Tourism Management 87 (2021) 104393

Contents lists available at ScienceDirect

Tourism Management

journal homepage: www.elsevier.com/locate/tourman

The immediate and subsequent effects of public health interventions for COVID-19 on the leisure and recreation industry

Yan Fang [a], Lijun Zhu [b,*], Yiyi Jiang [a], Bihu Wu [c]

[a] School of Recreational Sports and Tourism, Beijing Sport University, Beijing, 100084, China
[b] Institute of New Structural Economics, Peking University, Beijing, 100871, China
[c] International Center for Recreation and Tourism Research, College of Urban and Environmental Sciences, Peking University, Beijing, 100871, China

ARTICLE INFO

Keywords:
Government response
Public health interventions
COVID-19
Crisis management
Leisure and recreation activities

ABSTRACT

Public health interventions to combat COVID-19 can be viewed as an exogenous shock to the economy, especially for industries—such as leisure, recreation, and tourism—that rely heavily on human mobility. This study investigates whether and how exactly the economic impact of government public health policies varies over time. Focusing on the leisure and recreation industry, we use data for 131 countries/regions from February to May 2020 and employ generalized difference-in-differences models to investigate the short- and longer-term effects of public health policies. We find that stricter policies lead, on average, to an immediate 9.2–percentage-point drop in leisure and recreation participation. Even so, that industry recovers in about seven weeks after a COVID-19 outbreak in countries/regions that undertake active interventions. After thirteen weeks, leisure and recreation involvement recovers to 70% of pre-pandemic levels in a place that actively intervened but stagnates at about 40% in one that did not.

1. Introduction

The spread of the novel coronavirus disease 2019 (COVID-19) has become a global pandemic—affecting more than 200 countries in a matter of months since the first confirmed case was reported in Wuhan, China, in mid-December 2019. According to the World Health Organization (WHO), this pandemic had resulted in some 180 million confirmed cases and more than 3 million deaths globally by the end of June 2021 (WHO, 2021). The pandemic has also triggered a massive spike in uncertainty, sparking fears of an economic crisis and recession (Nicola et al., 2020). According to World Bank's Global Economic Prospects Report (2021), the global economy is estimated to have shrunk 4.3% in 2020. While almost all sectors have been affected, the tourism and leisure industry lies among the hardest-hit and most damaged global industries (Abbas et al., 2021). A report of the pandemic impacts on tourism launched by World Tourism Organization indicates that export revenues from tourism could fall by $910 billion to $1.2 trillion in 2020, which will have a wider impact and could reduce global GDP by 1.5%–2.8% (UNWTO, 2020).

To minimize the spread of this virus, governments all around the world have implemented a wide range of public health measures: travel restrictions, domestic lockdowns, public testing, and bans on mass gatherings. Mobility and travel restrictions can effectively mitigate the pandemic (Chinazzi et al., 2020), but such measures can have adverse effects on the economy (Bonaccorsi et al., 2020) and especially on the leisure, recreation, and tourism industry—given its reliance on human mobility (Bakar & Rosbi, 2020; Yang, Zhang, & Chen, 2020). Fig. 1 plots changes in visits to leisure and recreation locales in nine countries from different continents during the 3–4 months following the first domestic COVID-19 case (Google, 2020).[1] It is clear that the leisure and recreation industry has been severely affected worldwide during the pandemic, and a severe decline in the leisure and recreation industry has occurred in each country following adoption of public health measures.

Although there is a consensus on the importance of credible measures from government to generate market confidence and reduce the risk from this virus for the tourism industry (Assaf & Scuderi, 2020), little is known on the actual effect of the policies adopted (Weible et al., 2020). The combination of the decline in Fig. 1 and an impending economic recession suggests that, although the government plays an essential role in crises and crisis management, its actions might sometimes not be economically beneficial (Hur, 2019; Rosenthal & Kouzmin, 1997). Thus we are led to ask: When there is a serious global health

* Corresponding author.
E-mail addresses: yanfang113@126.com (Y. Fang), lijunzhu@nsd.pku.edu.cn (L. Zhu), yiyijiangpku@126.com (Y. Jiang), tigerwu@urban.pku.edu.cn (B. Wu).

[1] The data are downloaded from the Google mobility trend database; see detailed information in Section 2.2.

https://doi.org/10.1016/j.tourman.2021.104393
Received 8 August 2020; Received in revised form 2 July 2021; Accepted 10 July 2021
Available online 13 July 2021
0261-5177/

emergency like COVID-19, is it possible to maintain public health and economic growth at the same time? In other words: Are public health interventions an obstacle to economic performance?

It is critical to generate systematic evidence that would support effective policy decisions under the grim situation arising from pandemic of COVID-19—and in similar, future global emergencies. Hence we must carefully evaluate the economic impact of public health measures during this pandemic. Our study offers such an assessment, from a global perspective, for the leisure and recreation industry. We collected data on leisure and recreation activities and public health policies for more than 130 countries/regions and examined how participation in leisure and recreation activities has responded to government policies; for that purpose, we use a generalized difference-in-differences (DID) framework with dynamic treatment effects. That framework allows us to investigate the impact of public health interventions over time and, more specifically, the difference between immediate and subsequent effects. To the best of our knowledge, this paper is the first to estimate the full impact of public health interventions for COVID-19 at different time intervals.

2. Literature review

Over the past year, a large body of literature on COVID-19 and the leisure, recreation and tourism industry has emerged, mainly focusing on assessing the impact of the COVID-19 pandemic on this industry (e.g. Gossling et al., 2020; Yang et al., 2020), and discussing its recovery (e.g. Fotiadis et al., 2021; Sigala, 2020; Zhang et al., 2021). As one of the hardest-hit industries, many different sectors of leisure, recreation and tourism industry have been negatively impacted by the pandemic (Dolnicar & Zare, 2020; Gossling et al., 2020; Hall et al., 2020). The COVID-19 crisis is different in many ways from past ones (Kreiner & Ram, 2021). Yang et al. (2020) employed a 'dynamic stochastic general equilibrium' (DSGE) model for better understanding the impact of the pandemic on global tourism in this scenario.

