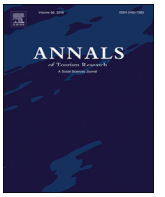
Annals of Tourism Research 109 (2024) 103830

Contents lists available at ScienceDirect

Annals of Tourism Research

journal homepage: https://www.journals.elsevier.com/annals-of-tourism-research



Full Length Article

Consumer spending during COVID-19 in a tourism city

Mengyao Ren [a], Yang Xu [a,b,*], Sangwon Park [c], Xiao Huang [d], Mengqi Sun [a], Jizhe Xia [e], Sun-Young Koh [f]

[a] Department of Land Surveying and Geo-Informatics, The Hong Kong Polytechnic University, Hong Kong, China
[b] Research Centre for Digital Transformation of Tourism (RCDTT), The Hong Kong Polytechnic University, Hong Kong, China
[c] College of Hotel and Tourism Management, Kyung Hee University, Republic of Korea
[d] Department of Environmental Sciences, Emory University, Atlanta, GA 30322, USA
[e] Shenzhen Key Laboratory of Spatial Smart Sensing and Service, Guangdong Key Laboratory of Urban Informatics, Ministry of Natural Resources (MNR) Key Laboratory for Geo-Environmental Monitoring of Great Bay Area, Shenzhen University, Shenzhen, 518000, China
[f] Jeju Research Institute, 253 Ayeon-ro, Juju-si, Jeju, 63147, Republic of Korea

ARTICLE INFO

Article history:
Received 25 October 2023
Received in revised form 8 August 2024
Accepted 21 August 2024
Available online xxxx

Handling Editor: Yang Yang

Keywords:
COVID-19
Behavior change
Pandemic
Social distancing
Consumer behavior
Big data

ABSTRACT

Leveraging large-scale transaction data, this study quantifies the impact of COVID-19 and policy responses on the spending behavior of both residents and domestic inbound travelers in Jeju, Korea. Findings reveal that both local and national COVID-19 situations significantly affected the spending behavior of both groups. Residents were more sensitive to local cases, while travelers were equally affected by local and national cases. Social distancing minimally impacted resident spending but caused over 20 % reductions in traveler spending. Stimulus payments boosted spending by over 10 % for residents without diminishing the effects of social distancing. Despite the overall benefit of these combined policies, certain economic sectors benefited notably while others suffered, thus leaving them with varying fates during and after the pandemic.

Introduction

In the 21st century, we have witnessed several major pandemics, such as SARS, MERS, Ebola, and most recently, the global COVID-19 pandemic, which has had a significant impact on the tourism industry (Wen, Huimin, & Kavanaugh, 2005; Cahyanto, Wiblishauser, Pennington-Gray, & Schroeder, 2016; Gössling, Scott, & Hall, 2020; Hall et al., 2020). Industries closely associated with tourism, such as the hotel, restaurant, and aviation industries, have all experienced unprecedented disruptions. Tourism-dependent cities have been particularly affected, facing declines in revenue and increased unemployment. Consequently, it is crucial for destination marketers to find ways to develop risk management strategies for mitigating economic losses while minimizing restrictions on tourist activity. A better understanding of the behavior patterns of both inbound travelers and local residents during a pandemic can provide valuable insights for enhancing the resilience of the tourism industry and effectively addressing similar potential threats in the future.

Numerous tourism studies have attempted to estimate the impact of COVID-19 on travel demand (Santos, Oliveira, & Aldrighi, 2021; Yang, Zhang, & Chen, 2020), risk perceptions (Rahman, Gazi, Bhuiyan, & Rahaman, 2021), flow patterns (Park, Kim, & Ho,

* Corresponding author at: Department of Land Surveying and Geo-Informatics, The Hong Kong Polytechnic University, Hong Kong, China.
E-mail addresses: mengyao.ren@connect.polyu.hk (M. Ren), yang.ls.xu@polyu.edu.hk (Y. Xu), sangwon.park@khu.ac.kr (S. Park), xiao.huang2@emory.edu (X. Huang), mengqi-lsgi.sun@connect.polyu.hk (M. Sun), xiajizhe@szu.edu.cn (J. Xia), sunyko@jri.re.kr (S.-Y. Koh).

https://doi.org/10.1016/j.annals.2024.103830

2022), and residents' attitudes toward tourism (Kamata, 2022). These relevant studies suggested the substantial effect of a pandemic as environment changes on travelers' planning and decision-making process. Most local and national governments executed a variety of policies in response to the COVID-19 pandemic to restrain travel behavior such as social distancing and lockdown or encourage activities including stimulus payments (Li, Foutz, Cai, Liang, & Gao, 2021). Importantly, however, the research that explores the extent to which policy executions have influenced travel behaviors is largely limited. A travel destination is a place where residents and travelers interact, which potentially facilitates disease transmission, subsequently influencing the risk perceptions of both population groups (Ren et al., 2022). With a restriction on going on international trips, domestic travel used to gain more popularity (Donaire, Galí, & Camprubi, 2021). This implies the importance of understanding different travel activities between two key stakeholders – residents and travelers – and their heterogeneous responses to local and national government policies.

Residents relatively have more information about the places in general and health-related services in particular than travelers. Based on the theory of information asymmetry (Bhargava & Chen, 2012), the party who has less information is likely to decide with imperfect information lack of understanding true values of their choices. Considering the concept of product familiarity (Johnson & Russo, 1984), travelers are relatively unfamiliar with the destination to visit compared to residents. The low level of destination familiarity can induce a high-risk perception (i.e., physical risk as a type of vacation risk component), which affects information searching and decision-making behaviors (Horng, Liu, Chou, & Tsai, 2012; Roehl & Fesenmaier, 1992). Furthermore, the protection motivation theory has primarily been employed to investigate tourists' perceptions and the adoption of protective behaviors concerning risky destinations and activities (Lu & Wei, 2019; Wang, Liu-Lastres, Ritchie, & Mills, 2019). People may show higher sensitivity and concern for the corresponding risks occurring in their vicinity and may have lower perceptions of risks far from their geographic location. This conforms to the first law of geography, known as the distance decay effect (Tobler, 2004). However, the health risks associated with pandemics can be spread in geospatial terms. This is likely to result in people's risk perception being influenced not only by the severity of the outbreak in their surrounding area (i.e., within their community or city associated with residents) but also by the severity of the outbreak in the external region (i.e., their country or internationally related to travelers) (Yang, Zhang, Wu, & Li, 2023).

Besides, the extant tourism literature on COVID-19 failed to accommodate the multifaceted nature of tourism products. In other words, the previous research focused on the impact of COVID-19 on travel demand in a particular destination. Yet, travel products comprise an amalgamation of various products and/or services reflecting different levels of importance, involvement, and flexibility (Jeng & Fesenmaier, 2002; Park & Fesenmaier, 2014). Based on adaptive decision makers (Payne, Bettman, & Johnson, 1993), individuals are likely to show divergent strategies in making consumption decisions according to different travel products such as accommodations, transportation, restaurants, and indoor and outdoor recreations. Thus, it is critical to investigate how individuals present dynamic decision-making processes for purchasing diverse products.

Therefore, based on the aforementioned research gaps, this study aims to address the following research questions: (1) To what extent does consumer spending in tourism cities vary in response to the severity of the pandemic, both locally (within the tourism city) and remotely (in the origin regions of travelers)? (2) How do policy responses, such as social distancing measures and economic stimulus, influence consumer spending in tourism cities? (3) To what extent do the impacts of the pandemic and policy responses differ between residents and inbound travelers? (4) To what extent do the impacts of the pandemic and policy responses vary across different economic sectors?

To address the research questions, this study analyzes the spending of residents and domestic inbound travelers in Jeju – a popular travel destination in the Republic of Korea – during the COVID-19 pandemic. The dataset covers a period from January 1, 2019, to September 30, 2020, encompassing over 300 million transactions and a total expenditure exceeding 11 billion won in Jeju. The study period spanned from January to September 2020, during which Korea experienced two waves of nationwide outbreaks and implemented a package of policy responses, including social distancing measures and stimulus payments at local and national levels. However, lockdown strategies were never implemented during this period. The soft social distancing measures in place did not impose inter- and intra-city travel restrictions, allowing residents and travelers to visit any place in Korea at any time. This context provides an experimental setting to observe the active behavioral responses of residents and travelers. Furthermore, it enables us to effectively estimate the impact of social distancing measures and stimulus payments on the behavior of residents and travelers when the influence of the pandemic itself is appropriately managed.

This research aims to contribute to the existing body of tourism research by shedding light on the distinct behavioral responses of residents and travelers in various economic activities during health crises. This study seeks to theoretically enrich our understanding of the risk perceptions and coping strategies of two key stakeholders in travel destinations, residents and tourists, in the face of significant changes in environmental health risks. Furthermore, our study intends to underscore the importance of jointly investigating local and external factors when analyzing the impacts of pandemics. This approach seeks to enable policymakers and stakeholders to better anticipate and prepare for forthcoming local and external risks, thereby enhancing the crisis management capacity and economic resilience of tourism cities.

Literature review and research hypotheses

Consumer behavior changes during public health crises

The COVID-19 pandemic and government intervention policies caused enormous impacts on many aspects of human life (Ballantyne, Singleton, & Dolega, 2022; Kim & Lee, 2021; Park, Tsou, Nara, Cassels, & Dodge, 2024). These substantial environmental changes have led to notable transformations in tourist behavior patterns and spending preferences (Baños-Pino, Boto-García,

Del Valle, & Sustacha, 2023; Williams, Chen, Li, & Baláž, 2022; Yu, Zhao, Tang, & Pang, 2023). Due to travel restrictions and apprehensions regarding health and safety, many individuals have opted for domestic travel as an alternative to international trips (Donaire et al., 2021). Additionally, tourists are increasingly drawn to outdoor and nature-based activities, seeking destinations that facilitate social distancing and minimize the risk of virus transmission (Park et al., 2022). This trend has led to a surge in visitation to rural and natural areas, while urban and densely populated tourist hotspots have experienced declining demand. The pandemic has also affected residents' attitudes toward tourism (Kamata, 2022). During the COVID-19 pandemic, interactions between residents and tourists at destination may increase the risk of disease transmission, posing health risks to both groups. Residents, especially when engaging in physical activities in crowded tourist locations, may have contact with incoming travelers, thus elevating their risk of infection.

Apparently, the pandemic brought about an economic recession. National and local governments have implemented various financial and non-financial aid policies, such as tax credits and stimulus payments. These measures have been proven to be effective in boosting consumer spending and leading to changes in consumer preferences, such as food purchasing habits (Chetty et al., 2020; Li et al., 2021; Lai, Morgan, Kassas, Kropp, & Gao, 2020; Kim & Lee, 2021). Although several studies have estimated the impact of the pandemic and government policies on general spending behavior, few have attempted to explain behavioral responses in travel consumption, particularly within the context of soft social distancing measures and traveler reactions to the pandemic in the absence of travel restrictions.

Moreover, most existing studies estimate the impacts of these policies by modeling changes in human behavior pre- and post-policy implementation. Considering that policy implementation frequently coincides with shifts in the pandemic's state, it becomes challenging to ascribe the observed behavioral changes solely to the enacted policies. Thus, adopting the analysis involving both pandemic and policy interventions is important to explore changes in human behaviors influenced by both these factors (Sheridan, Andersen, Hansen, & Johannesen, 2020; Yang, Mao, & Wen, 2022). As such, this study proposes the following research hypotheses:

H1: Consumer spending in a tourism destination is jointly affected by pandemic conditions locally and remotely.

