A Study on the Relationship between Air Transport and Regional Development Based on a Difference-in-Differences Model

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Abstract. In a global context, the relationship between air transport and regional development is complex. Given that a large number of small and medium-sized airports in China suffer from insufficient passenger traffic and rely on subsidies, the question of whether air transport can effectively promote regional development remains to be answered. Existing research has largely focused on economic dimensions, with insufficient attention paid to social aspects, and the underlying mechanisms remain unclear. To this end, this paper takes Huai'an City in Jiangsu Province, where Lianshui International Airport is located, as a case study. It employs DID and FEM models to conduct empirical analyses from both economic and educational perspectives, and constructs a mediation model to explore the underlying mechanisms. The findings reveal that: (1) air transport promotes economic development; (2) air transport inhibits educational development; (3) air transport presents both advantages and disadvantages, acting as a double-edged sword. Based on these findings, three recommendations are proposed: implementing a talent recruitment strategy; strengthening infrastructure development; and promoting inter-regional cooperation and resource sharing.

Keywords: Air Transport; Regional Development; DID Model

1 Introduction

In a global context, the relationship between air transport and regional development is complex. Whilst small and medium-sized airports in China generally suffer from a lack of passenger traffic and rely on subsidies, local authorities continue to actively plan new airports; the question of whether air transport can promote regional development remains to be answered. Taking Huai'an in Jiangsu Province as an example, although the airport attracted over 800 foreign-invested enterprises and generated annual tax revenues of 5.4 billion yuan following its opening in 2011, there has been a severe outflow of labour and constraints on social development, indicating that air transport presents both benefits and drawbacks. Existing research has largely focused on economic impacts, with insufficient attention paid to the social dimension and underlying mechanisms. Consequently, this study takes Huai'an City as a case study, employing a

T. G. Guan et al. (eds.), *Proceedings of the 2026 4th International Conference on Digital Economy and Management Science (CDEMS 2026)*, Advances in Economics, Business and Management Research 392,
https://doi.org/10.2991/978-94-6239-699-9_50

difference-in-differences model to conduct empirical analysis from both economic and educational perspectives. The aim is to address the core question of whether air transport ultimately benefits or hinders regional development.

2 Literature Review

International scholars began researching the relationship between air transport and regional economies at an early stage. Irwin & Kasarda (1991) find that airports strongly attract logistics, manufacturing, and long-distance travel-related professions [1]. Hawlena (2011) notes a shift in European air transport from major to regional airports, with usage depending on infrastructure and aviation services [2]. Hart & McCann (2000) and others support the bidirectional optimisation effect between air transport and regional economic structures [3].

Since the beginning of the 21st century, domestic scholars have gradually undertaken relevant research, primarily employing methods such as input-output analysis and Granger causality tests. Shen & Wu (2023) applied a VAR model with cointegration, Granger causality, impulse response, and variance decomposition to analyze the relationship between Su Nan Shuofang Airport and Wuxi's economic development (2005–2020)[4]. Luo & Sun (2023) built a theoretical framework for aerotropolis stages and empirically examined the causal link between Lanzhou Zhongchuan Airport and regional economic growth[5]. Using system dynamics, Feng (2023) found that airport air traffic growth and regional economic development reinforce each other[6].

Existing studies generally recognize air transport's positive effects on regional economies (e.g., employment, factor flows), but note it may hinder development in declining-population areas. Moreover, most research uses urban panel data and diverse methods yet overlooks social factors like education and healthcare, potentially biasing results. This paper addresses these gaps by taking Huai'an City as a case study, integrating social factors to explore the air transport–regional development relationship and support local policymaking.

3 Interaction Mechanisms and Research Hypotheses

Civil aviation drives and relies on regional development, with both positive and negative impacts across sectors. Focusing on economy and education under the net positive assumption, this paper proposes corresponding hypotheses.

Economic aspect: Air transport promotes enterprise clustering, industrial chains, and economies of scale (new economic geography), enhancing regional competitiveness. However, when the airport is smaller than a certain size, its positive impact is not particularly noticeable Assuming net positive effect, H1: H1: Air transport promotes regional economic development.

