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Airport traffic and urban consumption carrying capacity: empirical evidence from a prefecture-level airport panel dataset

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Abstract. Using panel data on prefecture-level cities with airports in China from 2011 to 2023, this study employs a two-way fixed effects model to examine the relationship between airport traffic and urban consumption carrying capacity. The results indicate that passenger throughput has no robust and statistically significant effect on the total retail sales of consumer goods. In the tourism revenue model, both airport traffic and hub-airport pressure exhibit significantly positive effects, reflecting the regional gateway effect. In the wholesale and retail sector model, the coefficient of hub-airport pressure is negative but statistically insignificant for cities served by non-hub airports. These findings suggest that whether airport traffic can be converted into local consumption depends largely on a city's capacity to absorb and accommodate demand through its tourism, commercial, and service sectors.

Keywords: airport traffic, regional gateway effect, consumption carrying capacity, hub-airport pressure, tourism revenue

1. Introduction

Expanding domestic demand and improving the long-term mechanism for stimulating consumption are important components of China's pursuit of high-quality economic development. The expansion of consumer demand depends not only on household income and market expectations, but also on whether cities can provide a stable and convenient supply of goods and services. As a key node in the integrated transportation system, airports connect passenger markets, business networks, and tourism destinations. As the network of civil transport airports continues to extend to a growing number of prefecture-level cities, many small and medium-sized cities have sought to enhance accessibility through airport construction, route development, and airport-oriented economic planning, with the expectation of stimulating tourism, business activities, and consumer spending.

However, airport passenger traffic does not necessarily translate into local consumption. Passenger throughput reflects the scale of air transportation activities but does not indicate whether travelers remain in the city and engage in local spending. Some airport cities function primarily as regional gateways or transit hubs, with passengers continuing on to surrounding tourist destinations or commercial centers after arrival. In other cases, although a city possesses an airport, inadequate connectivity between the airport and urban districts, tourist attractions, commercial areas, accommodation facilities, and catering services may prevent air traffic from being converted into local consumption. Therefore, whether airport traffic can generate additional consumption largely depends on a city's consumption carrying capacity.

The development of regional airport systems further reshapes this relationship. Hub airports generally possess denser route networks, higher flight frequencies, and more comprehensive commercial service facilities. Through their gateway functions, they may expand the customer base of surrounding cities, while their advantages in shopping, hospitality, dining, and business services may also attract consumption toward the central city. Consequently, hub airports may not only promote regional consumption growth but also alter the spatial distribution of consumption among cities.

Existing studies have extensively examined the effects of airport accessibility on economic growth, industrial agglomeration, employment, and regional openness, as well as issues related to airport cluster development, hub airport functions, and airport economic zones. In contrast, relatively little attention has been paid to the conversion of airport traffic into actual consumption from the perspective of consumption carrying capacity. This study addresses three questions. First, does airport passenger traffic consistently promote the expansion of local consumption? Second, does hub-airport pressure act as a gateway force that stimulates consumption or as a commercial attraction effect that draws consumption away in different consumption scenarios? Third, how can cities served by non-hub airports improve their consumption carrying capacity and avoid becoming merely transit nodes?

To answer these questions, this paper uses a sample of prefecture-level cities with operating civil transport airports during the period 2011–2023. We construct city-year indicators of airport traffic, hub-airport pressure, and consumption carrying capacity. In addition to total retail sales of consumer goods, we incorporate domestic tourism revenue, total tourism revenue, and the total sales value of wholesale and retail enterprises above the designated size to identify the heterogeneous effects of airport traffic on tourism-related and commercial consumption. The results indicate that airport passenger throughput does not exhibit a robust and statistically significant relationship with aggregate consumption. Hub-airport pressure has a significantly positive effect in tourism revenue models, reflecting a regional gateway effect, whereas its coefficient is negative but statistically insignificant in the wholesale and retail business context for cities served by non-hub airports.

2. Literature review and analytical framework

2.1. Airport accessibility and urban economic activities

Existing studies generally suggest that airports influence business interactions, tourism activities, and regional economic growth by improving external accessibility and reducing travel and transaction costs. Wang Linfeng and Long Yinyan examined the economic spillover effects of airports [1, 2]. Zhang Dong and Yang Xuebing argued that airports serve not only as transportation resource hubs but also as important carriers of the aviation economy [3]. Wang Tingting emphasized that airport development requires support from urban industries and service functions in order to realize its economic potential [4].