Various efforts have made by governments to support the tourism industry, and there exists substantial inter-country heterogeneity in terms of policy responses as countries have been impacted differently by the pandemic, and have different political system and culture, and tourism networks (Foo et al., 2020; Kreiner & Ram, 2021). The paces of tourism recovery across countries will obviously also be uneven, but for most countries the tourism restart will occur domestically (Hall et al., 2020). Some scholars have employed methods, such as the autoregressive distributed lag-error correction model, long short-term memory neural network and the generalized additive model, to forecast the possible recovery paths of the tourism industry (Fotiadis et al., 2021; Zhang et al., 2021).

Although government stimulus packages provide some relief for firms that are severely affected (Foo et al., 2020), the capacity for recovery of the tourism system is fundamentally affected by the imposition of nonpharmaceutical interventions (e.g. quarantine, border control) because of the extent to which they restrict mobility (Ryu et al., 2020). This argument indicates that public health interventions might delay the recovery of the tourism industry, a view also shared by Hall et al. (2020) and Gossling et al. (2020). However, a beneficial effect of stringent containment and closure policies has been found for travel and leisure companies that survive in the pandemic (Kaczmarek et al., 2021). This situation inspired a vigorous debate on the appropriate policy responses and on the resultant economic effects of public health policies (Lilley et al., 2020), but policymakers have had limited evidence to inform their decisions. Therefore, we contribute to the literature by examining the real effects of public health interventions on the leisure, recreation and tourism industry from the perspective of different time intervals—in particular we investigate whether and how exactly the economic impact of these measures varies over time.

3. Empirical model and data

3.1. DID model

After a domestic COVID-19 outbreak, there is considerable inter-country heterogeneity in public health interventions; these policies affect the dynamic evolution of economic activities, including the leisure and recreation industry. Among methods that are commonly employed to investigate the economic impact of policies—such as regression discontinuity designs, DID, propensity score matching (PSM), PSM–DID, and quasi-experimental methods (Crown, 2014; Lee & Lemieux, 2010)—

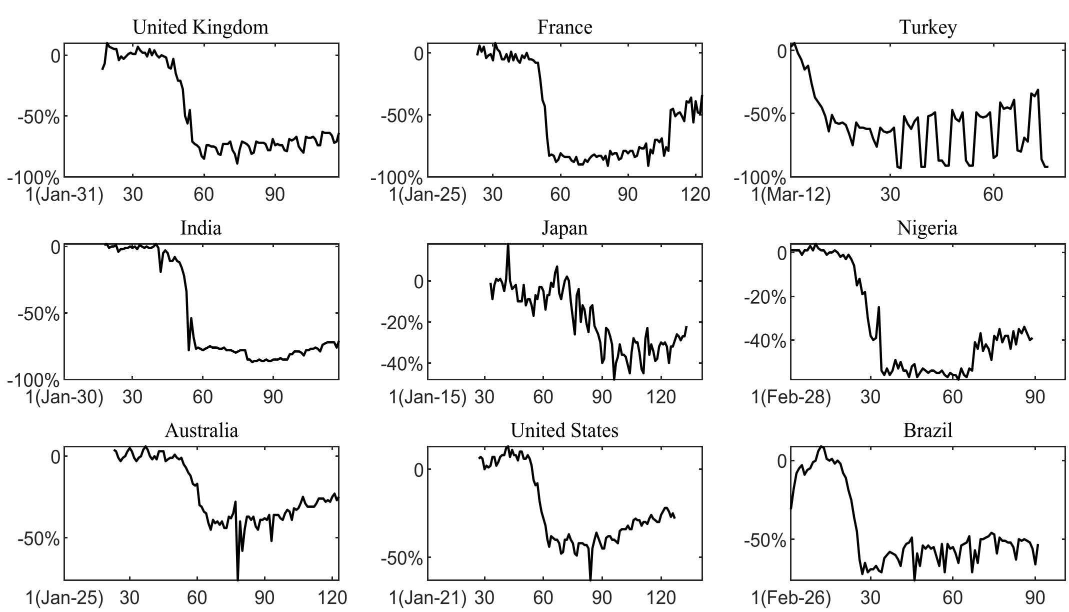

Fig. 1. Changes in the number of participations in leisure and recreation activities (horizontal axis marks the number of days after each country's first reported COVID-19 case).

we adopted DID because it can neutralize the selection bias that is naturally characteristic of governments' public health interventions during the pandemic.[2] The DID approach is an attractive choice for estimating causal effects when using research designs based on controlling for confounding variables or using instrumental variables is deemed unsuitable, and at the same time, pre-treatment information is available (Lechner, 2010). It is therefore one of the most popular tools for applied research in economics to evaluate the effects of public interventions and other treatments of interest on some relevant outcome variables (Abadie, 2005). The method has been widely used in general policy evaluation (e.g. Card & Krueger, 1994; Yeon et al., 2020) as well as studies on the tourism industry during COVID-19 (e.g. Brodeur et al., 2021; Polemis, 2020). In this paper, we use a generalized DID model in which (a) the treatment is a continuous index that measures the stringency of public health policies in each country and (b) the treatment effect lasts for multiple periods.[3] Our main regression model is as follows:

$$\Delta Leisr_{i,t} = \alpha + \sum_{k=-2}^{-1}\beta_k(Week_{i,t}^k) + \sum_{k=-2}^{-1}\gamma_k(Week_{i,t}^k \times PubH_i) + \sum_{k=2}^{13}\beta_k(Week_{i,t}^k) + \sum_{k=2}^{13}\gamma_k(Week_{i,t}^k \times PubH_i) + \varphi(PubH_i) + \text{Cases}_{i,t-1} + \sum_{d=2}^{7}\sigma_d + \text{Controls}_i + \varepsilon_{i,t} \tag{1}$$

here $\Delta Leisr_{i,t}$ denotes the change in leisure and recreation participation on date t as compared with the same weekdays from a pre-pandemic benchmark period, the five weeks from 3 January to February 6, 2020, in country/region i. For $k \geq 1$, $Week_{i,t}^k$ is a dummy set to 1 for days in the k th week after the first reported COVID-19 case in country/region i (and set to 0 otherwise).[4] The term $Week_{i,t}^k$ similarly denotes, for $k < 0$, week dummies before a COVID-19 outbreak; these indicators are included to test for parallel trends in the pre-treatment periods. The first week following a pandemic outbreak is the benchmark period, so that dummy is dropped from the regression.

