concerns and being less innovative [87]. Gu et al. [88] argue that consortium blockchain is superior in malware detection compared to other private or public standalone blockchain initiatives. Therefore, it is expected that blockchain-enabled SCF firms that are part of a consortium would be more innovative than standalone entities and thus gain more confidence from investors. Hence, we posit the following hypotheses:

H8a. *The WHO's announcement of COVID-19 as a 'pandemic' will lead to a lower valuation loss for blockchain-enabled SCF firms that are part of any consortium and are more R&D intensive than other blockchain-enabled SCF firms.*

H8b. *The WHO's announcement of COVID-19 as a 'pandemic' will lead to a lower valuation loss for blockchain-enabled SCF firms that are part of any consortium and are more capital intensive than other blockchain-enabled SCF firms.*

H8c. *The WHO's announcement of COVID-19 as a 'pandemic' will lead to a lower valuation loss for blockchain-enabled SCF firms that are part of any consortium and are more labor intensive than other blockchain-enabled SCF firms.*

Vu et al. [89] classify blockchain adoption by a firm into three stages: initiation, adoption, and implementation. The level of impact created by the blockchain varies for different stages of adoption by a firm [90]. Since firms implement the most innovative business solution after experimenting with various possible opportunities at the pilot stage, it is expected that investors' confidence would be higher when the blockchain-enabled SCF firms progress from the initiation to the implementation stage. At the same time, the movement to the implementation phase signals that the firm has gathered sufficient knowledge and capability in the technology, has been able to overcome the challenges of new technology by possibly completing a trial successfully, and is ready to take up the technology in a commercially viable manner. This raises the investors' confidence in the firm. Based on this argument, we develop our final set of hypotheses:

H9a. *The WHO's announcement of COVID-19 as a 'pandemic' will lead to a lower valuation loss for blockchain-enabled SCF firms that are at the implementation stage and are more R&D intensive than other blockchain-enabled SCF firms.*

H9b. *The WHO's announcement of COVID-19 as a 'pandemic' will lead to a lower valuation loss for blockchain-enabled SCF firms that are at the implementation stage and are more capital intensive than other blockchain-enabled SCF firms.*

H9c. *The WHO's announcement of COVID-19 as a 'pandemic' will lead to a lower valuation loss for blockchain-enabled SCF firms that are at the implementation stage and are more labor intensive than other blockchain-enabled SCF firms.*

We summarize our hypotheses in the form of a conceptual framework and present it in Fig. 2.

¹² Retrieved from: <https://www.reuters.com/business/global-companies-capex-hit-decade-high-growth-this-year-refinitiv-data-2021-06-23/>. Accessed 2nd January 2022.

¹³ Retrieved from: <https://www.shrm.org/resourcesandtools/hr-topics/compensation/pages/pandemic-forces-employers-to-cut-pay.aspx>. Accessed 2nd January 2022.

¹⁴ Retrieved from: <https://www.rvo.nl/sites/default/files/2019/12/Blockchain-Netherlands-Innovation-Network-versie-RVO.pdf>. Accessed 2nd January 2022.

¹⁵ Retrieved from: <https://www.ideatovalue.com/inno/nickskillcorn/2019/08/top-1000-companies-that-spend-the-most-on-research-development-charts-and-analysis/>. Accessed 2nd January 2022.

¹⁶ Retrieved from: https://www.scmr.com/article/7_supply_chain_financing_trends_to_watch_in_2019. Accessed 2nd January 2022.

¹⁷ Retrieved from oecd-ilibrary.org/sites/18ac5acb-en/index.html?itemId=/content/component/18ac5acb-en. Accessed 2nd January 2022.

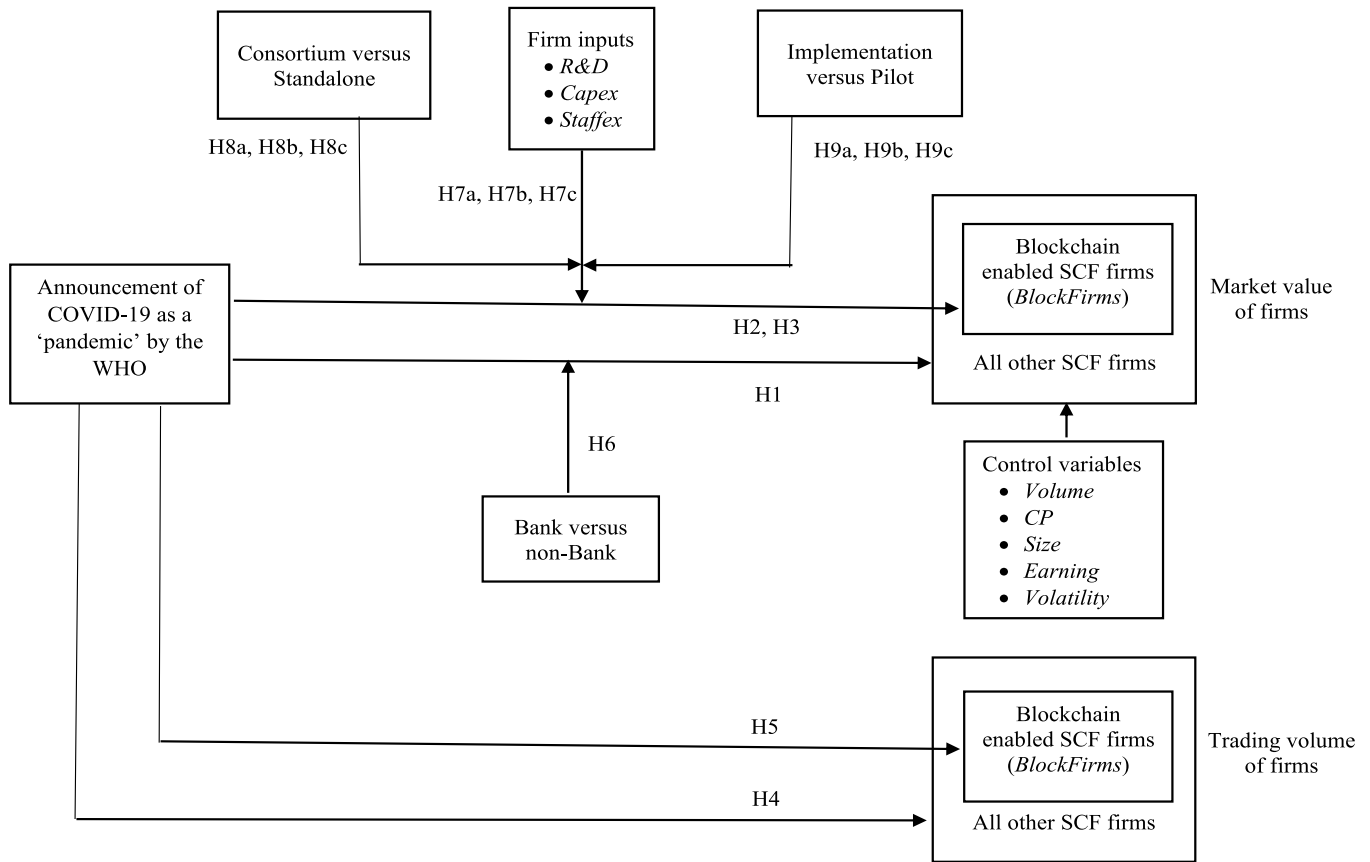


Fig. 2. Conceptual framework showing the proposed hypotheses.

4. Methodology

In this section, we describe the event study methodology adopted in this study to compute the CAAR and the CAAV for stocks of SCF firms around the event date. Then, we discuss the regression that is used to identify the factors that can explain the CAAR of those stocks.

4.1. Computation of CAAR

An event study is usually performed to assess whether an event containing new informational content makes investors earn abnormal stock returns [91]. Since our study aims to explore the impact of the WHO’s announcement of COVID-19 as a pandemic, we adopt an event study to determine the impact of the same in the context of SCF firms.

The event date is considered as day 0. The event window $[-m, n]$ represents a $(m+n+1)$ day interval around the event date, i.e., starting from m trading days before the event date and extending up to n trading days after the event date. The AR for stock i on day t , i.e., $AR_{i,t}$ is computed as the difference of actual stock return ($R_{i,t}$) and the expected stock return $E(R_{i,t})$ on that day. This can be expressed in the following manner.

$$AR_{i,t} = [R_{i,t} - E(R_{i,t})]. \tag{1}$$

The CAAR over any interval $[x, y]$ within the event window is estimated as follows.

$$CAAR_{x,y} = \sum_{t=x}^y \sum_{i=1}^N AR_{i,t}. \tag{2}$$

where, N is the total number of firms, and $\sum_{i=1}^N AR_{i,t}$ is the average abnormal return (AAR) on day t .

To confirm that our CAAR estimates are consistent across different

model specifications and cannot be explained by the factors of traditional asset pricing, we estimate the ARs around the event date with the help of four expected return models, namely the MM, the MM with EGARCH errors (MMEGE), FF3F, and C4F [92,93]. The use of multiple asset pricing factors in expected return models has been adopted by recent research on event studies [94]. We adopt the same practice to ensure the robustness of results.

To check the significance of the CAAR estimates that are obtained from the different models, we perform a skewness-adjusted t -test and the adjusted Patell Z-test. The skewness-adjusted t -test is superior to the cross-sectional t -test as it rectifies for skewed AR distribution. On the other hand, the adjusted Patell Z-test, a modified version of the Patell Z-test, successfully captures the cross-correlation of the ARs [95,96]. We provide a detailed description of the models and test statistics in Appendix A.2.

4.2. Computation of CAAV

For any stock i , the relative volume on trading day t can be defined as the ratio of the number of shares traded on that day ($S_{i,t}$) to the total number of shares outstanding ($O_{i,t}$). We transform the relative volume into their logarithmic value that are approximately normally distributed [97]. The daily log-transformed relative volume, $V_{i,t}$ (henceforth, volume) and the abnormal volume $AV_{i,t}$, can be determined as follows.

$$V_{i,t} = \log \left(\frac{S_{i,t}}{O_{i,t}} \right). \tag{3}$$

$$AV_{i,t} = (V_{i,t} - \bar{V}_i). \tag{4}$$

where \bar{V}_i represents the average daily trading volume estimated over the interval $[-210, -31]$ with reference to the event date.

The CAAV over the event window $[x, y]$ is estimated as follows.

$$CAAV_{x,y} = \sum_{t=x}^y \sum_{i=1}^N AV_{i,t} \quad (5)$$

where N represents the total number of firms, and $\sum_{i=1}^N AV_{i,t}$ denotes the average abnormal volume (AAV) on day t .

4.3. Cross-sectional regression analysis

We investigate the predictive ability of different factors in explaining the CAR generated by the firms using cross-sectional regression. Cross-sectional regression is a popular method to identify various firm-level characteristics that may potentially explain any abnormal gains earned by the sample firms [29]. The CAR for a sample firm i over the event window $[x, y]$ is estimated as follows.

$$CAR_{i,xy} = \sum_{t=x}^y AR_{i,t} \quad (6)$$

where $AR_{i,t}$ is the AR earned by the i^{th} firm on day t .

