Air Transport Promotes the Coordinated Development of Regional Economy

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ABSTRACT

Based on the theory of spatial economics, this study analyzed how air transport promotes the coordinated development of regional economies by enhancing regional accessibility and accelerating the flow of resources. In particular, the study analyzed the theoretical and managerial pathways through which air transport affects the coordinated development of regional economies. Moreover, the study constructed a double fixed-effects model, and used the panel data of "regional pairs" between 10 international aviation hub cities and 29 regional aviation hub cities in 2010-2019 to carry out empirical tests and analysis. The findings of the paper provide empirical evidence that air transportation promotes the coordinated development of regional economies. The findings also revealed that the effects and mechanisms of air transportation impact on the coordinated development of regional economies, and provide new perspectives for subsequent research. The findings of this paper provide empirical evidence that air transportation promotes the coordinated development of regional economies. The results of the study provide an important reference for policy makers through regional economic coordination, which is of practical significance especially in the strategic integration of air transport with the regional economy.

Keywords: Air transport, Coordinated development of regional economy, Elements circulation, Double fixed effect model.

1. Introduction

The coordinated development of regional economies has always been a topical issue in China's economic development and a key issue in the long-term development of various regions [1]. Since the reform and opening up, China's economy in all fields has achieved rapid development. However, when economic development achieved significant results, the gap between the economic

development of different regions gradually widened due to the influence of geographic location, natural resources, degree of urbanisation, level of development and other factors. At present, the gap between China's northern and southern regions, eastern, central and western regions is relatively obvious, and the uncoordinated and unbalanced economic development among regions is still China's basic national situation [2,3]. In recent years, “promoting coordinated regional economic development” and “promoting coordinated regional development” have appeared many times in the central documents. Moreover, improving the level of coordinated regional economic development has become one of the important tasks of the state work [4].

As a pioneering industry in the overall economic and social system, the transport industry is a bridge between the various segments of social production, circulation and consumption in the region [5]. Transport infrastructure, especially air transport, plays a crucial role as a key element in the flow of resources across regions. Spatial economics theory stresses that interregional accessibility and improved transport infrastructure can reduce transaction costs and facilitate the flow of resource factors, thereby enhancing regional economic linkages and interdependence. The development of the transport industry can reduce transport costs and improve regional accessibility. Transport can connect different links, effectively improve inter-regional connectivity, and accelerate the flow of regional resource factors. Transport can connect different links, effectively improve interregional connectivity, accelerate the flow of regional resource factors, narrow the economic gap between regions, and thus promote interregional economic balance [6,7].

Air transport is part of the national comprehensive transport system, and it has become the fastest growing industry in China's transport industry with features such as high output and high efficiency [8]. It plays a fundamental and pioneering role in the new journey of comprehensively building a strong socialist modernisation country [5]. As an important part of the transport industry, the air transport industry has the characteristics of long distance, high speed, high efficiency, among others. This can improve the accessibility between regions [9], make the economic ties and industrial development of regions that are far apart more closely, and ultimately promote the regional economic development [10,11]. Zhang Henglong et al. [12-14] studied the impact of the opening of transport on the coordinated development of the regional economy, and found that transport can improve accessibility, tap economic potential, and can to a certain extent reduce the differences in regional economic development between developed and less developed regions.

As a national strategic industry, air transport plays an important role in promoting circulation, expanding circulation and accelerating the construction of a new development pattern. The development of air transport will provide more jobs [15-18], increase consumer demand, enhance inter-regional connectivity and accelerate the flow of factors of production between regions, thus driving the development of regional economy [19,20]. At present, many scholars at home and abroad have carried out research on air transport industry and regional economic development. Federer [21], Juan [22] and Maeazzo M [23], focused on some countries and conduct empirical research based on the relationship between air transport data and the economic situation in these countries. The results of their studies shown that air transport has a significant role in promoting economic development [23]. The conclusion of Zhang Xueliang's study [24] on transport infrastructure and regional economic growth shown that transport infrastructure plays an important role in promoting regional economic growth. Wu Li [5] established an air transport capacity indicator system for 38 hinterland cities of 39 ten million airports, measures air transport capacity, and analyses the data, and the results show that air transport capacity enhancement has a significant positive impact on regional economic development. Huang Jie et al. [25] explored the role of air transport on the economic coordination of the central and western regions, and concluded that the construction of aviation hubs can significantly