The term $PubH_i$ is an index that measures governments' public health interventions; it reflects an average of ten sub-indices.[5] The interaction terms between policy and different week dummies are intended to capture the presumably heterogeneous effect of public health interventions during different time intervals. We incorporate a constant term (α), and β, γ, and φ are all regression coefficients; $\varepsilon_{i,t}$ is the random term. Cumulative confirmed COVID-19 cases prior to date $t-1$ ($\text{Cases}_{i,t-1}$) are also included in the regressions along with six day-of-week indicators (σ_d), excluding Monday. Control variables (Controls_i) contain various factors related to leisure and recreation involvement during the pandemic, including per-capita GDP (Houston & Wilson, 2002; Sumner et al., 2020; Thompson & Tinsley, 1978), average monthly temperature (Qi et al., 2020; Richardson & Loomis, 2005), the share of the population aged 65 and over (Abdulamir & Hafidh, 2020; Kruger et al., 2005), and the urbanization rate (Desmet & Wacziarg, 2021; Hauser, 1962).

To examine whether the empirical results are robust to model choices, we use a combination of a linear and a quadratic term for the date in order to capture both the change in leisure and recreation involvement and the dynamic effect of governmental public health interventions. This second regression model is written as

$$\Delta Leisr_{i,t} = \tilde{\alpha} + \tilde{\beta}_1(Date_{i,t}) + \tilde{\beta}_2\left(Date_{i,t}^2\right) + \tilde{\gamma}_1(PubH_i \times Date_{i,t}) + \tilde{\gamma}_2\left(PubH_i \times Date_{i,t}^2\right) + \tilde{\varphi}(PubH_i) + \text{Cases}_{i,t-1} + \sum_{d=2}^{7}\sigma_d + \text{Controls}_i + \varepsilon_{i,t} \tag{2}$$

where $Date_{i,t}$ represents the number of days after the first reported case in country/region i and where the other variables are defined as before. The term $\tilde{\alpha}$ is a constant term, and $\tilde{\beta}$, $\tilde{\gamma}$, and $\tilde{\varphi}$ are all regression coefficients. We again include interaction terms—between our policy index and the linear and quadratic date terms—to assess the effects of public policy intervention on the trend of participating in leisure and recreation activities.

3.2. Data sources

The data on trends in mobility—visits to recreation and retail destinations such as cafés, shopping centers, theme parks, museums, libraries, and movie theaters—are from Google's (2020) mobility trend database. Retailing places like shopping malls typically share a building with leisure places like movie theaters. Besides, the dataset covers partially both domestic and international tourism activities as leisure and recreation places defined in the google mobility data overlaps substantially with tourist spots; e.g. theme parks and museums included in the measurement are typically also tourist destinations. The period covered is from 16 February to May 26, 2020. The metric is the percentage change of leisure and recreation participation in the sample period compared to that in a pre-pandemic period, from 3 January to February 6, 2020, within the same country, which facilitates inter-country comparisons. The Google mobility trend database includes relatively complete and comparable data that are available for a large number of countries and regions. We therefore use these data to represent the change in leisure and recreation activities. Statistics on per-capita GDP, urbanization rate, and the percentage of population aged 65+ are from the World Bank Open Data website (https://data.worldbank.org), and the average monthly temperature for each country/region is obtained from Climate Data Online (NOAA, 2020).

Total confirmed COVID-19 cases from December 31, 2019 to 1 June 2020—as well as governments' responses to COVID-19—are included in the Response2covid19 data set assembled by Porcher (2020), which is widely used for assessing governmental reactions to COVID-19 (e.g., Nagpal et al., 2020; Uddin, Imam, Moni, & Thow, 2020). This dataset classifies public health interventions into ten categories: bans on mass gatherings (our *Mass* variable), bans on sports and recreation events (*Sport*), restaurant and bar closures (*Rest*), domestic lockdowns (*Domestic*), travel restrictions (*Travel*), declarations of states of emergency (*State*), public testing (*Testing*), enhanced surveillance (*Surveillance*), school closures (*School*), and postponement of elections (*Elect*). For a given date, each policy variable for a country takes the value 1 if the country has strictly implemented that policy at the national level, the value 0.5 if the implementation is partial or localized, or the value 0 if the focal policy is not implemented. It should be pointed out that the dataset does not integrate whether the measures are correctly implemented, and the level of the indices should not be interpreted as proxies for good or bad governance (Porcher, 2020).

Table 1 summarizes the proportion of countries/regions that adopt each of the ten interventions at different times after observing the first domestic case. By 30 days after the initial outbreak, 79.2% of the 131

[2] Selection bias in our context refers to the fact that government policies are endogenous–countries that have adopted stricter public health interventions might systematically different from those that have not.

[3] That is, the effect of public health interventions on the leisure and recreation industry lasts for more than one period, which is one week after its implementation in our analysis.

[4] Because there are only 27 countries/regions with observations in the fourteenth week after the first case, we restrict our attention to the initial thirteen weeks.

[5] Details of these ten public health measures are given in Section 3.2.

Table 1
Summary of governments' public health policies.

