A Study on the Measurement of Resilience and Regional Differences of China's Airport Economy from the Perspective of High-quality Development

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Abstract. This study examines airport economic resilience in twelve Chinese representative cities with established airport economies from 2010 to 2019 using panel data. Employing the Time Space Range Entropy Weight, Theil Index, Gini coefficient, and σ convergence model methods, the study found that the resilience index of China's airport economy increased rapidly from 2010 to 2019. Among them, Evolutionary index and Recovery Index increased significantly, while the Resistance Index increased less. As the development of airport economy is increasingly dependent on external environment, airport economy may suffer greater risks when dealing with external shocks. The analysis of differences in resilience development among airport economic zones reveals significant variations in their development and innovation capabilities, as well as the diverse airport development environments. These disparities have led to distinct characteristics in the resilience development of airport economies across different levels and regions during the study period. In terms of development trends, the overall difference in the resilience of the airport economy is gradually shrinking. The difference in the coastal regions is gradually shrinking, while the difference in the inland regions shows a fluctuating increase. If the imbalance and insufficiency of the development environment and resources are not further improved, the difference of the resilience of the airport economy in different regions of China may be further revealed in the future.

Keywords: airport economy; economic resilience; Time Space Range Entropy Weight method; Theil Index; Gini coefficient.

1. Introduction

China's economy has shifted from a stage of rapid growth to one of high-quality development. Economic resilience reflects the ability of the economy to with-stand shocks, adjust to them and continue to evolve, and is the economy's immune recovery system [1]. Improving economic resilience is the key to stable growth, high-quality development, and coping with uncertainties and risks. In recent years, the trade friction between China and the United States has become normalized, geopolitical conflicts and international health security localization and short-chaining of the global industrial chain is obvious, and the competition for the industrial chain has become more and more intense. China is facing a great change that has not been seen in a hundred years, so the research on eco-nomic resilience has high theoretical value and practical significance for the healthy and sustainable development of the economy. At present, the airport economy has become a "growth pole" for regional economic development and a "catalyst" for industrial optimization and upgrading. The development of the airport economy is an important measure to promote China's high-quality development, Smooth domestic and international economic cycles. Airport economy is an emerging regional economic pattern that relies on the resources of airport facilities to promote the concentration of production factors such as capital, information, technology and population in the areas around the airport through air transportation or aviation manufacturing activities by utilizing the industrial ag-glomeration effect of airports, and the economic space centered around the air-port forms industrial clusters with different degrees of aviation relevance[2]. By 2022, the total number of airport economy zones operating in China is 88. All airports with a passenger throughput of 10 million or more have set up airport economy zones, and more than 70% of small and medium-sized airports with a passenger throughput of 2 million to 10 million are engaged in airport economy construction. Studies have shown that the development of the Airport economy has made airport cities a carrier of high-end factors of production, which plays a very important role in promoting the high-quality development of the regional economy [3]. However, the Airport economy has significant externally oriented characteristics and is easily affected by trade restrictions and technological de-coupling, which will bring certain impacts on the Airport economy centered on the development of high-value-added and high-tech industries. In the face of severe changes in the external environment and the pattern of industrial restructuring, the quantitative study of airport economic resilience is of great significance to stabilize the Airport economy and drive the regional economic growth to achieve high-quality development. Therefore, by measuring the level of Resilience and regional variability of the airport economy and analyzing its trends, countermeasures can be provided to enhance the Resilience of China's airport economy, and further promote the high-quality development of China's airport economy.

2. Literature review

The study found that there is no theoretical research on the resilience of the Airport economy. Therefore, this section reviews the research on economic resilience. The study of resilience first appeared in the field of ecology, Canadian biologist Holling(1973)[4] expressed the system's response and adaptive capacity to different kinds of changes as a kind of "resilience", which was gradually spread across different fields. As research into regional economic resilience further develops, the evolutionary perspective is gaining wider acceptance.[5]. In previous research, the measurement techniques for assessing economic resilience from an evolutionary perspective can be grouped into two methods, including the core variable method and the indicator assessment method. The following describes two methods:

