Measuring short- and long-run impacts of COVID19 on the sharing economy and business models

Xinxin Wang[1] · **Zeshui Xu**[1] · **Anran Xiao**[1] · **Marinko Skare**[2,3]

Abstract

Research has highlighted the impact of COVID-19 on firms without elaborating on how the epidemic effect sharing economy and business models from both the short and long-run perspectives. Drawing on the literature-based view and the vector error-correction model, this study attempts to examine the effects of COVID-19 related factors on companies that provide or share access to goods and services that are facilitated by a community-based online platform. We argue that the government response, and the testing policy and contact tracing will promote managers to adjust their business model. In the long term, economic support, such as income support and debt relief, will reduce stuffs' motivation to work, leading to less achievements. On the other hand, due to the strictness of policies, people will increase online activities and stimulate the sharing economy. Using Indxx data and the Oxford COVID-19 Government Response Tracker database, the analysis of time series data from 75 U.S.-listed companies provides supports for both the short-run effects of the lockdown restrictions and closures with measures, and the government response, and the long-run effects of economic support, and the strictness of lockdown-style policies. This study contributes to business management literature by elaborating upon the causality relationships of how COVID 19 related factors effect sharing economy and business models in the short and long terms. The findings benefit scholars, managers, and policymakers of modernized firms.

Keywords Sharing economy · Business models · COVID-19 · Granger causality

✉ Marinko Skare
mskare@unipu.hr

1 Business School, Sichuan University, Chengdu 610064, China

2 Juraj Dobrila Univ Pula, Fac Econ & Tourism Dr Mijo Mirkovic, Preradoviceva 1-1, Zagrebacka 30, 52100 Pula, Croatia

3 University of Economics and Human Sciences in Warsaw, Okopowa 59, 01-043 Warsaw, Poland

Introduction

In an increasingly technology-based economy, the sharing economy has been a popular business model for firms to simulate sustainable practices and improve the competitive advantage, as it covers around activities facilitated through digital platforms and smart operations that enable peer-to-peer access to goods and services (Nadeem et al., 2021). The COVID-19 pandemic has impacted activities within the sharing economy in a precarious situation, across the world and forced many firms to respond. In this regard, scholars and managers have paid attention to the effect of COVID-19 on the sharing economy and business models in various fields (Clauss et al., 2022; Hossain, 2021). However, few studies focus on how COVID-19 related government response, economic support, and lockdown measures impact on the sharing economy in short and long terms, respectively, as well as business models. Hence, this research intends to examine the impact of COVID-19 at policy level, and reveal the causality relationship between the sharing economy and the epidemic.

Understanding the effect of the pandemic on the sharing economy is essential under the current environment, recent studies have identified and explained different facets of the sharing economy and differentiate between micro- and macro-mobility services (Alharthi et al., 2021). Yang and Lee (2022) revealed that the perceived physical risk of COVID-19 influences sharing economy services that users' decisions to adopt shared accommodation and office services. On the meal-sharing economy, Atsiz and Cifci (2021) evidenced the disruptive role of the coronavirus measures based on the service providers' perspective in terms of limiting meal-sharing activities (Atsiz & Cifci, 2021). At the same time, during the outbreak of COVID-19, business models have been limited due to decreased social contact. Researchers have investigated the changes and measures of business models response to the epidemic. The hospitality industry and gastronomy sector worldwide are among the hardest-hit industries from the COVID-19 lockdowns, Bhatti et al. (2021) examined the why and how of successful recovery attempts through business model innovation, and Harms et al. (2021) investigated configurations of causation and effectuation components associated with a high business model level. Similarly, small medium enterprises respond to the crisis via temporary business model innovation to add value to firms and create new revenue streams (Clauss et al., 2022). However, in general academic research on the impact of COVID-19 on the sharing economy is largely lacking (Hossain, 2021). There is a lack of understanding as to how sharing economy and business models have been effected by COVID-19 related policy-levels, how they responded to the crisis, and what kinds of short-term and long-term implications the pandemic may have on the sharing economy. Thus, there is a strong need for a systematic understanding of causality relationship between sharing economy and the epidemic, and the current study aims to tackle these gaps, by exploring the impact of COVID-19 at the policy level.

In this study, we aim to fill this research gap according to econometric analysis techniques, and we investigate the impact of COVID-19 for U.S. firms on the separate factors at four policy-levels, including containment and health index, economic support index, government response index, and stringency index. There is a paucity of empirical studies that provide evidence on the causality relationships between sharing economy and the epidemic both considering short and long terms (Li et al., 2022a; Tao et al., 2022). At the policy level, the vector error-correction model (VECM) helps understand how short-term and long-term influences between sharing economy and COVID-19, and a systematic literature review explores a comprehensive relationship with business models (Clauss, 2017).

Our study makes three contributions to current literature. First, joining the relevant indicators that the government acted upon, we enrich a policy-based view of sharing economy by providing a more detailed conceptual framework of causality relationship between sharing economy and the epidemic (Chen et al., 2022). We argue that government response has a positive impact on sharing economy in the short term, while policies of lockdown style have longer positive effects. Second, we combine the framework that facilitate the impact of COVID-19 on both sharing economy and business models to reveal that such impacts are contingent on the time periods. Therefore, our research contributes to business management literature by adopting policy social perspective aiming to further define the theoretical foundation of COVID-19 effects of sharing economy in terms of short term and long term, respectively (Tao et al., 2022). Third, we test the model on a U.S sample to extend prior studies on operational management in business and economics. Our empirical analysis rigorously tests the performance implications of COVID-19 and its factors at policy level. Therefore, this study offers insight into how reflections of firms in the face to policies related to the epidemic can be further managed in business models (Harms et al., 2021).

The remainder of this study is organized as follows: the "Literature review" section reviews the relevant literature on sharing economy and business models. The "Hypotheses development" section develops research hypotheses. The "Methodology" section presents the data sources and research model. The "Findings" section illustrates the results, and the "Discussions and implications" section discusses the implications of findings. The "Conclusions" section ends the study with some conclusions.

Literature review

What has impacted the sharing economy

The sharing economy has been widely integrated into activities such as accommodation, transport, food, healthcare and socializing (Atsiz & Cifci, 2021; Hossain & Mozahem, 2022) and has offered people different services through online platforms. We divide relevant literature impacted the sharing economy into five categories: legal and political, safe and security, sociocultural, economic and others. Table 1 lists some representative empirical literature on the factors affecting sharing economy.