2.2. Airport spatial distribution and the siphoning effect within airport systems

The economic impact of airports is also constrained by their spatial distribution and position within the aviation network hierarchy. Zhang Yihan et al. found significant regional disparities in airport accessibility across mainland China, which are associated with factors such as flight volume, airport operational scale, urban GDP, and population size [5]. Li Yafei et al. pointed out that airport service areas are not entirely restricted by administrative boundaries [6]. Xing Xinyuan argued that airports with high-quality route networks may exert a siphoning effect on the hinterland markets of neighboring airports [7].

2.3. Regional gateway effects and coordinated development

Hub airports should not be viewed solely as sources of negative siphoning effects. Huang Ke and Liu Yi argued that several hub airports in the Chengdu–Chongqing region possess complementary advantages and that coordinated planning based on the airport-cluster approach can facilitate resource integration [8]. Li Jian et al. noted that the differentiated functions, industrial coordination, and air–rail intermodal integration of Chengdu's dual-airport system have strengthened its capacity to stimulate regional economic development [9]. The development of airport clusters in the Guangdong–Hong Kong–Macao Greater Bay Area further demonstrates that inter-airport coordination has become an important issue in regional civil aviation development [10].

2.4. Literature assessment and theoretical mechanism

Overall, the existing literature provides three important foundations for this study. First, airport accessibility can influence urban economic activities. Second, the spatial distribution of airports affects the allocation of passenger and economic flows among cities. Third, hub-airport cities may either attract economic activities from surrounding hinterland cities or promote regional coordinated development through their gateway functions [11]. However, relatively few studies have directly examined whether airport traffic can be transformed into local urban consumption, and even fewer have distinguished between tourism-generated revenue and wholesale-retail commercial consumption. Building on the existing literature, this paper develops an analytical framework centered on the relationship among airport traffic, hub-airport pressure, and consumption carrying capacity.

3. Data, variables, and model specification

3.1. Sample selection and data sources

This study focuses on prefecture-level cities with operating civil transport airports during the period 2011–2023 and constructs a city–year panel dataset. The sample consists of prefecture-level cities for which both airport operation data and urban economic data can be successfully matched. The baseline panel includes 171 airport cities observed over 13 years, yielding a total of 1,953 city–year observations. This period provides relatively complete and consistent data coverage while encompassing the expansion of China's airport network, the development of airport cluster systems, and the economic fluctuations before and after the COVID-19 pandemic.

The dataset is compiled from five primary sources. First, airport operational data are obtained from the annual national airport statistical bulletins from 2011 to 2023 and aggregated to the city–year level after data cleaning. Second, economic indicators, including total retail sales of consumer goods, Gross Domestic Product (GDP), population size, fixed-asset investment, and industrial structure, are collected from the China Urban Database, regional GDP statistics, and the China City Panel Database. Third, data on domestic tourism revenue and total tourism revenue are incorporated. Fourth, geographic information on Chinese civil aviation airports is used to calculate great-circle distances between airport cities. Fifth, data on total retail sales of consumer goods and wholesale-retail trade activities at the prefecture-level city level are collected.

The data-cleaning process includes the standardization of city names, airport-name matching, and the processing of numerical variables. A standardized city identifier (city_std) is generated at the city level. Historical airport names, abbreviations, and cases involving multiple airports within a single city are reconciled and consolidated. Monetary variables and airport throughput indicators are converted into numerical form and transformed using natural logarithms. Missing values are not imputed. After data processing, the variable lnConsum contains 1,908 observations, lnPassenger contains 1,951 observations, the 200-kilometer hub-airport pressure variable contains 1,814 observations, domestic tourism revenue contains 1,593 observations, total tourism revenue contains 1,397 observations, and the total sales value of wholesale and retail enterprises above the designated size contains 1,911 observations.

3.2. Variable definitions

The dependent variables are grouped into three categories (see Table 1). First, the natural logarithm of total retail sales of consumer goods is used to measure aggregate consumption. Second, the natural logarithms of domestic tourism revenue and total tourism revenue are employed to capture tourism-generated income. Third, the natural logarithm of the total sales value of wholesale and retail enterprises above the designated size is used to reflect commercial shopping activities and the degree of urban consumption agglomeration.

Due to data availability constraints, the core explanatory variable is defined as the natural logarithm of airport passenger throughput, denoted as lnPassenger. Passenger throughput reflects the scale of air passenger traffic and serves as a fundamental proxy for airport accessibility and aviation activity. Alternative airport indicators include cargo and mail throughput as well as aircraft movements. Future research may further refine the analysis by incorporating route-level aviation network data.