Firstly, the core variable method calculates the extent of changes in key variables post-shock in order to demonstrate the economic system's shock-response and the speed of the economic system's recovery post-shock. Indicators such as unemployment and employment levels, total foreign trade statistics and GDP figures are regularly employed in this methodology. For example, Fingleton (2012) uses the number of people in employment as the core variable and measures the magnitude of change in this variable to represent the level of economic resilience in each region of the UK[6]. Bergeijk et al. (2017) measured the level of economic resilience of individual countries globally by choosing their total foreign trade as the core variable [7]. Feng Yuan et al. (2020) measured the economic resilience of 159 cities in 11 urban agglomerations in China over different time periods using GDP as the core variable and explored the economic resilience through the Shift-Share decomposition method [8]. Although this type of method calculates the Resistance and Recovery of the economic system, it lacks the consideration of the evolutionary capacity of the economic system.

Second, the indicator evaluation method quantitatively examines the resilience of economic systems by establishing an indicator system. The majority of prior studies have utilized the research of Martin scholars to create the indicator system necessary for measurement. Martin (2012) divides the mechanism of economic resilience into four stages of action from the adaptive theory. The first stage is the resilience of the economic system after a shock occurs, and the magnitude of this capacity reflects the vulnerability of the urban economic system in the face of shocks. The second stage is the ability of the economic system to self-regulate and recover after the shock, which is related to the sensitivity of the economic system. The third stage involves the economic system's capacity to rearrange its internal structure in response to external changes following a period of self-recovery, known as Recovery capacity. This greatly improves the economic system's adaptability. The fourth stage is the ability of the economic system to create a new development path, driven by learning and innovation, to achieve sustainable development of the system [5]. For example, Huang Jie et.al(2022) constructed the index system from the three aspects of resistance and resilience, adaptation and adjustment, and innovation and transformation with eight city clusters as the research object, and systematically researched the distributional dynamics of the Resilience of city clusters by using the Dagum Gini coefficient method, the Kernel density estimation method, and the Markov chain method.[9]. Ding et al. (2020) classified economic resilience into three dimensions: Resistance, recovery and adjustment, and adaptation and innovation, and constructed a system of indicators to evaluate the level of economic resilience in 12 contiguous special hardship areas in China [10]. Zeng Bing (2023) constructed a comprehensive evaluation Index system for economic resilience development from the perspective of high-quality development in three dimensions of Resistance , resilience and Evolutionary Index[11].Huo Songtao (2023) constructed the evaluation Index system of China's rural economic resilience from the dimensions of ecological resilience, production resilience and life resilience, and used the panel data of 31 provinces from 2007 to 2020, combined with the relativization treatment method and the coefficient of variation method to measure the rural economic resilience[12]. As far as the indicator system method is concerned, a unified standard for the division of resilience dimensions and the selection of indicators has not yet been formed, which needs to be further developed and improved. In summary, both current methods of quantitative research on economic resilience have some shortcomings, but the indicator evaluation method is more suitable for this study. Firstly, the method is more in line with the intrinsic requirements of high-quality development, as it incorporates the consideration of the evolutionary force. Secondly, because factor aggregation and knowledge spillover are the intrinsic driving force of the Airport economy, and adding the consideration of evolutionary force can better describe the airport economic resilience. Therefore, based on Martin's four-stage theory, this paper constructs the Index system of airport economic resilience on the basis of combing the concepts and connotations of airport economic resilience, and conducts quantitative research on the airport economic resilience of different regions in China. The first is to supplement the gaps in the study of airport economic resilience, and the second is to formulate strategies for the improvement of airport economic resilience and synergistic development, in order to promote the high-quality development of Airport economy.