Regarding legal and political, the operation of sharing economy platforms is regulated by the government and national laws, and unfavorable regulation will be a major obstacle for platforms (Boateng et al., 2019). Tax policy is also concerned in the sharing economy's accommodation (Belarmino & Koh, 2020). In addition, Hong and Lee (2018) found a greater level of political competition is associated with a more favorable regulatory response for sharing companies. Likewise, more contextualized studies carried out by Paik et al. (2019) round off the perspectives on political competition which helps the sharing economy create effective value.

The research on safety and security issues mainly focuses on privacy, physical security, and psychological security (Guo et al., 2021b; Jiang & Lau, 2021), particularly during the COVID-19, when participating in the sharing economy, consumers, services providers, platforms, and governments are especially concerned about vaccination, public health and safe social distance to prevent mass transmission of the virus (Hossain, 2021). In addition, privacy risks negatively affect the intention to use the sharing economy (Yi et al., 2020). Likewise, privacy assurance antecedents shape hosts' trust, thereby enhancing their continuance intention with regard to using the platform (Wang et al., 2020).

The sociocultural includes the concept of society and culture, which revolves around the notion of legitimacy within a society (Rojanakit et al., 2022). It is the most popular theme in sharing economy research, focusing on social value, social interaction, trust, and motivations. Gazzola et al. (2019) emphasized the importance of the socializing motivations, which impact on users' participation in sharing economy. Zhang et al. (2019) found social and emotional value play important roles in terms of the willingness of customers to repurchase in the sharing economy. Then, social interactions with the hosts contribute to a memorable experience (Sthapit & Jimenez-Barreto, 2018). Similarly, the issues of social interaction (Sthapit & Jimenez-Barreto, 2018) and smart technology (Papagiannidis & Davlembayeva, 2021) are considered to determine the emotional value, providing a memorable stay for the customer.

The economic group focuses on key topics such as income management, financial support, and financial risk. The sharing economy as an economic model enables individuals to share access to underutilized resources in order to receive monetary or non-monetary benefits (Jiang & Lau, 2021; Lu et al., 2021). To some extent, economic motivation forms the basis for participation (Milanova & Maas, 2017). However, Yi et al. (2020) argued that financial risks negatively affect the intention to use the sharing economy. In addition, numerous studies have developed a discussion of revenue management issues in sharing economy (Yi et al., 2020). Pricing strategies (Yi et al., 2020), customer reviews (Blal et al., 2018), and platform-level insurance (Luo et al., 2021), have impacts on the revenue performance of sharing economy platforms.

Table 1 Representative literature examining the impact on the sharing economy

Field	Reference	Independent	Dependent	Data	Impact
Legal/Political	(Hong & Lee, 2018)	Political competition	Governments' regulation	47 U.S.cities	P
	(Liu et al., 2020)	Carbon trading	Business model	4 companies, 28 customers	P
	(Paik et al., 2019)	Political competition	Ride-sharing	Archival data in U.S. cities	P
Safe/Security	(Yi et al., 2020)	Physical risks	Intention	300 usable questionnaires	P
	(Guo et al., 2021b)	Privacy and security risks	Trust	DiDi drivers in Guangzhou	N
	(Jiang & Lau, 2021)	Physical and psychological risks	Trust and intention	458 DiDi consumers	P
Sociocultural	(Hossain & Mozahem, 2022)	Freedom	Drivers' participation	31 interviews with drivers	P
	(Gazzola et al., 2019)	Socializing motivations	Users' participation	1,004 Italian participants 5,000 resamples	P
Economic	(Sthapit & Jimenez-Barreto, 2018)	Social interactions	Airbnb experiences	20 participants	P
	(So et al., 2019)	Social distance	guest loyalty	2,612 observations	N
	(Hossain & Mozahem, 2022)	Income	participation	31 interviews	P
	(Kwok & Xie, 2019)	Price positioning	Revenue performance	320,243 listings	P
Others	(Cheng et al., 2018)	Service quality	Attitudes	294 questionnaires	P
	(Li et al., 2019)	Digital platforms	Sharing practices	208 valid respondents	P
	(Li et al., 2021)	Drivers	Labor participation	U.S. Census	P

Source: Authors' research. "P" represents positive, and "N" represents negative

What has impacted the business models

Business model is a key bridge for efficient interactions between resource elements and organizational structures (Teece, 2010), which includes the interrelated dimensions of value proposition, value creation and value capture (Clauss, 2017; Mueller et al., 2018). Table 2 lists some representative literature to present the main impacts on business models.

Rapid advances in technology are shifting organizations from traditional product-centric models to digital business models with higher potential for value creation and capture (Paiola & Gebauer, 2020). Big data as one of the digital technologies enable extensive integration of information (Ciampi et al., 2021), while the management capability of big data analysis ensures smooth operation and value capture of business model. Song et al. (2022) revealed that big data management capabilities have a positive impact on the infrastructure attributes and the value attributes of business models. Enterprises leverage blockchain technology to upgrade their business models to sustainable environmentally oriented multi-faceted platforms. The importance of trust and quality is also stressed in the analysis of Yuan et al. (2021), who stated that the trustworthiness of entrepreneurial advocates and product quality have a positive impact on business to business parasympathetic relationships, and both contribute to the breadth and depth of super social interactions.

Business model innovation (BMI) has a significant impact on the core competencies of market share and corporate performance (Teece, 2010). More findings revealed that knowledge absorption (Bhatti et al., 2021) and knowledge management capabilities (Hock-Doepgen et al., 2021) have a positive effect on it. The proliferation of digital technologies has also triggered innovation in business models (Sjodin et al., 2020). Ciampi et al. (2021) asserted that big data analytics capabilities not only have a positive effect on BMI but also have an indirect positive effect on BMI through the mediation of entrepreneurial orientation, thus executives should efficiently use big data analytics capabilities to support entrepreneurial initiatives. Then, digital innovation also promotes BMI in three ways: organization-oriented, product-oriented, and product-organization complementary (Cheng & Wang, 2022). Other, Bhatti et al. (2021) argued that BMI is significantly dependent on agility, and more contextualized studies carried out by Clauss et al. (2021) round off the perspectives that strategic agility has a positive correlation with BMI and is reinforced by environmental turbulence. A further research theme related to environmental uncertainty was studied by Zhang et al. (2021), whose findings revealed that environmental uncertainty has a significant positive effect on the BMI-firm performance link. However, passive innovation resistance strongly hinders the adoption of BMI, This view was shared by Heidenreich et al. (2022), who argued that customers with a low resistance to passive innovation are more likely to accept BMI and thus promote continued adoption, while the opposite is true for customers with high resistance to passive innovation.