reduce the economic gap between regions. In recent years, the promotion of coordinated regional economic development has been frequently mentioned at the national level, especially in the 14th Five-Year Plan, which explicitly proposes to strengthen the synergistic development of inter-regional transport infrastructure, and focuses on the promotion of the interconnection of multi-modal transport networks, such as air and railway [26,27].

In previous studies, the impact of high-speed rail and other modes of transport on the coordinated development of regional economy has been effectively analysed and proved, indicating that high-speed rail can promote the flow of resource factors by enhancing inter-regional accessibility and lowering transaction costs, and then narrow the regional economic gap [28]. Guo Xing and Xu Wangtu [29] studied the impact of high-speed railway on the function of air hub airports, and proposed that high-speed railway can promote the balanced development of regional economy, especially in shortening the inter-regional economic distance and improving the connectivity has a significant role. Liu Mingwei [30] studied the layout of aviation hubs based on the optimisation of high-speed rail network and concluded that the expansion of high-speed rail network has a positive impact on the optimisation of the function and layout adjustment of aviation hubs. Air transport has also been effectively proven to promote regional economic growth [5,31]. However, the existing literature mainly focuses on the impact of land transport modes, such as high-speed rail, and the role of air transport on the coordinated development of regional economy has not been fully explored. Although high-speed rail has significant effects in short-distance regional economic coordination, the potential of air transport especially in long-distance, cross-provincial and even international connectivity has not been systematically studied, and the existing research needs to be further deepened.

Based on this, this study aims to fill this research gap by focusing on analysing the mechanism of air transport's influence on the coordinated development of regional economy. Based on the theory of spatial economics, this study will construct a double fixed-effects model to test the path of air transport's influence on the coordinated development of regional economy using panel data of 10 international and 29 regional air hub cities during 2010-2019. This study aims to provide a new perspective for subsequent theoretical discussions on the impact of air transport on the regional economy, and to provide empirical evidence for policymakers to better utilise air transport in promoting coordinated regional economic development.

2. Theoretical foundation

2.1 Theoretical perspective of spatial economics

Spatial economics focuses on economic activities and resource allocation in geographic space, with special emphasis on interactions and spillover effects between different regions [32]. According to the theory of spatial economics, economic interactions between regions are influenced by transport infrastructure and transport networks, especially air transport, which is a highly concentrated mode of transport that can significantly improve regional accessibility, reduce transaction costs, and thus promote the flow of resources and the coordinated development of regional economies [33].

The enhancement of air transport has a significant spillover effect. This effect is not limited to directly connected regions, but may also affect a wider area through the extended transport network. For example, the economic linkages brought about by air transport development not only lead to more frequent flows between major hub cities, but also enhance interregional economic integration by promoting industrial linkages within and outside the region and facilitating the reallocation of resources [24].

2.2 Spillover effects of transport infrastructure

Air transport affects the coordinated development of regional economies through its 'spillover effects'. The expansion of transport infrastructure not only enhances the economic vitality of the region directly affected, but also generates cross-regional spillover effects through the flow of resources, the expansion of markets and the reallocation of production factors to other regions. In particular, in regions where the regional economy is relatively backward, the popularity of air transport can promote the external input of capital, technology and other factors, thus accelerating their economic growth [8].

Specifically, air transport improves the accessibility of resources between regions by reducing transport costs and time costs, facilitating the flow of talent, capital and commodities, and thus breaking down the economic barriers between regions.

2.3 Current status of air transport development

The air transport industry, as an important part of the modern transport industry, has developed into a global industry since the beginning of the 20th century when it began to operate commercially. It has greatly shortened geographical distances and facilitated economic and cultural exchanges between different countries and regions with its fast and efficient characteristics.