3. Construction of the indicator system

3.1 Indicator system for resilience of the airport economy

In the context of rising uncertainties in the external environment, this paper is based on the theory of economic resilience under the perspective of evolutionary theory, combined with the connotation of high-quality development, which suggests that the economic resilience of the Airport economy refers to the ability of the Airport economy to resist external shocks, maintain its own development dynamics, and create new paths of growth for the Airport economy in the face of external risks such as the elevation of trade barriers, technological decoupling, and industrial chain breakage. On this basis, this paper refers to Martin's (2012) [5] stage division of economic resilience, combines the commonly used indicators for quantitative analysis of economic resilience and the corresponding indicators selected with reference to the theory of the dynamics of development of the Airport economy, and establishes a resilience indicator system of the Airport economy on the basis of feasibility, objectivity, and data accessibility. In the indicator system, firstly, the resilience indicator quantifies the ability of the airport economy system to withstand shocks. The gross airport economy product, the total population at the end of the year and the per capita disposable income in towns and cities constitute the secondary indicators of the size of the airport economy. The higher the regional economic strength and per capita disposable income, the better the ability to cope with external shocks. Total imports and exports as a share of GDP and real utilization of foreign capital constitute the secondary indicators of dependence on the external environment. Higher dependence on foreign trade and foreign investment indicates greater exposure to shocks such as trade frictions or technological blockades. The Recovery Index refer to the theory of the evolutionary dynamics of the airport economy and are constructed around the endogenous and exogenous resilience of the airport economy. Airport operation scale and fixed asset investment describe the endogenous dynamics of the airport economy. When the scale of airport operation and fixed asset investment reaches a certain scale, it brings profit factors such as time, cost, quality, and service to enterprises in the region, which becomes the endogenous resilience of the airport economy evolving. Government regulation and external support from the urban hinterland constitute the exogenous resilience of the airport economy development. At the time of crisis, the absorption of unemployed population by the economic hinterland, the support of hinterland industries for the development of airport economy, and the financial support of government policies become the key forces for the recovery of airport economy. Where industrial diversity refer the entropy calculation method of Wang Peng and Zhong Min (2021) [13]. Finally, the evolutionary index measures the ability of the airport economy to create new development paths and achieve sustained growth by selecting three aspects to measure: the level of government innovation input, enterprise innovation input and innovation output. Government innovation input reflects the government's investment in the innovation base, enterprise innovation input reflects the level of innovation R&D investment of enterprises, and innovation output reflects the level of innovation output results of the airport economy zone as a whole. The details are shown in **Table 1.**

3.2 Data description

Due to the relatively short period of time for the development of China's Airport economy, the statistics of Airport economy data vary from place to place. Comparatively speaking, the statistics of airport economic demonstration zones are more comprehensive and mature. With comprehensive consideration, this paper takes 12 airport economic demonstration zones as the research object. The data come from China County Statistical Yearbook, China City Statistical Yearbook, China Science and Technology Statistical Yearbook, and Civil Aviation from Statistics. For some missing data, they are measured by interpolation

Table 1. Results of the calculation of indicators and weights

Level 1	Level 2	Level 3	serial number	Direction of Indicators	weights
Resistance	Scale of the Airport economy	Airport economy gross domestic product	X1	Positive	0.039
		Total population at the end of the year	X2	Positive	0.028
		Urban disposable income per capita	X3	Positive	0.025
	External environmental dependencies	Ratio of total exports and imports to GDP	X4	Negative	0.007
		Actual utilization of foreign capital	X5	Negative	0.009
Recovery	Scale of airport operations	passenger throughput	X6	Positive	0.053
		cargo and mail throughput	X7	Positive	0.101
		Aircraft movements	X8	Positive	0.043
		Number of cities served by aircraft	X9	Positive	0.036
	fixed-asset investment	Airport fixed asset investment	X10	Positive	0.054
		Fixed asset investment in airport economic zone	X11	Positive	0.048
	Government financial support	Financial self-sufficiency rate	X12	Positive	0.018
	Industrial diversity	Industry-related diversity	X13	Positive	0.018
		Industry discrete diversity	X14	Positive	0.024
Evolutionary	Government investment in innovation	Number of students enrolled	X15	Positive	0.045
		Financial expenditure on education	X16	Positive	0.089
		Financial science expenditures	X17	Positive	0.122
	Enterprise investment in innovation	Number of R&D personnel in industries above designated size	X18	Positive	0.031
		Internal expenditure on R&D in industries above designated size	X19	Positive	0.048
	Innovation outputs	Number of patents granted	X20	Positive	0.056