CAR, as estimated by Eq. (6), is considered to be the dependent variable. We use different explanatory variables to develop four different regression specifications. These are shown below:

- Model 1:

$$CAR_{i,xy} = \alpha_0 + \alpha_1.Block_Dummy + \beta_1.Volume + \beta_2.CP + \beta_3.Size + \beta_4.Earning + \beta_5.Volatility + \epsilon.$$

- Model 2:

$$CAR_{i,xy} = \alpha_0 + \alpha_2.Block_Dummy * R\&D + \beta_1.Volume + \beta_2.CP + \beta_3.Size + \beta_4.Earning + \beta_5.Volatility + \epsilon.$$

- Model 3:

$$CAR_{i,xy} = \alpha_0 + \alpha_3.Block_Dummy * Capex + \beta_1.Volume + \beta_2.CP + \beta_3.Size + \beta_4.Earning + \beta_5.Volatility + \epsilon.$$

- Model 4:

$$CAR_{i,xy} = \alpha_0 + \alpha_4.Block_Dummy * Staffex + \beta_1.Volume + \beta_2.CP + \beta_3.Size + \beta_4.Earning + \beta_5.Volatility + \epsilon.$$

To identify the predictive factors specific to the blockchain-enabled SCF firms, we run six additional model specifications as follow:

- Model 5:

$$CAR_{i,xy} = \alpha_0 + \alpha_5.Consortium * R\&D + \alpha_6.Consortium + \beta_1.Volume + \beta_2.CP + \beta_3.Size + \beta_4.Earning + \beta_5.Volatility + \epsilon.$$

- Model 6:

$$CAR_{i,xy} = \alpha_0 + \alpha_7.Implementation * R\&D + \alpha_8.Implementation + \beta_1.Volume + \beta_2.CP + \beta_3.Size + \beta_4.Earning + \beta_5.Volatility + \epsilon.$$

- Model 7:

$$CAR_{i,xy} = \alpha_0 + \alpha_9.Consortium * Capex + \alpha_{10}.Consortium + \beta_1.Volume + \beta_2.CP + \beta_3.Size + \beta_4.Earning + \beta_5.Volatility + \epsilon.$$

- Model 8:

$$CAR_{i,xy} = \alpha_0 + \alpha_{11}.Implementation * Capex + \alpha_{12}.Implementation + \beta_1.Volume + \beta_2.CP + \beta_3.Size + \beta_4.Earning + \beta_5.Volatility + \epsilon.$$

- Model 9:

$$CAR_{i,xy} = \alpha_0 + \alpha_{13}.Consortium * Staffex + \alpha_{14}.Consortium + \beta_1.Volume + \beta_2.CP + \beta_3.Size + \beta_4.Earning + \beta_5.Volatility + \epsilon.$$

- Model 10:

$$CAR_{i,xy} = \alpha_0 + \alpha_{15}.Implementation * Staffex + \alpha_{16}.Implementation + \beta_1.Volume + \beta_2.CP + \beta_3.Size + \beta_4.Earning + \beta_5.Volatility + \epsilon.$$

Annual as well as daily data for the last one year is used to estimate the explanatory variables. The description of the variables is as follows.

- **Block_Dummy:** It is a dummy variable with value 1 if the firm has adopted blockchain and 0 otherwise.
- **R&D:** A firm's R&D intensity is measured by its R&D expenditure normalized by sales.
- **Capex:** A firm's capital intensity is measured by its capital expenditure normalized by sales.
- **Staffex:** A firm's labor intensity is measured by its staff expenditure normalized by sales.
- **Consortium:** It is a dummy variable with value 1 if the firm belongs to any blockchain consortium and 0 otherwise
- **Implementation:** It is a dummy variable with value 1 if the firm has progressed to the stage of blockchain implementation (i.e., performed at least one transaction before the event date) and 0 otherwise

Additionally, we consider five firm-level characteristics as control variables as follows.

- **Volume:** It is the logarithm of the average of daily number of shares traded.
- **CP:** Average of the daily closing prices (unadjusted, dollar-denominated).
- **Size:** Average of the daily market capitalizations (dollar-denominated).
- **Earning:** Average of the annualized daily returns.
- **Volatility:** Standard deviation of the annualized daily returns.

Studies, such as Akyildirim et al. [98], Sharma, and Paul [99], etc., have used these control variables to explain the ARs generated by announcements.

It can be argued that insights from the event study methodology are relevant only when outcomes are relatively stable over time. More specifically, the event should be free from any confounding events or any co-occurring changes within the time window of consideration [100]. However, such fundamentals are often challenged during a

pandemic. Hence, we take special care while building our dataset by excluding the firms with confounding events and analyzing the impact for different lengths of event windows. We elaborate on this further in the next section (data description) of our study. Our extensive literature review indicates that the researchers extensively use the event study method in the context of both epidemic and pandemic outbreaks. For instance, Kim et al. [101] investigate the impact of four epidemic outbreaks, namely avian flu, swine flu, bovine spongiform encephalopathy, and Salmonella Infantis on the valuation of restaurant firms. Similarly, scholars explore the effect of the 2003 SARS outbreak on the financial performance of Taiwan's tourism, biotech, wholesale, and retail industries [102,103]. Furthermore, several researchers use an event study to investigate the impact of the COVID-19 pandemic on the global stock market [104,105]. This further motivates us to analyze the impact of the COVID-19 on the valuation of SCF firms using an event study.

5. Data description

We consider 11th March 2020 as the event date on which the WHO declares the COVID-19 as a pandemic. Along with shorter event windows, we also consider longer event windows as they often account for leakage of market information and provide robustness to the results [106]. Thus, we select multiple event windows (from [0, +1] to [-30, +50]) to check the impact of the announcement on stock valuation [98]. Our sample comprises publicly traded organizations across the globe that perform financing activities to supply chain firms and are active from January 2019 to January 2020. We use the Thomson Reuters Eikon database to build the dataset. We search for a few keywords, such as 'supply chain finance,' 'platform finance,' 'reverse factoring,' and 'logistics finance' in the newswire, and identify 215 firms. Further, we impose two filters: first, we identify those firms that carry unique Reuters Instrument Codes (RIC); second, we exclude the firms that have experienced any confounding news such as merger, stock issuance, spin-off, etc., during the entire event window of [-30, 50]. Our final sample comprises stocks of 46 firms. The stepwise filtering of the sample is shown in Table 3. We use RICs to identify the firms that have either tested or implemented blockchain in their SCF platforms as of the event date. We identify 24 such firms that have invested in blockchain and classify them as 'BlockFirms'. Hence, in the context of our study, 'BlockFirms' are those firms that adopt blockchain technology in their SCF activities. However, the level of blockchain implementation varies across the firms. For example, as of the event date, Bank of America has filed 78 blockchain-related patents and has started hiring people to use Ripple's blockchain-based payment networks. Therefore, it is still in the test or pilot phase of adopting blockchain technology in trade financing. In contrast, Societe Generale has announced its first trade finance transaction on 22 January 2018 and further invested in Komgo, a blockchain-based SCF platform in August 2018. On 18 April 2019, it has issued a EUR 100 million covered bond that acted as a security token on the blockchain platform. Thus, we consider Societe Generale as a blockchain-enabled firm under the implementation phase. In our sample, 11 firms out of 24 'BlockFirms' have progressed from the pilot stage to the implementation stage of blockchain, i.e., they have performed at least one transaction using blockchain before the event date. Out of

Table 3
Description of the sample.

Selection of sample firms	Number
Identified firm names in the Thomson Reuters Newswire using keywords such as 'supply chain finance,' 'platform finance,' 'reverse factoring,' and 'logistics finance'	215
Deleted firms that do not carry unique RICs in the Eikon database as of event date	103
Deleted firms that had any confounding event(s) during the event window of [-30, 50]	66
Number of remaining firms	46

these total 24 'BlockFirms', 15 firms belong to at least one consortium before the event date. To get the details of these 'BlockFirms' and descriptions of their blockchain projects, please refer to Table A.1 of Appendix A.3. Other SCF firms are denoted as 'Non-BlockFirms'. Further, we identify two groups of firms based on their firm characteristics. Among 46 firms, 23 are in the banking business, and we refer to them as 'Banking.' The remaining 23 firms are denoted as 'Non-banking.'

We obtain all relevant data for the above-mentioned firms from the Thomson Reuters Datastream using unique RICs. Data related to the unadjusted closing stock price, trading volume, and market capitalization are sourced at a daily level for the last one year. Data related to R&D expenditure, capital expenditure, staff expenditure, and revenue are obtained at the yearly level as of 31st March 2019. Thus, we collect all relevant information from publicly available documents and not from any primary source. Table 4 lists the pairwise correlation among all variables, variance inflation factor (VIF) for independent variables, and relevant descriptive statistics. A positive and significant correlation exists between the two main explanatory variables: *Capex* and *Staffex*. Among the control variables, *CP* and *Size* are highly associated with other variables. VIF scores for the independent variables indicate that the regression models used in the study are not affected by multicollinearity. Additional daily data related to FF3F and C4F are obtained from Kenneth French's data library. To ensure that the impact of the WHO's announcement is free from any bias induced by extreme observations, we also compute the CAAR of the outlier-adjusted sample firms. The outlier-adjusted sample comprises all sample firms except those that fall in the top 10% or bottom 10% in terms of the CAR generated from day -30 to day 50.

6. Empirical findings

6.1. Descriptive statistics

Table 5 presents some descriptive statistics related to the sample firms for the pre-event and the post-event windows (including the event day). The pre-event period denotes the time interval from 30 days to 1 day prior to the event, and the post-event period includes the time period from the event date to 50 days after it. From Table 5, it is evident that the average daily unadjusted dollar-denominated price reduces from the pre-event (\$34.46) to the post-event period (\$27.53). In the pre-event period, the average daily return percentage (annualized) is recorded as a minor loss (-0.62%). However, the return decreases even further in the post-event period (-2.03%). The volatility of the return increases in the post-event period (6.32%) compared to the pre-event period (3.06%). The logarithm of the average daily volume of trades also increases after the event. Also, the average daily market capitalization reduces slightly from the pre- to the post-event period. However, there is no change recorded for average shares outstanding between the two-time windows.

6.2. Impact of the WHO's announcement on the market value of SCF firms

To investigate the effect of the WHO's announcement on SCF firms, we determine the CAAR as per Eq. (2) and present our findings in Table 6. We estimate the CAAR for two sets of firms (i.e., all sample firms and outlier-adjusted sample firms) over different event windows. From Table 6, we observe that our sample firms incur a significant loss in valuation close to the event date. According to the MM, MMEGE, FF3F, and C4F models, the firms on an average earn -2.8%, -2.1%, -3.2%, and -2.8%, respectively, around the event window [-1, +1]. These significant valuation losses are consistently observed throughout the entire event window. In the longest window of our study, (i.e., [-30, +50]), sample firms experience a negative and significant CAAR of -19.3%, -23.8%, -28.0%, and -22.3% as per the MM, MMEGE, FF3F, and C4F models, respectively. Therefore, it seems that there is a permanent

Table 4
Correlation matrix, VIF, and descriptive statistics of variables.

	CAR	Block_Dummy	R&D	Capex	Staffex	Volume	CP	Size	Earning	Volatility	
Correlation matrix and VIF	CAR	1									
	Block_Dummy	0.270	1								
	R&D	0.159	-0.030	1							
	Capex	0.154	-0.052	0.766**	1						
	Staffex	0.009	0.140	-0.164	-0.034	1					
	Volume	0.117	0.290	-0.146	-0.224	-0.137	1				
	CP	0.649**	0.312*	0.354*	0.384*	0.259	-0.046	1			
	Size	0.377*	0.476**	-0.073	-0.088	0.081	0.596**	0.550**	1		
	Earning	-0.125	0.014	0.209	0.178	0.218	-0.027	0.328*	0.283	1	
	Volatility	-0.906**	-0.179	-0.064	-0.066	-0.091	-0.026	-0.694**	-0.460**	-0.103	1
	VIF	–	1.395	2.866	2.704	1.339	4.427	4.877	2.386	1.354	2.321
Descriptive statistics	N	46	46	46	46	46	46	46	46	46	
	Mean	-0.169	0.523	0.033	0.013	0.034	14.268	2.258	22.992	-0.002	0.024
	Std. Deviation	0.654	0.505	0.058	0.025	0.112	2.931	2.096	2.505	0.015	0.044
	Minimum	-4.153	0.000	0.000	0.000	0.000	6.972	-6.578	16.890	-0.062	0.006
	Maximum	0.457	1.000	0.181	0.127	0.591	19.344	5.084	26.786	0.028	0.302

Table 5
Descriptive statistics for the firms.