Table 2 Representative literature examining the impact on the business models

Field	Reference	Independent	Dependent	Data	Impact
KM	(Guo et al., 2021a)	KI and IT capability	EBMD and NBMD	205 Chinese firms	P
	(Bhatti et al., 2021)	KM	BMI	172 IT firms	P
	(Zheng et al., 2021)	KM	BMI	3,973 observations	P
	(Hock-Doepgen et al., 2021)	External KM	BMI	197 SMEs	P
Digital	(Cheng & Wang, 2022)	Digital Innovation	BMI	167 firms in China	P
	(Ciampi et al., 2021)	BDAC, EO	BMI	253 UK firms	P
	Song et al., 2022	BDAC	Infrastructure attribute	242 SMEs in China	P
Agility	(Bhatti et al., 2021)	Agility	BMI	172 firms in Pakistan	P
	(Clauss et al., 2021)	Strategic agility	BMI	432 German firms	P
Innovation	(Futterer et al., 2022)	Value offering architecture	Consumers' intention	896 questionnaires	P
	(Heidenreich et al., 2022)	Passive innovation resistance	Continuous BMI adoption	551 responses	N
Perceived value	(Chen et al., 2019)	Service quality and trust	Behavioral Intention	Taiwan's online population	P
	(Yuan et al., 2021)	Service, product, trust	B2B relationship	273 questionnaires	P
Others	(Bao et al., 2021)	Geographic search	BMI	287 firms	P
	(Benzidia et al., 2021)	Electric vehicles	BM	307 survey participants	P
	(Klein et al., 2021)	Sustainable commitment	BMI	167 German firms	P

Source: Authors' research

"P" represents positive, and "N" represents negative

KM Knowledge Management, *KI* knowledge integration, *IT* Information Technology, *EO* Entrepreneurial Orientation, *BDAC* Big Data Analytics Capabilities, *EBMD* Efficiency-centered Business Model Design, *NBMD* Novelty-centered Business Model Design, *BMI* business models innovation, *B2B* Business to Business

Hypotheses development

The global spread of COVID-19 has prompted an extraordinary range and impact on sharing economy. In this study, we consider four factors at the policy level in our research model.

1. Containment and health. COVID-19 has sparked public concern about vaccine development and access to cleanliness, sanitation and health care, while also promoting interdisciplinary inquiry and public health advocacy (Wen et al., 2021). In the transport industry, there have been numerous incidents of passengers catching COVID-19 in Uber (Hossain, 2021). The hygiene of online rental platforms is not satisfactory in dealing with the COVID-19 pandemic (Wang et al., 2021a). In general, some sharing economy platforms have good countermeasures such as disinfection, wearing masks, temperature screening, contact tracing, limiting access to the platform based on health status, and reporting COVID-19 positive cases in the community (Mont et al., 2021). However, there are also some platforms that are lax in safety and hygiene protection due to the lack of cleaning materials and protective equipment (Hossain, 2021). These cases undoubtedly increased public fear and distrust of using sharing economy services. More contextualized studies carried out by Yang and Lee (2022) round off the perspectives that perceived physical risk negatively affects trust, thus reducing the use of sharing economy. Hossain (2021) perceived that sharing economy faces huge challenges in terms of maintaining social distance, health and safety. This provides the necessary flexibility for containment and health to function responsively and decrease risk and increase effectiveness. Thus, we formulate the following hypothesis:

    H1. Containment and health index has a significant effect on sharing economy.

2. Economic support. Reduced demand for participation in sharing economy platforms means that service providers such as drivers and landlords face financial crises from job losses and canceled bookings, while they are not even entitled to basic labor protections because they are treated as independent contractors rather than workers (Hossain, 2021). The vision of service providers such as drivers for higher revenues in the sharing economy was thwarted by COVID-19 (Hossain & Mozahem, 2022), forcing an exit from the sharing economy in search of more substantial revenues. These findings are consistent with the discussion of (Atsiz & Cifci, 2021), who argued that in Turkey's meal-sharing sector, all hosts are frustrated with the financial support, as they do not benefit from financial assistance from the government and platforms, notwithstanding the heavy losses. Despite this, many countries have adopted relief packages designed to help businesses stay afloat, protect jobs to low-income families and the unemployed. However, for very small businesses, disaster loan assistance harms business operations, especially when the damage is severe (Watson, 2022), as they often bear the additional risk of repaying the loan. Take a long time, economic support will reduce the motivation for people to continue to work, and reduce the workload. On the basis of the arguments above, the following hypothesis is proposed:

H2. Economic support has a long-run negative effect on sharing economy.

3. Government response. The pandemic has caused anxiety, cancellations, unemployment, reduced income, social distance, and health and safety issues in the sharing economy (Hossain, 2021), which has dealt a great blow to sharing economy platforms, consumers, and service providers engaging in activities. Each government has made policy response almost under containment and closure, economic response, health systems, and miscellaneous, which includes travel restrictions, bans on public gatherings, emergency investments in health facilities, new social welfare provision, contact tracing and other interventions to curb the spread of the virus and strengthen health systems. For ridesharing platforms, the government has strict limits on the number of passengers in different types of vehicles and has a policy that shared vehicles or taxis should be regularly monitored and sanitized. Hossain (2021) investigated effective government responses, such as changes to the existing regulations, the development of furlough schemes, measures to regulate sharing economy services, and financial support for citizens, which would facilitate the management of the sharing economy sectors and buffer social anxiety. Therefore, the following hypothesis is proposed:

H3. Government response have a positive effect on sharing economy.