In the ten-year period from 2010 to 2019, the total turnover of China's air transport has been steadily increasing year by year, and even if it is affected by various factors such as the financial crisis in the middle of the period, China's air transport maintains an upward trend. As shown in Figure 1, in 2019, the industry as a whole completed a total transport turnover of 129.27 billion tonne kilometres, an increase of 7.1% over the previous year. This growth not only reflects the continued increase in demand for air transport, but also the improvement of air transport capacity.

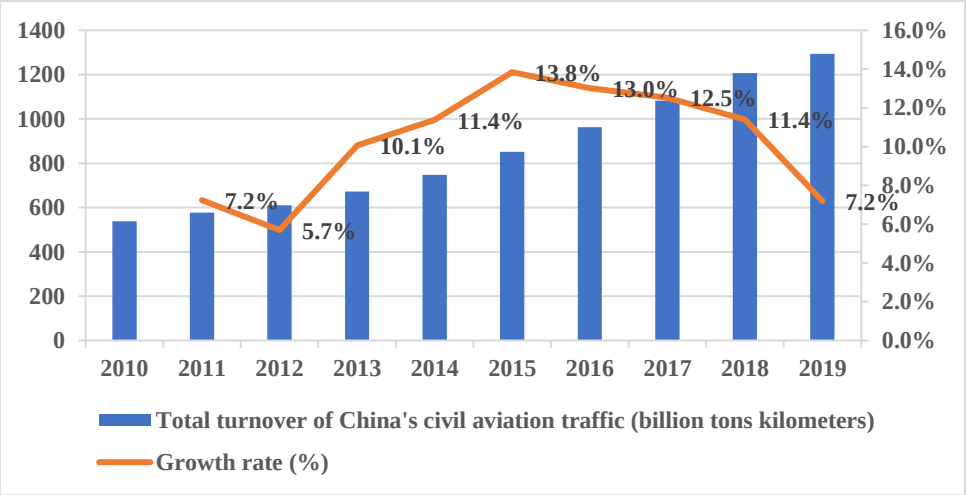

Figure 1. Statistics and Growth of China's Total Civil Aviation Transport Turnover, 2010-2019

As shown in Figure 2, the number of China's civil aviation transport aircraft showed a year-on-year increase, and as of the end of 2019, the number of transport aircraft on the register of China's civil aviation industry as a whole was 3,818, an increase of 179 over the end of the previous year, with a growth rate of 4.91%, which is somewhat lower than that of the previous year, but it still shows the rapid development of the air transport industry. The slowdown in economic growth, rising operating costs such as fuel prices and labour costs, and the uncertainty of the international trade environment have restricted route expansion plans, and airlines have been more cautious in acquiring new models, which have combined to lead to a fall in the growth rate of the number of aircraft.

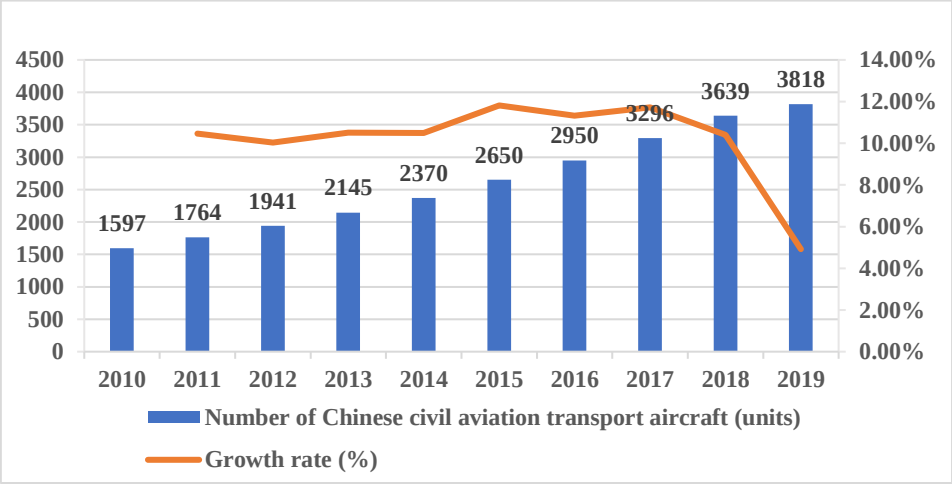

Figure 2. Statistics and growth of the number of Chinese civil aviation transport aircraft, 2010-2019

3. Research design

3.1 Sample selection and data sources

All data used in this study come from the China Statistical Yearbook and local statistical yearbooks of each region.