Particulars	Pre-event window	Post-event window
Mean unadjusted price (\$)	34.46	27.53
Mean annualized return (%)	-0.62	-2.03
SD of annualized return (%)	3.06	6.32
Log of mean trading volume	9.807	9.909
Log of mean market capitalization	16.962	16.937
Log of mean shares outstanding	14.370	14.370

valuation loss for all SCF firms due to the announcement. This negative impact is not immediate as we do not find a significant drop in the [0, +1] event window. However, the loss is quite prominent in the [0, +2] window. This significant loss can also be observed in the [-15, +15] event window, as estimated by the C4F model. Fig. 3 provides a visual depiction of the valuation loss of firms. The valuation loss is persistent even for a long post-event time period (i.e., [+1, +50]). In contrast, none of the models depict any significant valuation loss for the sample firms in the pre-event time period (i.e., [-30, -1]).

The outlier-adjusted sample firms exhibit a significant negative CAAR around and after the event. Hence, we may conclude that the sample SCF firms are adversely impacted by the WHO’s announcement. Such adverse market reaction cannot be explained by standard asset pricing factors and extreme price movement of a few outliers. Thus, these findings support Hypothesis 1.

6.3. Blockchain versus non-blockchain firms

We perform a sub-sample analysis and explore the impact of the WHO’s announcement on *BlockFirms* and *Non-BlockFirms*, separately. We compute the CAAR for these two groups of firms using the same MM, MMEGE, FF3F, and C4F models across all event windows and report the results in Table 7. Interestingly, there is not a single event window where *BlockFirms* incur a significant loss of valuation. On the contrary, *Non-BlockFirms* exhibit a significant valuation loss across all event windows. It seems that valuation loss encountered by all SCF firms in the sample is predominantly driven by abnormal losses for *Non-BlockFirms*. *BlockFirms*, on the other hand, show enough investor confidence during the turbulent time period. Fig. 4 presents the CAAR estimated by the C4F model for both *BlockFirms* and *Non-BlockFirms* for the [-15, +15] event window. It shows that the WHO’s announcement has almost no impact on the *BlockFirms*. However, *Non-BlockFirms* experience a major and consistent valuation loss after the announcement. This supports Hypothesis 2.

This negative and significant CAAR for *Non-BlockFirms* can be potentially caused by either the higher magnitude of losses of a few sample firms or a significantly large number of sample firms that move

into the loss-making domain due to the announcement. We explore the same using a binomial sign test. This test measures whether the percentage of firms earning negative returns on a particular day in a specific time window is significantly different from 50% or not. We compute the AAR earned by *BlockFirms* and *Non-BlockFirms* and the percentage of firms from each group earning losses on a particular day in the [-15, +15] event window. We show the results obtained from the MM and C4F models in Table 8. The columns ‘Mean (%)’ and ‘Negative (%)’ represent the AARs and the percentage of loss-earning firms on each day, respectively. It yields two important insights. First, the C4F model shows a lower impact of the announcement than the MM model. The C4F model includes traditional asset pricing factors that play an important role in explaining the AAR. Second, there are few days, i.e., Days 1, 9, and 12, when a higher number of firms among *BlockFirms* earn negative returns. In contrast, *Non-BlockFirms* earn losses on 7 out of 15 days in the post-event period. Even *Non-BlockFirms* start experiencing valuation loss from one day before the event day, probably due to some information leakage or anticipation of panic. These findings support Hypothesis 3.

6.4. Impact of the WHO’s announcement on the trading volume

To determine the impact of the WHO’s announcement on the trading volume, we compute the CAAV around the event date using Eq. (5). Table 9 presents the estimated CAAV for all sample SCF firms as well as for the sub-samples *BlockFirms* and *Non-BlockFirms* across different event windows. From Table 9, it is evident that all sample SCF firms generate abnormally high trading volume around the event day and in the post-event period. The significant increase in trading volume is evident immediately after the event. In the event window [0, +1], sample firms on the whole experience a CAAV of 1.335, and the CAAV increases up to 12.454 surrounding the event window (i.e., [-30, +50]). This insight is consistent with the low return and high volume relationship in the bear market reported by Chen [77]. Thus, it statistically supports Hypothesis 4 of this study. However, such a significant increase in abnormal trading volume is guided by *Non-BlockFirms*. *Non-BlockFirms* experience a much higher trading volume compared to *BlockFirms*. While a significant increase in the trading volume for *BlockFirms* is observed only within the first two days of the event day, it is consistently higher in case of *Non-BlockFirms* for most of the event windows. This finding supports Hypothesis 5.

Our analysis of the CAAV for the *BlockFirms* and *Non-BlockFirms* in the [-15, +15] time window suggests that *Non-BlockFirms* experience a much higher trading volume than *BlockFirms* in the post-announcement time period. A visual representation of the phenomenon is depicted in Fig. 5. The permanent increase in the trading volume for the *Non-BlockFirms* after the event day is similar to the findings of Sanders and Zdanowicz [107]. In contrast, the trading volumes of *BlockFirms* within the entire event window remain stable, indicating the investors’

Table 6
Cumulative average abnormal returns (CAAR).

Event window	Market model (MM)		Market model with EGARCH errors (MMEGE)		Fama-French 3-factor model (FF3F)		Carhart 4-Factor Model (C4F)	
	All firms	Outlier adjusted	All firms	Outlier adjusted	All firms	Outlier adjusted	All firms	Outlier adjusted
-30 to -1	-0.002 (-0.054) [-0.061]	-0.005 (-0.108) [-0.098]	-0.003 (-0.078) [-0.066]	-0.001 (-0.008) [-0.022]	-0.003 (-0.061) [-0.080]	-0.002 (-0.041) [-0.067]	-0.002 (-0.056) [-0.033]	0.001 (0.002) [0.001]
-1 to +1	-0.028*** (-2.617) [-2.106]	-0.024** (-2.486) [-2.332]	-0.021** (-1.975) [-1.876]	-0.020** (-1.986) [-2.008]	-0.032*** (-2.989) [-2.606]	-0.024** (-2.066) [-2.203]	-0.028*** (-2.617) [-2.601]	-0.024** (-2.448) [-2.589]
-2 to +2	-0.080*** (-4.576) [-4.594]	-0.071*** (-3.556) [-4.128]	-0.076*** (-4.334) [-4.717]	-0.072*** (-4.060) [-4.353]	-0.094*** (-5.326) [-5.546]	-0.072*** (-4.116) [-4.766]	-0.087*** (-3.979) [-3.885]	-0.053*** (-3.343) [-3.671]
-3 to +3	-0.066*** (-2.781) [-2.892]	-0.049*** (-2.589) [-2.861]	-0.059*** (-2.578) [-3.067]	-0.049*** (-2.602) [-2.861]	-0.083*** (-2.665) [-2.742]	-0.042** (-2.464) [-3.011]	-0.076** (-2.441) [-2.241]	-0.036** (-2.114) [-2.432]
-4 to +4	-0.087*** (-3.517) [-4.263]	-0.074*** (-3.584) [-3.056]	-0.081*** (-3.293) [-4.433]	-0.073*** (-3.066) [-3.898]	-0.107*** (-3.228) [-3.937]	-0.063*** (-2.668) [-2.815]	-0.100*** (-3.018) [-3.556]	-0.057*** (-3.102) [3.722]
-5 to +5	-0.111*** (-3.799) [-5.643]	-0.097*** (-4.121) [-5.836]	-0.105*** (-3.603) [-5.828]	-0.096*** (-3.118) [-5.343]	-0.137*** (-3.829) [-5.522]	-0.093*** (-4.033) [-4.868]	-0.126*** (-3.550) [-5.057]	-0.084*** (-3.606) [-4.811]
-10 to +10	-0.105*** (-3.735) [-3.781]	-0.088*** (-3.801) [-3.163]	-0.107*** (-3.889) [-3.991]	-0.087*** (-2.987) [-3.031]	-0.147*** (-2.916) [-3.558]	-0.080*** (-2.865) [-3.121]	-0.122** (-2.433) [-2.645]	-0.056*** (-2.988) [-3.018]
-15 to +15	-0.142*** (-4.585) [-4.362]	-0.130*** (-4.225) [-4.260]	-0.147*** (-4.724) [-4.617]	-0.127*** (-4.550) [-4.720]	-0.192*** (-3.196) [-4.064]	-0.115*** (-3.112) [-4.128]	-0.158*** (-2.691) [-3.110]	-0.085*** (-2.601) [-3.119]
-30 to +50	-0.193*** (-5.049) [-4.274]	-0.181*** (-4.892) [-4.176]	-0.238*** (-5.619) [-5.281]	-0.192*** (-4.626) [-4.024]	-0.280*** (-3.897) [-4.742]	-0.207*** (-3.656) [-4.322]	-0.223*** (-3.148) [-3.750]	-0.162*** (-4.121) [-4.323]
0 to +1	-0.006 (-0.478) [0.445]	-0.003 (-0.206) [0.398]	-0.001 (-0.017) [0.310]	-0.002 (-0.102) [0.332]	-0.007 (-0.595) [0.107]	-0.006 (-0.081) [-0.007]	-0.006 (-0.478) [0.445]	-0.003 (-0.212) [0.105]
0 to +2	-0.042*** (-3.267) [-2.303]	-0.035*** (-3.116) [-2.895]	-0.040*** (-3.184) [-2.957]	-0.036*** (-2.969) [-2.905]	-0.050** (-2.522) [-2.068]	-0.024** (-2.108) [-2.427]	-0.048** (-2.443) [-3.170]	-0.023** (-2.041) [-2.820]
+1 to +5	-0.071*** (-3.552) [-5.438]	-0.062*** (-3.243) [-4.886]	-0.066*** (-3.116) [-5.560]	-0.060*** (-2.888) [-4.121]	-0.087*** (-3.145) [-5.098]	-0.056*** (-2.662) [-4.404]	-0.085*** (-3.092) [-5.013]	-0.055*** (-2.703) [-3.862]
+1 to +10	-0.051** (-2.320) [-2.655]	-0.045*** (-2.580) [-2.772]	-0.051** (-2.320) [-2.655]	-0.045*** (-2.581) [-2.748]	-0.075** (-1.986) [-2.222]	-0.072** (-2.369) [-2.602]	-0.060* (-1.676) [-1.737]	-0.020** (-2.005) [-2.349]
+1 to +15	-0.095*** (-4.002) [-4.537]	-0.095*** (-4.467) [-4.988]	-0.100*** (-4.331) [-4.682]	-0.093*** (-3.184) [-3.689]	-0.129*** (-2.838) [-4.033]	-0.078*** (-2.686) [-3.737]	-0.106** (-2.355) [-3.029]	-0.059*** (-2.581) [-2.820]
+1 to +50	-0.145*** (-4.008) [-4.409]	-0.153*** (-4.358) [-4.786]	-0.180*** (-5.160) [-4.645]	-0.160*** (-4.854) [-4.650]	-0.214*** (-3.684) [-4.978]	-0.175*** (-3.112) [-4.636]	-0.172*** (-3.008) [-4.016]	-0.147*** (-4.800) [-5.010]

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively. Skewness-adjusted t-statistics and the adjusted Patell Z-statistics are reported in () and [], respectively.

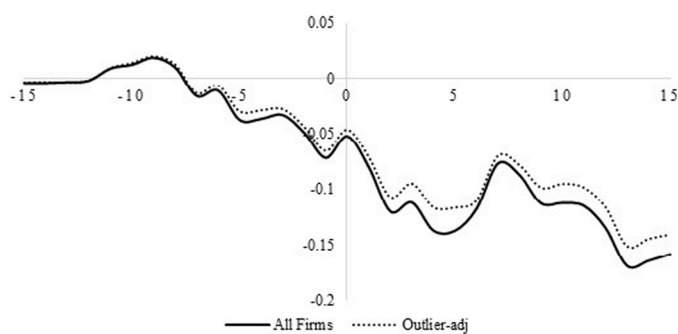


Fig. 3. CAAR of all sample SCF firms and outlier-adjusted sample firms for the event window [-15, +15].

confidence in these stocks. Hence, it provides support to Hypotheses 4 and 5 of our study.