H2: Social distancing measures suppress consumer spending.

H3: Economic stimulus measures boost consumer spending.

Adaptive behaviors toward government policies between residents and travelers

Protection Motivation Theory (PMT) explains how individuals perceive and evaluate specific threats and subsequently engage in protective behaviors (Floyd, Prentice-Dunn, & Rogers, 2000; Rogers, 1975). In tourism, the application of protection motivation theory has focused on exploring tourists' perceptions and protective behaviors toward potentially risky destinations and activities (Slevitch & Sharma, 2008; Wang et al., 2019). However, while research has examined the protective behaviors of tourists, a significant research gap exists in understanding the differences between residents and tourists in their evaluations of and responses to health threats. At a destination, residents and tourists may have unequal access to information about the location and its healthcare services, leading to varying levels of trust in the local government. This idea is related to the theory of information asymmetry, which refers to the difference in the amount and quality of information that sellers and buyers have in consumer behavior (Mavlanova, Benbunan-Fich, & Koufaris, 2012). Information asymmetry creates an imbalance of power. For instance, when a seller possesses more information than the buyer, the buyer is more likely to make a decision based on incomplete and/or misleading information (Park & Nicolau, 2015). This can result in a lack of trust and confidence in their decisions. Likewise, residents relatively have more information about healthcare issues/services in a particular place (i.e., where they live) than travelers, leading to an imbalance of power.

The different behaviors between residents and travelers at the same place can be attributed to destination familiarity. Perceived familiarity affects not only information-searching behaviors but also the decision-making process (Carneiro & Crompton, 2010; Horng et al., 2012; Roehl & Fesenmaier, 1992). Some studies suggest that individuals with low levels of familiarity with a product (or destination) are more likely to spend time and effort searching for information (Carneiro & Crompton, 2010). Based on the idea of utility maximization, people tend to keep gathering information until they can certify the acceptable values of their future decisions. Residents are relatively more familiar with a place as a residential area than travelers. This difference in perceived familiarity between residents and tourists can lead to varying costs and efforts in evaluating their abilities to cope with risks and uncertainties, ultimately resulting in distinct behavioral responses. A destination showed dynamic conditions of the pandemic denoting the first and second waves of COVID-19. To alleviate the outcomes of the pandemic, the government implemented several strategic policies such as social distancing and stimulus payments. Two stakeholder groups, residents and travelers, have different amounts and quality of information and levels of familiarity associated with geographical and psychological distances. The different characteristics lead to heterogeneous consumption behaviors in spending on travel products.

Furthermore, the multifaceted nature of travel products requires people to make multiple choices throughout their trips. Individuals have different levels of importance and risks to the diverse products/services, which leads to dynamic decision-making strategies (Jeng & Fesenmaier, 2002). The concept of adaptive decision-maker suggests that individuals tend to use a variety of strategies to make judgments and choices in responding to changes in decision circumstances (Payne et al., 1993). This implies that people including both residents and travelers are likely to develop varying strategies across diverse travel products where individuals present different levels of decision flexibility and priority to decide. As such, this study proposes the following research hypotheses:

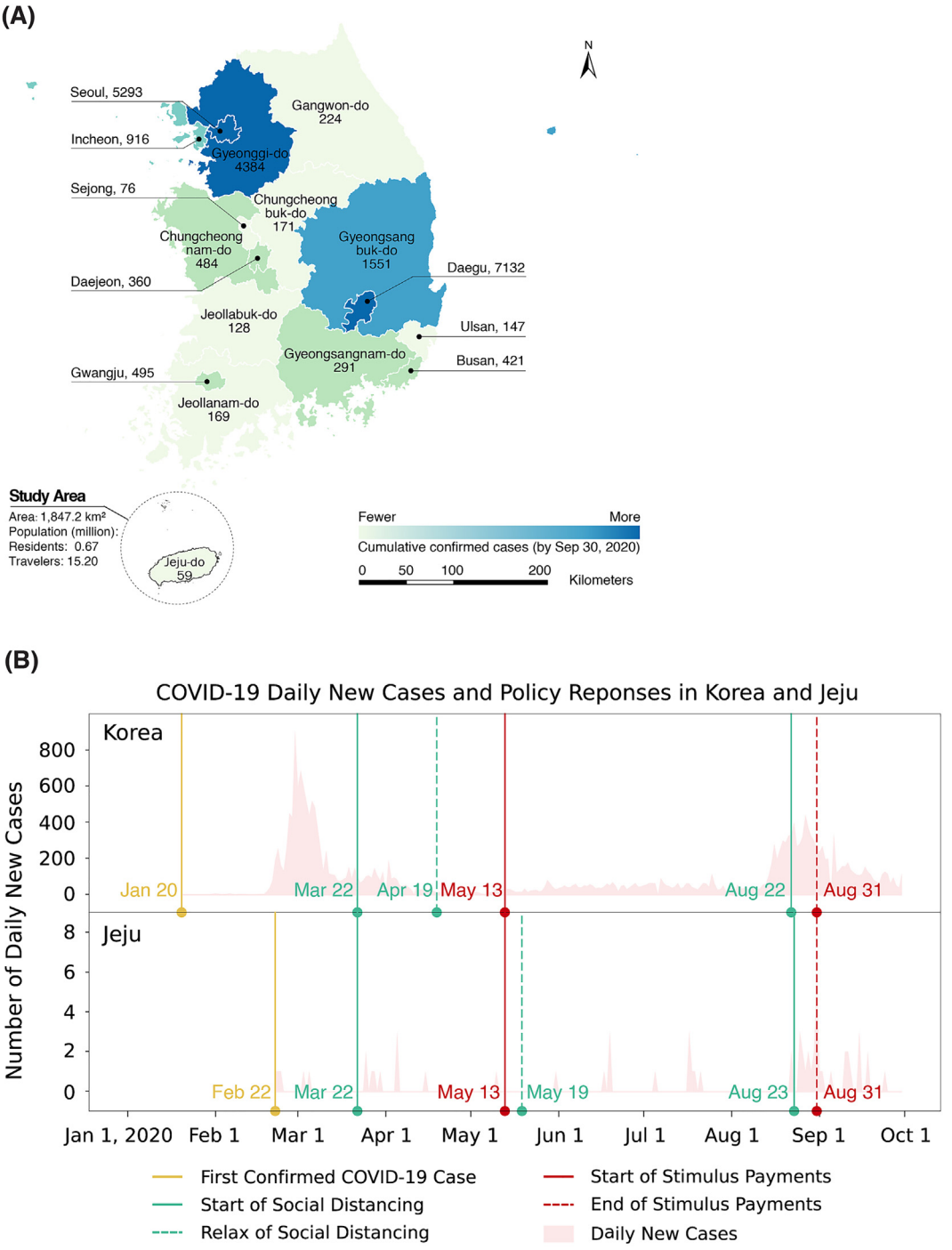


Fig. 1. (A) Cumulative confirmed cases of COVID-19 in Korea by the end of September 2020, at the province level, and the location of Jeju Special Self-Governing Province in Korea. (B) Timeline of COVID-19 daily new cases and policy responses in Korea and Jeju, from the first confirmed case in Korea on January 20 to September 30, 2020.

H4: The pandemic and policy responses produce heterogeneous effects on consumer spending between local residents and inbound travelers.

H5: The pandemic and policy responses produce heterogeneous effects on consumer spending across different economic sectors.

Table 1
Description of COVID-19 and policy response variables.

Variables	Description
DNC	Number of daily new cases in Korea
JDNC	Number of daily new cases in Jeju
KSD	Dummy variables indicating the social distancing measures implemented by the national government of Korea from March 22, 2020, to April 19, 2020
JSD	Dummy variables indicating the social distancing measures implemented by the local government of Jeju from March 22, 2020, to May 19, 2020
KJSD	Dummy variables indicating the social distancing measures implemented by both the national and local governments from August 23, 2020, to September 30, 2020
Stimulus	Dummy variables indicating the stimulus payments distributed from May 13, 2020, to August 31, 2020

By testing the aforementioned hypotheses, this research aims to contribute to a better understanding of the behavioral differences between residents and tourists in tourist destinations during pandemics. Additionally, it seeks to uncover the influence of local and external health risk factors, as well as policy interventions, on consumer behavior.

Study area and data

Study area

This study analyzes the spending behavior of both residents and domestic inbound travelers during the pandemic in a popular tourism destination, Jeju Special Self-Governing Province, the Republic of Korea (hereafter Jeju, Korea). As shown in Fig. 1A, Jeju is an administrative region in southwestern Korea with a total area of 1847.2 km^2. It has about 0.67 million residents and attracts about 15 million travelers annually. During the COVID-19 pandemic, the Korean government did not implement strict lockdown strategies. Instead, it adopted soft social distancing policies that allowed residents and travelers unrestricted access to any location in Korea. It provided an experimental context to study the dynamic behavioral responses of residents and travelers to COVID-19 and government policies, largely free from the potential impact of mobility restrictions.

COVID-19 and policy responses in Korea

COVID-19 data for this study was sourced from the census data released by the Ministry of Health and Welfare, Republic of Korea. From January 20, 2020 (the date of the first reported COVID-19 case in Korea), until the end of September 2020, Korea experienced two waves of nationwide outbreaks. Fig. 1B depicts the timeline of daily new COVID-19 cases and corresponding policy responses in Korea and Jeju. The first wave, spanning from February 19 to mid-April 2020, originated from a cluster in Daegu, while the second wave, occurring from mid-August to the end of September 2020, was centered in Seoul. Jeju recorded its first local case on February 22, 2020. During the first wave of the national outbreak, Jeju did not have a large-scale outbreak, with fewer than 10 confirmed cases per day. However, during the second wave, Jeju experienced a notable increase in daily new cases. In this context, both the national and local status of the outbreak may influence the behaviors of residents and travelers in Jeju.

In terms of policy responses, both the national and local governments implemented social distancing measures in response to the 1st and 2nd waves of the national outbreak, respectively. During the 1st wave of the national outbreak, the national government implemented social distancing measures from March 22 to April 19. Meanwhile, the Jeju local government extended measures from March 22 to May 19, lasting a month longer than the national implementation period. In response to the 2nd wave outbreak, the national and local governments issued social distancing measures on August 22 and 23, respectively, which remained in place until the end of September. These measures were aimed at limiting the maximum number of people and hours of operation of various establishments (such as restaurants, nightclubs, and indoor sports facilities). However, these measures did not impose strict travel restrictions, either within or between cities.

In terms of economic responses, a significant measure implemented in Korea is the emergency cash transfer payments in 2020. Under the stimulus payment scheme, every Korean citizen was entitled to receive consumption vouchers issued by the government. The scheme was initiated on May 1, 2020, allowing people to register for the vouchers, and the earliest transfers were issued on May 13, 2020. To ensure that the funds were used for purchases, the government provided citizens with pre-paid cards or credit card deposits and set a deadline of August 31, 2020, for spending the vouchers. Additionally, the payment could be utilized for small businesses and was not limited to the area of residence, allowing small businesses in the tourism industry to benefit.

Therefore, this study includes two COVID-19 continuous variables (i.e., the number of daily new cases in Korea and the number of daily new cases in Jeju) and four policy dummy variables as independent variables (Table 1). The four dummy variables represent policy implementation, with a value of 1 assigned to the days when the respective measures were implemented, and 0 otherwise.

