

Reporting Summary

Nature Portfolio wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Portfolio policies, see our [Editorial Policies](#) and the [Editorial Policy Checklist](#).

Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a Confirmed

- | | | |
|-------------------------------------|-------------------------------------|--|
| <input type="checkbox"/> | <input checked="" type="checkbox"/> | The exact sample size (n) for each experimental group/condition, given as a discrete number and unit of measurement |
| <input type="checkbox"/> | <input checked="" type="checkbox"/> | A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | The statistical test(s) used AND whether they are one- or two-sided
<i>Only common tests should be described solely by name; describe more complex techniques in the Methods section.</i> |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | A description of all covariates tested |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals) |
| <input type="checkbox"/> | <input checked="" type="checkbox"/> | For null hypothesis testing, the test statistic (e.g. F , t , r) with confidence intervals, effect sizes, degrees of freedom and P value noted
<i>Give P values as exact values whenever suitable.</i> |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | Estimates of effect sizes (e.g. Cohen's d , Pearson's r), indicating how they were calculated |

Our web collection on [statistics for biologists](#) contains articles on many of the points above.

Software and code

Policy information about [availability of computer code](#)

Data collection Arcgis 10.8 was used to match weather data, air pollution data and simulated data for future climate to the city level.

Data analysis Data analysis was conducted in Stata17.

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Portfolio [guidelines for submitting code & software](#) for further information.

Data

Policy information about [availability of data](#)

All manuscripts must include a [data availability statement](#). This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our [policy](#)

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Research involving human participants, their data, or biological material

Policy information about studies with [human participants or human data](#). See also policy information about [sex, gender \(identity/presentation\), and sexual orientation](#) and [race, ethnicity and racism](#).

Reporting on sex and gender

The main variable is the number of tourists from all 330 cities in China to 12 cities in Inner Mongolia of China. It is from mobile phone signaling data provided by China Unicom. They also provide us with the number of female and male tourists. Since the data covers the whole population using China Unicom, it should be representative for gender.

Reporting on race, ethnicity, or other socially relevant groupings

This study has not collected information on.

Population characteristics

See below.

Recruitment

We use the whole population and there is no sampling selection issues.

Ethics oversight

According to the IRB guidelines and guidelines for academic research in China, our study does not require ethical review or approval as it is secondary research without individually identifiable information.

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☐ Life sciences

☒ Behavioural & social sciences

☐ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see [nature.com/documents/nr-reporting-summary-flat.pdf](https://www.nature.com/documents/nr-reporting-summary-flat.pdf)

Behavioural & social sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description

Quantitative city-level panel data.

Research sample

The city-level data covers the weekly number of China Unicom tourists who traveled from 330 cities nationwide to cities in Inner Mongolia during the sample period from May 1 to October 31 in 2020 and 2021. The reason why we choose Inner Mongolia as the destination region is that Inner Mongolia is the most popular summer vacation destination in China primarily due to mild summer temperatures. In 2023, Inner Mongolia received 230 million tourists and generated tourism revenue of 335 billion RMB, accounting for 6.8% of the country's tourism revenue.

The tourists are identified based on mobile signaling data from China Unicom. Using a disciplined, multi-step process, China Unicom can identify groups of tourists based on individual movement trajectories. Although the original mobile phone signaling data is at the individual level, confidentiality and availability constraints necessitated the use of aggregated data at the city level. Customized according to our research requirements, this data was directly provided by China Unicom.

China Unicom is one of the top three telecommunication operators and a prominent mobile phone service provider, forming an oligopolistic competition pattern with China Mobile and China Telecom in the telecommunication industry. China Unicom holds a market share of approximately 19.1% and boasts a subscriber base exceeding 300 million at the end of 2021. Given that the three telecommunications operators in China essentially encompass the entire population and exhibit significant homogeneity in terms of products, services, and models, there are negligible differences in individual user characteristics (Investor Insights Asia, 2023). Consequently, we posit that subscriber data from China Unicom provides an accurate representation of the number of tourists. Previous studies discussing population mobility have also employed signaling data from China Unicom, leading to the conclusion that these data samples are representative (Wang et al., 2024; Jia et al., 2020; Zhou et al., 2020). Taking gender as an example. Due to the lack of data on tourist characteristics in the entire Inner Mongolia region, we use the statistical report on tourists received by Hohhot, the largest tourist city in Inner Mongolia, during the National Day in 2020 as a reference for comparison. Among the tourists to Inner Mongolia from China Unicom, approximately 68% were male and around 32% were female. This distribution aligns closely with the reported figures of 61.82% male tourists and 38.18% female tourists.