		Number of inventions	X21	Positive	0.107

4. Method

4.1 Indicator weight assignment based on Time Space Range Entropy Weight method

This paper is based on the Time Space Range Entropy Weight method to assign weights to the three-level evaluation indicators of airport economic resilience. The traditional Entropy Weight method can only make use of the information at a particular point in time, while this method can simultaneously make use of the amount of information in the two dimensions of time and space, so that it can respond to the differentiation of the indicators from the spatial and temporal dual dimensions of the evaluation object [14]. The calculation formula is:

$$y_{ijt} = \frac{x_{ijt}-min\,(x_{ijt})}{max\,(x_{ijt})-min\,(x_{ijt})}(If\ x_i\ is\ positive) \tag{1}$$

$$y_{ijt} = \frac{max\,(x_{ijt})-x_{ijt}}{max\,(x_{ijt})-min\,(x_{ijt})}(If\ x_i\ is\ negative) \tag{2}$$

$$E_i = -\,ln\,(mn)^{-1}\sum_j\sum_t p_{ijt} * ln(p_{ijt}) \tag{3}$$

$$\omega_i = \frac{1-E_i}{k-\sum_i E_i} \tag{4}$$

$$Z_{jt} = \sum \omega_i y_{ijt} \tag{5}$$

Where, $p_{ijt} = y_{ijt}/\sum_j\sum_t y_{ijt}$ .If $p_{ijt} = 0$ then define $p_{ijt} * \ln(p_{ijt}) = 0$. y_{ijt} is the dimensionless processing of data x_{ijt}.

4.2 Methodology for analyzing regional difference

The formula for calculating the Gini coefficient of resilience level in the airport economy used in this paper is as follows:

$$G = \frac{1}{2n^2 Z}\sum_{i=1}^{n}\sum_{j=1}^{n}\left|Z_i-Z_j\right| \tag{6}$$

$$G = \frac{1}{2n^2\overline{Z_r}}\sum_{i=1}^{n_r}\sum_{j=1}^{n_r}\left|Z_{ri}-Z_{rj}\right| \tag{7}$$

where G represents the Gini coefficient of the Resilience Index of all the Airport economic zones under study, and G_r is the Gini Index that measures the difference in the construction level of individual Airport economic zones in region r; Z_i represents the economic Resilience Index of the ith Airport economic zone, and Z_{ri} represents the economic Resilience Index of the ith Airport economic zone in region r ; $\overline{Z_r}$ denotes the mean value of the airport economic Resilience Index of individual Airport economic zones in region r, and $\overline{Z}$ denotes the mean value of each city's airport economic Resilience Index nationwide; n_r the number of provinces in region r,n is the total number of provinces.

The Theil Index can distinguish the overall differences into intragroup and intergroup differences, and its value ranges from 0 to 1, with higher values indicating bigger differences. The Theil Index T, which measures the overall differences in the level of airport economic resilience in each region, can be defined as follows:

$$T = T_a + T_b = \sum_{r=1}^{2}(\frac{n_r}{n} * \frac{Z_r}{Z} * T_r) + \sum_{r=1}^{2}(\frac{n_r}{n} * \frac{Z_r}{Z} * ln\frac{Z_{ri}}{Z_r}) \tag{8}$$

$$T_r = \frac{1}{n_r}\sum_{i=1}^{n_r}(\frac{Z_{ri}}{Z_r} * ln\frac{Z_r}{Z}) \tag{9}$$

where T_a and T_b represents intra-region and inter-region differences, respectively, and T_r is the Theil Index that measures the difference in the level of airport economic resilience among provinces in region r. The σ-convergence model can be used to measure the dispersion of airport economic resilience indices in regions within a certain range, and σ is defined as follows:

$$\sigma = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(lnZ_i - \frac{1}{n}\sum_{i=1}^{n}lnZ_i)^2} \tag{10}$$

If σ becomes smaller over time it implies that the level of airport economic resilience is changing in the direction of convergence and the difference is shrinking; conversely, it indicates that the difference in the level of airport economic resilience is increasing.