In this study, 10 international aviation hub cities and 29 regional aviation hub cities were matched in two groups from 2010 to 2019, without considering the direction of flow, and excluding city pairs with incomplete data within 10 years, a total of 237 "regional pairs" are formed.

3.2 Model Setting

The benchmark regression in this study uses a double fixed effects regression model, which is set up as equation (1):

$$Ec_{ijt} = \alpha_0 + \alpha_1 Flight_{ijt} + \alpha_2 X_{ijt} + u_{ij} + \eta_t + \varepsilon_{ijt} \qquad \text{[Formular 1]}$$

i, j: indicates two regions, respectively, and the two regions do not differentiate between flow directions.

t: denotes the year

Ec_{ijt}: level of coordinated regional economic development in region *i* and region *j* in year *t*

$Flight_{ijt}$: level of interregional air transport development in region *i* and region *j* in year *t,* measured by the number of interregional flights

X_{ijt}: control variables at the level of regions *i* and *j*

u_{ij}: region *i* and region *j* fixed effects to control for factors that do not change over time at the region pair level

η_t: year fixed effects to control for factors that affect all samples within the sample period

ε_{ijt}: random error term

3.3 Variable selection and description

3.3.1 Explained variables

The explanatory variable is the level of coordinated regional economic development. The coordinated development of regional economy is the process in which inter-regions are becoming closer in economic interaction, the gap in economic development between regions is decreasing, and inter-regional economic ties are becoming closer and mutually reinforcing. The degree of coordination of interregional economic development is reflected in closer interregional economic ties, a gradual narrowing of the gap in the level of interregional economic development, and a continuous reduction in the differences in economic growth between regions [34]. Therefore, the above three indicators will be selected in this study to evaluate the level of coordinated regional economic development.

In light of this, the study improves the calculation method according to the characteristics of the research object, and constitutes the calculation model for measuring the level of coordinated regional economic development in this study. The specific calculation methods are as in equations (2) to (5).

$$Er_{ijt} = \frac{\sqrt{gdp_{it}pop_{it}} \times \sqrt{gdp_{jt}pop_{jt}}}{dis^2{}_{ij}} \quad \text{[Formular 2]}$$

$$Ed_{ijt} = \left| \frac{pgdp_{it} - pgdp_{jt}}{Max(pgdp_t) - Min(pgdp_t)} \right| \quad \text{[Formular 3]}$$

$$Ef_{ijt} = \left| gdpth_{it} - gdpth_{jt} \right| \quad \text{[Formular 4]}$$

$$Ec_{ijt} = w_{ijt}^1 Er_{ijt} + w_{ijt}^2 Ed_{ijt} + w_{ijt}^3 Ef_{ijt} \quad \text{[Formular 5]}$$

i, j: indicates two regions, respectively, and the two regions do not differentiate between flow directions.

t: denotes the year

Er: economic linkages between region *i* and region *j*, a positive indicator

Ed: difference in level of economic development between region *i* and region *j*, a negative indicator

Ef: differences in economic growth between region *i* and region *j*, negative indicator

gdp: urban GDP

pop: total urban resident population

dis: spatial distance between the two cities

pgdp: urban GDP per capita

gdpth: growth rate of urban GDP

On this basis, the entropy weighting method is applied to the three indicators in each year to get w^1 to w^3, and finally get the coordinated economic development level *Ec* of 237 regional pairs in each year.