Credit and debit card transaction data

The credit and debit card data used in this study was sourced from one of the leading credit card companies in Korea. This dataset, which guarantees anonymity, encompasses a comprehensive collection of 39,772,559 aggregated transaction records.

Table 2
Example of transaction records.

Date	Consumption category	Consumer type	Expenditure	Number of Transactions
2019-01-01	Korean Style Restaurants	resident	100,097	5
2019-01-01	Urban Transit Systems	traveler	1,911,400	3
……	……	……	……	……
2020-09-30	Convenience Store	traveler	57,342	8
2020-09-30	Hair Beauty	resident	150,900	2

These records span a timeframe from January 1, 2019, to September 30, 2020, capturing over 300 million transactions and a total expenditure of over 11 billion won in Jeju, Korea. The data analyzed in this study comprises aggregated expenditure amount and number of transactions derived from transaction records. The aggregation was performed based on transaction date, consumption categories, and consumer groups. As shown in Table 2, the dataset for analysis consists of time series data of aggregated consumption, differentiated by consumer categories and consumption categories, at a daily granularity.

This study examines consumer spending from three distinct dimensions: consumer groups (residents and travelers), consumption categories (overall and eight specific categories), and consumption variables (expenditure and number of transactions).

- **Consumer groups:** The classification of consumer groups in this dataset, namely residents and travelers, is provided by the data provider based on the transaction records and registration information. For all transaction records in Jeju, users whose registration places are also in Jeju are classified as residents. Users registered in other Korean provinces or cities outside of Jeju Province are classified as travelers. As such, the traveler in this dataset specifically refers to domestic inbound travelers.
- **Reclassified consumption categories:** The dataset includes 22 broad consumption categories, each with five levels of subcategories, resulting in over 1500 specific consumption categories. To better capture changes in the consumption behavior of residents and travelers, with a focus on household and tourism-related spending, the authors manually reclassified the original categories into eight. They are transportation, accommodation, outdoor recreation, indoor recreation, in-person service, restaurants, food and beverage retail, and general retail. Together, these eight categories account for over 80 % of the records in the dataset. Further details and examples of venues for each category can be found in Table 3. Ultimately, the study analyses consumer spending at the overall level and in eight reclassified categories.
- **Consumption variables:** Expenditure and the number of transactions are aggregated by date, consumer group, and consumption category. Both variables are analyzed in this study to provide insights into different aspects of consumer spending. Expenditure reflects the economic characteristics of consumption behavior, capturing variations in consumer demand across different sectors at an aggregate level. The number of transactions captures changes in consumption frequency and patterns, providing insights into activity-related characteristics.

Table 3
Reclassified consumption categories and the percentage of each category in total expenditure and transactions.

Category	Example of Transaction Types	No. of subtypes	Share of Resident Expenditure	Share of Resident Transactions	Share of Traveler Expenditure	Share of Traveler Transactions
Transportation	Automotive Gas/Oil Stations, Renting of Motor Vehicles, Coastal Water Passenger Transport, Vehicle Parking Facilities, Urban Transit Systems, Charter Bus Transport, etc.	48	13.11 %	8.06 %	6.09 %	5.41 %
Accommodation	Hotels, Inns, Condominium, juvenile Camps, Renting of Non-Residential Buildings, etc.	23	1.42 %	1.03 %	8.58 %	4.54 %
Outdoor Recreation	Golf and Skiing Facilities, Amusement and Theme Park, Botanical and Zoological Gardens, Natural Parks, etc.	22	1.73 %	1.05 %	3.65 %	2.71 %
Indoor Recreation	Computer Game Room, Singing Room, Museum, Billiard Room, Bowling Alley, Swimming Pool, Library, Reading Room, Physical Fitness Facility, etc.	23	0.63 %	1.13 %	0.85 %	1.36 %
In-Person Service	Personal Care Services: Hair Beauty, Saunas, Skin Beauty, etc. Household Services: Household Laundry Services, Repair of Household Machinery, etc.	43	1.97 %	1.49 %	0.67 %	0.64 %
Restaurant	Korean Style Restaurants, Confectioners Shops, Pizza, Hamburger, Sandwich, Noodle Houses, Bars and Canteens, Chicken Shops, Lunch Counters, Western Style Restaurants, etc.	16	15.96 %	21.48 %	21.40 %	23.93 %
Food and Beverage Retail	Convenience Stores, Supermarkets, Retail & Wholesale of Food and Beverage, e.g., Fruit and Vegetables, Meat, Fish and Marine Products, Dairy Products, Rice Cakes, etc.	83	18.80 %	35.35 %	11.72 %	27.28 %
General Retail	Retail & Wholesale: Clothing, Cosmetics and Perfumery, Gifts, Novelties and Souvenirs, etc.	350	28.88 %	16.43 %	20.01 %	16.00 %
Total		**608**	**82.49 %**	**86.01 %**	**72.97 %**	**81.88 %**

Consequently, a total of 36 time series are derived from the credit card dataset. This includes four overall consumption time series for resident expenditure, resident transactions, traveler expenditure, and traveler transactions, as well as 32 time series (four for each of the eight consumption categories). All time series were recorded at a daily granularity and span from January 1, 2019, to September 30, 2020. See Supplementary Information (SI) Appendix Fig.S1 for details. Descriptive statistics for all consumption variables are presented in SI Appendix Table.S9.

Methodology

This study aims to assess the impact of COVID-19 and government policies on daily expenditure and transactions of residents and travelers across various consumption categories, as well as at an overall level. A series of regression models were utilized to examine the relationship between consumer behavior and different factors. To ensure the robustness and validity of the models, several techniques were employed to control seasonal effects in the time series data and to identify the optimal time lags between the dependent and independent variables.

Seasonal adjustments of time series data

To mitigate the issue of spurious regressions arising from the autocorrelation of time series data, we first conducted an Augmented Dickey-Fuller (ADF) test. The results indicate that almost all the consumption time series reject the null hypothesis at the 5 % significance level, providing evidence of non-stationarity and seasonal effects in the data (SI Appendix, Table.S10). We next introduced control variables $Season_t$ and $SeasonPost_t$ to manage the seasonality, as shown in Eq. (1)–(3):

$$ln\ (y_t) = \beta_0 + Season_t + SeasonPost_t + \varepsilon_t \tag{1}$$

Where:

$$Season_t = \sum_{m=Jan}^{Nov} * \alpha_m * I(Month_t = m) + \sum_{w=Mon}^{Sat} * \alpha_w * I(Weekday_t = w) + \alpha_h * Holiday_t \tag{2}$$

$$SeasonPost_t = \left[\sum_{m=Jan}^{Aug} * \alpha_m^{'} * I(Month_t = m) + \sum_{w=Mon}^{Sat} * \alpha_w^{'} * I(Weekday_t = w) + \alpha_h^{'} * Holiday_t\right] * Post_t \tag{3}$$

Here y_t refers to the corresponding consumption indicator on day t, where $t = (1, \ldots,639)$ denotes the number of days starting from January 1, 2019.

Seasonal effects are accounted for by incorporating the variables $Season_t$ and $SeasonPost_t$. Both $Season_t$ and $SeasonPost_t$ consist of a set of dummy variables to capture the seasonal variations related to the month-of-year, day-of-week, and public holidays. Specifically, $Month_t$ indicates the month corresponding to day t. If $Month_t$ equals m, where m ranges from January to November, the dummy variable for month m is assigned a value of 1; otherwise, it is set to 0. Similarly, $Weekday_t$ indicates the day of the week corresponding to day t. If $Weekday_t$ matches w, where w represents Monday to Saturday, the dummy variable for the day of the week w is set to 1; otherwise, it is set to 0. The variable $Holiday_t$ is a dummy variable that indicates whether day t falls on a public holiday. If day t is a public holiday, $Holiday_t$ is assigned a value of 1; otherwise, it is set to 0. $Season_t$ controls the seasonal effects throughout the entire period, while $SeasonPost_t$ captures the effects specifically after the outbreak by introducing the interaction term between the seasonal factors and the dummy $Post_t$. The variable $Post_t$ takes a value of 1 if day t is greater than or equal to 385, which corresponds to January 20, 2020, the day when the first cases of COVID-19 was reported in Korea. Otherwise, $Post_t$ is set to 0.

To validate the effectiveness of the seasonal adjustments, unit root tests were performed on the model residuals ε_t, which showed that all residuals are stationary (SI Appendix, Table.S11). Besides, we performed Johansen cointegration tests for the de-seasonalized consumption time series and the independent time series variables. The results indicate the existence of statistically significant co-integration relationships among the time series (SI Appendix, Table.S12).

Identify the optimal time lags of COVID-19 variables through cross-correlation analysis

Determining the optimal time lag between time-series variables is critical for examining causal relationships between variables. Cross-correlation analysis is an extensively employed statistical methodology that quantifies the magnitude and direction of temporal relationships with time delays between variables within time series (Akal, 2004; Shi, Di, Zhang, Feng, & Svirchev, 2018). This method involves computing the correlation coefficient between two time series at specific time lags, and the identification of the optimal time lag occurs when the maximum correlation is observed.

This study assumes that local and national COVID-19 situations influenced the spending behavior of residents and travelers in the past two weeks. Thus, we perform cross-correlation analysis between a given seasonal adjusted consumption time series and a given COVID-19 variable, with a time lag range of 0–14 days, where the COVID-19 variable leads. Both the consumption variables and the COVID-19 variables have been logarithmically transformed to ensure consistency with subsequent regression analysis.

By conducting pairwise cross-correlation analysis on four overall consumption time series and two COVID-19 indicators, we have determined the optimal time lags that reflect the response of consumer behavior to COVID-19 at the overall level. The results

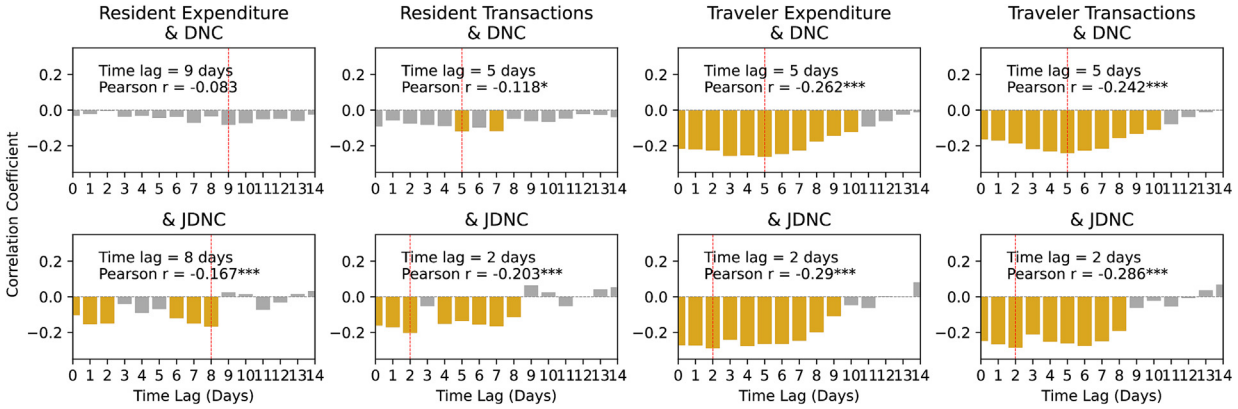


Fig. 2. Cross-correlation analysis results for overall spending time series vs. national daily new cases (DNC), and overall spending time series vs. Jeju daily new cases (JDNC).

of the time lag detection are illustrated in Fig. 2. At the overall level, both residents and travelers exhibit longer optimal time lags in their response to national daily new cases compared to Jeju daily new cases. For travelers, there is consistency in the time lags observed for both expenditure and transactions in response to the COVID-19 indicator. However, residents exhibit inconsistency, with expenditures showing a longer time lag compared to transactions.