5. Results and analysis

Firstly, the collected data were processed dimensionless using equations (1) and (2), and then the indicator weights were calculated according to equations (3) and (4) The results of the weighting calculations (**Table 1**). Secondly, the calculation results are obtained by weighting and summing the obtained weights, and then the arithmetic mean of the Resilience Index for different airport economy zones is calculated

5.1 Changes in the average level of resilience of airport economy

From a general perspective, the average resilience index of China's airport economy zones has increased year by year since 2010. As shown in **Fig.1**.The average Resilience Index of the Airport economy in 2019 has increased by 108.23% from the 2010 level, with an average annual improvement of 8.502%. In terms of indicators, among the average resilience calculation results of all the Airport economic zones from 2010 to 2019, the indicator of Evolutionary Index increased most significantly, with an average annual increase of 9.74% .Among them, government innovation input and innovation output increased by 15.55% and 15.04% per year respectively, and enterprise innovation input increased by 9.08% per year, which shows that the government plays a very important role in the process of development. The Recovery Index came next, with an average annual growth of 4.93%. Among them, the average annual growth of fixed asset investment is 9.75%. Among the fixed asset investment, airside fixed asset investment focused more, with an average annual growth of 14.41%, and airport fixed asset investment grew by 5.47%. It reflects that, during the study period, China's airport economy has experienced a high-speed growth phase centered on the development and construction of airport surrounding areas, with emphasis on the construction of airport protection capacity, and the accelerated aggregation of development factors. It is worth mentioning that the airport operation scale grew at an average annual rate of 7.76%, which is a fast development. Among them, the average annual improvement in the level of passenger throughput is 8.826%, the average annual improvement in the level of cargo and mail throughput is 6.320%, the average annual improvement in the level of aircraft movements is 6.870%, and the average annual improvement in the level of the number of navigable cities is 8.65%. Comparing the growth rates of the four indicators, It can be seen that the average annual growth rate of cargo and mail throughput is lagging behind the average annual growth rate of passenger throughput, which can reveal the problem of uneven development of China's air transportation. Therefore, China's civil aviation industry should put an end to the idea of "emphasizing passengers over cargo", vigorously develop air logistics, strengthen the core of the development of the airport economy, and enhance the resilience of the development of the airport economy. Among the resistance indicators, growth is slightly weaker, with an average annual growth rate of 3.8%. Among them, the size of the airport economy grew by 10.49% per year on average, but with the gradual increase in the level of openness to the outside world, the external dependence of the development of the airport economy gradually increased, which had a negative impact on the resistance of the airport economy.

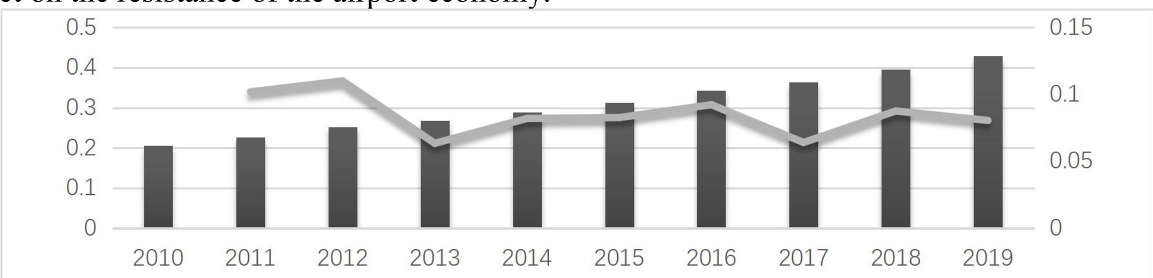

Fig. 1. Average value and annual growth rate of Resilience Index, 2010~2019

5.2 Analysis of difference in the level of resilience of the airport economy

According to the 2019 airport economic Resilience Index, a division based on 10% above the average is classified as a high level, and 10% below is classified as a low level. The division is then based on the coastal region and the inland region, and the division results obtained are shown in the **Table 2** below.

Table 2: Regional and level delineation of the Airport economy

Level/Regional	coastal	interior
High	Beijing, Guangzhou, Shanghai	
Middle	Nanjing, Hangzhou	Chengdu, Chongqing
low	Ningbo	Zhengzhou, Changsha, Xi'an, Guiyang