4. Stringency. The government has responded to COVID-19 with a range of non-pharmaceutical public health interventions such as masks, social distancing, lockdowns, border closures, and home quarantine (Hale et al., 2021). However, they have largely affected businesses around the world and deprived them of a key aspect of sharing economy: companion relationships (Atsiz & Cifci, 2021; Papagiannidis & Davlembayeva, 2021). These findings are consistent with the perspective of (Milanova & Maas, 2017), who asserted that non-pharmacological public health interventions are the opposite of the principles promoted by the sharing economy, and because of the months-long lockdown, the transportation and accommodation sector suffered the greatest losses compared to all sharing economy sectors. For the accommodation sector, to compensate for the losses caused by the lockdown, some hosts will raise the price of accommodation, which undoubtedly pools the cold water on the enthusiasm of participants of the SE (Mont et al., 2021). Likewise, So et al. (2019) believes that social distance can have a negative impact on the loyalty relationship with SE service providers. For the transport sector, ridesharing services are no longer popular, and the requirement to maintain social distancing can significantly reduce the number of riders (Mont et al., 2021). In addition, the perceived risk of Covid-19 is relatively high among travelers around the world due to a range of controls (Yost & Cheng, 2021), which tends to have a negative impact on people's participation in the SE (Hale et al., 2021). It is worth mentioning that although the sharing economy platforms in the accommodation and transportation sectors have been severely hit, freelancers, education, and entertainment industry-related platforms, especially those that include options for contactless delivery are gaining popu-

larity and opening up new opportunities due to the rapid digitization caused by the COVID-19 lockdown (Zhu & Liu, 2021). Therefore, our last hypothesis is as follows:

H4. Stringency has a long-run positive effect on sharing economy.

Methodology

This section presents the study object, data sources, and how COVID 19 related factors interacts with each other, and how those interactions affect sharing economy. Based on research gaps identified in Introduction, we quantify these interactions using econometric analysis techniques including unit root tests, vector error-correction model (VECM), Granger causality test, impulse response, and variance decomposition.

Data source and analysis

In this study, we identify the impact of COVID 19 on sharing economy for the firms in the United States. In Indxx Database, the Indxx US Sharing Economy Index measures the performance of 75 companies that are associated with the sharing economy model or are engaged in acquiring, providing or sharing access to goods and services that are facilitated by a community based on-line platform. The Indxx Database is available online on the website (https://www.indxx.com/indices/thematic/indxx-us-sharing-economy-index-ntr). Therefore, we use this index as a proxy to show the sharing economy in United States, and collect the series data as working days from January 1, 2020 to July 8, 2022.

To represent the policy response of COVID-19 in the United States, we collect four indices from the Oxford Covid-19 Government Response Tracker (OxCGRT) that focuses on collecting systematic information on policy measures that government has taken to tackle COVID 19. Based on the OxCGRT database (https://www.bsg.ox.ac.uk/research/research-projects/covid-19-government-response-tracker), four policy indices are considered as: (1) containment and health index, combined 'lockdown' restrictions and closures with measures such as testing policy and contact tracing, short term investment in healthcare, as well investments in vaccines; (2) economic support index, recorded measures such as income support and debt relief; (3) government response index, recorded how the response of governments has varied over all indicators in the database, becoming stronger or weaker over the course of the outbreak; and (4) stringency index, recorded the strictness of 'lockdown style' policies that primarily restrict people's behaviors. Table 3 reports the description and metrics of variables, and sharing economy factor is the dependent variable and denoted as L_indeks; On the other hand, the independent variables are COVID 19 related factors, denoted as L_cont, L_econ, L_gov, and L_string.

Table 3 Description and metrics of variables in the study

Indicators	Variables	Description	Metrics	Sources
Sharing economy factor	L_indeks	U.S. Sharing economy index	in Mln (logarithm)	Indxx
COVID 19 related factors	L_cont	Containment and health index	in Mln (logarithm)	OxCGRT
	L_econ	Economic support index	in Mln (logarithm)	OxCGRT
	L_gov	Government response index	in Mln (logarithm)	OxCGRT
	L_string	Stringency index	in Mln (logarithm)	OxCGRT

Source: Indxx database, OxCGRT database

VCEM model

Theoretical and policy background show the change in business model as consequences of COVID-19. Next, we aim to assess the impact of COVID-19 on the sharing economy in the United States according to empirical analysis. The research model is used to achieve this goal. The following equation describes the long-term relations amongst the sharing economy index, COVID-19 related containment and health index, economic support index, government response index, and stringency index,

$$L\_indeks_t = \alpha + \beta_1 L\_cont_t + \beta_2 L\_econ_t + \beta_3 L\_gov_t + \beta_4 L\_string_t + \varepsilon_t \quad (1)$$

where L_indeks is the natural logarithm of sharing economy concentrations, L_cont represents situation of the containment and health, L_econ is for the economic support, L_gov is for the government response, and L_string is the natural logarithm of stringency values. $t = 1, 2, \cdots, T$ represents the time, α is the constant. $\beta_1, \beta_2, \beta_3, \beta_4$ are the long-term elasticity estimates of the independent variables, and ε_t is the error terms.

When the variables are cointegrated, Vector Error-Correction Model (VECM) assesses the Granger causality, indicating both the short-run and long-run causal relations according to the F statistics and the t statistics of the regressors and the error correction term CE (-1). The formulation is as follows:

$$(1 - B) \begin{bmatrix} \Delta L\_indeks \\ \Delta L\_cont \\ \Delta L\_econ \\ \Delta L\_gov \\ \Delta L\_string \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \\ \alpha_5 \end{bmatrix} + \sum_{i=1}^{P} 1 - \begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13} & \beta_{14} & \beta_{15} \\ \beta_{21} & \beta_{22} & \beta_{23} & \beta_{24} & \beta_{25} \\ \beta_{31} & \beta_{32} & \beta_{33} & \beta_{34} & \beta_{35} \\ \beta_{41} & \beta_{42} & \beta_{43} & \beta_{44} & \beta_{45} \\ \beta_{51} & \beta_{52} & \beta_{53} & \beta_{54} & \beta_{55} \end{bmatrix}$$

$$\times \begin{bmatrix} \Delta L\_indeks_{t-1} \\ \Delta L\_cont_{t-1} \\ \Delta L\_econ_{t-1} \\ \Delta L\_gov_{t-1} \\ \Delta L\_string_{t-1} \end{bmatrix} + \begin{bmatrix} \varphi_1 \\ \varphi_2 \\ \varphi_3 \\ \varphi_4 \\ \varphi_5 \end{bmatrix} CE_{t-1} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \\ \varepsilon_{5t} \end{bmatrix} \quad (2)$$

where $(1 - B)$ is the lag operator, Δ is the first difference operator, and ε_t refers to white noise error.

After Granger-causality tests reveal causal relationships between variables, variance decomposition and impulse response are used to quantify the causal impact of one variable on another and to estimate how each variable reacts to changes in the other variables.

Findings

In this section, we conduct the VECM model to investigate the short and long-run impact of COVID-19 on sharing economy.