6.5. Banking versus non-banking sub-samples

To explore whether the firm characteristics in our sample of SCF firms play an important role in our findings, we perform a sub-sample analysis. More specifically, we divide both *BlockFirms* and *Non-BlockFirms* into two groups: *banking* and *non-banking*. We compute the ARs earned by these two groups of firms in different event windows using the Carhart 4-factor model (C4F). The outcomes of the analysis are documented in Table 10.

Table 10 shows that neither *banking* nor *non-banking* stocks that adopt blockchain (i.e., *BlockFirms*) experience any valuation loss due to the WHO's announcement of the COVID-19 as a pandemic. In contrast, both *banking* and *non-banking* firms under *Non-BlockFirms* incur significant valuation losses. This finding is consistent across all event windows. To investigate the difference in CAARs earned by *banking* and *non-banking* firms for each group, we perform a Welch *t*-test for all event

Table 7
Cumulative average abnormal return of the sample firms.

Event window	Market model (MM)		Market model with EGARCH errors (MMEGE)		Fama-French 3-factor model (FF3F)		Carhart 4-factor model (C4F)	
	<i>BlockFirm</i>	<i>Non-BlockFirm</i>	<i>BlockFirm</i>	<i>Non-BlockFirm</i>	<i>BlockFirm</i>	<i>Non-BlockFirm</i>	<i>BlockFirm</i>	<i>Non-BlockFirm</i>
-30 to -1	-0.001 (-0.013) [0.110]	-0.005 (-1.103) [0.202]	-0.001 (-0.051) [0.129]	-0.010 (-1.029) [-1.000]	-0.000 (-0.008) [0.010]	-0.006 (-0.903) [-0.089]	-0.000 (-0.007) [-0.006]	-0.002 (-0.086) [-0.061]
-1 to +1	-0.002 (-0.197) [0.289]	-0.055*** (-3.241) [-4.367]	-0.001 (-0.111) [0.150]	-0.049*** (-2.871) [-4.439]	0.001 (0.058) [0.458]	-0.067*** (-4.084) [-4.444]	0.001 (0.106) [0.538]	-0.066*** (-4.012) [-4.395]
-2 to +2	-0.038 (-1.568) [-1.633]	-0.125*** (-4.992) [-6.975]	-0.037 (-1.563) [-1.637]	-0.119*** (-4.730) [-7.064]	-0.024 (-1.153) [-1.073]	-0.169*** (-4.047) [-7.008]	-0.019 (-0.944) [-0.721]	-0.161*** (-3.949) [-6.658]
-3 to +3	-0.016 (-0.535) [-0.106]	-0.121*** (-3.690) [-5.437]	-0.014 (-0.491) [-0.303]	-0.107*** (-3.228) [-5.554]	-0.001 (-0.058) [0.369]	-0.171*** (-3.137) [-5.530]	0.004 (0.115) [0.731]	-0.162*** (-3.036) [-5.153]
-4 to +4	-0.036 (-1.099) [-1.227]	-0.143*** (-4.119) [-6.799]	-0.034 (-1.093) [-1.412]	-0.133*** (-3.512) [-6.921]	-0.036 (-1.099) [-1.227]	-0.208*** (-3.406) [-6.851]	-0.009 (-0.333) [-0.286]	-0.198*** (-3.327) [-6.522]
-5 to +5	-0.047 (-1.174) [-1.548]	-0.180*** (-4.757) [-7.962]	-0.045 (-1.170) [-1.003]	-0.045*** (-2.570) [-2.739]	-0.026 (-0.708) [-1.174]	-0.259*** (-4.088) [-8.252]	-0.018 (-0.486) [-0.621]	-0.245*** (-3.996) [-7.835]
-10 to +10	-0.046 (-1.134) [-1.068]	-0.170*** (-5.103) [-5.349]	-0.044 (-1.155) [-1.015]	-0.177*** (-5.055) [-5.514]	-0.007 (-0.189) [-1.060]	-0.299*** (-3.183) [-5.629]	0.011 (0.287) [-0.339]	-0.266*** (-2.964) [-4.707]
-15 to +15	-0.075 (-1.579) [-1.336]	-0.214*** (-6.579) [-5.689]	-0.073 (-1.576) [-1.588]	-0.227*** (-6.082) [-5.888]	-0.027 (-0.526) [-0.707]	-0.371*** (-3.286) [-5.908]	-0.003 (-0.041) [-0.924]	-0.329*** (-3.052) [-4.934]
-30 to +50	-0.035 (-1.478) [-1.353]	-0.257*** (-4.747) [-4.252]	-0.034 (-1.192) [-1.450]	-0.351*** (-4.896) [-4.552]	-0.090 (-1.174) [-1.072]	-0.487*** (-3.676) [-5.177]	-0.048 (-0.631) [-0.952]	-0.414*** (-3.297) [-4.133]
0 to +1	0.010 (0.865) [0.640]	-0.013 (-0.605) [-1.394]	0.012 (1.028) [1.384]	-0.023 (-1.027) [-1.320]	0.008 (0.648) [1.612]	-0.023 (-1.032) [-1.619]	0.007 (0.559) [1.549]	-0.025 (-1.102) [-1.771]
0 to +2	-0.013 (-0.741) [-0.059]	-0.074*** (-3.975) [-4.359]	-0.012 (-0.707) [-0.165]	-0.070*** (-4.022) [-4.421]	-0.015 (-0.821) [-1.417]	-0.105*** (-2.821) [-4.058]	0.002 (0.116) [0.888]	-0.103*** (-3.741) [-3.943]
+1 to +5	-0.027 (-0.878) [-0.408]	-0.118*** (-4.578) [-7.709]	-0.025 (-0.865) [-0.645]	-0.111*** (-4.027) [-1.320]	-0.009 (-0.341) [-0.244]	-0.171*** (-3.519) [-7.770]	-0.008 (-0.297) [-0.586]	-0.169*** (-3.502) [-7.767]
+1 to +10	-0.015 (-0.614) [-1.130]	-0.086** (-2.287) [-3.584]	-0.014 (-0.609) [-1.251]	-0.092** (-2.412) [-7.795]	0.012 (0.523) [-0.456]	-0.171** (-2.333) [-3.749]	0.023 (0.940) [0.231]	-0.152*** (-2.133) [-2.859]
+1 to +15	-0.037 (-1.146) [-1.319]	-0.137*** (-3.168) [-5.230]	-0.036 (-1.206) [-1.334]	-0.137*** (-3.168) [-5.230]	-0.018 (-0.561) [-1.076]	-0.251*** (-2.789) [-5.267]	-0.001 (-0.006) [-1.399]	-0.221** (-2.551) [-4.234]
+1 to +50	-0.013 (-0.634) [-1.291]	-0.161** (-2.421) [-3.602]	-0.013 (-0.888) [-1.048]	-0.233*** (-3.417) [-3.819]	-0.098 (-1.520) [-1.431]	-0.342*** (-3.061) [-4.630]	-0.066 (-1.065) [-1.590]	-0.287*** (-2.690) [-3.609]

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively. Skewness-adjusted t-statistics and adjusted Patell Z-statistics are reported in () and [], respectively.

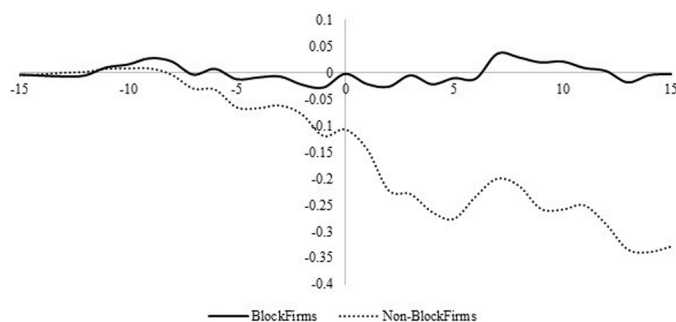


Fig. 4. CAAR of blockchain-enabled SCF firms (*BlockFirms*) and other SCF firms (*Non-BlockFirms*) for the event window [-15, +15] computed using the CF4 model.

windows. The *t*-statistics suggest no significant difference in CAARs between *banking* and *non-banking* firms under both groups of *BlockFirms* and *Non-BlockFirms*. Therefore, we do not find any evidence supporting our Hypothesis 6 and conclude that the firm characteristics (banking or non-banking) do not play a significant role in this context. Rather, the investors' sentiment related to blockchain is so strong that it is not eroded even with the WHO's announcement related to COVID-19.

6.6. Predictive factors explaining the valuation loss

To identify the predictive factors explaining the valuation loss for SCF firms, we perform a cross-sectional regression analysis, following the description in Section 4.3. The CAR estimated by the C4F model for the [-15, +15] time window is used as the dependent variable in the regression. The results for models 1 to 4 (as specified in Section 4.3) are reported in Table 11. In model 1, *Block Dummy* is found to be positive and significant. This indicates that *Non-BlockFirms* earn higher valuation loss compared to *BlockFirms*. Models 2 and 3 in Table 11 show that the impact of the interaction between *Block Dummy* and *R&D* on CAR is

Table 8
Average abnormal return of *BlockFirms* and *Non-BlockFirms*.

Event days	BlockFirms				Non-BlockFirms			
	Market model (MM)		Carhart 4-factor model (C4F)		Market model (MM)		Carhart 4-factor model (C4F)	
	Mean (%)	Negative (%)	Mean (%)	Negative (%)	Mean (%)	Negative (%)	Mean (%)	Negative (%)
Day -15	-0.250	56.67	-0.310	56.67	-0.460	58.18	-0.480	58.18
Day -14	-0.090	50.00	-0.190	50.00	0.250	50.00	0.220	40.91
Day -13	-0.230	58.33	-0.150	50.00	0.160	41.82	0.310	42.73
Day -12	0.120	43.33	0.160	43.33	0.240	46.36	0.120	41.82
Day -11	1.660	40.83	1.540	39.17	0.510	42.73	0.600	37.27
Day -10	0.540	39.17	0.560	39.17	0.350	45.45	0.070	45.45
Day -9	1.040	43.33	1.180	39.17	0.120	36.36	0.010	41.82
Day -8	-0.550	62.50	-0.590	56.67	-0.960	52.73	-1.160	52.73
Day -7	-2.930***	83.33***	-2.510*	83.33***	-2.230***	81.82**	-2.650***	81.82**
Day -6	0.920	39.17	1.090	39.17	0.490	40.91	-0.180	40.91
Day -5	-2.440**	63.33	-1.970	57.50	-2.260***	86.36**	-3.370***	81.82**
Day -4	0.170	37.50	0.350	37.50	0.040	45.45	-0.170	50.00
Day -3	0.090	37.50	0.170	37.50	0.110	50.00	0.530	27.27
Day -2	-1.250	52.50	-1.540	54.17	-1.990	59.09	-1.650	59.09
Day -1	-0.280	56.67	-0.550	54.17	-3.190***	77.27***	-4.140***	77.27***
Day 0	1.650	39.00	1.600	39.17	1.130	45.45	1.240	45.45
Day 1	-1.610	66.50*	-0.940	66.67*	-3.450***	72.73***	-3.720***	77.27***
Day 2	-2.310**	79.17***	-0.510	58.33	-5.030***	72.73***	-7.810***	77.27***
Day 3	2.050**	37.50	2.160**	33.33	0.350	45.45	-0.680	54.55
Day 4	-2.110**	66.67*	-1.690	62.50	-2.270***	73.64***	-3.420***	68.18*
Day 5	1.300	41.67	1.160	41.67	-1.430	45.45	-1.300	45.45
Day 6	-1.170	58.33	-0.120	50.00	2.590*	50.00	4.240**	36.36
Day 7	4.220***	16.67	4.750***	16.67	3.880**	31.82	3.390*	36.36
Day 8	-0.810	50.00	-0.720	50.00	-0.920	68.18**	-1.370	68.18*
Day 9	-1.380	70.83**	-0.940	70.83**	-2.730**	72.73***	-4.330***	77.27***
Day 10	0.310	45.83	0.190	45.83	0.390	40.91	-0.160	40.91
Day 11	-1.740	66.67*	-1.240	62.50	1.180	59.09	0.820	54.55
Day 12	-1.070	62.50	-0.560	58.33	-2.590**	72.73***	-3.560***	72.73***
Day 13	-2.700**	83.33***	-2.170*	83.33***	-4.380***	86.36***	-4.780***	81.82***
Day 14	1.180	37.50	1.380	41.67	0.100	36.36	-0.530	45.45
Day 15	0.150	41.67	0.170	50.00	0.620	36.36	1.070	31.82

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

Table 9
Cumulative average abnormal volume of all sample firms, *BlockFirms*, and *Non-BlockFirms*.