Similarly, we assessed the optimal time lag between specific consumer groups and consumption variables with the COVID-19 indicators (Fig. 3). The results indicate that consumer spending exhibits distinct time lags in response to COVID-19 indicators across different categories. For travelers, there is a relatively consistent time lag observed for spending across all categories in response to national daily new cases, while there is greater heterogeneity in the response to Jeju daily new cases. In contrast, residents exhibit notable variations in their responses to both national and Jeju daily new cases across different categories, with the spending in retail displaying a longer time lag. The identified optimal time lags for each corresponding time series were incorporated into the respective regression models in the subsequent analyses.

Regression model

The final regression models incorporate two COVID-19 variables and four policy dummy variables, as well as control variables for the month-of-year, day-of-week, and public holidays both before and after the outbreak of COVID-19 in Korea. The model is formulated as follows:

$$ln\,(y_t) = \beta_0 + \beta_1 * ln\left(DNC_{t\,-\,lag1}\right) + \beta_2 * ln\left(JDNC_{t\,-\,lag2}\right) + \beta_3 * KSD_t + \beta_4 * JSD_t + \beta_5 * KJSD_t$$
$$+\beta_6 * Stimulus_t + Season_t + SeasonPost_t + \varepsilon_t \quad (4)$$

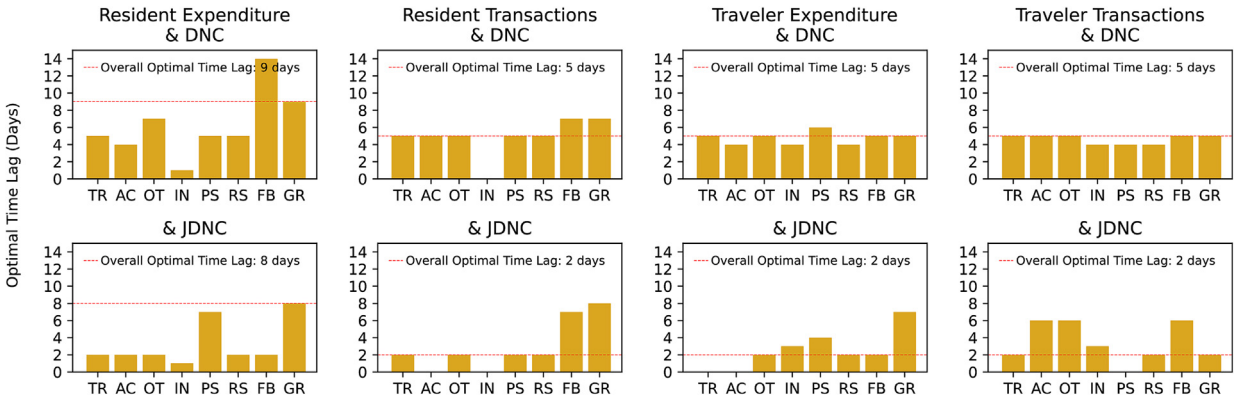


Fig. 3. The optimal time lag of COVID-19 variables for different consumption categories' time series. The labels on the horizontal axis denote the abbreviations for the consumption categories, where: TR-Transportation, AC-Accommodation, OT-Outdoor Recreation, IN-Indoor Recreation, PS-In-Person Service, RS-Restaurant, FB-Food and Beverage Retail, GR-General Retail.

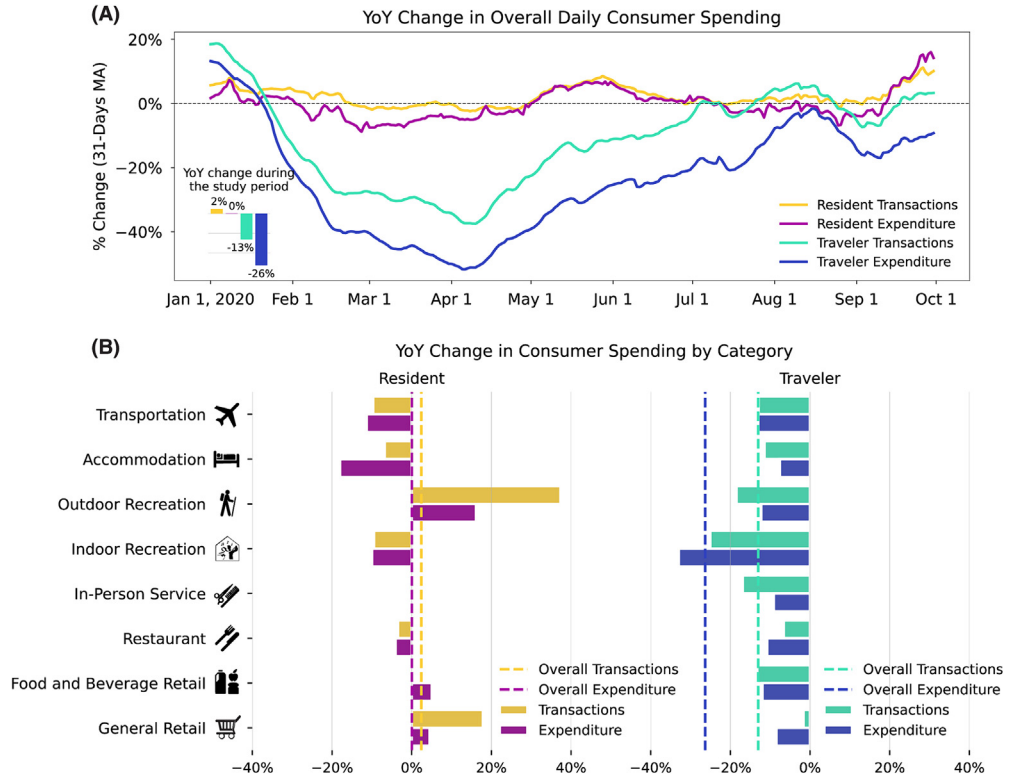


Fig. 4. (A) The year-over-year (YoY) change in overall expenditure and transactions of residents and travelers at a daily granularity; the bar graph in the lower left corner shows the YoY change in overall expenditure and transactions of residents and travelers in the entire study period from January 20 to September 30, 2020. (B) The YoY change in expenditure and transactions of residents and travelers across different categories in the entire study period.

Here y_t refers to the corresponding consumption indicator on day t, where $t = (1, \ldots, 639)$ denotes the number of days starting from January 1, 2019. $DNC_{t\ -\ lag1}$ indicates the number of national COVID-19 new cases on the day of $t - lag1$, where $lag1$ is the time lag determined through cross-correlation analysis. Similarly, $JDNC_{t\ -\ lag2}$ corresponds to the number of Jeju daily new cases on day $t - lag2$. To ensure meaningful and elastic estimations, log transformations are applied to the continuous variables, including the dependent variables and the national and Jeju daily new cases. Given the presence of zeros in the *DNC* and *JDNC* observations, we applied an offset of 1 to all values before performing the logarithmic transformation to ensure that all observations are positive integers.

Table 4
Regression results of overall models.

	Model	**Model**	**Model**	**Model**
	Resident Expenditure	**Resident Transactions**	**Traveler Expenditure**	**Traveler Transactions**
Constant, β_0	22.892***	12.445***	22.757***	12.190***
DNC, β_1	−0.022	−0.014***	−0.055***	−0.046***
JDNC, β_2	−0.088**	−0.04	−0.054	−0.055
KSD, β_3	−0.06	−0.023	−0.175***	−0.141***
JSD, β_4	0.064	0.022	−0.029	−0.039
JSD, β_5	−0.024	−0.042	−0.275***	−0.225***
Stimulus, β_6	0.221***	0.115***	0.102	0.082
R^2	0.427	0.481	0.873	0.815
Adj. R^2	0.388	0.446	0.865	0.803
N	639	639	639	639
F stat	21.565	27.442	159.785	122.251
P value	0.000	0.000	0.000	0.000
AIC	−574.886	−1428.96	−958.494	−1025.26
BIC	−392.03	−1246.1	−775.638	−842.407

[1] *Statistically significant at 10 % level. **Statistically significant at 5 % level. ***Statistically significant at 1 % level.
[2] Standard Errors are heteroscedasticity robust (HC1).

The policy dummy variables are denoted as *KSD*, *JSD*, *KJSD*, and *Stimulus*. *KSD* represents the first national social distancing measure. *JSD* indicates the first Jeju social distancing measures. *KJSD* captures the combined effects of the second national and Jeju social distancing measures (as these were implemented almost simultaneously during the 2nd wave of the national outbreak). Stimulus reflects the stimulus payments. If day t falls within the implementation period of a particular policy, the corresponding dummy variable is set to 1; otherwise, it is set to 0.

$Season_t$ and $SeasonPost_t$ refer to the control variables for seasonal adjustment, as detailed in Eqs. (2)–(3) in section 4.1.

As such, the regression models yield a set of coefficients $[\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6]$, capturing the effects of *DNC*, *JDNC*, *KSD*, *JSD*, *KJSD*, and *Stimulus* on consumer spending, respectively. These coefficients are estimated for 4 overall consumption models (resident expenditure, resident transaction, traveler expenditure, and traveler transaction), and 4*8 category-specific models. The estimation results are summarized in Table 4 ~ Table 8 and the coefficients are visualized in Fig. 5 and Fig. 6. For the full regression results, please refer to SI Appendix Table S13 ~ Table S16.

Results

Year-over-year change in consumer spending during the pandemic

Overall resident spending was sensitive to the evolution of the pandemic but the degree of change was relatively stable over the entire study period

By comparing consumer spending by Jeju residents between 2020 and 2019 in Fig. 4A, we obtained the year-over-year (YoY) difference - at the daily granularity - of the overall expenditure (purple line) and the total number of transactions (yellow line) to reveal changes occurred during the pandemic. The daily expenditure and transactions experienced a slight but discernible decline during the first national outbreak, followed by a notable recovery during the stable period and some fluctuations during the second national outbreak. The results show that the spending behavior of Jeju residents responded to the evolution of the pandemic. However, even when the pandemic situation was relatively severe (e.g., first and second national outbreaks), the daily reductions of expenditure and frequency of purchases were bounded, with the largest declines of 8.8 % and 2.4 %, respectively. We next obtain the YoY change over the entire study period – from January 20 to September 30, 2020 - of the overall expenditure (purple bar) and transactions (yellow bar in the bar graph in the lower left corner of Fig. 4A). The results suggest that, although resident spending temporarily declined when the pandemic was severe, overall spending remained constant or even increased slightly over a relatively long period, with expenditure increasing by 0.06 % and transactions increasing by 2.41 %.

Overall traveler spending experienced a greater reduction and took longer to recover compared to resident spending

Compared to residents, traveler daily expenditure and number of transactions experienced greater declines since the first national outbreak, with the largest declines of 51.7 % and 37.5 %, respectively (Fig. 4A). This downturn lasted for nearly six months and did not fully recover until August 2020. Then, another relatively slight and short-lived decline followed the second national outbreak. During the entire study period from January 20 to September 30, 2020, the reduction in traveler spending was substantial, with expenditure decreasing by 26 % and transactions decreasing by 13 % (the bar graph in the lower left corner of Fig. 4A). The results reveal strong responses of traveler spending to the evolution of the pandemic, even in the absence of strict travel restrictions.