Descriptive summary

As previously introduced, the impact of COVID-19 consists of four aspects for United States considering working days. To make the results accurate, we take the log of all variables. In Table 4, we report descriptive statistics for the entire sample data.

Unit root test and optimal lag selection

The variable's stationarity is the prerequisite for econometric analysis to eliminate spurious or nonsense regression in time series analysis, and applying the time-series econometrics method requires stationary data before investigating the long-term relationship amongst variables through cointegration. Fisher–ADF (Augmented Dickey–Fuller) test and Fisher–PP (Phillips–Perron) test (Choi, 2001), are conducted to investigate the statistical property of stationarity. Table 5 reports the results of the unit root tests based on two testing procedures. The null hypothesis of these two tests is that all time series contain unit roots. If the null hypothesis is rejected, one time-series at least is stationary at the level. The results show that not all variables are stationary at the level, but all stationary at the first difference.

To ensure the non-autocorrelation of the residuals, the Akaike information criterion (AIC), Schwarz Information Criteria (SC) and the Hannan–Quinn information criterion (HQ) are used for determining the optimal lag truncation. Table 6 provides the VAR lag order selection criteria amongst all variables. Combined with sequential modified LR test statistic at 5% level and final prediction error, the 1st-order lag is selected as the optimal lag.

Table 4 Descriptive statistics of variables

Variable	Obs.	Mean	Std. Dev.	Min	Max	Kurtosis
l_indeks	658	7.8587	0.2609	7.1798	8.2487	2.1048
l_cont	658	3.8982	0.7343	0	4.2661	19.1613
l_econ	658	2.4253	1.9834	0	4.1510	1.1804
l_gov	658	3.8409	0.7461	0	4.2523	17.3013
l_string	658	3.7816	0.8647	0	4.3368	13.6103

Source: Authors' research

Table 5 Results of the unit root test of variables

Variables	ADF		PP		Order of integration	
	Level	Difference	Level	Difference	ADF	PP
l_indeks	−0.8193	−16.3197***	−0.8401	−26.3660***	I(1)	I(1)
l_cont	−5.9849***	−5.5876***	−7.5203***	−24.9573***	I(0)	I(0)
l_econ	−1.3897	−26.5170***	−1.3665	−26.5170***	I(1)	I(1)
l_gov	−5.1566***	−5.3671***	−7.2793***	−25.1125***	I(0)	I(0)
l_string	−5.0070***	−25.4091***	−4.9147***	−25.6827***	I(0)	I(0)

Source: Authors' research

*, ** and *** represent the 10%, 5% and 1% significance levels, respectively

Cointegration test

Due to that the two variables of L_indeks, and L_econ are first-order single integers, and other three variables are level-order single integers, there may be a long-term and balanced relationship between sharing economic and COVID 19 related variables. Before conducting cointegration test, we examine the roots of characteristic polynomial to see whether the VAR satisfies the stability condition or not. Based on the selected optimal lag, Table 7 lists the inverse roots of AR characteristic polynomial, and no root lies outside the unit circle, indicating that the model satisfies the stability.

In the following, the Johansen method is applied to perform a cointegration test on the five variables. In Table 8, the trace test indicates that there are 4 cointegrating equations at the 0.05 level. The sharing economy of the US and the COVID 19 related factors are at least three correlation assumptions. There is a long-term balanced and stable relationship between sharing economy and the four variables.

The normalized cointegration equation is:

$$CE(t) = L\_indeks_{t-1} + 37.08L\_cont_{t-1} + 0.25L\_econ_{t-1}$$
$$- 32.05L\_gov_{t-1} - 4.75L\_string_{t-1} - 0.01$$

According to the coefficients of variables, in the long term, sharing economy is positively correlated with government response, and stringency, whereas, it is negatively correlated with containment and health, and economic support. Since the data were logarithmically processed, the coefficient of each variable is the respective elastic coefficient. The normalized cointegration equation indicates that

Table 6 VAR lag order selection criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	256.8096	NA	3.20e-07	−0.7665	−0.7324	−0.7533
1	6221.2700	11819.9800*	4.49e-15*	−18.8471*	−18.6422*	−18.7677*

Source: Authors' research

* indicates lag order selected by the criterion

Table 7 Inverse roots of AR characteristic polynomial

Lag specification	Root	Modulus
1	$0.9937 - 0.012i$	0.9937
	$0.9937 + 0.012i$	0.9937
	0.9639	0.9639
	0.9570	0.9570
	0.8804	0.8804

Source: Authors' research

when the containment and health index increased by 1%, sharing economy index decreased by 37.08%. The reason may be that the implementation of containment and threats to health have created public fear and distrust of sharing economy services (Zhu & Liu, 2021). Trust is regarded as the lifeblood of innovation in sharing economy services (Thi Thanh Huong et al., 2022), and the lack of trust from customers hinders the implementation (Zhang et al., 2019). Sharing economy index decreased by 0.25% when the economy support index increased by 1%; The result is in line with that the growth in loans due to Covid-19 will plunge the banking sector into credit risk and financial distress, with a negative impact on banks' profitability and solvency in the long run. When the government response index increased by 1%, sharing economy index increased by 32.05%. During the controlled and de-escalation phases of the pandemic, platforms compensated service providers for losses suffered during the blockade, and governments included temporary workers in their relief schemes and provided them with unemployment benefits (Hossain & Mozahem, 2022). In the longer term, the positive policy responses have facilitated participation in the sharing economy. In addition, to revive sharing economy operations, platforms and consumers responding positively to policies and paying constant attention to hygiene rules can also help build sufficient "trust" and "safety" (Hossain, 2021), to facilitate SE activities (Guo et al., 2021b; Luo et al., 2021). Sharing economy index increased by 4.75% when the stringency index increased by 1%. The findings are in the line with the previous studies. Stringency measures can be effective in controlling the spread of Covid-19 (Maier & Brockmann, 2020). Plümper and Neumayer (2022) found that a local strategy instead of a

Table 8 Unrestricted cointegration rank test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trance statistic	0.05 critical value	Prob.
None*	0.1209	206.7852	88.8038	0.0000
At most 1*	0.0835	122.1136	63.8761	0.0000
At most 2*	0.0536	64.8303	42.9153	0.0001
At most 3*	0.0262	28.6455	25.8721	0.0220
At most 4	0.0169	11.2204	12.5180	0.0816

Source: Authors' research

* denotes rejection of hypothesis at the 0.05 level

national strategy is a long-term plan, which involves dynamic contact tracing of positive cases and isolating those in contact with them to contain the spread of the virus. This more flexible moderate lockdown between hard and soft is the choice of most countries (Plümper & Neumayer, 2022). In addition, stringency measures are like two sides of the coin, it poses challenges for enterprises but also facilitate the rapid development of digital technology (Leidner, 2020). Digital technology has prompted SE enterprises to adapt and innovate their BMs to accommodate unexpected lockdowns (Carroll & Conboy, 2020). Enterprises that adopt a digital strategy have greater flexibility in responding to crises (Beaunoyer et al., 2020).

