Research on the Impact of Digital Economy on the Development of Airport Economy under the Perspective of New Quality Productivity

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Abstract. Against the backdrop of developing new-quality productive forces, the digital economy, with its unique mode of production, innovation capacity, and driving force, as well as its role in fostering new technologies and skilled labor, fully demonstrates its strength and potential as a representative of these emerging productive forces. This study measures and conducts an econometric analysis of the development levels of the digital economy and the airport economy based on panel data from 43 prefecture-level cities and municipalities in China from 2011 to 2021. The findings indicate that the digital economy significantly promotes the development of the airport economy. The mediation effect analysis reveals that enhancing airport preference and technological innovation can positively reinforce the impact of the digital economy on airport economy development. Additionally, the regional heterogeneity analysis indicates that the digital economy exerts a stronger influence on the airport economy in the eastern and central regions than in the western region of China.

Keywords: Airport economy; Digital economy; New-quality productive forces; Empirical analysis; Heterogeneity analysis

1 Introduction

Amid accelerating globalization and rapid advancements in information technology, the airport economy has emerged as a key driver of urban development. China has established 17 airport economic demonstration zones, which have significantly promoted industrial clustering, regional economic optimization, and international cooperation. The introduction of new-quality productive forces in 2023 further emphasizes the need for the airport economy to identify new growth drivers. The digital economy—defined by innovation, efficiency, and the creation of new technologies and talent—aligns closely with the core attributes of these new forces. A strong interactive relationship exists between the digital economy and the airport economy.

In the broader context, developing the digital economy is a key strategy for fostering new-quality productive forces and unlocking growth potential in the airport economy. Existing research provides valuable insights. Since Tapscott introduced the concept of

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the "digital economy era" in 1996 [1], scholars have explored its economic implications, with Lu Minfeng [2] highlighting data as a new production factor and Sabli [3] et al. identifying key global research trends. Other studies emphasize its role in improving innovation efficiency, resource allocation, and consumer market expansion [4].

Parallel to this, the aerotropolis concept has framed the airport as a new urban growth pole. Van Wijk [5] and Kasarda [6] stress the airport's evolving function and the need for coordinated development strategies. Chinese scholars, such as Zhao Nanqi [7] and Wang Haijie [8], have examined the spatial, industrial, and strategic dimensions of airport economies, confirming their central role in regional growth under national strategies like "dual circulation."

2 Mechanism Analysis and Research Hypotheses

2.1 Theoretical Framework of Digital Economy and Airport Economy Development

The airport economy represents a modern economic model centered on integrated transport systems and the strategic advantages of international hub airports in passenger, cargo, and information flows. It offers high-efficiency, high-quality, and high value-added services to global markets, fostering industrial agglomeration and serving as a strategic node in global industrial restructuring. Amid globalization, it has emerged as a key driver of regional economic growth [9].

Based on this, we propose the first hypothesis:

H1: The digital economy has a significant positive impact on the development of the airport economy.

2.2 Mechanism Analysis

The Digital Economy Promotes Airport Economic Development by Enhancing Airport Industry Preference.

This forms the basis for the following hypothesis:

H2: The digital economy promotes the development of the airport economy by enhancing airport industry preference.

The Digital Economy Promotes Airport Economic Development by Strengthening Technological Innovation Capability.

These insights underpin the following hypothesis:

H3: The digital economy promotes the development of the airport economy by strengthening technological innovation capability.

3 Model Specification and Variable Description

3.1 Model Construction

Based on the aforementioned research hypotheses, we first establish the following basic model to verify the direct impact of the digital economy on the development of the airport economy:

$$Aec_{it} = \beta_0 + \beta_1 Dig_{it} + \beta_c Z_{n,it} + \mu_i + \delta_t + \varepsilon_{it} \quad (1)$$

Where Aec_{it} represents the level of airport economy development in city i at time t; Dig_{it} denotes the level of digital economy development in city i at time t; $Z_{(i,t)}$ represents the control variables; β_0 is the intercept term; β_1 is the regression coefficient of the explanatory variable; μ_i captures the individual fixed effects of city i that do not vary over time; δ_t represents time-fixed effects; and ε_{it} is the random error term.