Table 1. Definitions of main variables

Variable Category	Variable Name	Description
Aggregate Consumption	*lnConsume*	Natural logarithm of total retail sales of consumer goods
Tourism Revenue	$lnDomestic_{t}ourism_{r}evenue$	Natural logarithm of domestic tourism revenue
Tourism Revenue	$lnTourism_{t}otal_{r}evenue$	Natural logarithm of total tourism revenue
Commercial Consumption	$lnLimited_{w}holesale_{r}etail_{s}ales$	Natural logarithm of the total sales value of wholesale and retail enterprises above the designated size
Airport Traffic	*lnPassenger*	Natural logarithm of airport passenger throughput at the city level; throughput is aggregated for cities with multiple airports
Hub-Airport Pressure	$Siphon_{p}ressure_{200km}$	Distance-adjusted relative passenger-size advantage of the hub airport within a 200-kilometer radius
Control Variables	$lnGdp$, $lnPop_{c}ontrol$, $Service_{s}hare$	Economic scale, population size, and the share of the tertiary sector

Note: Variable names correspond to the processed dataset field names. Monetary variables and airport-throughput variables are transformed using natural logarithms in all regression analyses.

The hub-airport pressure variable is designed to capture the influence of nearby hub airports on a local airport city. For each airport city and year, the study identifies, within a radius of 200 kilometers, the non-local airport city with the largest passenger throughput as the regional hub airport. The measure incorporates both the relative size advantage of the hub airport and the distance-decay effect. A higher value indicates the presence of a larger and geographically closer hub airport exerting stronger competitive or spillover influences on the local city.

The control variables include economic scale, population size, and industrial structure. These are measured by the natural logarithm of regional GDP, the natural logarithm of the resident population or annual average population, and the share of tertiary-industry value added in regional GDP, respectively. In the subsample analysis, "non-hub airport cities" refer to prefecture-level airport cities after excluding municipalities directly under the central government, provincial capitals, and sub-provincial cities.

3.3. Measurement of hub-airport pressure

The construction of the hub-airport pressure indicator is based on two considerations. First, the greater the size advantage of a hub airport relative to a local airport, the stronger its capacity to organize regional passenger movements and consumption activities. Second, the influence of a hub airport is subject to a distance-decay effect: the shorter the distance, the greater the likelihood that residents and travelers will choose the hub airport for air travel, consume in the hub city, or access regional tourism destinations through it.

Using latitude and longitude information from the airport geographic database, this study calculates great-circle distances between airport cities. For cities with multiple airports, the airport with the highest passenger throughput in a given year is selected as the representative airport location. Subsequently, for each city *i* in year *t*, the non-local airport city *c* with the largest passenger throughput within a 200-kilometer radius is identified as the hub airport city. Hub-airport pressure is defined as follows (Equation (1)):

$$Siphon_{it} = \frac{lnPassenger_{ct} - lnPassenger_{it}}{Distance_{ic}} \quad (1)$$

where $Passenger_{ct}$ denotes passenger throughput in the hub-airport city, $Passenger_{it}$ denotes passenger throughput in the local airport city, and $Distance_{ic}$ represents the distance between the representative airports of the two cities. A higher value of this indicator implies that the nearby hub airport possesses a greater size advantage over the local airport and is geographically closer.

Importantly, this measure does not presuppose that the influence of a hub airport is necessarily negative. Hub-airport pressure may enhance tourism revenue in neighboring cities through a regional gateway effect, while it may also weaken local commercial consumption in non-hub airport cities through a commercial attraction effect. Accordingly, the interpretation of the indicator depends on the estimated effects across different dependent variables rather than treating it as synonymous with a "siphoning effect".

3.4. Model specification

To examine the relationship between airport traffic and urban consumption carrying capacity, the following baseline model is estimated (Equation (2)):

$$lnY_{it} = \alpha + \beta lnPassenger_{it} + \gamma X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (2)$$

where *i* denotes cities and *t* denotes years. The dependent variable Y_{it} alternatively represents total retail sales of consumer goods, domestic tourism revenue, total tourism revenue, and the total sales value of wholesale and retail enterprises above the designated size. $Passenger_{it}$ denotes airport passenger throughput, X_{it} is a vector of control variables, and μ_i and λ_t represent city fixed effects and year fixed effects, respectively.