Variables	Days after first case						
	1	15	30	45	60	75	90
Elect	8.3%	42.9%	63.8%	69.7%	94.4%	90.9%	87.5%
	(36)	(35)	(36)	(33)	(18)	(11)	(8)
School	15.7%	66.7%	79.2%	72.0%	53.1%	95.7%	55.6%
Mass	15.0%	53.7%	68.8%	76.8%	90.0%	100.0%	100.0%
Sport	16.5%	57.7%	72.0%	78.8%	90.0%	100.0%	100.0%
Rest	7.9%	36.6%	50.4%	54.5%	56.0%	62.5%	57.9%
Domestic	7.9%	42.3%	62.4%	64.6%	68.0%	70.8%	68.4%
Travel	19.7%	61.8%	79.2%	83.8%	96.0%	100.0%	100.0%
State	5.5%	26.0%	38.4%	47.5%	42.0%	50.0%	36.8%
Testing	22.8%	18.7%	26.4%	31.3%	34.0%	45.8%	47.4%
Surveillance	0.0%	0.8%	5.6%	10.0%	14.0%	16.7%	21.1%
Observations	(127)	(123)	(125)	(99)	(50)	(24)	(19)

Notes: Reported values are the percentage of countries that adopt each of ten policies on the *n*th day after the first reported case. In the second row, numbers in parentheses are total observations for the *Elect* variable; the last row gives the total number of observations for all other variables.
Data Source: Porcher (2020).

countries/regions in our sample[6] have implemented travel restrictions and 68.8% (resp., 62.4%) have implemented bans on mass gatherings (resp., domestic lockdowns). A majority of countries/regions have also closed schools and restaurants, prohibited sports events, and postponed elections. Declaring a state of emergency, large-scale testing, and surveillance are used relatively less often across countries. The $PubH_i$ index we use in regressions, which is the average of these ten public health measures, is 0.37 at the 30-day mark following the first confirmed case in country/region *i*.[7] That is, a typical country has implemented 3.7 out of 10 public health measures within the first month of its first reported COVID-19 case.

4. Results

4.1. Change in leisure and recreation involvement following public health interventions

Public health policies have immediate negative consequences for the leisure and recreation industry. Table 2 shows the changes in leisure and recreation activities around the dates when three selected measures are put into place. Compared with the pre-pandemic benchmark, participation in leisure and recreation activities declined on average by 37.2 percentage points (p.p.) one day after domestic lockdowns were implemented—that is, by a much greater amount than the 23.6-p.p. Decrease one day before policy implementation.[8] This average decline becomes even more pronounced, at 57.1%, one month after the announcement of domestic lockdowns. This result is consistent with the previous finding that global tourism has slowed down significantly as a result of travel restrictions and lockdowns (Gossling et al., 2020). After 60 days, however, the leisure and recreation industry show signs of recovery: the relative changes average −43.0%, or nearly 14 p. p. Higher than those 30 days after policy implementation. These raw comparisons document the existence of a decline-then-recovery pattern in leisure and recreation activities following implementation of domestic lockdowns. A similar trend is observed for travel restrictions and bans on mass gatherings. Next, we verify these dynamic changes in a formal regression setting.

Table 2
Change in leisure and recreation involvement after public health interventions.

	Days around policy implementation				Obs.
	−1 day	+1 day	+30 days	+60 days	
Domestic lockdowns	−23.6%	−37.2%	−57.1%	−43.0%	94
Travel restrictions	−15.0%	−26.2%	−55.9%	−41.5%	119
Bans on mass gatherings	−12.2%	−22.0%	−57.5%	−41.2%	110

4.2. Impact of public health interventions on participation in leisure and recreation activities

Table 3 reports the coefficients, from our baseline regression model, which are related to the effects of public health policies on participation in leisure and recreation activities. In model (1), γ_{-1} (resp., γ_{-2}) is the coefficient for the interaction term between the policy index and the dummy variable for one week (resp., two weeks) before a COVID-19 outbreak. Both of these coefficients are statistically insignificant,

Table 3
Regression coefficients from model (1).

Param.	Value	S.D.	Param.	Value	S.D.
			φ	−24.78***	6.03
β_{-2}	2.38	7.24	γ_{-2}	20.13	17.83
β_{-1}	2.17	5.16	γ_{-1}	17.37	13.45
β_2	−4.24	3.73	γ_2	−24.86***	8.16
β_3	−11.83***	3.42	γ_3	−38.77***	7.60
β_4	−21.38***	3.20	γ_4	−37.15***	7.21
β_5	−27.25***	3.18	γ_5	−29.81***	7.18
β_6	−30.70***	3.20	γ_6	−20.45***	7.20
β_7	−41.49***	3.20	γ_7	6.36	7.21
β_8	−51.94***	3.19	γ_8	36.91***	7.17
β_9	−58.52***	3.19	γ_9	58.77***	7.21
β_{10}	−58.01***	3.25	γ_{10}	63.61***	7.34
β_{11}	−60.86***	3.31	γ_{11}	78.06***	7.53
β_{12}	−57.33***	3.38	γ_{12}	81.84***	8.05
β_{13}	−58.26***	3.47	γ_{13}	107.11***	9.81

Notes: β_k is the coefficient for our indicator variable for the k th week after a COVID outbreak if $k > 0$ (or for the k th week before a COVID outbreak if $k < 0$). The coefficient γ_k is for the interaction term between the k th week dummy and the public health policy index ($PubH_i$). Param. = parameter; S.D. = standard deviation.
***indicates significance at the 1% level.

[6] The panel data covers 130 countries and 1 region (Hong Kong), which is the full sample that Google's mobility trend database contains.
[7] We choose 30 days as it provides observations that are long enough without sacrificing the sample size. We have also tried to construct the policy index over different durations and found results that are qualitatively similar to what is presented in the text.
[8] These numbers (−37.2% and −23.6%) are the percentage changes in leisure and recreation activities relative to the benchmark period: 3 January to 6 February.

suggesting that there are no pre-treatment differences in the trend of leisure and recreation activities for countries that would have intervened differently in response to the pandemic's outbreak.

Recall that our dummy for the first week is used as the benchmark and so is omitted from these regressions. The coefficients $\beta_2, \ldots, \beta_{13}$ are for the dummies for weeks following the coronavirus outbreak. Most values of β are negative and become more so over time. The impact of public health interventions is captured by the values of φ and γ. The $\gamma_2, \ldots, \gamma_6$ are negative, γ_7 is insignificant, and $\gamma_8, \ldots, \gamma_{13}$ are positive, which suggests that the effects of public health policies on the leisure and recreation industry are heterogeneous over different time intervals. To illustrate this impact—and the difference between short and longer terms—in Fig. 2 we use the estimated coefficients given in Table 3 to plot the change of leisure and recreation involvement in two types of countries/regions: in the first type, there is no public health intervention (i.e., $PubH_i$ index = 0); in the second, public health policies are implemented to the average extent (i.e., $PubH_i$ index = 0.37).