Event window	Trading volume		
	All firms	<i>BlockFirms</i>	<i>Non-BlockFirms</i>
-1 to +1	1.736*** (4.908)	1.149 (1.513)	2.217*** (6.010)
-2 to +2	3.289*** (5.910)	2.340*** (2.878)	4.099*** (5.422)
-3 to +3	4.417*** (5.726)	2.820* (1.747)	5.814*** (5.222)
-4 to +4	4.793*** (4.767)	2.587 (1.565)	6.697*** (5.195)
-5 to +5	5.875*** (4.956)	2.284 (1.456)	8.125*** (5.116)
-10 to +10	11.368*** (6.116)	3.577 (1.079)	14.578*** (5.423)
-15 to +15	15.143*** (6.104)	5.344* (1.711)	20.269*** (6.064)
-30 to +50	12.454** (2.477)	1.799 (0.283)	21.172*** (2.853)
0 to +1	1.335*** (4.575)	1.260** (2.419)	1.344*** (4.512)
0 to +2	1.901*** (5.135)	1.758*** (3.092)	1.949*** (3.870)
+1 to +5	1.786** (2.099)	0.866 (0.713)	2.516** (2.041)
+1 to +10	2.109 (1.315)	-0.131 (-0.061)	3.929 (1.624)
+1 to +15	1.793 (0.773)	-2.274 (-0.702)	5.235 (1.595)
+1 to +50	-3.084* (-1.891)	-3.049 (-1.632)	-3.582 (-1.395)

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively. t-statistics are reported in ().

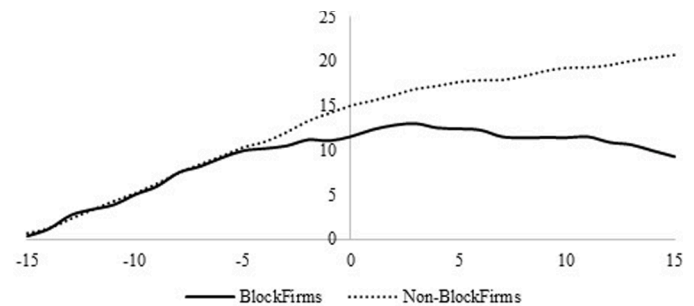


Fig. 5. CAAV for the blockchain-enabled SCF firms (*BlockFirms*) and other SCF firms (*Non-BlockFirms*) for the event window [-15, +15].

significant. It is also observed that the interaction of *Block_Dummy* and *Capex* has a positive and significant relationship with CAR. However, there is no significant relationship between CAR and the interaction term *Block_Dummy*Staffex*. Therefore, we infer that *BlockFirms* that make a higher investment in R&D and capital expenditure suffer significantly less valuation loss due to the event. Thus, we find support for Hypothesis 7a and 7b, but not for Hypothesis 7c. The control variables show a consistent association with CAR across all four regression models.

So far, we find that the adoption of blockchain enables SCF firms (i.e., *BlockFirms*) to protect against the erosion of firm value during the pandemic. Moreover, R&D and capital expenditure play an important role in this regard. Next, we aim to identify specific predictive factors that guide *BlockFirms* to protect the market value. We again run a set of cross-sectional regressions where we use CAR of *BlockFirms* estimated by

Table 10
Cumulative average abnormal returns of banking and non-banking sub-samples.

Event window	BlockFirms	Non-BlockFirms	Welch t	Banking	Non-banking	Welch t
	Banking	Non-banking		Banking	Non-banking	
-1 to +1	0.010 (0.667) [1.403]	-0.012 (-0.778) [-1.131]	0.022 {1.019}	-0.042*** (-2.809) [-3.292]	-0.083*** (-3.285) [-4.227]	0.040 {0.894}
-2 to +2	-0.017 (-0.641) [-0.014]	-0.023 (-0.641) [-1.536]	0.006 {0.149}	-0.096*** (-4.086) [-5.463]	-0.205*** (-2.713) [-5.781]	0.109 {0.874}
-3 to +3	0.009 (0.199) [1.080]	-0.022 (-0.414) [-0.373]	0.031 {0.472}	-0.067** (-2.392) [-4.882]	-0.232*** (-2.570) [-4.882]	0.165 {1.082}
-4 to +4	-0.001 (-0.081) [0.523]	-0.021 (-0.395) [-1.474]	0.019 {0.304}	-0.102*** (-2.829) [-5.939]	-0.265** (-2.535) [-4.894]	0.163 {0.918}
-5 to +5	-0.016 (-0.402) [-0.918]	-0.020 (-0.285) [-0.606]	0.004 {0.052}	-0.141** (-2.234) [-7.224]	-0.317*** (-2.868) [-5.762]	0.176 {0.914}
-10 to +10	-0.007 (-0.144) [-0.481]	0.037 (0.567) [0.054]	-0.044 {-0.537}	-0.186*** (-5.235) [-6.496]	-0.336** (-2.041) [-1.949]	0.150 {0.573}
-15 to +15	-0.060 (-1.216) [-0.892]	0.078 (0.878) [0.866]	-0.138 {-1.367}	-0.202*** (-4.279) [-4.971]	-0.416** (-2.099) [-3.077]	0.214 {0.667}
-30 to +50	-0.132 (-1.359) [-1.472]	0.069 (0.662) [-0.578]	-0.201 {-1.366}	-0.344*** (-6.213) [-4.315]	-0.463** (-1.974) [-2.381]	0.119 {0.327}

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively. Skewness-adjusted t-statistics, adjusted Patell Z-statistics, and Welch t-statistics are reported in (), [], and {}, respectively.

Table 11
Cross-sectional regression for cumulative abnormal returns of SCF firms.

Explanatory variables	Dependent variable: CAR [-15, +15]			
	Model 1	Model 2	Model 3	Model 4
Intercept	0.906*** (2.311)	0.761** (2.169)	0.828*** (2.353)	0.626 (1.605)
Block_Dummy	0.140** (1.987)	-	-	-
Block_Dummy*R&D	-	2.322*** (2.987)	-	-
Block_Dummy *Capex	-	-	7.215*** (3.070)	-
Block_Dummy *Staffex	-	-	-	-0.133 (-0.407)
Volume	0.057*** (3.956)	0.056*** (3.732)	0.060*** (4.002)	0.057*** (3.441)
CP	0.085*** (3.377)	0.066*** (2.628)	0.062*** (2.435)	0.095*** (3.611)
Size	-0.081*** (-3.454)	-0.070*** (-3.294)	-0.075*** (-3.524)	-0.067*** (-2.822)
Earning	-0.589*** (-3.984)	-0.651*** (-4.742)	-0.595*** (-4.336)	-0.636*** (-4.152)
Volatility	-0.806*** (-12.618)	-0.840*** (-13.501)	-0.851*** (-13.534)	-0.784*** (-11.735)
Adjusted R ²	0.906	0.916	0.917	0.897
F-statistic	70.269***	79.555***	80.495***	63.207***

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively. t-statistics are reported in ().

the C4F model for the [-15, +15] time window as the dependent variable. More specifically, we run models 5 to 10 (as specified in Section 4.3) to explain the impact of *consortium* and *implementation* dummies on the CAR of *BlockFirms* and report the results in Table 12. Results of models 5 and 6 reveal that the interaction terms *Consortium**R&D and *Implementation**R&D are positive and significant. While interacting capital expenditure (*Capex*) of *BlockFirms* with *consortium* and *implementation* dummies, we find a similar positive and significant association as depicted in the results of models 7 and 8. However, no significant association is observed in case of the interactions between staff expenditure (*Staffex*) and *consortium* and *implementation* dummies in models 9 and 10. This suggests that the R&D effort and capital expenditure of

BlockFirms that are part of any consortium or have progressed from the pilot to the implementation stage of a blockchain project successfully protect the valuation of firms despite the WHO’s announcement. Hence, we find support for Hypotheses 8a, 8b, 9a, and 9b, but not for Hypotheses 8c and 9c.

In summary, we can opine that investors’ confidence is high for blockchain-enabled SCF firms. This is consistent with the responses obtained from the digital survey conducted by McKinsey in 2020, where 70% of the European respondents have suggested that their companies will increasingly go through a digital transformation in the post-COVID-19 era.¹⁸ The R&D effort and capital expenditure decisions of the firms can play an instrumental role in making it happen. Further, being a part of a consortium rather than a standalone effort or a progression from the pilot to the implementation stage of a blockchain project enhances the investors’ confidence and leads to value protection.

7. Discussion

7.1. Implications for research

Our work has strong research implications. We investigate the impact of adopting blockchain on the market valuation and trading volume of SCF firms after the declaration of COVID-19 as a pandemic by the WHO on 11th March 2020. The related scholarly works in this area largely focus on issues such as resilience strategy, service operations, risk mitigation, etc. The market performance of SCF firms has not caught the researchers’ attention yet. Also, most studies have not included empirical analysis to investigate the impact of the pandemic. Our research addresses this issue with the help of stock price and volume data of SCF firms. It shows the importance of considering both valuation and trading to understand the financial impact of a major event.

Second, the exploration of the extant literature indicates that the use

¹⁸ Retrieved from: <https://www.mckinsey.com/~media/McKinsey/Business%20Functions/McKinsey%20Digital/Our%20Insights/How%20six%20companies%20are%20using%20technology%20and%20data%20to%20transform%20themselves/The-next-normal-the-recovery-will-be-digital.pdf>. Accessed 2nd January 2022.

Table 12
Predictive regression for cumulative abnormal returns of SCF firms that adopted blockchain.

Explanatory variables	Dependent variable: CAR [-15, +15]					
	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
Intercept	-0.727 (-0.772)	-0.909 (-0.937)	-0.667 (-0.665)	-1.178 (-1.220)	-1.463 (-1.370)	-1.514 (-1.536)
Consortium*R&D	0.616** (1.984)	–	–	–	–	–
Implementation*R&D	–	0.563** (2.167)	–	–	–	–
Consortium*Capex	–	–	0.399* (1.651)	–	–	–
Implementation*Capex	–	–	–	1.976** (2.015)	–	–
Consortium*Staffex	–	–	–	–	-0.599 (-0.868)	–
Implementation*Staffex	–	–	–	–	–	-0.002 (-0.051)
Consortium	-0.113 (-1.116)	–	-0.097 (-0.930)	–	-0.049 (-0.433)	–
Implementation	–	-0.212* (-1.888)	–	-0.203 (-1.588)	–	-0.148 (-1.496)
Volume	0.036* (1.706)	0.024 (1.165)	0.035 (1.602)	0.022 (1.046)	0.034 (1.478)	0.026 (1.196)
CP	0.045 (1.235)	0.044 (0.222)	0.055 (1.469)	0.043 (1.194)	0.068* (1.737)	0.061* (1.687)
Size	0.001 (0.016)	0.017 (0.386)	-0.002 (-0.051)	0.028 (0.630)	0.026 (0.547)	0.036 (0.785)
Earning	-0.452** (-1.996)	-0.615*** (-2.812)	-0.495** (-2.125)	-0.591*** (-2.625)	-0.463* (-1.821)	-0.607*** (-2.580)
Volatility	0.293 (0.548)	0.221 (0.426)	0.250 (0.443)	0.363 (0.697)	0.612 (0.993)	0.464 (0.856)
Adjusted R ²	0.404	0.455	0.356	0.423	0.290	0.368
F-Statistic	3.135**	3.627**	2.737**	3.303**	2.281*	3.135**

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively. t-statistics are reported in ().

of event study is at a nascent stage in the domain of SCF. Though Lam et al. [29] discuss the effect of financial innovation on the market value of the SCF firms using an event study, they do not consider the impact of severe supply chain disruption that can take place during a pandemic. Thus, this work contributes to the existing body of knowledge by depicting a broader picture, i.e., the role of financial innovation to protect the financial health of SCF firms during the pandemic. Our research encourages future researchers to undertake an event study for understanding the impact of financial innovations.