To further explore the mechanism through which the digital economy influences the development of the airport economy, we validate the hypothesized mediating variables by constructing the moderation models (5) – (6):

$$Aec_{it} = \alpha_0 + \alpha_1 Dig_{it} + \varepsilon_{it} \quad (2)$$

$$M_{n,it} = \alpha_2 + \alpha_3 Dig_{it} + \varepsilon_{it} \quad (3)$$

$$Aec_{it} = \alpha_4 + \alpha_5 Dig_{it} + \alpha_6 M_{n,it} + \varepsilon_{it} \quad (4)$$

$$Aec_{it} = \gamma_0 + \gamma_1 Dig_{it} + \gamma_2 M_{it} + \sum_{n=3}^{5} \gamma_n Z_{n,it} + \varepsilon_{it} \quad (5)$$

$$Aec_{it} = \varphi_0 + \varphi_1 Dig_{it} + \varphi_2 M_{it} + \varphi_3 Dig_{it} * M_{it} + \sum_{n=4}^{6} \varphi_n Z_{n,it} + \varepsilon_{it} \quad (6)$$

where $M_{n,it}$ represents the mediating variable, and $Dig_{it}*M_{it}$ denotes the interaction term between the digital economy and the moderating variable.

3.2 Variable Description

Dependent Variable: Urban Airport Economy Development Level (Aec).

The study assesses airport economic development from macro-regional dynamics, meso-industrial performance, and micro-firm behavior. Drawing on the framework of Cui Ting and Cao Yunchun (2010) and using prefecture-level data, it constructs a composite index based on four dimensions , as outlined in Table 1:

An entropy-weighted TOPSIS approach is used to integrate these indicators objectively.

Table 1. Indicator System for Evaluating the Development Level of Airport Economy

Primary Indicator	Secondary Indicator	Weight Coefficient	Indicator Attribution
Hinterland Support Index	GDP per Capita	4.30%	+

(HSI)	Tertiary Industry Contribution to GRP	2.41%	+
	Urban Fixed-Asset Investment (UFAI)	10.78%	+
Airport Catchment Analysis	Air Freight Throughput	33.12%	+
	Air Passenger Traffic	17.34%	+
Urban Development Potential Index (UDPI)	R&D Personnel Full-Time Equivalent	16.40%	+
	Road Area per Capita	2.60%	+
Industrial Performance Metrics	Number of Designated-Size Enterprises	13.05%	+

Core Explanatory Variable: Urban Digital Economy Development Level (Dig).

These indicators are detailed in Table 2. To ensure an objective evaluation, this study employs the entropy-weighted TOPSIS method to process the data, ultimately deriving a comprehensive evaluation index for urban digital economy development.

Table 2. Indicator System for Evaluating the Development Level of Digital Economy

Primary Indicator	Secondary Indicator	Weight Coefficient	Indicator Attribution
Internet Penetration Rate	Internet Users per 100 Population	14.68%	+
Information Industry Workforce Profile	Employees in ICT Service Sector	47.39%	+
Industrial Output Value of Internet Sector	Telecommunication Service Volume per Capita	23.26%	+
Mobile Telephone Penetration Rate	Telephone Subscribers per 100 Population	8.16%	+
Digital Financial Development Index	Digital Financial Inclusion Index	6.51%	+

Mediating Variables.

Airport Industry Preference (InUp).

Reflects the industrial reliance on airport resources, measured as the ratio of tertiary to secondary industry value-added, indicating the degree of high-tech, high-value-added clustering in airport zones.

Technological Innovation Capability (TeIn).

Quantified as the ratio of R&D expenditure to the total output of the tertiary sector, capturing the indirect influence of technological advancements on airport economy expansion.

Control Variables.

To comprehensively analyze the impact of the digital economy on the development of the airport economy and to mitigate endogeneity issues caused by omitted variables, this study incorporates several control variables:

Regional Economic Development Level (Eco), Foreign Investment (Inv), Urbanization Level (Urb) and Human Capital (Hum).

3.3 Data Description

The analysis employs panel data from 43 prefecture-level cities in China over the period 2011–2021, as shown in Table 3. Data sources include the China Urban Statistical Yearbook, CEIC China Economic Database, EPS Database, local statistical bulletins, the Statistical Yearbook on Science and Technology of Prefecture-Level Cities, and the Peking University Digital Inclusive Finance Index Report.