3.3.2 Explanatory variables

The explanatory variable is the level of interregional air transport development. Since the number of flights can directly reflect the frequency and scale of air transport, which is one of the important indicators for assessing the level of air transport services, this study applies the number of inter-regional flights to measure the level of air transport development as an explanatory variable. In order to eliminate the influence of the differences in the level of air transport development between different regions and to make the model more stable, the explanatory variables are taken as the mean values of the indicators of the two regions and logarithmically processed. To ensure the robustness of the research results, in the subsequent robustness test, the number of flights of the explanatory variables are replaced with the interregional air passenger traffic and total air turnover, and the

regression results are compared with the test results to further test the correctness of the conclusions.

3.3.3 Control variables

In selecting control variables, this study selected the following variables based on the influence of other factors on the coordinated development of the regional economy:

(1) Other modes of transport: road passenger traffic (Hpv), road freight traffic (Hfv), railway passenger traffic (Rpv), railway freight traffic (Rfv). Road and railway transport modes belong to the same category of transport modes. In previous studies, the impact and path mechanism of road and railway transport, especially high-speed rail transport, on the coordinated development of regional economy have been effectively analysed and demonstrated [28]. The volume of passenger and freight transport by road and rail is directly related to the efficiency of the movement of people and goods. The convenience and efficiency of transport reduces the cost of circulation, promotes industrial docking and collaboration between different regions, facilitates the balanced development of economic activities and further promotes interregional economic coordination.

(2) Characteristics of economic development: the mileage of roads in the region (mh), financial expenditure (fe), the proportion of tertiary industry in GDP (pGDP), and the total amount of imports and exports (tie) are selected. Mileage is one of the most basic indicators of transport level, and the growth of mileage can reflect the level of transport network construction within a certain region. Fiscal expenditure selects public budget expenditure as a measurement indicator. The proportion of tertiary industry in GDP reflects the characteristics of regional industrial structure, and the proportion of tertiary industry is often related to the level of economic development and economic diversification. The level of openness to the outside world reflects the degree of regional participation in the international economy, which plays an important role in regional economic development, and the total amount of imports and exports is chosen to measure the level of economic openness. Similar to the explanatory variables, the control variables also take the mean value of the indicators of the two regions and are logarithmically processed.

4. Analysis of empirical results

4.1 Descriptive statistics

Table 1 shows the results of the descriptive statistics of the variables. Through the descriptive statistics of the variables, we found that the core explanatory variables inter-regional air transport development level, regional economic co-ordination and development of the water mean are much smaller than the maximum value, which reflects the imbalance of the development of air transport and the co-ordinated development of the regional economy among the hub cities in China.

Table 1. Descriptive statistics of variables

variable name	sample size	average	standard deviation	minimum value	maximum
Ec	2370	0.127	0.084	0.021	0.994
Flight	2370	7.860	1.150	2.303	10.519
Hpv	2370	9.645	0.942	7.13	12.02
Hfv	2370	10.099	0.486	7.32	11.46
Rpv	2370	8.533	0.890	5.05	11.36
Rfv	2370	7.219	1.015	0.26	9.45
mh	2370	7.156	0.828	4.86	11.04

fe	2370	4.053	0.115	3.76	4.37
pGDP	2370	11.054	1.146	7.07	13.7
tie	2370	9.486	0.666	5.9	11.49

Source: By authors.

4.2 Analysis of base regression results

The impact of air transport on coordinated regional economic development was analysed by regression using stata 16.0 software, and Table 2 shows the regression results of air transport on coordinated regional economic development. Among them, column (1) did not add control variables with fixed effects. Column (2) adds control variables related to roads and railways. Column (3) adds economic development characteristics control variables to column (2). Column (4) adds individual, year fixed effects to the control variables, and the results show that the estimated coefficients are significantly positive at the 5 per cent level, indicating that increased air transport capacity has a positive impact on the level of coordinated regional economic development. Columns (5) to (7) are the results of taking inter-regional economic linkages, economic gaps, and economic growth differences as explanatory variables, and the results show that the estimated coefficients of air transport capacity on economic linkages are positive and significant at the 0.1% level, the estimated coefficients of economic gaps are positive and significant at the 0.1% level, and the estimated coefficients of economic growth differences are negative and significant at the 0.1% level, which indicates that The impact of air transport on coordinated regional economic development is significant in terms of increasing interregional economic linkages and decreasing interregional economic growth differentials.