As compared with a destination that undertakes no policy responses, those in which public health measures are actively implemented see an immediate 9.2-p.p. Drop in leisure and recreation activities during the first week. After a month, the relative decline in the leisure and recreation industry is 21.4 p. p. In the case with no response but a far greater 44.3 p. p. In the case of interventions. During the second month, leisure and recreation activities continue to decline in the former case yet gradually stabilize in the latter. By the eighth week, the leisure and recreation industry in countries with public health interventions performs slightly better than in those without any such policy. From the eighth to the thirteenth week, the participation in leisure and recreation activities remains relatively stable in the no-policy case but begins a recovery in countries that have actively intervened. In the thirteenth week, leisure and recreation involvement returns to 70% of its pre-pandemic level in a country/region that actively intervened but is stuck at 40% in one that did not. While the negative short-run effect confirms results in the literature, the positive longer-term effects of public health interventions might be due to the following reasons. It is well documented that active public health interventions are a useful tool in mitigating and controlling the pandemic (e.g. Chinazzi et al., 2020), which brings less panic concerning the pandemic and, therefore, more certainty about the financial stability, corporate liquidity and solvency (IMF, 2020). Besides, strong government public health policies and quick policy responses could help travel and leisure companies and consumers to cope with a pandemic (Kaczmarek et al., 2021). In particular, they learn how to conduct business in a relatively safe way—e.g. sitting 1 m apart in restaurants or bars (Sigala, 2020). Together, these contribute to a faster recovery of the tourism industry over the medium run.

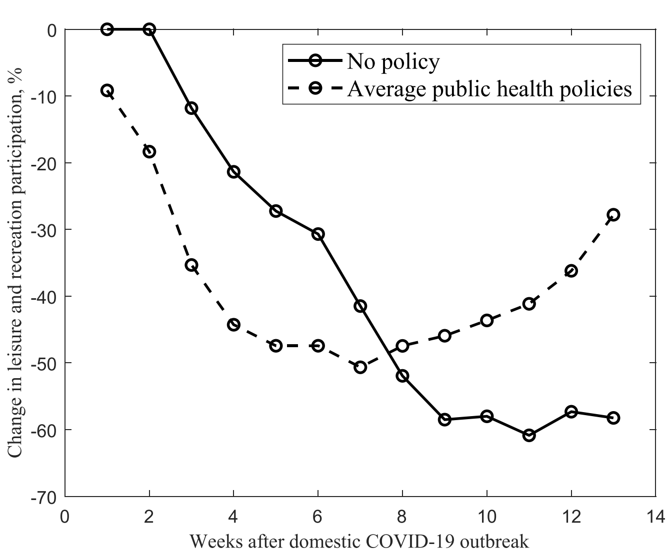

Fig. 2. Public health policies and change in leisure and recreation participation.

To address problems that could arise from missing variables—which might affect public health intervention and leisure and recreation activities but are not among our controls—we added country/region fixed effects to the baseline regression and accordingly dropped all variables that do not change over time. The results are similar, both qualitatively and quantitatively, to those reported in Table 3.[9]

4.3. Robustness check for the impact of public health interventions on participation in leisure and recreation activities

Regression model (2) amounts to a robustness check in which we use a combination of a linear and quadratic date terms—rather than week dummies—to capture the decline-then-recovery pattern of participation in leisure and recreation activities. The results are presented in Table 4. In column [1], the coefficient for $Date_{i,t}$ is negative and that for its squared term is positive, confirming the observed decline-then-recovery pattern. Public health measures are added as independent variables in column [2]; and in column [3] we control for country fixed effects. The impact of policies on the trend of leisure and recreation activities is captured by the coefficients for the policy index $PubH_i$ and for the two interaction terms between the policy index and first & second order term of date.

This table shows that the coefficient for $PubH_i \times Date_{i,t}$ is significantly negative while that for $PubH_i \times Date_{i,t}^2$ is significantly positive. Using these values yields the following estimate: with average public health intervention, it takes 50 days for leisure and recreation activities to recover; this duration is practically identical to the baseline results (7 weeks = 49 days) reported in Table 3.

5. Conclusion and discussion

This paper presents an empirical analysis of how public health interventions for COVID-19 affect leisure and recreation activities. Employing a DID modelling framework, we collect data for more than 130 countries/regions, and find that the longer-term effects of public

Table 4
Regression results from model (2).

	[1]	[2]	[3]
$Date_{i,t}$	−1.31***	−1.47***	−1.60***
	(0.02)	(0.07)	(0.06)
$Date_{i,t}^2$	0.01***	0.007***	0.007***
	(0.000)	(0.001)	(0.001)
$PubH_i$		−70.47***	
		(4.83)	
$PubH_i \times Date_{i,t}$		−0.95***	−0.62***
		(0.22)	(0.14)
$PubH_i \times Date_{i,t}^2$		0.033***	0.031***
		(0.002)	(0.002)
Cases	Yes	Yes	Yes
Controls	No	Yes	No
Country FE	No	No	Yes
Day-of-week FE	Yes	Yes	Yes
R^2	0.13	0.33	0.43
Observations	9859	7969	9384

Notes: The dependent variable is $\Delta Leisr_{i,t}$, change in leisure and recreation activities. FE = fixed effects.
***indicates significance at the 1% level.

[9] In particular, $\gamma_2, \ldots, \gamma_6$ are negative, γ_7 is insignificant, and $\gamma_8, \ldots, \gamma_{13}$ become positive and increase over time.

health policies differ substantially from their immediate impact. In particular, stringent public health interventions have an immediate negative effect on participation in leisure and recreation activities, which declines 9.2 additional percentage points upon policy implementation and remains still at a lower level after six weeks; those interventions, however, help the leisure and recreation industry to surpass its recovery—when compared with the case of no interventions—in about seventh weeks after a COVID-19 outbreak. After thirteenth weeks, leisure and recreation activities are already at 70% of their pre-pandemic level in countries/regions that intervened actively; however, they stagnate at about 40% in those that did not.