Table 3. Empirical City

Regional Distribution	City or Municipality
Eastern Region	Beijing, Tianjin, Shanghai, Nanjing, Shijiazhuang, Xiamen, Hangzhou, Yantai, Sanya, Ningbo, Zhuhai, Fuzhou, Jieyang, Haikou, Guangzhou, Shenzhen, Qingdao, Quanzhou, Jinan, Wenzhou, Nanning
Western Region	Chengdu, Yinchuan, Lhasa, Urumqi, Xining, Lanzhou, Lijiang, Chongqing, Guiyang, Xi'an, Kunming
Central Region	Wuhan, Hohhot, Changchun, Taiyuan, Shenyang, Dalian, Harbin, Changsha, Zhengzhou, Hefei

Descriptive analysis (Table 4) reveals significant cross-city disparities in airport economy development (maximum 0.791, minimum 0.00958, standard deviation 0.12) and in digital economy metrics, reflecting pronounced regional differences. Notably, the high standard deviation in technological innovation (42.55) underscores substantial differentiation across regions. Control variables such as foreign investment also exhibit marked variance, largely driven by regional economic and geographical factors.

Table 4. Descriptive Statistical Results of Variables

VARIABLES	N	mean	sd	min	max
Level of Airport-Centric Economic Development	473	0.119	0.120	0.00958	0.791
Level of Digital Economy Development	473	0.119	0.106	0.00742	0.671
Airport Proximity Preference Index	473	1.539	0.838	0.431	5.348
Airport-Centric Logistics Efficiency	473	5.347	9.097	$3.22e^{-05}$	67.60
Technological Innovation	473	32.05	42.55	0.332	442.4
Trade Competitiveness Index	473	0.0990	0.398	-0.956	0.994

4 Empirical Results and Analysis

4.1 Baseline Regression

Using OLS, fixed-effects, and random-effects models—with model selection supported by a Hausman test—the digital economy development level (Dig) consistently shows a robust, significantly positive effect on airport economy development (Aec) as Table 5. The fixed-effects regression yields a coefficient of 0.271 (significant at the 1% level), confirming Hypothesis H1 that a one-unit increase in digital economy development enhances airport economic performance. Regional economic development (coefficient 0.073), urbanization (0.154), and human capital (0.012) further positively contribute to airport economy growth, while foreign investment is statistically insignificant due to its structural characteristics [10], thus validating Hypothesis H1.

Table 5. Empirical Results

	(1) Aec	(2) OLS	(3) Fe	(4) Re
Dig	0.850***	0.717***	0.271***	0.344***
	(0.035)	(0.037)	(0.040)	(0.038)
Eco		-0.004	0.073***	0.067***
		(0.011)	(0.008)	(0.008)
Inv		0.012***	0.001	0.001
		(0.002)	(0.002)	(0.002)
Urb		0.025***	0.154***	0.048***
		(0.005)	(0.034)	(0.012)
Hum		-0.001	0.012**	0.009*
		(0.005)	(0.005)	(0.005)
_cons	0.018**	-0.209**	-1.775***	-1.046***
	(0.006)	(0.101)	(0.223)	(0.113)
N	473.000	473.000	473.000	473.000
IFE	Y	Y	Y	
TFE	Y	Y	Y	
r2	0.560	0.649	0.477	
r2_a	0.559	0.645	0.419	

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

4.2 Regional Heterogeneity Analysis

Grouped regression analysis across Eastern, Central, and Western regions (Table 6) indicates that digital economy development significantly promotes airport economy growth in all regions, with the Central region exhibiting the most pronounced effects.

Urbanization significantly impacts the Eastern and Western regions but is less influential in the Central region, where interregional collaboration seems critical. Human capital is significant only in the Central region, suggesting that talent constraints affect inland areas more acutely.

Table 6. Subgroup Regression Results

	(1) Aec	(2) Eastern Region	(3) Western Region	(4) Central Region
Dig	0.271***	0.304***	0.147**	0.356***
	(0.040)	(0.066)	(0.057)	(0.066)
Eco	0.073***	0.068***	0.069***	0.081***
	(0.008)	(0.015)	(0.012)	(0.012)
Inv	0.001	-0.005	0.001	0.004
	(0.002)	(0.005)	(0.002)	(0.002)
Urb	0.154***	0.188***	0.199***	-0.005
	(0.034)	(0.052)	(0.062)	(0.053)
Hum	0.012**	0.013	0.010	0.010*
	(0.005)	(0.009)	(0.011)	(0.005)
_cons	-1.775***	-1.933***	-1.842***	-0.947***
	(0.223)	(0.373)	(0.345)	(0.361)
N	473.000	231.000	121.000	121.000
r2	0.477	0.443	0.553	0.675
r2_a	0.419	0.375	0.490	0.629
F	77.427	32.621	26.027	43.696

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

4.3 Mediating Effects

Two mediating mechanisms are identified in Table 7:

1. Airport Industry Preference (InUp): Digital economy development significantly enhances industry proximity to airports (coefficient 2.389, p<0.01), which in turn mediates 23.25% of the total effect of digital economy on airport economy development, thereby confirming Hypothesis H2.
2. Technological Innovation (TeIn): The digital economy significantly boosts technological innovation (coefficient 167.97, p<0.01), which mediates 18.08% of the effect, supporting Hypothesis H3.