Third, the incorporation of multiple expected return models such as MM, MMEGE, FF3F, and C4F models ensures the robustness of results. Also, it facilitates the visualization of the variations of the returns across the models. For instance, the AAR estimated by C4F differs from that of MM as the former includes standard asset pricing factors in its model specification. Our research highlights the importance of using multiple models to calculate the stock returns.

Fourth, the regression analysis helps in identifying the firm-related and blockchain project-related factors that influence the valuation of the blockchain-enabled SCF firms. Furthermore, our work contributes to the existing literature by highlighting the role of R&D intensity and capital expenditure in blockchain initiatives for protecting the market value of SCF firms. Finally, we find that joining a blockchain consortium instead of leading a standalone effort as well as progression from the pilot stage to the implementation stage of a blockchain project boosts the investors' confidence, thus yielding value protection against the pandemic. Our research yields important insights about the various aspects of blockchain projects and how they interact with firm characteristics to predict the market impact.

7.2. Implications for practice

This research has several practical implications. First, according to the Securities and Exchange Commission (SEC) of the USA, credit risk due to the low transparency of the business operations remains a

problem for SCF firms.¹⁹ Further, the COVID-19 pandemic brings more complexity to the problem. In this context, our research shows that a blockchain-based system facilitates the reduction in information asymmetry and ensures higher transparency in the existing practices. This is an important observation for leaders of SCF firms who want their firms to remain unaffected by the pandemic.

Second, COVID-19 has unleashed an immense growth opportunity for the fintech companies that provide blockchain services. According to a survey involving 1000 respondents and conducted in April 2020, 63% of the participants have expressed their willingness toward digital payments instead of visiting the bank.²⁰ Cryptocurrencies used by blockchain services can be useful for secure business-to-business (B2B) and retail operations. Our research showcases that SCF firms could be early adopters of blockchain, and so fintech companies specializing in blockchain could engage with these firms as potential customers.

Third, a blockchain-based platform facilitates the inclusion of a higher number of suppliers and reduces the buyers' reliance on a few suppliers. Such a platform can be crucial in maintaining an undisrupted material flow during a pandemic. Also, blockchain technology helps the suppliers to maintain better working capital and higher visibility of the material flow in the presence of disruption. For this reason, both suppliers and buyers exhibit a rising inclination toward blockchain. The projected growth of the blockchain technology market from USD 10.9 billion to USD 84.5 billion during 2019 and 2026 supports this observation.²¹ Our research encourages SCF firms to invest in the blockchain

¹⁹ Retrieved from: <https://www.gtreview.com/magazine/volume-18-issue-4/supply-chain-finance-time-covid/>. Accessed 2nd January 2022.

²⁰ Retrieved from: <https://www.outlookindia.com/outlookmoney/technology/banks-will-need-blockchain-and-cloud-post-covid-19-4779>. Accessed 2nd January 2022.

²¹ Retrieved from: Blockchain Supply Chain Finance Market Size 2021–Industry Analysis, Size, Share, Trends, Market Demand, Growth, Opportunities and Forecast 2026 – MarketWatch. Accessed 2nd January 2022.

Table A.1

List of blockchain-enabled SCF firms and description of their blockchain projects.

Serial no.	Blockchain-enabled SCF firms (<i>BlockFirms</i>)	Description on blockchain project	Status as of event date	Progress/area of application
1	JP Morgan	JP Morgan explored blockchain technology to improve money transfer from the first quarter of 2019. In 2021, it joined Taulia, Temasek, and DBS to develop a blockchain payments platform.	Pilot or test phase	On 12 April 2021, JP Morgan has announced that two blockchain-based new solutions are being used to improve fund transfers with reduced cost and greater transparency. <i>Confirm</i> is one of these two that tracks mismatched payment details and thus reduces the number of returned or rejected transactions. Another one, <i>PayDirect</i> , captures new fund flows and channels to pay using existing pay-in and pay-out methods globally.
2	Bank of America	Bank of America joined a consortium, Marco Polo, to enhance the efficiency of international trade using blockchain technology in the third quarter of 2019.	Pilot or test phase	Bank of America has launched the concept 'supply chain as a service' to integrate early payment and financing mechanisms on a single platform that is visible to suppliers, buyers, and creditors. As of the event date, Bank of America has filed 78 blockchain-related patents and has started hiring people to use Ripple's blockchain-based payment networks.
3	CGI Incorporation	CGI teamed up with Salesforce to leverage Salesforce blockchain and integrate it into their CRM in the last quarter of 2019. The CRM solution aimed to connect with both suppliers' and buyers' bank accounts.	Pilot or test phase	CGI Incorporation has launched a <i>CGI Trade360 SaaS</i> solution for efficient trade financing. The experimentation of this solution on a hybrid blockchain platform has started, as of February 2020. Four banks and SkuChain, the blockchain innovator, are involved in this project.
4	Banco Santander	In 2017, Banco Santander partnered with Tradeshift to take advantage of its blockchain-based trading platform. Santander Group joined the we.trade consortium and developed a blockchain laboratory.	Implementation phase (first real-time trade announced on 3 July 2018)	Banco Santander has used public Ethereum blockchain, which is an open-source blockchain technology. On 12 September 2019, the company has announced the launching of a USD 20 million bond with end-to-end blockchain technology. In June 2021, the asset management arm of Santander has introduced a new trade finance fund with a capital of 25 million pounds.
5	BBVA	BBVA joined a financial consortium R3 as a member to facilitate global trade flows. It aimed to develop an end-to-end solution for trade finance using Corda, a distributed ledger platform.	Implementation phase (first trade announced on 27 November 2017)	In 2018, BBVA has used blockchain-based letter of credit in the project related to the import of frozen tuna from Mexico. On 10 August 2021, BBVA has announced that it would use Trusple, a blockchain trade finance platform of the Ant Group to facilitate financial transactions in Spain and Mexico.
6	HSBC	In 2018, HSBC joined ING to execute the first commercial trade finance transaction through blockchain. It developed a consortium contour and attracted several other members to join this platform to initiate blockchain-driven trade finance.	Implementation phase (first trade announced on 14 May 2018)	HSBC has developed a new blockchain-based supply chain platform named ReChainME to accelerate trade finance transaction with a higher level of security and transparency. It has also successfully executed blockchain-based trade finance transactions along with TATA Steel. Moreover, it has also initiated trade finance transactions related to shipment between two countries, New Zealand and China.
7	BNP Paribas	In the third quarter of 2019, BNP Paribas took part in the pilot Trado model based on the blockchain technology to build a sustainable supply chain finance solution.	Implementation phase (first trade announced on 21 December 2016)	BNP has collaborated with the Ant Group for facilitating international trade by small and medium enterprises using Trusple platform. This blockchain-based technology is expected to strengthen the China-France trade flows. BNP has also invested significantly in TradeIX, a blockchain-based trade finance platform.
8	UniCredit	UniCredit completed the first blockchain-based trade finance transaction via the we.trade platform in the fourth quarter of 2018. The we.trade project was an outcome of a consortium formed by UniCredit along with six other banks.	Implementation phase (first trade announced on 21 March 2019)	UniCredit has used the we.trade blockchain platform to enable a tinplate trade between Steelforce and its customer Gruppo ASA. UniCredit has been active in blockchain-based trade finance platform <i>Digital Trade Chain (DTC)</i> to facilitate cross-border and domestic trades for small and medium enterprises. It is involved in promoting green trade finance using the we.trade platform with QNB ALAHLI and Banca Comercială Română.
9	Oracle	Oracle developed its blockchain platform to promote cross-border supplier payments with lower cost and higher security. The pilot has been performed with ICS financial systems.	Implementation phase (first trade announced on 18 March 2019)	Oracle has launched <i>Oracle Banking Trade Finance (OBTf)</i> blockchain adapter to transform relevant information easily to blockchain datasets and thus it has provided higher efficiency and reduced risk. Moreover, it has bridged cross-ledger blockchain interoperability and kept both buyer and seller-related credit information secure and transparent.
10	Danske	In the third quarter of 2018, Danske joined the consortium Marco Polo to promote API-driven trade finance services. The pilot exercise aimed at optimizing working capital flows.	Pilot or test phase	On 20 June 2021, Danske has announced that it would allow credit cards used in crypto trading. Moreover, it would allow deposits in crypto investments. Prior to this, on 24 November 2020, it has collaborated with Windward to automate and digitalize financial crime controls of the bank.

(continued on next page)

Table A.1 (continued)