The estimation results in Table 2 illustrate that air transport development significantly contributes to the increase in the level of coordinated regional economic development, mainly by contributing to the increase in the level of interregional economic linkages and the reduction in the level of economic growth disparities.

Table 2. Benchmark regression results

explanatory variable	(1) *Ec*	(2) *Ec*	(3) *Ec*	(4) *Ec*	(5) *Er*	(6) *Ed*	(7) *Ef*
Flight	-0.00209	0.00277**	0.00236*	0.00205*	88.08***	0.0791***	-0.146***
	(-1.37)	(2.84)	(2.42)	(2.11)	(3.33)	(4.51)	(-3.63)
Railway road control variables	clogged	clogged	be	be	clogged	clogged	clogged
Remaining control variables	clogged	clogged	clogged	be	clogged	clogged	clogged
individual fixed effect	clogged	be	be	be	clogged	clogged	clogged
Year fixed effects	clogged	be	be	be	clogged	clogged	clogged
N	2370	2370	2370	2370	2370	2370	2370
R^2	0.001	0.684	0.690	0.694			

Note: *, **, *** represent 5%, 1% and 0.1% significance levels, respectively, as in the following tables.

5. Robustness Tests

5.1 Endogeneity test

Although this study has added control variables such as road and railway passenger and freight traffic, fiscal revenue, total import and export, and the proportion of the tertiary industry in GDP, it is still difficult to avoid the problem of omission of variables. Moreover, the increase of air transport capacity helps to promote the coordinated development of regional economy, but the coordinated development of inter-regional economy also increases the air transport capacity, so there may be a causal relationship between the air transport capacity and the coordinated development of regional economy, which leads to the endogeneity problem.

In this study, referring to Yang Bo and Cui Qi[35], the core explanatory variables, the previous one-period value (*L.Flight*) and the previous two-period value (*L2.Flight*), are included as instrumental variables in the model for parameter estimation. Columns (1) to (3) of Table 3 report the results of parameter estimation under two-stage least squares (2SLS) with the introduction of the instrumental variables *L.Flight*, *L2.Flight* separately versus both *L.Flight* and *L2.Flight*.

Table 3. Estimation results of instrumental variables

explanatory variable	(1)	(2)	(3)
	Ec	*Ec*	*Ec*
Flight_IV	*L.Flight*	*L2.Flight*	*L.Flight* and *L2.Flight*
Flight	-0.056	-0.0085	-0.0111
control variable	be	be	be
Individual and year fixed effects	be	be	be
L.Flight	0.9140		0.7973
L2.Flight		0.8482	0.1305
N	2133	1896	1896

Based on the 2SLS regression, the robustness of the instrumental variables needs to be tested. In order to achieve this, a Weak Instruments Test was conducted on the instrumental variables (the amount of flights lagged by one period) of this study. The original hypothesis of this test is that the instrumental variables are weak instrumental variables. As shown in Table 4, the Weak Instruments Variable Test is significantly not equal to 0, so the original hypothesis is rejected. Therefore, the instrumental variable used in this study is not a weak instrumental variable and this instrumental variable can be used and again shows that air transport development has a significant positive impact on the level of coordinated regional economic development.

Table 4. Weak instrumental variable tests

variable	*IV* Variables	*R-sq*	*Adjusted R-sq*	*Partial R-sq*	*Robust*	*Prob > F*
flight	*L.flight*	0.8826	0.8821	0.8160	1822.45	0.0000

5.2 Replacement of explanatory variables

Further testing of the regression results is still needed to ensure the correct reliability of the regression results. In this study, the explanatory variables are replaced with the air passenger volume (passenger) and the total air turnover (turnover) for estimation. The regression results are shown in Table 5, which indicates that the estimated coefficients of the core explanatory variables are positive and similar to the regression results, indicating that the results of this study are robust.