Table 7. Mediation Effect Analysis Results

	(1) Aec	(2) InUp	(3) Aec	(4) TeIn	(5) Aec
Dig	0.271***	2.389***	0.208***	167.973***	0.222***

	(0.040)	(0.368)	(0.041)	(23.912)	(0.041)
Eco	0.073***	0.686***	0.055***	19.349***	0.068***
	(0.008)	(0.076)	(0.009)	(4.965)	(0.008)
Inv	0.001	-0.022	0.001	1.056	0.000
	(0.002)	(0.019)	(0.002)	(1.251)	(0.002)
Urb	0.154***	0.648**	0.137***	141.729***	0.113**
	(0.034)	(0.311)	(0.033)	(20.190)	(0.035)
Hum	0.012**	0.117**	0.008	3.532	0.010**
	(0.005)	(0.050)	(0.005)	(3.220)	(0.005)
InUp			0.026***		
			(0.005)		
TeIn					0.000***
					(0.000)
_cons	-1.775***	-10.974***	-1.488***	-1121.563***	-1.448***
	(0.223)	(2.063)	(0.224)	(134.057)	(0.237)
N	473.000	473.000	473.000	473.000	473.000
r2	0.477	0.440	0.507	0.385	0.493
r2_a	0.419	0.378	0.452	0.317	0.435

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

5 Main Research Conclusions and Policy Recommendations

5.1 Research Conclusions

Based on panel data from 43 cities (2011–2021) and employing an entropy-weighted TOPSIS approach, this study evaluates urban airport economy and digital economy development to assess their interaction and underlying mechanisms. The key conclusions are:

1. Digital Economy's Impact: The digital economy significantly promotes airport economic development by improving operational efficiency, driving industrial upgrading, and facilitating international integration. Digital integration optimizes resource allocation, enhances market responsiveness, and supports flexible industrial restructuring, thereby reinforcing global competitiveness.
2. Regional Variation: The positive influence of the digital economy is more pronounced in the eastern and central regions, where advanced digital capabilities and innovation drive greater efficiency and internationalization. In contrast, the western region experiences a weaker effect due to infrastructural and market openness constraints.
3. Mediating and Moderating Mechanisms:
   a. Mediators: Both airport industry preference and technological innovation are crucial in mediating the digital economy's effect on airport development. Enhanced industrial clustering and innovation act as key transmission mechanisms.

b. Moderator: Improved airport logistics efficiency further strengthens this effect by facilitating rapid goods flow and reducing transaction costs. Conversely, higher trade competitiveness can negatively moderate the relationship, possibly due to intensified market pressures and resource reallocation challenges.

5.2 Policy Recommendations

Drawing on these findings, several targeted policy recommendations are proposed:

1. Region-Specific Strategies: Tailor policies to regional conditions. The eastern and central regions, benefiting from established digital infrastructures and mature markets, should continue to harness digital opportunities. The western region, by contrast, requires strengthened infrastructure, market liberalization, and an enhanced digital ecosystem to better absorb digital investments. National strategies should reflect these disparities by promoting digital integration, innovation, and talent cultivation based on regional strengths.
2. Leveraging the Digital Economy as a Multidimensional Driver:
   a. Exploit digital technologies and innovations to build robust regional economies that underpin airport growth.
   b. Optimize foreign investment channels to attract high-tech and modern service sectors.
   c. Accelerate urbanization and transportation infrastructure development to secure efficient logistics and expand market access.
   d. Invest in human capital to supply the skilled workforce necessary for the smart, green, and service-oriented transformation of the airport economy.
3. Utilizing Mediating and Moderating Mechanisms:
   a. Encourage convergence between traditional industries and digital sectors to drive structural and high-end industrial development.
   b. Enhance logistical networks and reduce operational costs to improve the responsiveness and efficiency of the airport economy.
   c. Promote international cooperation and market expansion to mitigate global trade uncertainties and safeguard competitive positioning within global value chains.

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