Granger causality test based on the VECM model

The cointegration relationship illustrates the long-term relationship and trend between the various variables. To explore the bi-directional or uni-directional Granger causality between sharing economics and COVID-19 related variables, the VECM model is established based on short fluctuation and long-run equilibrium relationship. On the other hand, a vector autoregressive model was used to examine the short-run Granger causality when the variables are stationary by preprocessing. Using Eviews 12.0 software, a specific estimation of the VECM model is presented, and the results indicate that the cointegration relationship is effective because of the negative value in the estimated value of the error correction term in the equation. The matrix of the estimated coefficient vector is formed as follows:

$$
\begin{bmatrix} \Delta L\_indeks \\ \Delta L\_cont \\ \Delta L\_econ \\ \Delta L\_gov \\ \Delta L\_string \end{bmatrix} = \begin{bmatrix} -0.0003 \\ 0.0058 \\ 0.0012 \\ 0.0056 \\ 0.0051 \end{bmatrix} + \begin{bmatrix} -0.0386 & -0.0679 & 0.3644 & -0.0513 & 0.0168 \\ -0.1102 & -0.8748 & 7.3241 & -0.5107 & -1.9932 \\ -0.0049 & -0.0279 & 0.1840 & -0.0187 & -0.0589 \\ 0.1184 & 0.9286 & -7.8630 & 0.5388 & 2.0699 \\ 0.0118 & -0.0505 & 0.0744 & -0.0458 & -0.0451 \end{bmatrix}
$$

$$
\times \begin{bmatrix} \Delta L\_indeks_{t-1} \\ \Delta L\_cont_{t-1} \\ \Delta L\_econ_{t-1} \\ \Delta L\_gov_{t-1} \\ \Delta L\_string_{t-1} \end{bmatrix} + \begin{bmatrix} -0.0030 \\ 0.0020 \\ -0.0323 \\ 0.0012 \\ 0.0220 \end{bmatrix} CE_{t-1} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \\ \varepsilon_{5t} \end{bmatrix}
$$

The first coefficient of the error correction term, −0.0030, represents that when the COVID 19 related factors remain unchanged, a change in the US's sharing economy in the t period can eliminate the previous period. The adjustment intensity of −0.0030 brings the unbalanced state back to a balance state. This indicates that sharing economy of the US has a reverse self-correction mechanism with the weak ability. The second coefficient of the error correction term, 0.0020, indicates that a change to the containment and health index input in the t period decrease from the previous period. The third coefficient of the error correction term, −0.0323, showing a change in the economic support index input in the t period decrease from the previous period. 0.0013, as a fourth coefficient of the error correction term, indicates that a change to the government response index input in the t period increase from the previous period. 0.0220, as a last coefficient of the error

correction term, shows that a change in the stringency index input in the t period increase from the previous period. The adjustment coefficients for the containment and health index, the government response index, and stringency index inputs are both positive, showing that the unbalanced error cannot be corrected and that there will be a larger error. As a result, a change to coefficients of the economic support index has a significant influence on sharing economy.

The Granger causality test examines the non-logical causal relationship between the five variables in the short term. Table 9 lists the Granger causality test results based on the VAR model and the VECM model. The tests show that in the short term, neither an economic support nor stringency during COVID-19, is a Granger cause for sharing economy in the US, while the containment and health, and the government response are both the Granger cause for the sharing economy with the significant impact. A uni-directional long-run causal relationship was explored running from the other COVID 19 related variables to the sharing economy concentration. In Table 9, the coefficients of CE (−1) of sharing economy and economic support are negative at the 1% level of significance, whereas the level of stringency is positive at the same level of significance, indicating that the bi-directional long-run causality or a feedback effect amongst them. Long-run causality exists between sharing economy, economic support, and stringency.

Impulse response and variance decomposition

The impulse response function is used to assess the effect of a shock on one variable on the other five variables. As a result, a shock to one variable has an immediate dynamic structure. Five variables are described as having a binary relationship as an exogenous response. The findings of impulse response indicated one variable's response to the shocks from other variables. Figure 1 shows the responses of

Table 9 Granger causality test results based on the VAR model and the VECM model

Dependent variable D(l_indeks)	Independent variable					
	Short-run causality				Long-run causality	
	D(l_cont)	D(l_econ)	D(l_gov)	D(l_string)	CE (−1)	t-statistics
D(l_indeks)	7.9033***	0.1343	4.8268**	0.8534	−0.0030***	−2.5180
D(l_cont)	0.3605		0.0034	0.0022	1.3695	0.0020	0.5359
D(l_econ)	1.7402	3.0172*		4.3287**	3.4692*	−0.0323***	−2.8086
D(l_gov)	0.1947	0.5516	0.0451		1.7594	0.0011	0.3798
D(l_string)	0.0011	0.8485	0.0016	4.6555**		0.0220***	4.9349

Source: Authors' research

The null hypothesis states no causal relationships between variables, and CE (−1) represents the difference operator

CE_{it-1} is the error correction term lagged for one period

*, ** and *** represent the 10%, 5% and 1% significance levels, respectively

Response of L_INDEKS to L_CONT Innovation

Response of L_INDEKS to L_ECON Innovation

Response of L_INDEKS to L_GOV Innovation

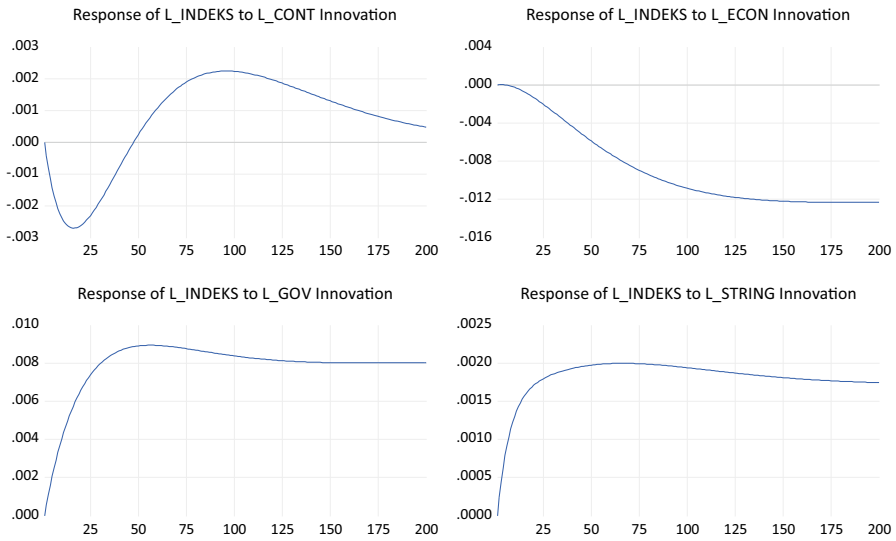Response of L_INDEKS to L_STRING Innovation