Heterogeneity of year-over-year change across different consumption categories

We next compare the YoY change in consumer spending across different categories over the entire study period (Fig. 4B and SI Appendix Fig.S2). For residents, we can observe considerable heterogeneity across spending categories, despite that the overall expenditure and purchase frequency changed slightly over the study period. Some categories exhibited notable increases, such as outdoor recreation, food and beverage retail, and general retail, while other categories presented notable decreases, such as transportation, accommodation, indoor recreation, and restaurants. Such a disparity highlights a great shift in the spending preferences of residents in certain aspects during the pandemic. For example, the number of transactions by residents decreased by about 10 % for indoor recreation but increased by about 37 % for outdoor recreation, indicating that residents did not reduce recreational activities in general but preferred outdoor rather than indoor recreation when they had health concerns or were restricted by policy. Similarly, residents spent about 4 % less in restaurants but 5 % more on food and beverage products during the pandemic, suggesting a shift in demand for food and beverage from out-of-home to in-home modes but generally unchanged or even slightly increased in terms of the amount.

Traveler spending declined in all categories, but the intensity of the decline varied significantly across categories (Fig. 4B). It suggests that apart from the decrease in traveler arrivals and overall traveler spending, travelers also adjusted their preferences and priorities for different activities during the pandemic. Activities with flexible alternatives and a higher risk of disease spread (i.e., outdoor recreation, indoor recreation, and in-person service) experienced larger declines than other categories. However, activities that cannot be easily substituted, such as accommodation and restaurants, experienced a smaller decline.

Impacts of COVID-19 and policy responses on overall resident and traveler spending

This section presents the estimated coefficients of COVID-19 and policy variables in the overall expenditure and transactions models for residents and travelers (Fig. 5 and Table 4).

Residents were affected more by local COVID-19 situations, while travelers were affected equally by local and national COVID-19 situations

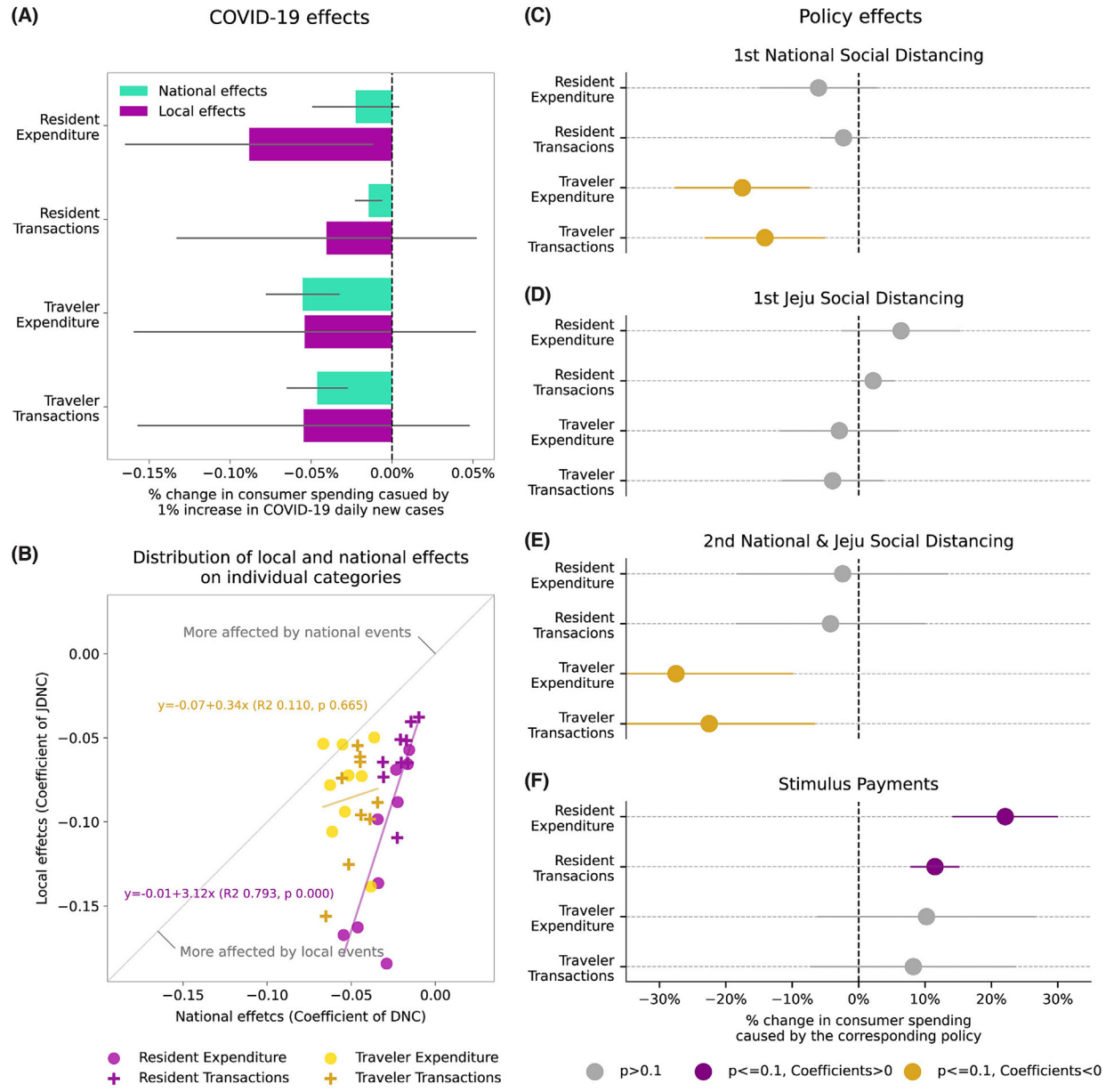


Fig. 5. The effects of COVID-19 and policy responses on the overall expenditure and transactions of residents and travelers. (A) Local and national COVID-19 impacts on overall expenditure and transactions of residents and travelers. The purple and green bars demonstrate the coefficients of Jeju daily new cases and national daily new cases, respectively, and error bars mark 95 % confidence intervals. (B) Distribution of local and national COVID-19 impacts on resident and traveler spending in different consumption categories. The yellow marks COVID-19 impact on traveler spending, and purple marks the impact on resident spending. (C)-(F) Policy effects on overall expenditure and transactions of residents and travelers. The yellow marks significant negative ($p < 0.1$), purple marks significant positive ($p < 0.1$), grey marks nonsignificant, and error bars mark 95 % confidence intervals. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

As shown in Fig. 5A, residents were sensitive to both local and national disease spread but were more concerned about the local situation. The estimated coefficients of Jeju daily new cases in the overall resident expenditure and transactions models are −0.088 and −0.04, respectively, indicating that a 1 % increase in Jeju daily new cases led to 0.088 % and 0.04 % reductions in overall resident expenditure and transactions, respectively. The corresponding reductions caused by the national daily new cases were 0.022 % and 0.014 %, respectively, which were significantly smaller than the impact of the local situations. In addition, both COVID-19 variables had greater effects on expenditure than on transactions. It suggests that resident expenditure and activity participation decreased significantly when the spread of the disease was severe, but the decrease in expenditure was greater.

Travelers had the same level of sensitivity to local and national disease spread. Travelers' responses to the severity of disease spread were also consistent in terms of expenditure and activity participation. Each 1 % increase in Jeju daily new cases resulted in

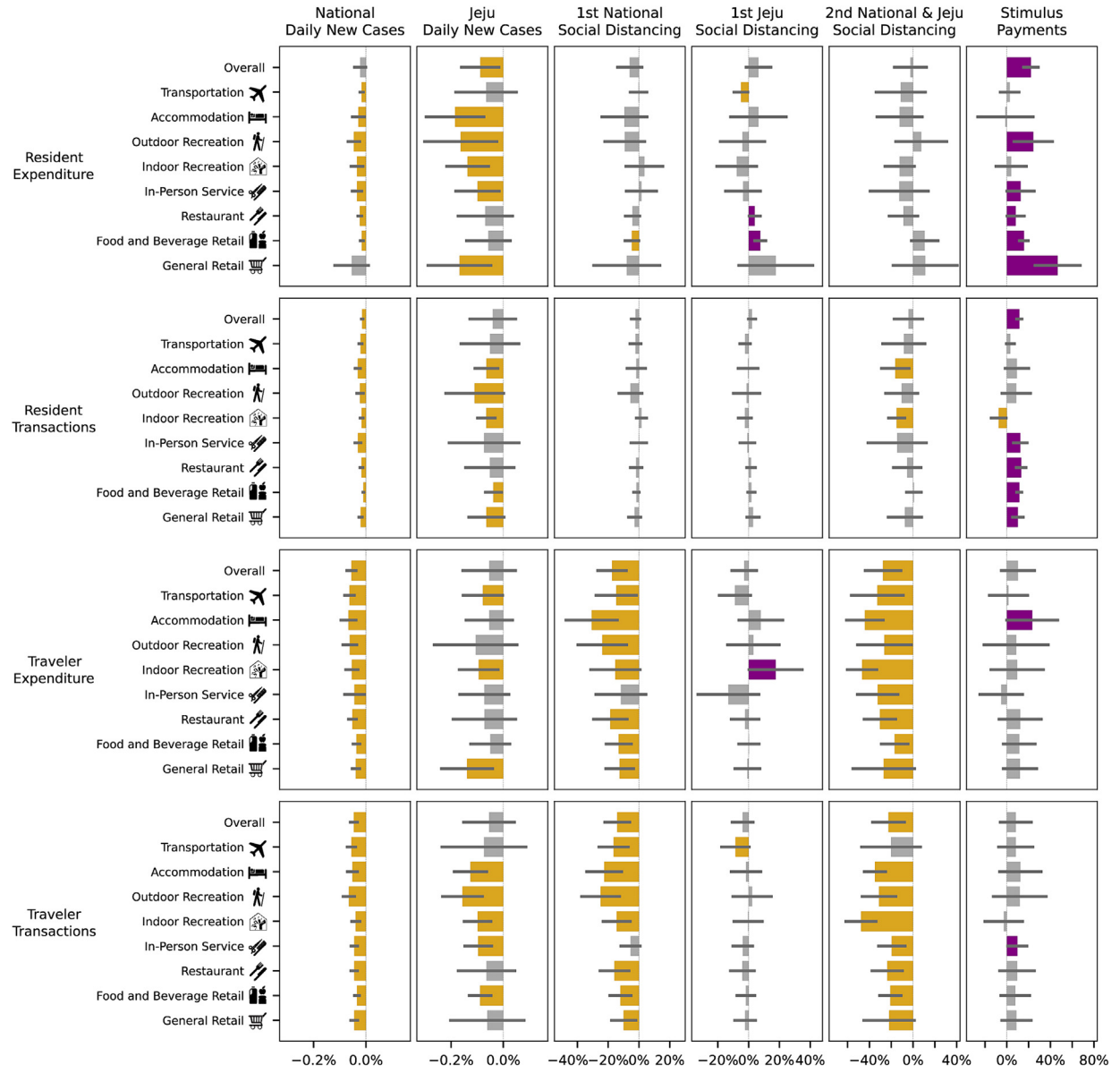


Fig. 6. The effects of COVID-19 and policy responses on resident and traveler spending across different categories. The bars represent the estimated effects, where yellow marks significant negative ($p < 0.1$), purple marks significant positive ($p < 0.1$), grey marks nonsignificant, and error bars mark 95 % confidence intervals. The estimated effect of national and Jeju daily new cases implies the % change in consumer spending caused by a 1 % increase in the corresponding indicator. For other policy factors, the estimated effect implies the % change in consumer spending caused by the implementation of the corresponding policy. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

0.054 % and 0.055 % reductions in overall traveler expenditure and transactions. The corresponding reductions caused by national daily new cases were 0.055 % and 0.046 %, respectively. These findings are in line with our hypotheses **H1** & **H4** that consumer spending in Jeju was jointly affected by pandemic conditions locally and remotely, and the impacts were heterogeneous for residents and travelers.