Education aspect: Air transport attracts skilled talent and connects labor markets; industrial clustering fosters cooperation between educational institutions and enterprises. But it may cause a siphon effect, benefiting large cities while harming smaller

towns. Assuming net positive effect, H2: Air transport promotes regional educational development.

4 Research Design

4.1 Sample Selection and Data Sources

This study designates Huai'an City (the location of Lianshui International Airport) as the experimental group, and the five surrounding cities without airports—Chuzhou, Suqian, Bengbu, Huainan and Suzhou—as the control group, covering the period from 2005 to 2021. Taking into account the lag in the impact of airport operations, the period from January to June of each year is designated as the current year of operation, whilst July to December is recorded as the following year. Data sources include China Economic Net, the National Bureau of Statistics, the *China Urban Statistical Yearbook*, the Huai'an Municipal Government and Bureau of Statistics, the China Regional Economic Database, the *Statistical Bulletin on National Economic and Social Development*, and the *Statistical Bulletin on the Development of China's Civil Aviation Industry*.

4.2 Econometric Mode

This study employs a DID model, treating the opening of civil airports as a quasi-natural experiment. Based on panel data from 2005 to 2021 for Huai'an and surrounding cities without airports, the study analyses the impact of airport opening on regional development from both economic and educational perspectives. The model is specified as follows:

$$Y_{it}=\alpha_0+\alpha_1 Policy_{it}+\beta\varphi_{it}+\theta_t+\delta_i+\varepsilon_{it} \quad (1)$$

Y represents the regional development variable for sample i in year t, where α_1 is the coefficient of the main explanatory variable, β is the coefficient of the covariate,θ_t is the time fixed effect,δ_i is the individual fixed effect, and ε_{it} is the random error term.

4.3 Variable Description

Dependent variables: This section analyses the data from both economic and educational perspectives, drawing upon the work of Liu Bingsheng et al. (2023)[7] the economic dimension is measured using GDP (G), whilst the educational dimension is measured using education expenditure (ES).

Key Explanatory Variable: Civil Aviation Airport Access $Policy_{it}$

Control Variables: This study selects other major factors influencing regional development as covariates in the model. These include: local general budget expenditure (e), the level of development of the secondary and tertiary industries (si/ti), the total number of schools (pmu), total retail sales of consumer goods (r), and per capita GDP (gp).

5 Empirical Analysis of the Relationship between Air Transport and Regional Development

5.1 Descriptive Statistics

Table 1. Descriptive statistics

	(1)	(2)	(3)	(4)	(5)
Variable	N	mean	sd	min	max
did	102	0.108	0.312	0	1
logpt	102	1.668	4.350	0	15.118
logg	102	15.400	0.765	13.710	17.070
loges	102	11.830	1.006	9.250	13.660
loggp	102	10.460	0.673	8.833	11.880
logpmu	102	6.595	0.440	5.841	7.764
logsi	102	14.720	0.781	12.810	16.350
logti	102	14.560	1.057	12.830	20.210
logr	102	14.510	0.942	12.290	16.370
loge	102	13.590	0.955	11.390	15.400

As shown in the table 1, the maximum value of the dependent variable, regional GDP, is 17.070, and the minimum is 13.710. There are certain disparities in the levels of economic development across different cities, indicating that the economic development of cities in the Yangtze River Delta still has room for further improvement; the average value of education expenditure is 11.830, which differs by 1.83 from the maximum value of 13.660 and by 2.58 from the minimum value, suggesting that the level of educational development varies considerably. In terms of standard deviation (SD), the data for the vast majority of variables fall within the range of 0 to 1, indicating that the data are not highly dispersed.

5.2 Baseline Regression

As shown in the table 2, after incorporating covariates and controlling for time fixed effects and individual fixed effects, the overall results of the baseline regression reveal that the coefficient for (1) is positive, whilst the coefficients for (2) are all negative. Furthermore, (2) are all significant at the 10% significance level, whilst (1) is significant at the 5% level. This indicates that air transport has a positive promotional effect on the economy and a negative inhibitory effect on education.