11	Commerzbank	Commerzbank became a part of the trade finance consortium Marco Polo. It performed the first pilot transaction in 2020 and the first live transaction in the second quarter of 2021.	Pilot or test phase	On 10 May 2021, Commerzbank performed its first cross-border transaction between Şişecam and Kuraray Europe GmbH. On 20 May 2021, it performed its second blockchain-based transaction between KSB and Voith. The product underlying the first transaction has laminated glass interlayers, whereas for the second transaction it has special couplings.
12	Deutsche Bank	Deutsche Bank invested significantly in the R3 consortium and joined the we.trade platform in 2017. As a pilot, the TradeLens platform was developed for supply chain financing.	Pilot or test phase	Deutsche bank has been conservative in using blockchain for trade finance transactions. Although it is a part of the R3 consortium, it has adopted a wait-and-see approach toward participating in TradeLens, a Hyperledger Fabric infrastructure used by other members of the consortium. Currently, Deutsche bank has focused on the "Digital Standard Initiative" to digitize even the smallest denominator invoices.
13	Standard Chartered	Standard Chartered performed the first blockchain-based supply chain finance transaction through WeQChain, a platform developed by Linklogis, in the first quarter of 2019. It was also a member of the R3 Marco Polo consortium.	Implementation phase (first trade announced on 24 January 2019)	In October 2018, Standard Chartered has collaborated with HSBC and other banks to develop a blockchain-based trade finance platform, eTradeConnect. In August 2019, it has collaborated with SAP Ariba to further expand their financial supply chain solution. In September 2020, it has performed the first cross-border transaction using Trusple platform of the Ant Group. In 2021, it has launched its first fully owned blockchain-based trade finance platform and facilitated the paperless export transaction of Tata Steel from a metal firm of Bangladesh.
14	Societe Generale	Societe Generale joined a pilot program in 2017 to improve domestic and international trades through blockchain. It provided access to various corporate clients on the we.trade platform. The first regular corporate client for Societe Generale was W41TP.	Implementation phase (first trade announced on 22 January 2018)	Societe Generale has performed its first trade finance transaction in the agricultural commodities sector. In August 2018, it invested in Komgo, a blockchain-based supply chain finance platform. On 18 April 2019, it has issued an EUR100 million covered bond that acted as a security token on the blockchain platform. With AXA IM, it transacted EUR 3 million unsecured bonds in the public Ethereum blockchain. On 15 April 2021, it has issued the first structured product on the Tezos public blockchain.
15	ANZ Bank	ANZ Bank was part of the eTradeConnect and Trade Information Network (TIN) to facilitate domestic as well as cross-border trades. It was in the pilot phase and aimed to broaden the consortium and perform a live transaction.	Pilot or test phase	ANZ Bank has worked with XinFin, a blockchain company to apply blockchain in its trade finance network. Using XinFin's XDC network, the first non-fungible token transaction has been executed in 2020. ANZ has also become a part of <i>Trade Finance Distribution (TFD) Initiative</i> to further explore the blockchain-based trade finance transaction.
16	Bank of China (BOC)	BOC announced the launching of Bay Area Trade Finance Blockchain Platform in the last quarter of 2018. It performed its first trade finance transaction through eTradeConnect in the last quarter of 2020.	Pilot or test phase	The Chinese Government has infused USD 4.7 million in 2018 as 'special funding' over three years to develop a blockchain-based trade finance platform. BoC has also been invited to test the trade finance platform developed by the Central Bank of China. It has performed the first blockchain-based trade finance transaction in the last quarter of 2020.
17	Emirates NBD	Emirates NBD was using the EdgeVerve blockchain platform for their pilot study since 2017. It adopted PROXIMA+, a supply chain finance solution, for high-end factoring in the last quarter of 2020.	Implementation phase (first trade announced on 12 October 2016)	Emirates NBD has executed its first blockchain-based trade finance with India's ICICI bank. From thereon, it has made significant progress from pilot to production. It has issued chequebooks with unique QR codes and 20 random characters on the MICR of each check registered on the blockchain platform. From March 2018, this has been rolled out for all customers in the UAE region. From January to March 2019, it has mined 35 million cheques.
18	Siemens	Siemens Financial Services used TradeIX to build their blockchain-based trade finance solution. A range of projects, including the Marco Polo consortium, was in the pilot stage.	Implementation phase (first trade announced on 25 February 2019)	Siemens Financial Services, a subsidiary of Siemens, has worked closely with JP Morgan, Commerzbank, and Standard Chartered Bank to facilitate SCF on the blockchain platform. Further, it has contributed to blockchain-based transactions, specifically in the food and beverage industry for product recall, food contamination, etc.
19	SEB	Since 2017, SEB was a part-owner of R3 that has launched the platform Corda. At the end of 2020, it set up contour, a blockchain-based global trade finance platform, for its own production environment.	Pilot or test phase	Contour has the aim to digitize the USD 18 trillion SCF market. It has entered into live production from October 2020. It has performed a series A+ fundraising round in 2021.
20	Tietoevry	In the middle of 2019, Tietoevry developed a decentralized business network. It joined R3 and performed the pilot on the blockchain solution Corda.	Pilot or test phase	Tietoevry has developed a proof of concept of Smart money which has aimed to issue a conditional digital payment guarantee based on different computer protocols. It also aims to contribute to the transfer of data from monitoring devices of diabetic children to hospital and facilitate business using the blockchain-based platform.

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Table A.1 (continued)

21	SAP Ariba	In 2017, SAP Ariba partnered with the fintech company Hijro to facilitate the inventory providing mechanism to the Hijro Asset Distribution Network based on blockchain. It aimed to provide a flexible working capital solution to the business.	Pilot or test phase	To track shipments, SAP Ariba has joined the UK-based Fintech Everledger in 2017. It has augmented the SAP S/4 HANA Finance platform to restrict payment fraud and prompt the approval process. Further, it has optimized days sales outstanding (DSO) and accounts receivable factoring. It has also tracked third-party collections and aimed to enhance transparency.
22	Kakao	In 2019, Kakao launched the Klaytn blockchain network that was 15 times faster than Ethereum. Other players, such as Shinhan Bank, tied up with Kakao to further strengthen its trade finance solution.	Pilot or test phase	Besides Klaytn, Kakao has also launched Krust, a blockchain enterprise in Singapore. It has also set up Ground X subsidiary to lead cross-border blockchain-based trades. In 2021, the fintech unit of Kakao, Kakao Pay has been listed with a surge price of as high as 155%.
23	Tencent	In the middle of 2019, Tencent announced the first trade under SCF program through the platform WeChain. It also invested heavily in WeChat through which the restaurant services got reimbursed by corporate treasurers.	Implementation phase (first trade announced on 11 July 2019)	Tencent has used a new blockchain-based platform TrustSQL to promote digital authentication, asset management, and shared economies. It has also built blockchain as a service solution (TBaaS) on Tencent cloud. It has also supported the FSCP BCOS protocols and the Hyperledger Fabric. WeChain, the very own business solution of Tencent, has focused on digital verification of documents.
24	Dayli Fintech	In 2018, Dayli Fintech launched the blockchain-based GPI platform and added it to its existing trade finance solution SWIFT. Further, SWIFT's GPI platform GPI Link and R3 worked together to integrate trade platforms.	Pilot or test phase	The pilot has become stronger as R3 has continuously included other firms in its network. Further, it has also used Ripple's XRP, a growing digital gross settlement system. It has been building an ecosystem called ICON that would join multiple companies, government departments, hospitals, banks, universities to interact without any third-party involvement. Dayli Intelligence, a subsidiary of Dayli Financial Group, has joined a Japanese consortium to smoothen cross-border trades.

technology to enhance their business operations, satisfy their investors, and protect themselves against the adversities of the financial market.

Fourth, R&D intensity and capital expenditure can be helpful for the value protection of blockchain-enabled SCF firms. Also, joining a blockchain consortium or progressing from the pilot to the implementation phase of a blockchain project can raise investors' confidence and facilitate value protection. The insights obtained from our analysis are consistent with the earlier-mentioned real-life phenomena such as extensive R&D activities of Chinese firms, leadership position of IBM in the blockchain market, and collaborative ventures of Italian firms, etc. Hence, SCF firms interested in implementing blockchain technology are strongly encouraged to join a consortium and let their investors know about this activity. Moreover, if they progress in implementing the blockchain project, they should make it a point to inform their investors about it.

Finally, one may argue that the announcement of WHO may not create a long-lasting impact on the valuation of 'Non-BlockFirms' firms as most stock markets are performing decently months after the announcement, as shown in Fig. 1. However, it is important to understand that the WHO's announcement is only one of many such events that require investors' trust to protect the valuation loss during uncertain times. The adoption of an advanced technology like blockchain may help those SCF firms protect their value in similar or more impactful future events.

7.3. Limitations and future research directions

One limitation of our study is the limited number of SCF firms in the sample. Considering a larger set of SCF firms (both listed and unlisted) may provide better insights. However, due to the lack of data, our sample size is restricted. Moreover, we obtain firm-level blockchain-related information solely from publicly available documents, i.e., secondary sources. We find that the information related to blockchain implementation and progress of these firms varies significantly. Therefore, it is difficult to identify a suitable threshold to classify them under small-scale or large-scale implementation. Hence, based on available information, we classify them as firms that are in the 'pilot' or 'implementation' stage and run our analysis on the basis of that. Despite these limitations, our study provides several interesting research opportunities for future investigation. First, our study explores the financial performance of SCF

firms based on stock price reaction only. An in-depth analysis of the operational efficiency gained by SCF firms after the adoption of blockchain can be of interest to practitioners. Information obtained from the primary sources, such as qualitative information from interviews of the leadership team of the organization, may provide detailed insights about blockchain projects in terms of their operational efficiency and scale of implementation. Second, the investigation of factors leading to the large valuation loss of non-blockchain firms can be of interest to researchers. Third, our work focuses on the impact of blockchain on the value protection of SCF firms. It can be extended to other entities of the supply chain, such as logistics service providers and retailers. Finally, investigating the effect of technology-related innovations on the financial health and efficiency of day-to-day business operations for the different members in the supply chain ecosystem during the COVID-19 pandemic can provide important insights.

8. Conclusion

In this article, we study the impact of the adoption of blockchain to protect the market valuation of SCF firms during COVID-19 using an event study. We first investigate the impact of the WHO's announcement of the COVID-19 as a pandemic on the stock price of sample SCF firms. We calculate the CAAR earned by sample stocks over different event windows using four expected return models. To ensure the robustness of the results, we also compute the ARs of the outlier-adjusted sample. Further, we compute the CAAV to explore whether there is a significant abnormal change in the trading volume of the sample firm around the event date. We also investigate whether firm-level heterogeneity (e.g., banking or non-banking SCF firms) plays an instrumental role in value protection or loss of firms due to the announcement. Finally, we incorporate a cross-sectional regression analysis to study whether the firm-level inputs (e.g., R&D intensity, capital expenditure, and staff expenditure) of SCF firms enable them to maintain their valuation in the COVID-19 era. In addition, we also explore whether being a part of a blockchain consortium rather than operating in a standalone manner or progression from the pilot to the implementation stage of a blockchain project leads to value protection for blockchain-enabled SCF firms. Our study yields several interesting insights related to returns and trading volume of SCF firms, investors' reactions

toward the WHO's announcement, and important determinants of such reaction. We conclude that SCF firms that have adopted blockchain experience an insignificant impact of COVID-19 on their valuation compared to those that did not adopt blockchain. This insight remains consistent for the sub-sample analysis of *banking* and *non-banking* SCF firms. Thus, we show that investors' confidence in blockchain has protected the valuation loss of SCF firms during the COVID-19 pandemic. Next, we find that the

implementation of blockchain induces stability in SCF firms' trading volume. Further, we discover that investment in R&D and capital expenditure strengthen SCF firms' financial position and reduce valuation loss. More importantly, these two factors play a crucial role for blockchain-enabled SCF firms that are part of any blockchain consortium or have moved to the implementation of blockchain. Our work will be useful for SCF firms that aspire to stay ahead of the curve in the aftermath of a pandemic.

Appendix

A.1 Announcement by the WHO



Virtual press conference on COVID-19 – 11 March 2020

Speaker key:

TJ	Tarik Jasarevic
TAG	Dr Tedros Adhanom Ghebreyesus
MO	Moussa
MR	Dr Mike Ryan
TJ	Chen
MK	Dr Maria Van Kerkhove
UF	Unidentified female speaker
HE	Helen
IS	Isabelle
CR	Christoph
KA	Katrin
KI	Kai
CL	Clive
MA	Maeve

TJ Good afternoon, everyone. Thanks to everyone watching us on the WHO Twitter account, I understand, the WHO Face book account and also the WHO YouTube channel. Journalists who are watching us can ask questions, as any other day. Those who are dialling in, it's * 9 on your keypad and those who are watching us on Zoom will click raise hand. This is the regular WHO update on COVID-19 with our usual guests, WHO director-general, Dr Tedros, Dr Mike Ryan and Dr Maria Van Kerkhove.

We will have an audio file, as we usually do, some 15, 20 minutes after the briefing and the transcript will be posted tomorrow. Also we are sending you news from other regions so please pay attention to what comes from us. I'll give the floor to Dr Tedros for his opening remarks.

00:01:01

TAG Thank you, Tarik. Good afternoon, everybody. In the past two weeks the number of cases of COVID-19 outside China has increased 13-fold and the number of affected countries has tripled. There are now more than 118,000 cases in 114 countries and 4,291 people have lost their lives.

A.2. Methodology: Expected return models used to compute the CAAR

Thousands more are fighting for their lives in hospitals. In the days and weeks ahead we expect to see the number of cases, the number of deaths and the number of affected countries climb even higher. WHO has been assessing this outbreak around the clock and we're deeply concerned both by the alarming levels of spread and severity and by the alarming levels of inaction.

We have therefore made the assessment that COVID-19 can be characterised as a pandemic. Pandemic is not a word to use lightly or carelessly. It's a word that, if misused, can cause unreasonable fear or unjustified acceptance that the fight is over, leading to unnecessary suffering and death.

Describing the situation as a pandemic does not change WHO's assessment of the threat posed by the virus. It doesn't change what WHO is doing and it doesn't change what countries should do. We have never before seen a pandemic sparked by a coronavirus. This is the first pandemic caused by a coronavirus and we have never before seen a pandemic that can be controlled at the same time.