According to the results of the resilience level hierarchy, Cities with high levels of resilience in their airport economic zones are located along the eastern seaboard, including Beijing, Guangzhou and Shanghai. Firstly, from the point of view of Resistance Index, the airport economic zones of these three cities have favorable hinterland economic conditions, which have formed a strong support for the early development of the airport economy. The scale of development of the airport economy in Beijing, Shanghai and Guangzhou is larger and more robust. Secondly, in terms of Recovery Index, the airports relied on by these three airport economic zones are based were the first to be developed in China, and have received more resources in the course of their development. With the growth in scale, the development gap between these three airports and other airports has gradually widened, creating a stronger attraction for elements within the periphery and a siphoning effect on airports that are relatively lagging behind in development. Specifically, the airports based on these three cities have a large number of based airlines and a large amount of capacity, a well-developed route network and high-frequency flight density, and the scale of airport operations is among the world's largest. In addition, these three hinterland cities of the airport economic zone are more comprehensive in terms of industrial development and are better able to withstand the impact of economic crisis or economic sanctions. Finally, the three high resilience cities are more innovative in terms of the Evolutionary Index. Beijing has the highest Evolutionary Index, with two secondary indicators, Government Innovation Input and Innovation Output, ranking first and much higher than the other cities. Shanghai has the highest value of the enterprise innovation input indicator and the second highest value of the government innovation input and innovation output indicators. Guangzhou has the second highest value for the two secondary indicators of government innovation input and innovation output, and the value of enterprise innovation input is slightly higher than the average value.

Cities with medium levels of resilience include Nanjing, Hangzhou, Chengdu and Chongqing. Firstly, in terms of Resistance Index, the gap between the size of the critical economy of cities with medium resilience level and high resilience level is not obvious. Second, in terms of Recovery Index, all four cities are above average in terms of airport operation scale. It is worth noting that medium resilience level cities have better performance in fixed asset investment, in which the level of fixed asset investment in Airport economic zone in Chongqing region ranks first, while Nanjing, Hangzhou and Chengdu rank third, fourth and fifth respectively. Finally, in terms of Evolutionary Index, the gap between medium resilience level cities and high resilience level cities is large, and the gap with low resilience level cities is not obvious. It shows that the problem of unbalanced development of innovation capacity of China's Airport economy is more prominent.

5.3 Analysis of trends in regional difference

Table 3 shows the Gini coefficient, the Theil Index and the σ value that measure the difference between the eastern coast and the inland of China's airport economic resilience level. From the three indices, it can be seen that the overall difference in the level of airport economic resilience is still large, and the difference between the east coast is larger than the difference between the west and inland. Specifically, in 2019, for example, the highest evaluation value is 0.834 for Beijing, which is 4.23 times the overall minimum value, and 2.99 times the minimum value of the coastal region. The highest appraisal value in the western inland region is 0.418, which is 2.12 times the lowest value. As a whole, the values of the three indicators decrease over time, which reflects that the difference of China's airport economic resilience is shrinking year by year. Looking at the different regions of the three indicators, the critical air economy in the coastal region is gradually shrinking, but the difference in the inland region shows a fluctuating upward trend throughout the study period.

Table 3:Calculation of regional difference

indicators	Gini coefficient			Theil Index			σ convergence model		
regional	coast	interior	all regions	coast	interior	all regions	coast	interior	all regions
2010	0.228	0.112	0.264	0.088	0.020	0.143	0.538	0.349	0.454
2011	0.229	0.134	0.267	0.087	0.029	0.145	0.536	0.377	0.463
2012	0.220	0.143	0.260	0.081	0.033	0.137	0.515	0.382	0.454
2013	0.222	0.123	0.253	0.083	0.025	0.131	0.514	0.345	0.438
2014	0.215	0.127	0.243	0.077	0.026	0.122	0.489	0.343	0.422
2015	0.217	0.132	0.239	0.082	0.031	0.118	0.495	0.341	0.425
2016	0.208	0.138	0.234	0.072	0.033	0.113	0.471	0.355	0.417
2017	0.204	0.127	0.245	0.072	0.028	0.124	0.494	0.364	0.434
2018	0.131	0.054	0.230	0.062	0.033	0.110	0.452	0.364	0.410
2019	0.177	0.136	0.222	0.052	0.032	0.103	0.427	0.365	0.397