To explore the underlying mechanism, the hub-airport pressure variable is incorporated into the model (Equation (3)):

$$lnY_{it} = \alpha + \beta lnPassenger_{it} + \theta Siphon_{it} + \gamma X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \tag{3}$$

The primary focus is the sign and statistical significance of the coefficient θ. A significantly positive θ in the tourism revenue models would suggest that hub airports generate positive spillovers through a regional gateway effect. Conversely, a negative θ in the wholesale and retail consumption models for non-hub airport cities would indicate the presence of commercial attraction pressure exerted by hub airports. Standard errors in all models are clustered at the city level. It should be noted that the relationship between airport traffic and urban consumption may be subject to bidirectional influences. Air passenger flows may affect local consumption through tourism, business travel, and shopping activities, while cities with stronger consumption bases and greater tourism attractiveness may attract additional flight routes and passenger traffic. Furthermore, time-varying factors such as local tourism promotion policies, the opening of high-speed rail services, and major exhibitions or events may simultaneously influence airport traffic and consumption performance. To mitigate these concerns, the analysis employs two-way fixed effects and a set of control variables, and robustness checks are conducted using one-period lagged airport variables. Nevertheless, the empirical findings should be interpreted as evidence of statistical associations rather than strict causal relationships.

4. Empirical results

4.1. Descriptive statistics and variable coverage

The baseline panel dataset covers 171 airport cities from 2011 to 2023, yielding a total of 1,953 city–year observations. The variable lnConsume contains 1,908 observations, lnPassenger contains 1,951 observations, and the 200-kilometer hub-airport pressure variable contains 1,814 observations. Among the scenario-specific variables, domestic tourism revenue covers 1,593 observations, total tourism revenue covers 1,397 observations, and the total sales value of wholesale and retail enterprises above the designated size covers 1,911 observations. The wholesale and retail consumption regressions reported in Table 2 additionally require non-missing values for hub-airport pressure, airport traffic, and all control variables. Consequently, the full-sample model uses 1,349 observations, while the subsample model for non-hub airport cities uses 1,015 observations.

Each regression is estimated using all available observations for the variables involved. Differences in sample size across columns mainly result from missing data on tourism revenue, hub-airport pressure, and population controls. All specifications control for city fixed effects, year fixed effects, economic scale, population size, and the share of the tertiary sector. Standard errors are clustered at the city level. Therefore, the regression results should be interpreted as evidence of statistical associations rather than strict causal effects.

4.2. Baseline results: airport traffic does not necessarily translate into aggregate consumption

Column (1) of Table 2 reports the results for total retail sales of consumer goods. The coefficient on airport passenger throughput is 0.0070 (p = 0.6715), while the coefficient on hub-airport pressure is −0.5768 (p = 0.6924). Neither coefficient reaches conventional levels of statistical significance. These findings indicate that, after controlling for city characteristics, year-specific shocks, and other relevant factors, there is no stable and statistically significant relationship between airport passenger traffic and aggregate urban consumption.

Table 2. Regression results of airport traffic, hub-airport pressure, and different consumption scenarios

Variables	Total Retail Sales of Consumer Goods	Domestic Tourism Revenue	Total Tourism Revenue	Wholesale and Retail Sales Above Designated Size	Domestic Tourism Revenue (Non-Hub Cities)	Total Tourism Revenue (Non-Hub Cities)	Wholesale and Retail Sales Above Designated Size (Non-Hub Cities)
ln Passenger	0.0070	0.1148***	0.1208***	-0.0159	0.0840*	0.0949**	-0.0470
	(0.0165)	(0.0435)	(0.0427)	(0.0526)	(0.0459)	(0.0415)	(0.0615)
Hub-Airport Pressure	-0.5768	7.6268**	9.4794***	-6.1108	7.2485*	10.4641***	-10.0589
	(1.4580)	(3.3494)	(3.5252)	(5.2620)	(3.7918)	(3.7830)	(6.6830)
ln GDP	1.0003***	0.4469***	0.3866**	0.6486***	0.4606***	0.3480**	0.6244***
	(0.0797)	(0.1546)	(0.1717)	(0.1137)	(0.1695)	(0.1727)	(0.1317)
ln Pop	-0.0637	-0.2364*	-0.3075***	0.1481	-0.3143**	-0.3836**	0.2393
	(0.0673)	(0.1341)	(0.1139)	(0.1052)	(0.1542)	(0.1731)	(0.2023)
ServiceShare	1.4331***	1.2139*	0.2747	-0.5458	1.2178*	0.2191	-0.7185
	(0.2348)	(0.6352)	(0.7277)	(0.4757)	(0.7325)	(0.9031)	(0.5459)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1346	1119	948	1349	844	696	1015
Number of Cities	163	158	155	163	122	123	127
R^2	0.9876	0.9692	0.9511	0.9500	0.9644	0.9385	0.9024

Note: Clustered standard errors at the city level are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. All models control for city fixed effects and year fixed effects.