Table 2. Regression results of the DID model

Variable	(1) GDP	(2) Education Expenditure
did	0.123**	-0.235*
	(2.30)	(-1.71)
logsi		
logti		
logr		
loggp		0.874***
		(3.55)
loge	-0.025	
	(-0.45)	
logpmu		0.352**
		(2.01)
Time Fixed Effects Controlled	Yes	Yes
Individual Fixed Effects Controlled	Yes	Yes
Constant	12.951***	4.049
	(24.81)	(1.47)
Observations	102	102
R-squared	0.984	0.949

Note: "did" refers to the Policyit variable. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively; the same applies below.

5.3 Parallel Trends Test

The parallel trends test is a prerequisite for the DID model, requiring that the trends of the experimental group and the control group be consistent prior to policy implementation. This study uses the year of Lianshui Airport's opening as the base period, comparing the four years prior to opening (–4 to –1) with the four years following (1 to 4). If the parallel trends hold, the regression results for each period in the four years prior to the opening will be non-significant; graphical analysis can also assist in this assessment.

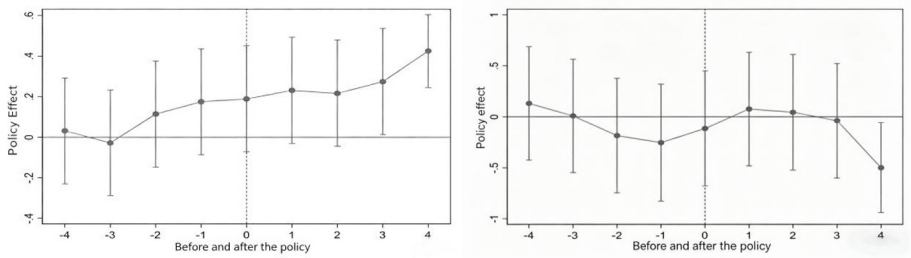

Fig. 1. Parallel trend test

Figure 1 represents the parallel trends tests for GDP and education expenditure, respectively. It can be seen from Figure 1 that the regression coefficients for the four years prior to policy implementation are not significant, indicating that there was no significant difference between the experimental and control groups prior to policy implementation; thus, the parallel trends test is passed.

5.4 Robustness Tests

Given the potential for artificial interference in the statistical compilation of GDP and education expenditure data, there may be some uncertainty regarding the validity of using these metrics alone to assess regional conditions. To enhance the robustness of the results and further mitigate issues of endogeneity and data manipulation, following the approach of Ou Guoli (2024)[8], we selected the annual total electricity consumption of prefecture-level cities and the number of university students as new indicators to replace the original variables used to measure regional development. The specific estimation results are shown in Table 3.

Table 3. Robustness check

Variable	(1) Total Electricity Consumption	(2) Number of College Students
did	0.133*	-0.258**
	(1.83)	(-2.42)
Covariates	Yes	Yes
Time Fixed Effects Controlled	Yes	Yes
Individual Fixed Effects Controlled	Yes	Yes
Constant	-10.259***	8.045***
	(-5.05)	(5.81)
Observations	102	102
R-squared	0.670	0.612

As shown in the table 3, after incorporating covariates, time fixed effects and individual fixed effects, the coefficients of the core explanatory variables (1) and (2) are both significant at the 10% level, with (2) also being significant at the 5% level. This directly indicates that air transport has a significant positive effect on the annual total electricity consumption of prefecture-level cities, whilst exerting a significant negative effect on the number of university students in these cities. Indirectly, this suggests that air transport plays a positive role in promoting the economic development of prefecture-level cities, whereas it exerts a negative, inhibitory effect on educational development. This indicates that the results of the baseline regression mentioned above are relatively robust.

6 Conclusions and Policy Recommendations

Using the 2010 opening of Lianshui International Airport as a quasi-natural experiment, with Huai'an City as the treatment group and surrounding cities as the control group, this study examines the relationship between air transport and regional development from the perspectives of both economy and education. The results indicate that air transport promotes economic development but inhibits educational development. Based on these findings, three recommendations are proposed for the Huai'an Municipal Government: First, Talent recruitment strategy, offer housing, research support, subsidies, industry-university training, and overseas collaborations to reduce population outflow. Second, Reinvest economic dividends in education, increase education funding, improve rural schools, and provide free skills training to convert economic growth into human capital. Third, Share educational resources via air transport, establish mechanisms for teacher sharing, joint distance learning, and off-site research; support cross-border economic zones with policies to encourage talent return.

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