Table 5. Replacement results

explanatory variable	(1)	(2)
	Ec	*Ec*
Passenger	0.00245*	
	(2.00)	
turnover		0.00111
		(1.21)
Railway road control variables	be	be
control variable	be	be
individual fixed effect	be	be
Year fixed effects	clogged	be
N	2370	2370
R^2	0.0709	0.693

5.3 Tests for regional heterogeneity

There are significant differences between different regions of China in terms of their level of economic development, infrastructure development, market demand and policy environment. For example, the eastern coastal regions have strong market demand for civil aviation due to their developed economies, while the western regions may have relatively slow development of civil aviation due to the limitations of their geographical environment and level of economic development. In addition, there are differences in the civil aviation infrastructure development and service capacity of different regions. Specifically, some regions may have more complete airport facilities and efficient air traffic management systems, while other regions may have deficiencies in these areas. Therefore, there may be some differences in the impact of air transport on coordinated regional economic development in different regions, and there is a need to analyse the results of full-sample regressions on the impact of air transport on coordinated regional economic development in terms of subregional differences [36].

Based on this, the present study divided the 39 aviation hub cities under study into seven regions, namely, Northeast, North China, East China, Central and South China, Southwest, Northwest and Xinjiang, with four cities in Northeast China, five cities in North China, 11 cities in East China, nine cities in Central and South China, five cities in Southwest China, four cities in Northwest China, and one city in Xinjiang, in accordance with the *Basic Classification Methods of the National Airspace* issued by the Civil Aviation Administration of China (CAAC). Since this study is to match 10 international aviation hub cities and 29 regional aviation hub cities in two groups as the research object, the only city with complete data in North China region is Beijing to Taiyuan, there is only 1 city in Urumqi in Xinjiang region, so the North China and Xinjiang regions are excluded, and the analysis is to test the remaining five regions. The regression results are shown in Table 6.

Table 6. Tests for regional heterogeneity

explanatory variable	(1)	(2)	(3)	(4)	(5)
	Northeast	Eastern	Central South	Southwest	Northwest
Flight	0.0967	-0.0033	-0.0009	-0.0030	0.0002
control variable	be	be	be	be	be
individual fixed effect	be	be	be	be	be
Year fixed effects	be	be	be	be	be
N	20	130	160	50	20
R^2	1.000	0.7352	0.8054	0.9156	1.000

Through the subregional sample regression results, it can be seen that the impact of air transport on the coordinated development of the regional economy has obvious regional differences. Moreover, air transport on the coordinated development of the regional economy between the cities of the Northeast and Northwest has a positive role in promoting the coordinated development of the regional economy, and has a greater impact on the Northeast region. On the other hand, the coefficients of air transport on the coordinated development of regional economy in East China, South Central and Southwest China are negative, and air transport between cities in East China region has a greater inhibiting effect on the coordinated development of regional economy. This may be explained by the fact that the specificity of their geographical location makes transport links between these two regions and other economic centres relatively weak, and air transport has become an important means of filling transport gaps and strengthening interregional ties. Particularly, in the Northeast and Northwest, where the population is more dispersed, the distances between cities are long and the development of transport infrastructure is relatively lagging behind, making aviation a key means of meeting the demand for fast travel and efficient logistics.

This may be due to the fact that the north-eastern and north-western regions are developing air transport to compensate for geographical disadvantages, facilitate resource flows and expand markets. At the same time, these regions are supported by national policies, such as the strategy for the development of the western region and the strategy for the revitalization of the northeastern region, which have contributed to the rapid development of air transport and thus to the coordinated development of the regional economy.

In contrast, the more developed economies and more diversified industrial structures of the eastern, central and southern and south-western regions, as well as competition from other modes of transport, such as well-developed road and high-speed rail networks, have reduced reliance on air transport, leading to diminishing marginal benefits of air transport. Also, the air transport market in these regions may be relatively saturated, making it difficult to explore new growth points, while the high cost and competitive pressure of air transport may lead to a limited contribution to the economy.