Fig 2 shows the results of the Theil Index decomposition of the Resilience Index of the airport economy. The results show that China's overall Resilience Index of the airport economy shows a fluctuating downward trend in both intra-group differences and inter-group differences. Specifically, the Theil Index of Evolutionary is the largest in terms of numerical magnitude, followed by the Theil Index of Recovery, and the smallest value of the Resistance index. In terms of trends, the intra-group differences in the Theil Index of Evolutionary Strength began to show a decreasing trend. However, the between-group difference index always showed a sharp fluctuation. Theil Index of Recovery intra-group differences as well as inter-group differences showed a significant downward trend. The Resistance Theil Index intra-group differences and inter-group differences also showed a decreasing trend but not significant. Combined with the σ-convergence model (in Table 4), the Evolutionary index has a large variability during the study period, and although the variability within the same region has decreased, the trend is not obvious from the different regions as well as the overall view. It indicates that the current imbalance in the innovation and development capacity of the airport economy is prominent. In terms of resilience, both its Theil Index and σ value show a clear downward trend, indicating that the variability of the intrinsic driving force of the airport economy in each region is decreasing year by year. Theil Index and σ value of Resistance are relatively small, but have begun to show a rising trend from the trend.

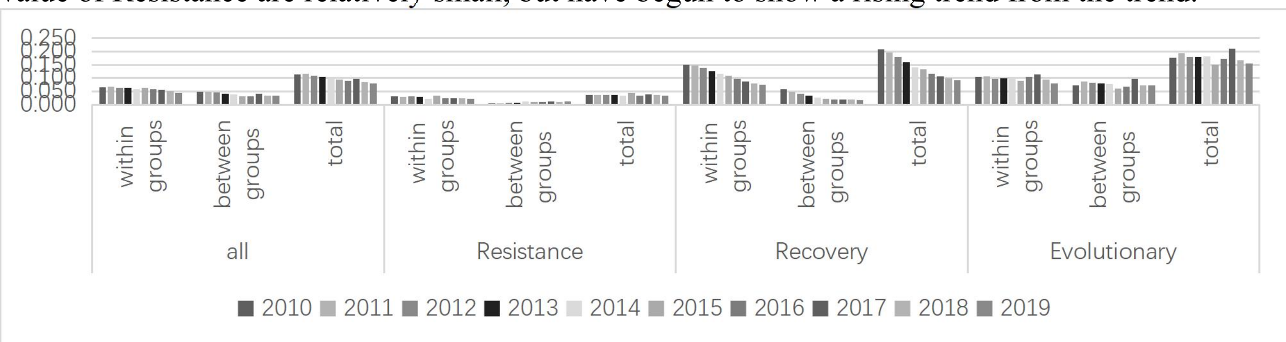

Fig 2 Calculation of Theil Index for within-group differences and between-group differences

Table 4: σ convergence model results

year	Resistance	Recovery	evolutionary

2010	0.271	0.763	0.566
2011	0.271	0.717	0.579
2012	0.273	0.681	0.568
2013	0.276	0.647	0.552
2014	0.276	0.615	0.552
2015	0.319	0.591	0.517
2016	0.293	0.532	0.554
2017	0.3	0.498	0.621
2018	0.306	0.471	0.556
2019	0.306	0.468	0.552

6. Conclusions

Based on the theory of economic resilience and the connotation of high-quality development, this paper proposes the definition of airport economic resilience, based on which the airport economic Resilience Index system is constructed, and the weights of the Indexes are determined by combining Time Space Range Entropy Weight method. And then quantitatively analyzed the economic resilience level of China's 12 airport economic demonstration zones, and quantitatively analyzed by using the Gini coefficient method, the Theil Index method and the σ convergence model method, comparing the differences of the Airport economic zones in different regions. The main findings results are as follows:

First, from the perspective of the overall average change in Resilience, the Resilience Index of China's airport economy demonstration zones realized a substantial increase of 108.23% during the study period. Among them, the average annual growth rate of government innovation investment is higher than the average annual growth rate of enterprise innovation investment, reflecting the leading role of the government in the cultivation of innovation capacity in airport economy zones. From the perspective of fixed asset investment, the development of the area around the airport is the focus of airport economy development in this period. With the further improvement of the facilities around the airport, the cost of factor circulation and transaction costs have been further reduced, and the intrinsic driving force of its development has been further strengthened. From the perspective of airport operation scale, the growth of cargo and mail throughput perennially lags behind the growth of other indicators, reflecting the current lag in the development of aviation logistics, which has a negative impact on the development of airport economy.