The above finding is reaffirmed by the results of different category models (Fig. 5B). By comparing the coefficients of Jeju and national daily new cases in different category models for residents and travelers, we find that the impact of local COVID-19 cases was about three times greater than the impact of national cases on resident spending in all categories. The purple fitted line in Fig. 5B has a slope of 3.12, with an R^2 of 0.793 and a *p*-value of 0.0002 (Table 4). In comparison, local and national cases affected traveler spending to a comparable extent, given that most yellow points in the scatterplot are distributed around the y = x reference line. The above observations reveal that residents and travelers have different perceptions of the health risks of national and local disease transmission.

Table 5
Regression results of resident expenditure.

	Model - 0	Model - 1	Model - 2	Model - 3	Model - 4	Model - 5	Model - 6	Model - 7	Model - 8
	Overall	**Transportation**	**Accommodation**	**Outdoor Recreation**	**Indoor Recreation**	**In-Person Service**	**Restaurant**	**Food and Beverage Retail**	**General Retail**
Constant, β_0	22.892***	20.675***	19.337***	19.065***	18.171***	18.871***	21.406***	21.297***	21.551***
DNC, β_1	−0.022	−0.016***	−0.029**	−0.046***	−0.034**	−0.034***	−0.023***	−0.016***	−0.055
JDNC, β_2	−0.088**	−0.066	−0.184***	−0.163**	−0.136***	−0.098**	−0.069	−0.057	−0.167***
KSD, β_3	−0.060	−0.003	−0.095	−0.093	0.035	0.016	−0.042	−0.046*	−0.080
JSD, β_4	0.064	−0.050*	0.064	−0.040	−0.078	−0.037	0.039*	0.076***	0.176
JSD, β_5	−0.024	−0.113	−0.123	0.076	−0.123	−0.127	−0.087	0.107	0.112
Stimulus, β_6	0.221***	0.027	−0.013	0.243**	0.040	0.126*	0.081*	0.157***	0.466***
R2	0.427	0.792	0.623	0.365	0.347	0.431	0.587	0.315	0.206
Adj. R2	0.388	0.779	0.597	0.323	0.304	0.393	0.560	0.269	0.153
N	639.000	639.000	639.000	639.000	639.000	639.000	639.000	639.000	639.000
F stat	21.565	72.407	30.309	13.282	12.090	16.440	62.832	15.509	7.810
P value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AIC	−574.886	−742.100	3.344	116.747	−115.556	−47.632	−1017.185	−787.415	489.656
BIC	−392.030	−559.244	186.200	299.603	67.300	135.224	−834.329	−604.559	672.512

[1] *Statistically significant at 10 % level. **Statistically significant at 5 % level. ***Statistically significant at 1 % level.
[2] Standard Errors are heteroscedasticity robust (HC1).

Social distancing had a notable impact on travelers but a limited impact on residents

The effects of all social distancing measures on overall resident expenditure and transactions were insignificant (Fig. 5C-E). It suggests that changes in resident spending during the pandemic were mainly the result of the active response to the spread of the disease, with limited impact from social distancing measures.

For travelers, social distancing measures implemented by local and national governments resulted in a substantial reduction in traveler spending. The first national social distancing led to a 17.5 % and 14.1 % reduction in overall traveler expenditure and activity participation, respectively. The corresponding reductions caused by the second national and Jeju social distancing were 27.5 % and 22.5 %. Conversely, the first social distancing measures issued by the local government only had a limited impact on both traveler expenditure and activity participation. It should be acknowledged that the notable decline is presumably due to two reasons. One is the decline in the number of tourist arrivals in Jeju. Another is that arrived travelers may reduce activity participation and overall expenditure when traveling around the island due to policy restrictions on certain activities.

The above findings partially support the hypothesis **H2** that social distancing measures would suppress consumer spending. However, such an effect was significant for travelers, while it had a limited impact on residents.

Stimulus payments boosted resident spending significantly but had a limited impact on travelers

As shown in Fig. 5F, the stimulus payments positively affected resident spending, and the impact was more pronounced in expenditure (22.1 %) than in transactions (11.5 %). This suggests that the policy had a greater impact on consumer spending in the economic aspect than on activity participation. During the period of the economic stimulus policy, consumers exhibited not only an increase in the frequency of their consumption but also a substantial increase in their expenditure per purchase.

However, the impact of stimulus payments on traveler spending in Jeju is found to be limited. Although these payments in Korea can be used for small businesses outside of their place of residence, specifically targeting the tourism industry, the results indicate a constrained effect. These findings align with the conclusions drawn from certain prior studies (Kim, Koh, & Lyou, 2020; Chetty et al., 2020; Watanabe, 2020). It has been observed that consumer vouchers and stimulus payments issued by governments during pandemics can effectively boost food and overall household spending. However, the impacts on the recovery of consumption in face-to-face service sectors such as hotels, leisure, transport, and retail are limited.

These findings offer partial support for our hypothesis **H3**, that stimulus payments effectively boosted consumer spending in Jeju, primarily among residents.

Heterogeneous effects of COVID-19 and policy responses on consumer spending across different consumption categories

This section presents the estimated coefficients of COVID-19 and policy variables in models of both groups' expenditure and transactions across different consumption categories. The summarized results have been shown in Fig. 6 and Tables 5–8.

Heterogeneous effects of local and national COVID-19 situations

For residents, as illustrated in Fig. 6, the escalation of national COVID-19 cases resulted in declines in both expenditure and transactions across almost all categories. Similarly, an increase in local COVID-19 cases led to decreases in consumption, primarily in accommodation, outdoor and indoor recreation, and retail sectors. Specifically, a 1 % increase in national COVID-19 cases was associated with a 0.02 % decrease in both resident expenditure and transactions across nearly all categories. Furthermore, each 1 % increase in Jeju COVID-19 cases caused approximately a 0.1 % decrease in transactions, while expenditure on accommodation and general retail experienced a 0.2 % decrease. These findings suggest that certain economic sectors suffer more than others when

Table 6
Regression results of resident transactions.

	Model - 0	Model - 1	Model - 2	Model - 3	Model - 4	Model - 5	Model - 6	Model - 7	Model - 8
	Overall	**Transportation**	**Accommodation**	**Outdoor Recreation**	**Indoor Recreation**	**In-Person Service**	**Restaurant**	**Food and Beverage Retail**	**General Retail**
Constant, β_0	12.445***	9.847***	8.284***	8.310***	8.407***	8.295***	11.025***	11.414***	10.530***
DNC, β_1	−0.014***	−0.021***	−0.031***	−0.023**	−0.016***	−0.031***	−0.017***	−0.010***	−0.020***
JDNC, β_2	−0.040	−0.051	−0.064**	−0.109*	−0.065***	−0.073	−0.052	−0.038**	−0.065*
KSD, β_3	−0.023	−0.023	−0.018	−0.055	0.016	−0.001	−0.019	−0.017	−0.028
JSD, β_4	0.022	−0.023	−0.004	−0.013	−0.025	−0.009	0.016	0.018	0.028
JSD, β_5	−0.042	−0.084	−0.163**	−0.104	−0.150***	−0.145	−0.053	0.008	−0.075
Stimulus, β_6	0.115***	0.033	0.093	0.087	−0.075*	0.124***	0.132***	0.115***	0.101***
R2	0.481	0.611	0.794	0.789	0.847	0.450	0.441	0.554	0.519
Adj. R2	0.446	0.585	0.780	0.775	0.837	0.413	0.404	0.524	0.486
N	639.000	639.000	639.000	639.000	639.000	639.000	639.000	639.000	639.000
F stat	27.442	37.816	62.019	77.438	99.678	24.107	33.988	34.448	37.549
P value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AIC	−1428.957	−1094.459	−823.480	−260.679	−1127.388	−520.379	−1154.805	−1625.345	−678.036
BIC	−1246.101	−911.603	−640.624	−77.823	−944.532	−337.523	−971.949	−1442.489	−495.180

[1] *Statistically significant at 10 % level. **Statistically significant at 5 % level. ***Statistically significant at 1 % level.
[2] Standard Errors are heteroscedasticity robust (HC1).

the disease spreads extensively. The decline in consumption frequency is considerably smaller compared to the decline in expenditure amount, indicating a significant reduction in the average amount spent per transaction. Consequently, these economic sectors are more likely to experience pronounced price fluctuations.

For travelers, the increase in national COVID-19 cases triggered a relatively consistent expenditure and activity participation decline in almost all categories. Specifically, a 1 % increase in the national COVID-19 cases reduced traveler expenditure and transactions by about 0.05 % in most categories. The increase in local COVID-19 cases only caused declines in traveler spending in certain categories, such as transportation, indoor recreation, and general retail. A 1 % increase in the Jeju COVID-19 cases reduced traveler expenditure and transactions by about 0.1 % to 0.2 %. This implies that as the national COVID-19 situation worsens, there is a high probability of experiencing a general reduction in tourist arrivals, resulting in a relatively consistent change in spending across all consumption categories. On the other hand, local COVID-19 conditions have an impact on tourists' activity choices and spending decisions at destinations, leading to significant variations in the effects across different categories.

The above findings confirmed the hypotheses **H1**, **H3**, and **H4** that consumer spending in Jeju was jointly affected by pandemic conditions locally and remotely and the impacts were heterogeneous across consumer groups and consumption categories.

The impact of social distancing was relatively consistent on expenditure and number of transactions but heterogeneous across categories

Table 7
Regression results of traveler expenditure.

	Model - 0	Model - 1	Model - 2	Model - 3	Model - 4	Model - 5	Model - 6	Model - 7	Model - 8
	Overall	**Transportation**	**Accommodation**	**Outdoor Recreation**	**Indoor Recreation**	**In-Person Service**	**Restaurant**	**Food and Beverage Retail**	**General Retail**
Constant, β_0	22.757***	19.912***	20.305***	19.540***	18.026***	17.625***	21.315***	20.660***	21.299***
DNC, β_1	−0.055***	−0.063***	−0.067***	−0.061***	−0.054***	−0.044**	−0.052***	−0.036***	−0.038***
JDNC, β_2	−0.054	−0.078*	−0.054	−0.106	−0.094**	−0.073	−0.072	−0.050	−0.138***
KSD, β_3	−0.175***	−0.147**	−0.307***	−0.239***	−0.154*	−0.117	−0.186***	−0.131***	−0.125**
JSD, β_4	−0.029	−0.089	0.079	0.031	0.175*	−0.132	−0.023	0.002	−0.009
JSD, β_5	−0.275***	−0.327**	−0.442***	−0.262**	−0.468***	−0.324***	−0.304***	−0.168**	−0.269*
Stimulus, β_6	0.102	0.016	0.233*	0.086	0.095	−0.051	0.123	0.115	0.122
R2	0.873	0.710	0.836	0.685	0.723	0.308	0.811	0.799	0.742
Adj. R2	0.865	0.691	0.825	0.664	0.704	0.262	0.798	0.786	0.725
N	639.000	639.000	639.000	639.000	639.000	639.000	639.000	639.000	639.000
F stat	159.785	64.233	97.871	38.675	53.151	12.843	105.592	99.606	70.635
P value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AIC	−958.494	−418.314	−275.262	65.001	71.963	143.607	−709.436	−947.553	−577.827
BIC	−775.638	−235.458	−92.406	247.857	254.819	326.463	−526.580	−764.697	−394.971

[1] *Statistically significant at 10 % level. **Statistically significant at 5 % level. ***Statistically significant at 1 % level.
[2] Standard Errors are heteroscedasticity robust (HC1).