Our study provides empirical support for the views held by some public health experts during the coronavirus pandemic. As Dr. Anthony Fauci—director of the US National Institute of Allergy and Infectious Disease—stated: "We should be looking at public health measures as a vehicle, or a gateway, to opening the country, not as the obstacle in the way" (Johnson, 2020). In light of the demonstrated sharply differing effects of government public health interventions over different time intervals, leaders worldwide should remain cognizant, when designing public health interventions (and determining how long they should last), of the trade-off between short-term economic losses and longer-term benefits. Besides, the containment and closure policies typically bear substantial social and economic costs, governments should also carefully balance the undertaken actions' costs and benefits (Kaczmarek et al., 2021).

It is also important to note that, although public health interventions play a leading role in the recovery of the leisure, recreation and tourism industry, that recovery was not full in the sample period we studied. A practical implication of this finding is that more comprehensive measures, e.g. a combination of public health interventions and economic stimulus, should be adopted in this special period. For example, as argued by Yang et al. (2020), such a comprehensive approach should include simultaneous subsidies designed to encourage the consumption of tourism, hospitality, and leisure as well as subsidies to the health sector to facilitate post-pandemic recovery. The world has experienced a number of major epidemics/pandemics in the last 40 years, yet none had similar implications for the global economy as the COVID-19 pandemic (Gossling et al., 2020). Therefore, whether government responses to previous pandemic, like economic policies, are still effective under strict public health interventions should be examined in the context of COVID-19. Furthermore, leisure, recreation and tourism are closely connected to other parts of the economy through input-output linkages, and the recovery of the sector depends critically on other sections of the economy given the high interdependence. Therefore, policy coordination across industries is of particular importance for successful recovery of the leisure, recreation and tourism industry.

From a long run perspective, the pandemic and the induced public health interventions should be considered as a transformative opportunity for the tourism industry–it should not only recover but also reimagine and reform the next normal and economic order (McKinsey & Company, 2020; Sigala, 2020). COVID-19 presents a once in a generation opportunity for such a transformation (Brouder, 2020). During the COVID-19, new health protocols have been applied for safe recreation and travel, which restores confidence and stimulates demand with new safe and clean labels for the industry (OCED, 2020). In the recovery and post-pandemic periods, leisure, recreation and tourism should be further directed towards a truly sustainable and resilient profile that is fit for a future with constant changes and full of new challenges (Romagosa, 2020).

In any pandemic, intervening at the initial stage is crucial for affecting how it evolves. We remark that policies tend to converge as governments gradually learn which of them are most effective. From the standpoint of identification, variation in government interventions during the pandemic's initial stage is much greater than at later stages (as can been seen from Table 1). Hence we studied the impact of government policies adopted immediately after a COVID-19 outbreak and focused on the four-month period from February to May 2020. Thus, one limitation of our research is its relatively short-term assessment. Investigation for a longer period of time—with attention given to second or even third waves of outbreaks, as occurred in many parts of the world—would therefore be a valuable extension of this study. Moreover, changes in leisure and recreation involvement cannot be fully captured by the numbers of visitors to retail and recreation establishments; the current non-availability of sufficient data precludes the quantification of this bias, which is therefore a promising avenue for future research.

Impact statement

Pandemic has been one of critical research topics in social science, and it is currently a hot issue in the midst of the coronavirus pandemic. Given the health and economic tradeoffs for public interventions in the COVID-19 pandemic, we investigate the economic impact of public health interventions on leisure and entertainment industry at different time intervals. A noteworthy contribution comes from difference between immediate and subsequent effects of public health interventions on leisure and recreation industry. We found that public health policies have a large positive effect on this industry in its later recovery phase, though it imposes a negative impact in the early declining phase, highlighting the essential role of public health actions on both epidemic control and economic recovery under serious global health issues. This finding provides a new look at the economic impact of public health measures and significant implications for leisure and recreation operators and policymakers in crisis management.

Credit author statement

Yan Fang: Conceptualization, Writing - Original Draft. **Lijun Zhu:** Methodology, Data Curation, Supervision. **Yiyi Jiang:** Writing - Review & Editing. **Bihu Wu:** Writing - Review & Editing.

Declaration of competing interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, or publication of this article.

Acknowledgements

The financial support for this study was provided by the National Natural Science Foundation of China [grant number 42001255] and China Postdoctoral Science Foundation [grant number 2020M680448].

References

Abadie, A. (2005). Semiparametric difference-in-differences estimators. *The Review of Economic Studies, 72*(1), 1–19. https://doi.org/10.1111/0034-6527.00321

Abbas, J., Mubeen, R., Iorember, P. T., Raza, S., & Mamirkulova, G. (2021). Exploring the impact of COVID-19 on tourism: Transformational potential and implications for a sustainable recovery of the travel and leisure industry. *Current Research in Behavioral Sciences, 2*, 100033. https://doi.org/10.1016/j.crbeha.2021.100033

Abdulamir, A. S., & Hafidh, R. R. (2020). The possible immunological pathways for the variable immunopathogenesis of COVID—19 infections among healthy adults, elderly and children. *Electronic Journal of General Medicine, 17*(4), Article em202. https://doi.org/10.29333/ejgm/7850

Assaf, A., & Scuderi, R. (2020). COVID-19 and the recovery of the tourism industry. *Tourism Economics, 26*(5), 731–733. https://doi.org/10.1177/1354816620933712

Bakar, N. A., & Rosbi, S. (2020). Effect of Coronavirus disease (COVID-19) to tourism industry. *International Journal of Advanced Engineering Research and Science, 7*(4), 189–193. https://doi.org/10.22161/ijaers.74.23