4.3. Tourism revenue generation: hub-airport pressure reflects a regional gateway effect

Columns (2) and (3) of Table 2 use domestic tourism revenue and total tourism revenue as the dependent variables, respectively. The coefficients on lnPassenger are 0.1148 and 0.1208, both positive and statistically significant at the 1% level, indicating a stable positive association between airport passenger throughput and tourism-related revenue generation.

Hub-airport pressure also exhibits a significantly positive effect in the tourism revenue models. In the domestic tourism revenue model, the coefficient is 7.6268 and is significant at the 5% level. In the total tourism revenue model, the coefficient reaches 9.4794 and is significant at the 1% level. Similar results are observed in the subsample of non-hub airport cities, where the coefficients remain positive and statistically significant at the 10% and 1% levels, respectively. These findings suggest that, within the tourism context, hub-airport pressure is more consistent with a regional gateway effect than with a siphoning effect.

4.4. Wholesale and retail activities: evidence of commercial attraction in non-hub airport cities remains limited

Columns (4) and (7) of Table 2 present the results for the wholesale and retail sector. In both the full sample and the subsample of non-hub airport cities, the coefficients on hub-airport pressure are −6.1108 and −10.0589, respectively. Although both coefficients are negative, neither is statistically significant. Likewise, lnPassenger fails to exhibit a significant positive relationship with wholesale and retail sales. Because wholesale and retail consumption depends more heavily on the quality of commercial districts, brand availability, and the overall service capacity of a city, non-hub airport cities may face competitive pressure from nearby central cities with stronger commercial attraction. However, the current empirical evidence supports only a cautious interpretation: there are indications of a commercial attraction or siphoning effect, but the evidence remains insufficient to draw definitive conclusions.

4.5. Robustness checks using alternative indicators and lagged variables

Table 3. Additional tests using alternative measures of hub-airport pressure

Variables	Domestic Tourism Revenue	Wholesale and Retail Sales Above Designated Size (Non-Hub Cities)
ln Passenger	0.0562*	-0.0885
	(0.0334)	(0.0838)
Hub Airport Size / Distance	0.0509*	
	(0.0289)	
Relative Size of Hub Airport to Local Airport		-0.1131
		(0.0737)
ln GDP	0.4513***	0.6345***
	(0.1567)	(0.1294)
ln Pop	-0.2475*	0.2805
	(0.1375)	(0.1986)
ServiceShare	1.2475**	-0.7066
	(0.6344)	(0.5488)
Control Variables	Yes	Yes
City Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
Observations	1119	1015
Number of Cities	158	127
R^2	0.9691	0.9027

Note: Clustered standard errors at the city level are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Table 3 shows that, in the domestic tourism revenue model, the coefficient on the alternative measure of hub-airport pressure—defined as hub-airport size divided by distance—is 0.0509 and statistically significant at the 10% level. In the model for wholesale and retail sales in non-hub airport cities, the coefficient on the relative size of the hub airport compared with the local airport is −0.1131. Although the sign is negative, the estimate is not statistically significant. These results are broadly consistent with those reported in Table 2.

To address potential reverse-causality concerns, the study further replaces airport passenger throughput and hub-airport pressure with their one-period lagged values. The results indicate that lagged airport traffic remains insignificant in the aggregate consumption model. In contrast, the coefficients on lagged airport traffic are 0.1176 and 0.1346 in the domestic tourism revenue and total tourism revenue models, respectively, both significant at the 1% level. Lagged hub-airport pressure also remains significantly positive in the tourism specifications. In the wholesale and retail models for both the full sample and the non-hub airport subsample, lagged hub-airport pressure continues to exhibit a negative but statistically insignificant coefficient. Overall, the findings from the alternative-indicator and lagged-variable tests are consistent with the baseline results, suggesting that the main conclusions of the study remain robust and that the direction of the estimated relationships is not altered by the use of lagged explanatory variables.