Table 8
Regression results of traveler transactions.

	Model - 0	Model - 1	Model - 2	Model - 3	Model - 4	Model - 5	Model - 6	Model - 7	Model - 8
	Overall	**Transportation**	**Accommodation**	**Outdoor Recreation**	**Indoor Recreation**	**In-Person Service**	**Restaurant**	**Food and Beverage Retail**	**General Retail**
Constant, β_0	12.190***	9.291***	9.159***	8.595***	8.105***	7.296***	10.822***	10.876***	10.421***
DNC, β_1	−0.046***	−0.055***	−0.051***	−0.065***	−0.039***	−0.044***	−0.045***	−0.034***	−0.045***
JDNC, β_2	−0.055	−0.074	−0.125***	−0.156***	−0.098***	−0.096***	−0.064	−0.088***	−0.061
KSD, β_3	−0.141***	−0.165***	−0.226***	−0.249***	−0.145***	−0.055	−0.159***	−0.120***	−0.100**
JSD, β_4	−0.039	−0.086*	−0.017	0.022	−0.004	−0.038	−0.041	−0.019	−0.023
JSD, β_5	−0.225***	−0.201	−0.349***	−0.312***	−0.477***	−0.195***	−0.237***	−0.208***	−0.220*
Stimulus, β_6	0.082	0.082	0.124	0.119	−0.028	0.097*	0.094	0.078	0.089
R2	0.815	0.686	0.866	0.742	0.764	0.697	0.772	0.830	0.767
Adj. R2	0.803	0.665	0.857	0.725	0.749	0.676	0.757	0.818	0.751
N	639.000	639.000	639.000	639.000	639.000	639.000	639.000	639.000	639.000
F stat	122.251	57.565	155.725	55.005	62.883	42.627	102.542	116.690	95.107
P value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AIC	−1025.263	−597.710	−693.163	−205.632	−318.965	−924.261	−892.039	−1127.822	−816.916
BIC	−842.407	−414.854	−510.307	−22.776	−136.109	−741.405	−709.183	−944.966	−634.060

[1] *Statistically significant at 10 % level. **Statistically significant at 5 % level. ***Statistically significant at 1 % level.
[2] Standard Errors are heteroscedasticity robust (HC1).

Although the impact of all social distancing measures on overall resident spending was insignificant, these measures had a negative impact on resident expenditure and transactions in certain categories, such as transportation, accommodation, and indoor recreation. The largest decreases occurred in accommodation and indoor recreation caused by the 2nd national and Jeju social distancing, where transactions fell by 16.3 % and 15.0 %.

For travelers, the first national social distancing and the second national and Jeju social distancing caused a substantial decline in traveler spending across all categories. However, the extent of the declines shows significant heterogeneity across categories. Traveler spending on accommodation, outdoor recreation, and indoor recreation experienced a greater decline than other categories. Conversely, traveler spending on food and beverage retail and general retail dropped less than others. The effect of the first Jeju social distancing on traveler spending was insignificant in most categories.

The impact of a given social distancing implementation on a given consumption category was relatively consistent in economic and behavioral aspects. It suggests that the decline in expenditure across sectors during the implementation of social distancing measures was a concomitant effect of reduced activity participation. Sectors, where social distancing measures imposed more strict activity restrictions, experienced correspondingly greater declines in expenditure, such as transportation, recreation (especially indoor facilities), hospitality, restaurants, and services that require in-person contact. In comparison, sectors associated with essential subsistence and lower health risks during the pandemic were less affected in both economic and behavioral aspects, such as retail and outdoor recreation.

Impact of stimulus payments on different economic sectors

For residents, the stimulus payments effectively increased their purchase frequency by approximately 10 % in specific categories, such as in-person services, restaurants, food and beverage retail, and general retail (Fig. 6). However, the impact of stimulus payments on expenditure varied significantly across sectors, with the largest increase observed in general retail at 46.6 %. Notably, the rise in expenditure in general retail and food and beverage retail exceeded the increase in transaction frequency, indicating that residents spent more money per purchase in these retail sectors because of the policy. Besides, the stimulus payments boosted expenditure on outdoor recreation but led to a decrease in the frequency of consumption for indoor recreation, suggesting a shift in recreational activity preferences during the pandemic. Interestingly, in a seemingly vibrant consumer market, sectors like retail and recreation, with less risk of disease spread (i.e., outdoor recreation) benefited most from stimulus payments.

For travelers, the stimulus payments had a notable effect on increasing their purchase frequency by approximately 10 % in in-person services, while also leading to a significant 23.3 % increase in expenditure on accommodation. However, in comparison to residents, the impact of this policy on travelers' activity participation and expenditure was relatively limited. Nevertheless, the hospitality sector experienced substantial benefits from the stimulus payments.

Stimulus payments effectively boosted consumer spending in certain sectors without diminishing the effects of social distancing

Social distancing measures aim to mitigate the spread of the disease by reducing human mobility and interpersonal contact. Stimulus payments, on the other hand, are designed to encourage consumers to move out of their homes and engage in more activities to revitalize the economy and boost employment. Our results suggest that the stimulus payments did not diminish the effectiveness of social distancing at venues with high risks of disease spread, such as transportation, and indoor and outdoor recreation, while it effectively boosted consumer expenditure in other sectors that were less restricted by social distancing measures, such as retail. Indeed, our results demonstrate that social distancing policies and stimulus payments can be jointly effective. We find that stimulus measures even reinforced the restrictive effect of social distancing in certain places (e.g., indoor recreation),

as they directed consumers to spend their time and money elsewhere. The above findings are all in line with our hypotheses **H4** and **H5** that the policy responses produce heterogeneous effects on consumer spending across different economic sectors and consumer groups.

Discussion and conclusion

The global pandemic instigated by COVID-19 presented urban economies with an unprecedented set of complex challenges. The pervasive spread of the virus and corresponding policy measures led to significant shifts in consumer spending within urban areas. Through an analysis of expansive credit and debit card transaction data, we have elucidated the varied impacts of disease transmission and policy responses at both local and national scales on the spending patterns of residents and domestic travelers.

Theoretical Implications

Our findings underscore that both demographics exhibited sensitivity to local and national disease transmission severity. Specifically, residents showed heightened sensitivity to local disease spread, exhibiting strong reactions, particularly when engaging in activities necessitating physical contact, such as indoor and outdoor recreation. Conversely, travelers exhibited heightened concern regarding national-level disease spread when participating in activities such as public transportation and accommodation services, where they might interact more with other travelers. However, they were more sensitive to local disease spread while participating in activities that may involve increased interactions with residents, such as indoor and outdoor recreation and in-person services. This study carries significant implications for understanding the role of risk perception in shaping individual protective behaviors. Residents and travelers have access to different amounts and types of information and possess varying levels of familiarity associated with geographical and psychological distances. These differing characteristics lead to distinct risk perceptions and coping strategies.

This study highlights the heterogeneous impact of social distancing measures and stimulus payments on consumer behavior across multiple travel products (Wu & Carson, 2008). The research reveals that social distancing measures have minimal behavioral effects on residents but notably influence tourist behavior. Conversely, economic stimulus measures produce contrasting outcomes. These distinct behavioral responses by residents and travelers to different policies demonstrate the existence of adaptive decision-making in response to changes in the decision environment (Payne et al., 1993). Furthermore, the influence of policies on consumer spending varies across economic sectors, with the retail, restaurant, accommodation, and outdoor recreation sectors benefiting more from stimulus payments, while indoor recreation sectors suffer more. These findings underscore the priority of physiological and safety needs in consumer decision-making, aligning with Maslow's hierarchy of needs theory (Maslow, 1943).

Policy Implications

Our research findings underscore the joint impact of both local and national disease spread on local economies. This highlights the importance for island destinations similar to Jeju, such as Hong Kong, Singapore, and Hawaii, to consider the combined effects of local and external outbreaks during public health crises. Given the relative geographical independence of these destinations, disease transmission often occurs separately at the local and national levels. A tourism-oriented city geographically distant from the nationwide outbreak epicenter can still suffer substantial economic consequences as external risks infiltrate through inbound travelers. However, a surge in local COVID-19 cases often leads to larger declines in consumer spending across most sectors, emphasizing that controlling local disease spread is pivotal in mitigating economic losses over the long term.

Furthermore, the differential effects of policies on these two distinct groups emphasize the necessity of implementing tailored policies that account for the unique characteristics of each population. From a disease prevention standpoint, stricter measures may be required to regulate resident behavior in specific locales. From an economic recovery perspective, relying solely on general, nationwide economic tools may be insufficient in stimulating tourist expenditure in destination areas. Complementary economic instruments specifically targeted to travel destinations may be indispensable.

The heterogeneous impact of policies on consumer spending across different economic sectors highlights the importance of implementing a combination of economic stimulus and social distancing measures to achieve a balance between economic recovery and public safety (Gourinchas, 2020; Hsiao, Ko, & Zhou, 2022). A balanced policy approach can be accomplished through a nuanced design that distinguishes between venues eligible for consumption vouchers and those limited by social distancing norms (Dorn et al., 2022; Kaplan, Moll, & Violante, 2020; Kim & Oh, 2021). Government interventions have proven effective in directing spending toward industries that have been especially affected, thereby stimulating consumer spending and broader economic activity.

Limitations

We want to point out the limitations of this research. Firstly, despite the primary objective of this study is to examine the general differences in behavioral responses of residents and travelers, it is nevertheless acknowledged that a single destination analysis may have limitations in providing insights across all types of tourist destinations. Second, the classification of residents and travelers in this study is based on the categorization provided by credit card companies, which is determined by the user's registered location. The travelers in the dataset, apart from tourists, i.e., those visitors for leisure purposes, may also include a small percentage of other types of non-resident consumers, such as business or education-related visitors, or digital nomads who are temporary residents. Differences among various types of travelers were not adequately discussed in this study, which could be examined in future research. Third, this study employs multiple linear regression models rather than time series techniques, such as an error correction model, to estimate the effects of pandemic-related factors on consumer behavior. The latter may have the potential to be more effective in revealing both long-term and short-term relationships. However, to obtain more direct

and interpretable results, the former is employed in this study to provide more practical insights for application and policy implications.

CRediT authorship contribution statement

Mengyao Ren: Conceptualization, Formal analysis, Methodology, Writing - original draft, Writing - review & editing. **Yang Xu:** Conceptualization, Methodology, Project administration, Writing - review & editing. **Sangwon Park:** Conceptualization, Data curation, Writing – review & editing. **Xiao Huang:** Conceptualization, Writing - review & editing. **Mengqi Sun:** Methodology, Writing - review & editing. **Jizhe Xia:** Conceptualization, Writing - review & editing. **Sun-Young Koh:** Data curation, Writing - review & editing.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used ChatGPT to check the grammar and phrasing of the paper to improve its readability. The tool was employed only for language refinement purposes, and the edited portion did not exceed 10 % of the overall text. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Declaration of competing interest

We declare that there is no potential conflict of interest.