Bonaccorsi, G., Pierri, F., Cinelli, M., Flori, A., Galeazzi, A., Porcelli, F., & Pammolli, F. (2020). Economic and social consequences of human mobility restrictions under COVID-19. *Proceedings of the National Academy of Sciences, 117*(27), 15530–15535. https://doi.org/10.1073/pnas.2007658117

Brodeur, A., Clark, A. E., Fleche, S., & Powdthavee, N. (2021). COVID-19, lockdowns and well-being: Evidence from google trends. *Journal of Public Economics, 193*, 104346. https://doi.org/10.1016/j.jpubeco.2020.104346

Brouder, P. (2020). Reset redux: Possible evolutionary pathways towards the transformation of tourism in a COVID-19 world. *Tourism Geographies, 22*(3), 484–490. https://doi.org/10.1080/14616688.2020.1760928

Card, D., & Krueger, A. B. (1994). Minimum wages and employment: A case study of the fast-food industry in New Jersey and Pennsylvannia. *The American Economic Review, 84*, 772–793. https://doi.org/10.3386/w4509

Chinazzi, M., Davis, J. T., Ajelli, M., Gioannini, C., Litvinova, M., Merler, S., & Viboud, C. (2020). The effect of travel restrictions on the spread of the 2019 novel coronavirus (COVID-19) outbreak. *Science, 368*(6489), 395–400. https://doi.org/10.1126/science.aba9757

Crown, W. H. (2014). Propensity-score matching in economic analyses: Comparison with regression models, instrumental variables, residual inclusion, differences-in-differences, and decomposition methods. *Applied Health Economics and Health Policy, 12*(1), 7–18. https://doi.org/10.1007/s40258-013-0075-4

Desmet, K., & Wacziarg, R. (2021). JUE Insight: Understanding spatial variation in COVID-19 across the United States. *Journal of Urban Economics, 103332*. https://doi.org/10.1016/j.jue.2021.103332

Dolnicar, S., & Zare, S. (2020). COVID19 and airbnb: Disrupting the disruptor. *Annals of Tourism Research, 83*, 102961. https://doi.org/10.1016/j.annals.2020.102961

Foo, L. P., Chin, M. Y., Tan, K. L., & Phuah, K. T. (2020). The impact of COVID-19 on tourism industry in Malaysia. *Current Issues in Tourism*, 1–5. https://doi.org/10.1080/13683500.2020.1777951

Fotiadis, A., Polyzos, S., & Huan, T. C. T. (2021). The good, the bad and the ugly on COVID-19 tourism recovery. *Annals of Tourism Research, 87*, 103117. https://doi.org/10.1016/j.annals.2020.103117

Google. (2020). Google COVID-19 community mobility reports. Retrieved from https://www.google.com/covid19/mobility.

Gossling, S., Scott, D., & Hall, C. M. (2020). Pandemics, tourism, and global change: A rapid assessment of covid-19. *Journal of Sustainable Tourism, 29*(1), 1–20. https://doi.org/10.1080/09669582.2020.1758708

Hall, C. M., Scott, D., & Gossling, S. (2020). Pandemics, transformations, and tourism: Be careful what you wish for. *Tourism Geographies, 22*(3), 577–598. https://doi.org/10.1080/14616688.2020.1759

Hauser, P. M. (1962). Demographic and ecological changes as factors in outdoor recreation. In *Outdoor recreation resources Review commission study report* (Vol. 22, pp. 27–59). Washington D.C.: Government Printing Office.

Houston, R. G., & Wilson, D. P. (2002). Income, leisure and proficiency: An economic study of football performance. *Applied Economics Letters, 9*(14), 939–943. https://doi.org/10.1080/13504850210140150

Hur, H. (2019). Government expenditure on labour market policies in OECD countries: Responding to the economic crisis. *Policy Studies, 40*(6), 585–608. https://doi.org/10.1080/01442872.2018.1533113

IMF. (2020). Global financial stability report: Bridge to recovery. https://www.imf.org/en/Publications/GFSR/Issues/2020/10/13/global-financial-stability-report-october-2020#ExecSum.

Johnson, T. (2020). Mark zuckerberg. *Interview with anthony Fauci, criticizes trump administration's coronavirus response*. Yahoo Finance. Retrieved from https://uk.finance.yahoo.com/news/mark-zuckerberg-interview-anthony-fauci-225759943.html.

Kaczmarek, T., Perez, K., Demir, E., & Zaremba, A. (2021). How to survive a pandemic: The corporate resiliency of travel and leisure companies to the COVID-19 outbreak. *Tourism Management, 84*, 104281. https://doi.org/10.1016/j.tourman.2020.104281

Kreiner, N. C., & Ram, Y. (2020). National tourism strategies during the Covid-19 pandemic. *Annals of Tourism Research*. https://doi.org/10.1016/j.annals.2020.103076

Kruger, J., Ham, S. A., & Kohl, H. W., III (2005). Trends in leisure-time physical inactivity by age, sex, and race/ethnicity-United States, 1994-2004. *Morbidity and Mortality Weekly Report, 54*(39), 991–994. https://www.jstor.org/stable/23316683.

Lechner, M. (2010). *The estimation of causal effects by difference-in-difference methods*. Now publishers.

Lee, D. S., & Lemieux, T. (2010). Regression discontinuity designs in economics. *Journal Of Economic Literature, 48*(2), 281–355. https://doi.org/10.1257/jel.48.2.281

Lilley, A., Lilley, M., & Rinaldi, G. (2020). *Public health interventions and economic growth: Revisiting the Spanish flu evidence*. https://doi.org/10.2139/ssrn.3590008. https://ssrn.com/abstract=3590008. Available at: SSRN:.

McKinsey, & Company. (2020). Beyond coronavirus: The path to the next normal. Retrieved on 26 June 2021, from https://www.mckinsey.com/industries/healthcare-systems-and-services/our-insights/beyond-coronavirus-the-path-to-the-next-normal#.