Fig. 1 Responses of variables to one SD innovation

sharing economy to each COVID 19 related factors. Figure 2 provides the combined response of sharing economy to all variables.

Shocks from containment and health decreased in the first 20 working days and then increased stiffly till 100 wording days, finally at a slower pace. Sharing economy first decreased and then stabilized in reaction to shocks produced by declining economic support, whereas their response to shacks generated by the level of government response and stringency increased in the first 50 working days and then stabilized. In Fig. 2, containment and health index has less impact on the sharing economy, from negative effect to positive effect, and then tends to zero. Government response index and stringency index have positive impact on the sharing economy, and the former's effect is greater that the impacts are 0.008, and 0.002, respectively. Economic support has a negative impact and the response of the sharing economy changes from small to large, and gradually reaches 0.12 steadily.

Variance decomposition provides the contribution of sharing economic and four COVID 19 related aspects. Figure 3 presents the variance decomposition of the sharing economy using Cholesky factors. The results show that sharing economy of the US was greatly affected by its fluctuations in the initial stages. Containment and health, economic support, government response, and stringency with respect to COVID 19 impacted sharing economy in the second period, but the impact intensity was small with 0.001%, 0.007%, 0.18%, and 0.09%, respectively. Since then, the intensities of the effects of these four factors have risen rapidly, reaching its maximum in the 200th period, at 0.55%, 15.83%, 14.30%, and 0.20%, respectively. The long-term impact on sharing economy from COVID 19 related policy indices are limited and gradually stabilizes after the 100th period at around 5%. After the 150th period, the contribution of economic support is more
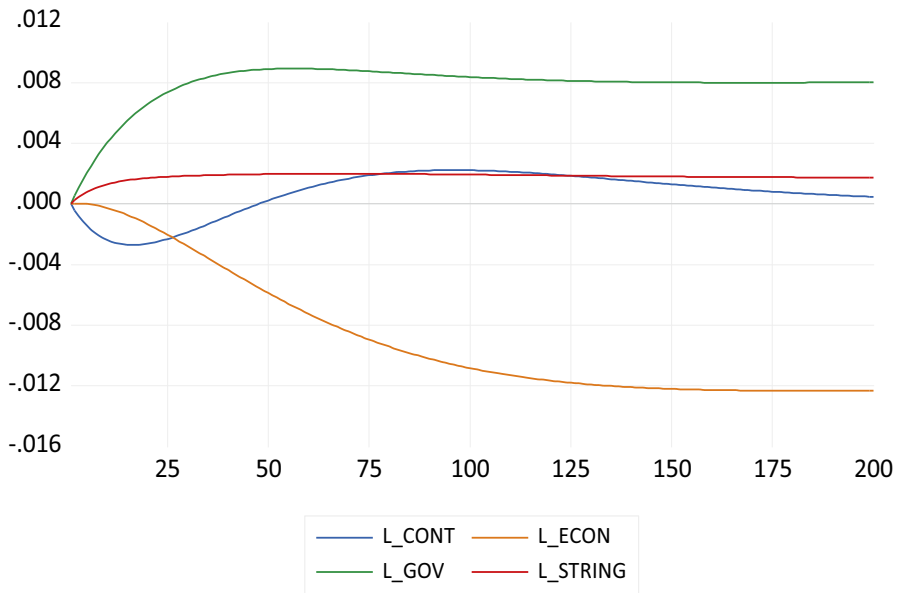
Fig. 2 Response of sharing economy to Cholesky one SD innovations

significant than the contribution of government response, which shows that in a long enough period, the economic support of the US has a more positive effect on sharing economic than the impact of the government response.

Discussions and implications

According to the findings related to the impact of COVID-19 on sharing economy, companies would seek more flexible business models to reduce the loss. In the following, we discuss the managerial implications from the perspectives of sharing economy and business models.
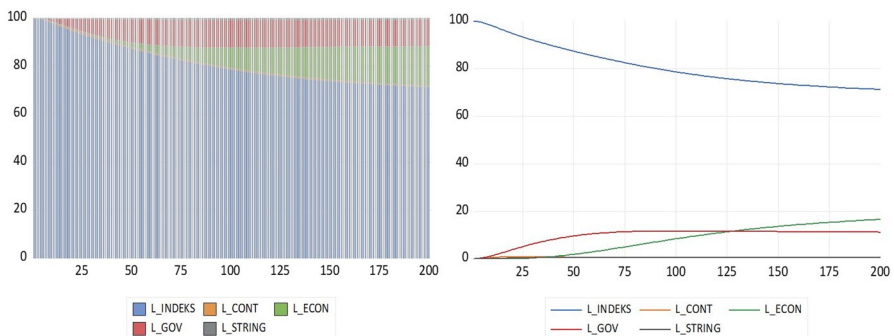
Fig. 3 Variance decomposition of the sharing economy using Cholesky factors

1. Consider to adopt new processes and technologies with the containment and health issues in sharing economy facilitates value creation and thus influence innovation in business models. Consumers fear continuing to share many services and spaces due to health and safety concerns (Zhu & Liu, 2021). Unfortunately, the lack of emotional value and trust is a huge barrier to the implementation of the sharing economy (Zhang et al., 2019). Therefore, the sharing platform depending on knowledge economy (Wang et al., 2022b) and uncertain decision-making methods (Wang et al., 2021b) provides a regulatory system that binds drivers to comply with hygiene regulations, such as wearing masks, disinfection, and uploading health certificates. Business partners with telemedicine companies to provide free online virus screening for communities to ensure employee health. Moreover, containment and health factor also impacts the consumers' behaviors. Unhealthy emotions and behaviors such as anxiety and depression, alcohol, drugs and self-harm alter consumer buying behavior (Alsukah et al., 2021). Consumer buying psychology and behavior change the way, motivation and place of purchase and therefore have a significant impact on the design of the business models. Consumers' concerns about safety and hygiene will lead them to choose to shop in innovative, contactless one-stop shops with hygiene guarantees.