5. Conclusion and policy implication

5.1. Main findings

This study yields three principal findings. First, no robust and statistically significant relationship is identified between airport passenger throughput and total retail sales of consumer goods, indicating that airport traffic does not automatically translate into local consumption. The mere presence of passenger flows is insufficient to generate consumption growth unless cities possess the capacity to retain and absorb those flows through appropriate commercial and service infrastructures. Second, both airport passenger throughput and hub-airport pressure exhibit significantly positive effects in the tourism revenue models. This finding suggests that hub airports may expand tourist inflows through a regional gateway effect, thereby enhancing tourism-related revenue generation in surrounding cities. Third, in the wholesale and retail sector models, the coefficient on hub-airport pressure is negative but statistically insignificant for non-hub airport cities. While this pattern is consistent with the possibility of commercial attraction or siphoning by larger central cities, the evidence is insufficient to support a strong conclusion regarding such effects.

5.2. Enhancing the local consumption carrying capacity of small and medium-sized airport cities

For small and medium-sized airport cities, policy priorities should shift from merely attracting passenger traffic to retaining consumption locally. Local governments and airport authorities should strengthen transportation connectivity among airports, urban centers, commercial districts, tourist attractions, and convention venues, thereby creating an integrated consumption chain linking airports, city centers, tourist destinations, and shopping areas. More specifically, airport shuttle services and tourism-oriented transport routes can be optimized around flight arrival schedules. Airports may provide dedicated access points for local tourism products, accommodation services, dining options, and specialty goods, while cities can introduce short-stay tourism packages, nighttime consumption programs, and preferential products targeted at air travelers. In addition, cities should cultivate differentiated consumption scenarios according to their passenger-flow characteristics. Business-oriented cities may focus on convention and exhibition activities as well as efficient accommodation and catering services. Tourism-oriented cities may emphasize integrated attraction tickets and cultural tourism consumption. Resource-based and border-region cities may leverage local specialties, ethnic cultural resources, and ecological tourism products to enhance visitor spending.

5.3. Strengthening the regional gateway function of hub airports while mitigating excessive commercial attraction

The positive relationship between hub-airport pressure and tourism revenue indicates that hub airports may serve as important gateways for regional tourism flows. Consequently, airport-cluster planning should not regard hub airports solely as competitors to surrounding airports. Instead, hub airports should be encouraged to assume regional passenger-distribution and traffic-allocation functions. Regional tourism products, through-ticketing arrangements, air–rail intermodal services, air–bus connections, and destination-promotion platforms can help surrounding airport cities share the passenger flows generated by hub airports. Hub-airport cities should avoid concentrating tourism services, passenger distribution functions, and commercial consumption excessively within their own jurisdictions. Meanwhile, neighboring airport cities should actively integrate into the passenger-source networks of hub airports by designing cross-city tourism routes, weekend travel packages, and short-haul air-travel products based on their own tourism resources and consumption characteristics.

5.4. Improving civil aviation governance and local policy evaluation systems

The evaluation of airport development should extend beyond traditional operational indicators such as passenger throughput, cargo and mail throughput, and aircraft movements. Greater attention should be paid to traffic-conversion indicators, including tourism revenue, accommodation and catering performance, wholesale and retail sales, passenger length of stay, and the efficiency of airport-to-city-center connections. Similarly, airport-cluster planning and route-allocation policies should recognize both the positive spillover effects and the potential attraction effects exerted by hub airports on surrounding cities. Policymakers should encourage neighboring airport cities to develop differentiated route networks and distinctive consumption scenarios. Civil aviation authorities may further promote data-sharing mechanisms among airport operators, tourism departments, commerce authorities, transportation agencies, and statistical bureaus. Regular monitoring of how air passenger flows are converted into local stays, accommodation, tourism activities, and shopping expenditures would improve policy evaluation. Airport subsidies, route-development programs, and tourism-promotion initiatives could then be linked more closely to actual consumption-conversion outcomes, thereby enhancing the effectiveness of airport investment and operational policies.

5.5. Limitations and directions for future research

Several limitations should be acknowledged. Although the use of one-period lagged airport variables helps alleviate concerns regarding reverse causality and simultaneity, it cannot substitute for identification strategies based on quasi-natural experiments or instrumental variables. In addition, detailed data on accommodation and catering revenues, tourist length of stay, and airport-to-attraction accessibility remain insufficiently available. The hub-airport pressure indicator also does not fully incorporate factors such as flight schedules, ticket prices, route quality, and multimodal travel times. Future research may exploit events such as airport construction and expansion projects, the opening of new air routes, or the introduction of high-speed rail services to implement difference-in-differences or event-study designs. Where stronger exogeneity assumptions can be established, researchers may further explore instrumental-variable approaches based on historical route networks, topographic conditions, and early airport-location patterns to obtain more rigorous causal estimates.

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