Nagpal, R., He, Y., Goyal, N., Radia, H., & Kumanan, M. (2020). Comparison between India, USA and China on the basis of rigidity of public health measures with case count and mortality rate during COVID-19. *Current Journal of Applied Science and Technology*, 127–132. https://doi.org/10.9734/cjast/2020/v39i1530726

Nicola, M., Alsafi, Z., Sohrabi, C., Kerwan, A., Al-Jabir, A., Iosifidis, C., & Agha, R. (2020). The socio-economic implications of the coronavirus pandemic (COVID-19): A review. *International Journal of Surgery (London, England), 78*, 185. https://doi.org/10.1016/j.ijsu.2020.04.018

NOAA. (2020). Climate data online: Dataset discovery. Retrieved from https://www.ncdc.noaa.gov/cdo-web/datasets.

OCED. (2020). Tourism policy responses to the coronavirus (COVID-19). https://www.oecd.org/coronavirus/policy-responses/tourism-policy-responses-to-the-coronavirus-covid-19-6466aa20/.

Polemis, M. (2020). *The impact of COVID-19 on hotel performance: Evidence from a Difference-in-Differences approach*. MPRA Paper. https://mpra.ub.uni-muenchen.de/id/eprint/102053.

Porcher, S. (2020). Response2covid19, a dataset of governments' responses to COVID-19 all around the world. *Scientific Data, 7*(1), 1–9. https://doi.org/10.1038/s41597-020-00757-y

Qi, H., Xiao, S., Shi, R., Ward, M. P., Chen, Y., Tu, W., Su, Q., Wang, W., Wang, X., & Zhang, Z. (2020). COVID-19 transmission in mainland China is associated with temperature and humidity: A time-series analysis. *The Science of the Total Environment, 728*(1), 138778. https://doi.org/10.1016/j.scitotenv.2020.138778

Richardson, R. B., & Loomis, J. B. (2005). Climate change and recreation benefits in an alpine national park. *Journal of Leisure Research, 37*(3), 307–320. https://doi.org/10.1080/00222216.2005.11950055

Romagosa, F. (2020). The COVID-19 crisis: Opportunities for sustainable and proximity tourism. *Tourism Geographies, 22*(3), 690–694. https://doi.org/10.1080/14616688.2020.1763447

Rosenthal, U., & Kouzmin, A. (1997). Crises and crisis management: Toward comprehensive government decision making. *Journal of Public Administration Research and Theory, 7*(2), 277–304. https://doi.org/10.1093/oxfordjournals.jpart.a024349

Ryu, S., Gao, H., Wong, J. Y., Shiu, E. Y. C., Xiao, J., Fong, M. W., & Cowling, B. J. (2020). Nonpharmaceutical measures for pandemic influenza in nonhealthcare settings – international travel – related measures. *Emerging Infectious Diseases, 26*(5), 961–966. https://doi.org/10.3201/eid2605.190993

Sigala, M. (2020). Tourism and COVID-19: Impacts and implications for advancing and resetting industry and research. *Journal of Business Research, 117*, 312–321. https://doi.org/10.1016/j.jbus res.2020.06.015

Sumner, A., Hoy, C., & Ortiz-Juarez, E. (2020). *Estimates of the impact of COVID-19 on global poverty*. WIDER Working Paper. United Nations University. https://doi.org/10.35188/UNU-WIDER/2020/800-9.

Thompson, C. S., & Tinsley, A. W. (1978). Income expenditure elasticities for recreation: Their estimation and relation to demand for recreation. *Journal of Leisure Research, 10*(4), 265–270. https://doi.org/10.1080/00222216.1978.11969366

Uddin, S., Imam, T., Moni, M. A., & Thow, A. M. (2020). Onslaught of COVID-19: How did governments react and at what point of the crisis? *Population Health Management, 24*(1), 13–19. https://doi.org/10.1089/pop.2020.0138

Unwto. (2020). Tourism and covid-19 – unprecedented economic impacts. Retrieved on 20 June 2021, from https://www.unwto.org/tourism-and-covid-19-unprecedented-economic-impacts.

Weible, C. M., Nohrstedt, D., Cairney, P., Carter, D. P., Crow, D. A., Durnová, A. P., & Stone, D. (2020). COVID-19 and the policy sciences: Initial reactions and perspectives. *Policy Sciences, 53*(2), 225–241. https://doi.org/10.1007/s11077-020-09381-4

Who. (2021). WHO coronavirus disease (COVID-19) dashboard. Retrieved on 29 June 2021, from https://covid19.who.int/.

World Bank. (2021). *Global economic Prospects (january 2021)*. Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/34710.

Yang, Y., Zhang, H., & Chen, X. (2020). Coronavirus pandemic and tourism: Dynamic stochastic general equilibrium modeling of infectious disease outbreak. *Annals of Tourism Research, 83*. https://doi.org/10.1016/j.annals.2020.102913

Yeon, J., Song, H. J., & Lee, S. (2020). Impact of short-term rental regulation on hotel industry: A difference-in-differences approach. *Annals of Tourism Research, 83*, 102939. https://doi.org/10.1016/j.annals.2020.102939

Zhang, H., Song, H., Wen, L., & Liu, C. (2021). Forecasting tourism recovery amid COVID-19. *Annals of Tourism Research, 87*, 103149. https://doi.org/10.1016/j.annals.2021.103149

Dr. Yan Fang is a postdoc in the School of Recreational Sports and Tourism at Beijing Sport University, China. She received PhD in Tourism Planning from Peking University in Beijing, China. Her main research interests are sports tourism, leisure, recreation and health, and interactions between climate change and tourism.

Dr. Lijun Zhu is an Assistant Professor in the Institute of New Structural Economics at Peking University in Beijing, China. He received PhD in Economics from Washington University in St. Louis. His main research interests are macroeconomics, economic growth and development, and the Chinese economy.

Dr. Yiyi Jiang is a Professor and Associate Dean of the School of Recreational Sports and Tourism at Beijing Sport University, China. Her main research interests include sport industry, tourism market, and international tourism cooperation.

Dr. Bihu Wu is a Professor and Director of International Center for Recreation and Tourism Research at Peking University in Beijing, China. His main research interests include tourism planning, destination marketing and tourism education.