Investor Insights Asia. Comparing China's Telecom Providers: China Mobile, China Telecom, and China Unicom (2023). <https://www.investorinsights.asia/post/comparing-china-s-telecom-providers-china-mobile-china-telecom-and-china-unicom>
Wang, J. et al. Evaluating flows of recreational ecosystem services using mobile phone data: A demonstration in the megacity of Beijing. *Applied Geography* 168, 103313 (2024).

Jia, J. S. et al. Population flow drives spatio-temporal distribution of COVID-19 in China. *Nature* 582, 389–394 (2020).

Zhou, Y. et al. Effects of human mobility restrictions on the spread of COVID-19 in Shenzhen, China: a modelling study using mobile phone data. *The Lancet Digital Health* 2, e417–e424 (2020).

Sampling strategy	The city-level samples includes all tourists to Inner Mongolia using China Unicom in each city.
Data collection	<p>A detailed data section can be found in the manuscript.</p> <p>The tourists data, which include weekly number of China Unicom tourists who traveled from 330 cities nationwide to cities in Inner Mongoli are directly provided by China Unicom.</p> <p>Weather data in this study were obtained from the National Climatic Data Center (NCDC,https://www.ncdc.noaa.gov/). The dataset covers 411 weather stations, with each city covered by at least one station. We merge the weather data with each city based on the latitude and longitude of each weather station and city.</p> <p>Air pollution data in this study was available from China's National Air Pollution Monitoring System (https://www.cnemc.cn/). The dataset contains daily concentrations of PM2.5 and ozone, as well as the average Air Pollution Index, sourced from about 1,400 air quality monitoring stations that cover all prefecture cities in China.</p> <p>To compute the travel cost, we compile a database that encompasses transportation expenses and travel time for various modes of transport. Flight costs and travel times were sourced from VariFlight (https://www.variflight.com/en/home). Train fares and travel times were derived from the official website of China Railway Ticketing 12306 (https://www.12306.cn/index/). Bus fares were gathered from the fare website (https://www.piaojia.cn/changtu/). The estimates cost of car travel were obtained from Gao De Map (https://gaode.com/).</p> <p>The annual counts of 5A-grade attractions and the four- and five-star hotels in destination cities were collected from the Bureau of Statistics of the Inner Mongolia Autonomous Region (https://tj.nmg.gov.cn/).</p> <p>The simulated data for future climate conditions are obtained from the National Tibetan Plateau Data Center (China) (http://data.tpdc.ac.cn). The dataset provides downscaled daily maximum and minimum temperatures on a 0.25°x0.25° grid.</p>
Timing	All datasets were collected and processed between May and June 2022.
Data exclusions	There are no missing values for the tourist statistics at the city level. However, there are a small number of missing values in the weekly weather and air pollution data, leading to the exclusion of samples with missing values in the regression. The total exclusion rate due to missing values was less than 0.1%, and the observations used in each regression are presented with the result tables.
Non-participation	The dataset contains the entire population of China Unicom tourists at the city level, with no instances of participant dropout.
Randomization	The data we used in this paper are summarized from whole population who uses mobilephone service from China Unicom. Thus, there is no randomization issue here.

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
<input checked="" type="checkbox"/>	<input type="checkbox"/> Antibodies
<input checked="" type="checkbox"/>	<input type="checkbox"/> Eukaryotic cell lines
<input checked="" type="checkbox"/>	<input type="checkbox"/> Palaeontology and archaeology
<input checked="" type="checkbox"/>	<input type="checkbox"/> Animals and other organisms
<input checked="" type="checkbox"/>	<input type="checkbox"/> Clinical data
<input checked="" type="checkbox"/>	<input type="checkbox"/> Dual use research of concern
<input checked="" type="checkbox"/>	<input type="checkbox"/> Plants

Methods

n/a	Involved in the study
<input checked="" type="checkbox"/>	<input type="checkbox"/> ChIP-seq
<input checked="" type="checkbox"/>	<input type="checkbox"/> Flow cytometry
<input checked="" type="checkbox"/>	<input type="checkbox"/> MRI-based neuroimaging

Plants

Seed stocks

n/a

Novel plant genotypes

n/a

Authentication

n/a