Acknowledgement

The authors would like to thank the editors and anonymous reviewers for their valuable comments on earlier versions of the manuscript. This research was partly supported by a grant from the Research Centre for Digital Transformation of Tourism, The Hong Kong Polytechnic University (Project No. 1-BBFG).

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.annals.2024.103830.

References

Akal, M. (2004). Forecasting Turkey's tourism revenues by ARMAX model. *Tourism Management*, *25*(5), 565–580.
Ballantyne, P., Singleton, A., & Dolega, L. (2022). Using unstable data from mobile phone applications to examine recent trajectories of retail Centre recovery. *Urban Informatics*, *1*(1), 21.
Baños-Pino, J. F., Boto-García, D., Del Valle, E., & Sustacha, I. (2023). The impact of COVID-19 on tourists' length of stay and daily expenditures. *Tourism Economics*, *29*(2), 437–459.
Bhargava, H. K., & Chen, R. R. (2012). The benefit of information asymmetry: When to sell to informed customers? *Decision Support Systems*, *53*(2), 345–356.
Cahyanto, I., Wiblishauser, M., Pennington-Gray, L., & Schroeder, A. (2016). The dynamics of travel avoidance: The case of Ebola in the us. *Tourism Management Perspectives*, *20*, 195–203.
Carneiro, M. J., & Crompton, J. L. (2010). The influence of involvement, familiarity, and constraints on the search for information about destinations. *Journal of Travel Research*, *49*(4), 451–470.
Chetty, R., Friedman, J. N., Hendren, N., & Stepner, M.The Opportunity Insights Team. (2020). How did Covid-19 and stabilization policies affect spending and employment? A new real-time economic tracker based on private sector data. *Vol. 91.* (pp. 1689–1699). Cambridge, MA: National Bureau of Economic Research.
Donaire, J. A., Galí, N., & Camprubi, R. (2021). Empty summer: International tourist behavior in Spain during Covid-19. *Sustainability*, *13*(8), 4356.
Dorn, F., Khailaie, S., Stoeckli, M., Binder, S. C., Mitra, T., Lange, B., ... Wollmershäuser, T., et al. (2022). The common interests of health protection and the economy: Evidence from scenario calculations of Covid-19 containment policies. *The European Journal of Health Economics*, 1–8.
Floyd, D. L., Prentice-Dunn, S., & Rogers, R. W. (2000). A meta-analysis of research on protection motivation theory. *Journal of Applied Social Psychology*, *30*(2), 407–429.
Gössling, 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.
Gourinchas, P. -O. (2020). Flattening the pandemic and recession curves. *Mitigating the COVID economic crisis: Act fast and do whatever*, *31*(2), 57–62.
Hall, M. C., Prayag, G., Fieger, P., & Dyason, D. (2020). Beyond panic buying: Consumption displacement and Covid-19. *Journal of Service Management*, *32*(1), 113–128.
Horng, J. S., Liu, C. H., Chou, H. Y., & Tsai, C. Y. (2012). Understanding the impact of culinary brand equity and destination familiarity on travel intentions. *Tourism Management*, *33*(4), 815–824.
Hsiao, C. Y. -L., Ko, S. I. -M., & Zhou, N. (2022). Financial relief policy and social distancing during the Covid-19 pandemic. *PLOS Global Public Health*, *2*(6), Article e0000663.
Jeng, J., & Fesenmaier, D. R. (2002). Conceptualizing the travel decision-making hierarchy: A review of recent developments. *Tourism Analysis*, *7*(1), 15–32.
Johnson, E. J., & Russo, J. E. (1984). Product familiarity and learning new information. *Journal of Consumer Research*, *11*(1), 542–550.
Kamata, H. (2022). Tourist destination residents' attitudes towards tourism during and after the COVID-19 pandemic. *Current Issues in Tourism*, *25*(1), 134–149.
Kaplan, G., Moll, B., & Violante, G. L. (2020). *The great lockdown and the big stimulus: Tracing the pandemic possibility frontier for the US. Vol. No. w27794.*National Bureau of Economic Research.
Kim, M., & Oh, Y. H. (2021). The impact of Covid-19 regional cash subsidies on the sales of local businesses in South Korea. *KDI Journal of Economic Policy*, *43*(2), 103–123.
Kim, M. J., & Lee, S. (2021). Can stimulus checks boost an economy under Covid-19? Evidence from South Korea. *International Economic Journal*, *35*(1), 1–12.
Kim, S., Koh, K., and Lyou, W. (2020). Do Covid-19 stimulus payments stimulate the economy? Evidence from card transaction data in South Korea. *Evidence from card transaction data in South Korea (September 29, 2020)*.
Lai, J., Morgan, S., Kassas, B., Kropp, J., & Gao, Z. (2020). Spending of economic stimulus payments and changes in food purchasing during the COVID-19 pandemic. *Choices*, *35*(3), 1–8.

Li, K., Foutz, N. Z., Cai, Y., Liang, Y., & Gao, S. (2021). Impacts of COVID-19 lockdowns and stimulus payments on low-income population's spending in the United States. *PLoS One*, *16*(9), Article e0256407.
Lu, S., & Wei, J. (2019). Public's perceived overcrowding risk and their adoption of precautionary actions: A study of holiday travel in China. *Journal of Risk Research*, *22*(7), 844–864.
Maslow, A. H. (1943). A theory of human motivation. *Psychological Review*, *50*(4), 370–396.
Mavlanova, T., Benbunan-Fich, R., & Koufaris, M. (2012). Signaling theory and information asymmetry in online commerce. *Information & Management*, *49*(5), 240–247.
Park, J., Tsou, M. H., Nara, A., Cassels, S., & Dodge, S. (2024). Developing a social sensing index for monitoring place-oriented mental health issues using social media (twitter) data. *Urban Informatics*, *3*(1), 2.
Park, S., & Fesenmaier, D. R. (2014). Travel decision flexibility. *Tourism Analysis*, *19*(1), 35–49.
Park, S., Kim, Y. R., & Ho, C. S. T. (2022). Analysis of travel mobility under Covid-19: Application of network science. *Journal of Travel & Tourism Marketing*, *39*(3), 335–352.
Park, S., & Nicolau, J. L. (2015). Asymmetric effects of online consumer reviews. *Annals of Tourism Research*, *50*, 67–83.
Payne, J. W., Bettman, J. R., & Johnson, E. J. (1993). The adaptive decision maker. Cambridge university press.
Rahman, M. K., Gazi, M. A. I., Bhuiyan, M. A., & Rahaman, M. A. (2021). Effect of Covid-19 pandemic on tourist travel risk and management perceptions. *PLoS One*, *16*(9), Article e0256486.
Ren, M., Park, S., Xu, Y., Huang, X., Zou, L., Wong, M. S., & Koh, S. -Y. (2022). Impact of the Covid-19 pandemic on travel behavior: A case study of domestic inbound travelers in Jeju. *Korea. Tourism Management*, *92*, Article 104533.
Roehl, W. S., & Fesenmaier, D. R. (1992). Risk perceptions and pleasure travel: An exploratory analysis. *Journal of Travel Research*, *30*(4), 17–26.
Rogers, R. W. (1975). A protection motivation theory of fear appeals and attitude change1. *The Journal of Psychology*, *91*(1), 93–114.
Santos, L. J., Oliveira, A. V., & Aldrighi, D. M. (2021). Testing the differentiated impact of the COVID-19 pandemic on air travel demand considering social inclusion. *Journal of Air Transport Management*, *94*, Article 102082.
Sheridan, A., Andersen, A. L., Hansen, E. T., & Johannesen, N. (2020). Social distancing laws cause only small losses of economic activity during the covid-19 pandemic in Scandinavia. *Proceedings of the National Academy of Sciences*, *117*(34), 20468–20473.
Shi, K., Di, B., Zhang, K., Feng, C., & Svirchev, L. (2018). Detrended cross-correlation analysis of urban traffic congestion and No2 concentrations in Chengdu. *Transportation Research Part D: Transport and Environment*, *61*, 165–173.
Slevitch, L., & Sharma, A. (2008). Management of perceived risk in the context of destination choice. *International Journal of Hospitality & Tourism Administration*, *9*(1), 85–103.
Tobler, W. (2004). On the first law of geography: A reply. *Annals of the Association of American Geographers*, *94*(2), 304–310.
Wang, J., Liu-Lastres, B., Ritchie, B. W., & Mills, D. J. (2019). Travelers' self-protections against health risks: An application of the full protection motivation theory. *Annals of Tourism Research*, *78*, Article 102743.
Watanabe, T. (2020). *The responses of consumption and prices in Japan to the covid-19 crisis and the Tohoku earthquake.*
Wen, Z., Huimin, G., & Kavanaugh, R. R. (2005). The impacts of SARS on the consumer behaviour of Chinese domestic tourists. *Current Issues in Tourism*, *8*(1), 22–38.
Williams, A. M., Chen, J. L., Li, G., & Baláž, V. (2022). Risk, uncertainty and ambiguity amid Covid-19: A multi-national analysis of international travel intentions. *Annals of Tourism Research*, *92*, Article 103346.
Wu, C. L., & Carson, D. (2008). Spatial and temporal tourist dispersal analysis in multiple destination travel. *Journal of Travel Research*, *46*(3), 311–317.
Yang, Y., Mao, Z., & Wen, Z. (2022). Pandemic severity, policy stringency, and tourism performance: A global analysis. *Journal of Travel Research*, *61*(8), 1928–1946.
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*, Article 102913.
Yang, Y., Zhang, L., Wu, L., & Li, Z. (2023). Does distance still matter? Moderating effects of distance measures on the relationship between pandemic severity and bilateral tourism demand. *Journal of Travel Research*, *62*(3), 610–625.
Yu, L., Zhao, P., Tang, J., & Pang, L. (2023). Changes in tourist mobility after COVID-19 outbreaks. *Annals of Tourism Research*, *98*, Article 103522.

Author Bios

Mengyao Ren is a PhD student in the Department of Land Surveying and Geo-Informatics, The Hong Kong Polytechnic University. Her research interests include human travel behavior, tourism big data, urban resilience, public transport, and urban planning.
Yang Xu is an associate professor in the Department of Land Surveying and Geo-Informatics, The Hong Kong Polytechnic University. His research interests include geographic information science (GIScience), urban informatics, trajectory data mining, and tourism big data.
Sangwong Park is a professor in the College of Hotel and Tourism Management, Kyung Hee University. His research interests include tourism big data, AI and marketing.
Xiao Huang is an assistant professor in the Department of Environmental Sciences, Emory University. His research interests include GeoAI, Big Data, natural hazards, data science/visualization, and remote sensing.
Mengqi Sun is a PhD student in the Department of Land Surveying and Geo-Informatics, The Hong Kong Polytechnic University. Her research interests include human mobility, spatial interaction, and GeoAI.
Jizhe Xia is an associate professor in the Department of Urban Informatics, Shenzhen University. His research interests include GeoAI, big data, and smart city.
Sun-Young Koh is an Associate Research Fellow at Jeju Research Institute. Her research interests include tourism geography, smart tourism, and destination planning.