WHO has been in full response mode since we were notified of the first cases and we have called every day for countries to take urgent and aggressive action. We have rung the alarm bell loud and clear.

As I said on Monday, just looking at the number of cases and the number of countries affected does not tell the full story. Of the 118 cases reported globally in 114 countries more than 90% of cases are in just four countries and two of those, China and the Republic of Korea, have significantly declining epidemics.

81 countries have not reported any cases and 57 countries have reported ten cases or fewer. We cannot say this loudly enough or clearly enough or often enough; all countries can still change the course of this pandemic. If countries detect, test, treat, isolate, trace and mobilise their people in the response those with a handful of cases can prevent those cases becoming clusters and those clusters becoming community transmission.

Even those countries with community transmission or larger cluster can turn the tide on this virus. Several countries have demonstrated that this virus can be suppressed and controlled. The challenge for many countries who are now dealing with large clusters or community transmission is not whether they can do the same; it's whether they will.

00:05:55

Some countries are struggling with a lack of capacity. Some countries are struggling with a lack of resources. Some countries are struggling with a lack of resolve. We're grateful for the measures being taken in Iran, Italy and the Republic of Korea to slow the virus and control their epidemics.

We know that these measures are taking a heavy toll on societies and economies, just as they did in China. All countries must strike a fine balance between protecting health, minimising economic and social disruption and respecting human rights. WHO's mandate is public health but we're working with many partners across all actors to mitigate the social and economic consequences of this pandemic.

- Market Model (MM)

In this particular model specification, the expected return of a stock following a single-factor market model can be represented in the following manner.

$$R_{i,t} = (\alpha_i + \beta_i R_{m,t} + \varepsilon_{i,t}). \quad (\text{A.1})$$

where $R_{i,t}$ denotes the return of the i^{th} stock on day t , $R_{m,t}$ represents the return of the reference market on day t , and $\varepsilon_{i,t}$ signifies the residual term

characterized by a random variable with zero mean and finite variance. The important assumptions are that $\epsilon_{i,t}$ is not autocorrelated, is completely uncorrelated with the market return $R_{m,t}$ and firm's return $R_{i,t}$ when $i \neq j$, and is homoscedastic in nature. The coefficient β_i can be defined as a measure of the sensitivity of $R_{i,t}$ on the reference market. Therefore, following (A.1.1), the abnormal return by MM, can be determined as follows.

$$AR_{i,t} = [R_{i,t} - (\alpha_i + \beta_i R_{m,t})]. \tag{A.2}$$

Although the MM model is the most popular and extensively applied in event studies, it exhibits a certain limitation. The inherent assumption of the MM model related to the constant risk-free rate violates the conjecture of time-varying market returns. For this reason, we take the help of the MMEGE model.

• *Market Model with EGARCH Error (MMEGE)*

The CAAR can also be computed using the MMEGE model that allows conditional heteroscedasticity in the residual or error terms of the market model. The EGARCH model, proposed by Nelson [1], is one of the extensions of the popular GARCH model, which is closer to the data generation process and provides superior estimates compared to the market model by capturing the variability in changes of return over time [2]. Moreover, EGARCH successfully captures the asymmetric effects of events on stock returns. For instance, the impact of any bad news on the stock price volatility is found to be much higher compared to the good news. It can be represented in the following manner.

$$\log h_t = \left[\omega + \frac{\alpha_1 \epsilon_{t-1} + \gamma_1 |\epsilon_{t-1}|}{\sqrt{h_{t-1}}} + \beta_1 \log h_{t-1} \right]. \tag{A.3}$$

where h_t , ω , and ϵ_t denote conditional variance, the intercept, and the residuals from mean filtration process, respectively. $\log h_t$ represents the log of the conditional variance, signifying the presence of exponential instead of the quadratic asymmetric effect. The logarithmic value ensures the non-negativity of the conditional variance. Here, a positive ϵ_{t-1} and a negative ϵ_{t-1} contribute $\left(\frac{(\alpha_1 + \gamma_1)|\epsilon_{t-1}|}{\sqrt{h_{t-1}}} \right)$ and $\left(\frac{(-\alpha_1 + \gamma_1)|\epsilon_{t-1}|}{\sqrt{h_{t-1}}} \right)$, respectively, to the log of the conditional volatility. The parameter α_1 and γ_1 captures the sign effect and the size effect, respectively. Again, we expect α_1 to be negative in real applications. The presence of persistence in volatility is governed by β_1 .

• *Fama-French 3-Factor Model (FF3F)*

We also employ the 3-factor model of Fama-French [3] to ensure that our CAAR estimates cannot be attributed to standard asset pricing factors, such as size and value premium. It can be expressed as follows.

$$R_{i,t} = \alpha_i + \beta_{1i} R_{m,t} + \beta_{2i} SMB_t + \beta_{3i} HML_t + \epsilon_{i,t}. \tag{A.4}$$

where $R_{i,t}$ denotes the return of the i^{th} stock on day t , $R_{m,t}$ represents the return of the reference market on day t , SMB_t is the size factor computed by small minus big at time t , HML_t is the value factor (book-to-market ratio) computed by high minus low at time t , and $\epsilon_{i,t}$ represents the residual term characterized by a random variable with zero mean and finite variance.

• *Carhart 4-Factor Model (CAF)*

Carhart 4-factor model is an extension of the Fama-French 3-factor model where the momentum of returns is included as the fourth factor. The model is presented below.

$$R_{i,t} = \alpha_i + \beta_{1i} R_{m,t} + \beta_{2i} SMB_t + \beta_{3i} HML_t + \beta_{4i} MOM_t + \epsilon_{i,t} \tag{A.5}$$

where $R_{i,t}$ denotes the return of the i^{th} stock on day t , $R_{m,t}$ represents the return of the reference market on day t , SMB_t is the size factor computed by small minus big at time t , HML_t is the value factor computed by high minus low at time t , MOM_t is the momentum factor computed by two-high-prior average returns minus two-low-prior average returns, and $\epsilon_{i,t}$ represents the residual term characterized by a random variable with zero mean and finite variance.

To check the significance of the CAAR estimates using all model specifications, we perform a skewness-adjusted t -test, proposed by Hall [4]. The test statistics are calculated as follows.

$$t_{skew} = \sqrt{N} \left(s + \frac{1}{3} \gamma s^2 + \frac{1}{27} \gamma^2 s^3 + \frac{1}{6N} \gamma \right). \tag{A.6}$$

where, $\gamma = \frac{N}{(N-2)(N-1)} \sum_{i=1}^N (CAR_i - CAAR)^3 (s_{CAAR})^{-3}$, $s = \left(\frac{CAAR}{s_{CAAR}} \right)$, and $(s_{CAAR})^2 = \frac{1}{N-1} \sum_{i=1}^N (CAR_i - CAAR)^2$.

For further discussion on skewness-adjusted t -test, please refer to Hall [4].

In addition to the skewness-adjusted t -test, we also employ the adjusted Patell Z-test proposed by Kolari and Pynnonen [5]. The adjusted Patell Z-test, which is a modified version of the Patell Z-test, successfully captures the cross-correlation of the abnormal returns. The test statistic can be expressed as follows:

$$AdjZ_{Patell} = Z_{Patell} \sqrt{\frac{1}{1 + (N-1)\bar{r}^2}} \tag{A.7}$$

where, $Z_{Patell} = \frac{1}{\sqrt{N}} \sum_{i=1}^N \frac{CSAR_i}{S_{CSAR_i}}$,

$$CSAR_i = \sum_{t=T_1+1}^{T_2} SAR_{i,t}, \quad S_{CSAR_i}^2 = (T_2 - T_1) \frac{M_i - 2}{M_i - 4}, \quad SAR_{i,t} = \frac{AR_{i,t}}{S_{AR_{i,t}}}$$

$$S_{AR_{i,t}}^2 = S_{AR_i}^2 \left(1 + \frac{1}{M_i} + \frac{(R_{m,t} - \bar{R}_m)^2}{\sum_{t=T_0}^{T_1} (R_{m,t} - \bar{R}_m)^2} \right), \quad S_{AR_i}^2 = \frac{1}{M_i - 2} \sum_{t=T_0}^{T_1} (AR_{i,t})^2$$

A.3. Tables

A.1 Announcement by the WHO



Virtual press conference on COVID-19 – 11 March 2020

Speaker key:

TJ	Tarik Jasarevic
TAG	Dr Tedros Adhanom Ghebreyesus MO Moussa
MR	Dr Mike Ryan TJ Chen
MK	Dr Maria Van Kerkhove
UF	Unidentified female speaker HE Helen
IS	Isabelle
CR	Christoph
KA	Katrin
KI	Kai
CL	Clive
MA	Maeve

TJ, Good afternoon, everyone. Thanks to everyone watching us on the WHO Twitter account, I understand, the WHO Face book account and also the WHO YouTube channel. Journalists who are watching us can ask questions, as any other day. Those who are dialing in, it's * 9 on your keypad and those who are watching us on Zoom will click raise hand. This is the regular WHO update on COVID-19 with our usual guests, WHO director-general, Dr Tedros, Dr Mike Ryan and Dr Maria Van Kerkhove.

We will have an audio file, as we usually do, some 15, 20 min after the briefing and the transcript will be posted tomorrow. Also we are sending you news from other regions so please pay attention to what comes from us. I'll give the floor to Dr Tedros for his opening remarks. 00:01:01

TAG, Thank you, Tarik. Good afternoon, everybody. In the past two weeks the number of cases of COVID-19 outside China has increased 13-fold and the number of affected countries has tripled. There are now more than 118,000 cases in 114 countries and 4291 people have lost their lives.

Thousands more are fighting for their lives in hospitals. In the days and weeks ahead we expect to see the number of cases, the number of deaths and the number of affected countries climb even higher. WHO has been assessing this outbreak around the clock and we're deeply concerned both by the alarming levels of spread and severity and by the alarming levels of inaction.

We have therefore made the assessment that COVID-19 can be characterised as a pandemic. Pandemic is not a word to use lightly or carelessly. It's a word that, if misused, can cause unreasonable fear or unjustified acceptance that the fight is over, leading to unnecessary suffering and death.

Describing the situation as a pandemic does not change WHO's assessment of the threat posed by the virus. It doesn't change what WHO is doing and it doesn't change what countries should do. We have never before seen a pandemic sparked by a coronavirus. This is the first pandemic caused by a coronavirus and we have never before seen a pandemic that can be controlled at the same time.

WHO has been in full response mode since we were notified of the first cases and we have called every day for countries to take urgent and aggressive action. We have rung the alarm bell loud and clear.

As I said on Monday, just looking at the number of cases and the number of countries affected does not tell the full story. Of the 118 cases reported globally in 114 countries more than 90% of cases are in just four countries and two of those, China and the Republic of Korea, have significantly declining epidemics.

81 countries have not reported any cases and 57 countries have reported ten cases or fewer. We cannot say this loudly enough or clearly enough or often enough; all countries can still change the course of this pandemic. If countries detect, test, treat, isolate, trace and mobilise their people in the response those with a handful of cases can prevent those cases becoming clusters and those clusters becoming community transmission.

Even those countries with community transmission or larger cluster can turn the tide on this virus. Several countries have demonstrated that this virus can be suppressed and controlled. The challenge for many countries who are now dealing with large clusters or community transmission is not whether they can do the same; it's whether they will. 00:05:55

Some countries are struggling with a lack of capacity. Some countries are struggling with a lack of resources. Some countries are struggling with a lack of resolve. We're grateful for the measures being taken in Iran, Italy and the Republic of Korea to slow the virus and control their epidemics.

We know that these measures are taking a heavy toll on societies and economies, just as they did in China. All countries must strike a fine balance between protecting health, minimizing economic and social disruption and respecting human rights. WHO's mandate is public health but we're working with many partners across all actors to mitigate the social and economic consequences of this pandemic.

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