Secondly, China's airport economy zones show obvious differences at different levels of development. High Resilience level airport economy zone airport development is more mature, airport operation scale level higher growth slowed down. At the same time, high Resilience level airport economy zones have greater advantages in government innovation input, enterprise innovation input, innovation output, and faster growth. Therefore, in the future, in addition to continuing to promote the development of airports, the medium Resilience Level Resilience Economy Zone also needs to pay more attention to the cultivation of innovation capacity. The airport economy zones with low levels of Resilience still need to focus on the construction of airport operation scale, taking into account the development of innovation capacity. Third, China's critical airport economic zones show significant differences at different levels of development. The airport in the high resilience level airport economic zone has developed more maturely, with slower growth at higher levels of airport operation scale. At the same time, it has a greater advantage in government innovation input, enterprise innovation input, innovation output, and faster growth. Therefore, in the future, in addition to continuing to promote the development of airports, the medium resilience level airport economic zone will need to focus more on fostering innovation capacity. Low resilience level cities still need to focus on the construction of airport operation scale, taking into account the development of innovation capacity.

Finally, the analysis of regional differences between coastal and inland cities shows that the overall differences in the resilience level of the Airport economy are gradually shrinking. In particular, the gap between the coastal regions in terms of Evolutionary Index and Recovery Index is gradually narrowing, while the difference in inland regions is increasing year by year. The evolution of this discrepancy can be attributed to several key factors. Firstly, the coastal region has a more convenient international transport and trade environment, which provides more opportunities and resources for the development of its renewed Evolutionary Index and promotes the overall improvement of renewed Evolutionary Index. At the same time, the coastal region is more economically developed and has richer resources and technological reserves, which is conducive to the pioneering development of the Airport economy. However, there are a number of challenges and constraints in the inland region. Firstly, the hinterland of the inland region is not sufficiently supplied with hinterland factors, and its advantages in international transport and trade are limited relative to the eastern seaboard region, which restricts the development of its Evolutionary Index. Secondly, there is more intense competition among airports in the inland regions, which leads to the dispersion of resources and passengers, and thus affects the adjustment and resilience. This developmental difference may further affect the future development of the Airport economic zone, leading to greater difference in the resilience level of China's Airport economy.

In view of the above research, this paper argues that the following three aspects should be taken to enhance the level of airport economic resilience and reduce inter-regional difference:

First, continued attention should be paid to the development of airports, especially air logistics. In this regard, airport infrastructure construction should be accelerated, including the construction of airport cargo terminals, e-commerce transshipment centers and specialized facilities for cold chain and special cargo, so as to achieve the extension of traditional logistics to new logistics businesses. In addition, the construction of airport logistics network should be strengthened to enhance the accessibility of the airside and roadside of the hub, and realize the efficient connection of air, road and railway. To address the problem of insufficient cargo sources in inland areas, policy support and subsidies should be strengthened to actively expand off-site cargo sources and promote the rapid development of the scale of airport operations.

Secondly, it is necessary to strengthen the innovation capacity of the airport economy. It is necessary to build a national collaborative innovation network for the airport economy and promote the circulation and gathering of innovation factors through industrial synergy, talent interoperability and cross-regional service support. At the same time, the management committees of the airport economy zones need to work together to build a regional innovation and cooperation mechanism, and establish a win-win sharing mechanism for cooperation in resources, projects, taxes, talents and other aspects around industrial cross-regional synergies, so as to enhance the enthusiasm for innovation and at the same time, safeguard the interests of industry members.

Finally, it is necessary to formulate a higher-level strategic plan, formulate a coordinated development strategy from the perspective of overall interests, and realize the cross-regional co-development of the airport-related economy. At the same time, the establishment of a public information platform for aviation logistics should be accelerated to achieve efficient docking of aviation logistics. This is conducive to the integration of unused regional aviation logistics resources and the realization of an orderly division of labor between airports. In addition, it is necessary to build a regional innovation network for the airport economy, provide resource support for the innovative development of the airport economy in the central and western regions, establish a sound mechanism for cross-regional innovation and collaboration in the airport economy, and promote the efficient allocation of innovation factors among different regions.

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