2. The government provides appropriate economic support in the short term. Government plays a key role in providing economic support schemes to address loan and resource issues. Many countries have adopted relief packages designed to help businesses stay afloat, protect jobs, or provide financial assistance to low-income families and the unemployed. Similarly, in the sharing economy sectors, unemployment insurance is provided to service providers, and small business grants and loans are available to landlords (Hossain, 2021). Financial support plays a key role for those facing unemployment during the epidemic and for the operation of sharing economy platforms. Some governments have proposed large stimulus packages, such as low-interest loans that will provide financial security for businesses to weather the crisis (Li et al., 2022b). In addition, several studies have shown a positive correlation between disaster loan assistance and income performance (Haynes et al., 2021), and businesses with resources to recover are more likely to benefit from economic assistance. In response to COVID-19, enterprise adapts their business models at every key level and develop plans to balance profit and cash flow for achieving the financial goal of maintaining positive cash flow (Wang et al., 2022a).

3. The government reacted quickly to prevent business closures by providing relief measures such as loans, wage support and subsidies during COVID-19. Atsiz and Cifci (2021) proposed that even if the pandemic persists, customer engagement will be stronger in cases where citizens respond to the government's call to take the necessary precautions. Companies need a more comprehensive and effective government response and business models adjustments to face the challenges (Li et al., 2022b). For example, institutional constraints such as lack of government support for digitization and investment in infrastructure, and limited government skills development programs in digitization have hindered the adoption of digital technologies (Amankwah-Amoah et al., 2021). For start-ups, government

response in the face of the crisis should be more targeted, with different policies for different groups of businesses, rather than a one-size-fits-all approach.

4. The government has responded to COVID-19 with a range of non-pharmaceutical public health interventions. Since that stringency has a long-run positive effect on sharing economy, managers could use sharing economy platforms to digitize internal operations and processes, redesign business models and even enhance business process innovation. The sharing economy has become increasingly popular and important as a means of consumption. The sudden COVID-19 dealt an unprecedented blow to the sharing economy (Zenker & Kock, 2020). The creation of contactless and mobile payments combines channel and facilitates the convenience, timeliness and efficiency of shopping, which has a positive impact on the design of efficiency-centered BMs (Tao et al., 2022). Some companies would opt for business model, albeit facing a longer time horizon and a higher probability of lost revenue. COVID-19 has accelerated digital transformation with a huge impact on business models (Soluk et al., 2021).

Conclusions

This research was conducted to examine the short and long-term impacts of COVID-19 on sharing economy and business models. Data was collected for U.S. firms from January 1, 2020 to July 8, 2022 on workdays. The study employed the VECM model to perform the empirical analysis. Four factors at the policy level, including containment and health index, economic support index, government response index, and stringency index, were considered as COVID-10 related variables due to these highly impact firms in daily life. To evaluate the epidemic shockwaves on business model, this research presented the information based on literature review and summarized the main results. To investigate the response to shocks to sharing economy, we presented the findings in the time series of the VECM model both considering short term and long term, respectively.

This study offered a clear causality relationship between the sharing economy and the epidemic in U.S. In the short run, since the results of hypothesis testing at 1% significance level, government response plays a positive impact on sharing economy with the coefficient 4.8268 to facilitate the management of the sharing economy sectors and buffer social anxiety. Containment and health factor reveals a fluctuant impact on sharing economy with the coefficient 7.9033 due to lower effectively and safety concerns. In the long run, at 1% significance level, economic support has a negative effect with the coefficient -0.0323 for the reason that it would reduce incentives to work and create wealth, while sharing economy is positively correlated with stringency with the coefficient 0.0220 to ensure the safety and enhance awareness of prevention. Some government responses, such as the development of closure and restriction policies (Hale et al., 2021), the design of health and safety rules (Wen et al., 2021), the regulation of SE services (Grieco, 2022), and financial support (Liu et al., 2022) facilitate the management of the SE sectors and buffer social anxiety (Hossain, 2021). Stringency measures

can be effective in controlling the spread of Covid-19 (Maier & Brockmann, 2020). Therefore, it is important to enhance measures of government response and effective stringency.

This research also presented business models that receive focus to reduce the effect of COVID-19. The control and lockdown policy developed in the pandemic have exposed the immaturity of the business models and the fragility of the organization, and it has a negative impact on start-ups (Gao, 2022). During the epidemic, it pushes digital transformation of organizations to the forefront, and matching digital technology and business models is crucial for companies to compete. Consumers' concerns about safety and hygiene will lead them to choose to shop in innovative, contactless one-stop shops with hygiene guarantees. Therefore, it also encourages the design of novelty-centred business models, which meets new customer value propositions, needs or experiences through innovation in content, structure or governance. Also, spending in the business model innovation sector helps to shape efficient and effective activities in sharing economy, which can play a role in the development of high technology in R&D.

This study discussed the long-term implications of the COVID-19 pandemic on the sharing economy, and explored how this may impact future responses among sharing platforms in the society that seeks sustainability. Sharing platforms can learn from each other about how to continue to respond in the face of the ongoing pandemic, and consider actions using more flexible business models for future preparedness to potential forthcoming crises. The research lies in selecting the used indicators to represent the impact of COVID-19 on the sharing economy at the policy level. Studies on the business models according to the empirical analysis will be possible to consider in future research. The implications for future research and opportunities to more work on the stated topic by adding some essential factors to get more insights about the stated relationships, as earlier studies used in different schematic fashions, such as online activities, financial crises (Liu et al., 2022), supply disruptions (Paul et al., 2021), and consequent impacts on the BMs, as well as lead to the adaptation and innovation of BMs by affecting digitalization.

Data availability Data will be available upon reasonable request from the corresponding author.

Declarations

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Conflict of interest The authors have no relevant financial or non-financial interests to disclose. Marinko Skare declares he has no conflict of interest. Xinxin Wang declares she has no conflict of interest. Zeshui Xu declares he has no conflict of interest. Anran Xiao declares she has no conflict of interest.

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