5.4 Time sensitivity test

In order to test whether the empirical results of this study will be subject to large fluctuations due to the selection of research samples and time, this study followed Wang Huaxing et al. [28] and adopted the method of changing the sample time window to verify the robustness of the empirical results. This was done by retaining the regression of only three sets of data in 2010-2018, 2011-2019, and 2013-2016. The regression results are shown in Table 7. Although, the total sample size decreases

after deleting the data of one year at the right end, the regression coefficients always remain positive, which shows that the conclusion of this study is robust and will not be influenced by the choice of samples and time.

Table 7. Time sensitivity test

explanatory variable	(1) 2010-2018	(2) 2011-2019	(3) 2011-2018
Flight	0.00215*	0.00351**	0.00368**
	(2.00)	(3.17)	(2.99)
Railway road control variables	be	be	be
control variable	be	be	be
individual fixed effect	be	be	be
Year fixed effects	be	be	be
N	2133	2133	1896
R^2	0.711	0.706	0.724

6. Conclusion

The air transport industry is a strategic industry related to the economic development of each locality. It serves as an important means for trade between national territories, and plays an important role in national economic and social development. In light of this, it has emerged as an indispensable means in promoting the modernisation of the country. The interaction between civil aviation transport industry and regional economy is inseparable. With the continuous development of aviation technology and the opening of air routes, civil aviation transport has become one of the most important links in the global economy, and plays a unique role in the economic development of cities in the region.

This study analyzed the theory and mechanism of air transport system and the coordinated development of regional economy. In light of this, it quantified the coordinated development of regional economy based on the panel data of "regional pairs" between 10 international and 29 regional aviation hub cities from 2010 to 2019, and constructs a model to empirically test and analyzed the effect and mechanism of air transport system. The model empirically tests and analyses the effect and mechanism of air transport on the coordinated development of regional economy.

This study found that the increased level of air transport has significantly contributed to the coordinated development of regional economies. This is mainly due to the fact that the development of air transport effectively improves interregional accessibility, facilitates the flow of resources and economic activities. It enhanced interregional economic linkages and helped to narrow the economic development gap between different regions. This impact is not only felt directly in areas with dense air transport networks, but also through spillover effects in other areas, contributing to the economic integration of these regions. The conclusion of the study was validated by considering the time sensitivity issue, the endogeneity issue and the robustness issue. Particularly in the north-eastern and north-western regions, the development of air transport has further contributed to coordinated regional economic development [37]. However, the study found that in the more economically

developed regions of East, Central and South China and Southwest China, the role of air transport promotion is relatively weaker, which may be related to the competition and market saturation of other modes of transport in these regions.

The focus of this study is to systematically explore the mechanism path of air transport on the coordinated development of regional economy and to verify its effect through large-scale panel data. The innovation of the study is that it combines the theory of spatial economics to analyse the role of air transport in promoting inter-regional economic ties, resource flows and factor agglomeration, which provides theoretical support for policy makers. Although this study reveals the effectiveness of air transport in promoting the coordinated development of regional economy, there are still deficiencies in the measurement of the level of coordinated development of regional economy and the comprehensive effect of the interaction between air transport and other modes of transport (e.g., high-speed rail and highway), which can be further deepened in the future.

In order to further optimise the role of air transport in narrowing regional economic gaps, policymakers should adopt comprehensive strategies to promote coordinated regional economic development. First, they should strengthen the construction of aviation hubs and the optimisation of route networks, especially in the western, central and northeastern regions where economic development is lagging behind. They should also provide more policy support to promote the opening of new routes for airline services through subsidies and financial assistance, so as to enhance the accessibility of these regions, break the traffic bottlenecks, and promote the flow of resources and economic exchanges. In addition, policies should also promote the synergistic development of air transport with other modes of transport to build an efficient multimodal transport network. This conclusion is an important reference for China's future transport policy, especially in the context of the Belt and Road Initiative [38].

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