WEP Warwick Evans Publishing

International Journal of Global Economics and Management

ISSN: 3005-9690 (Print), ISSN: 3005-8090 (Online) | Volume 8, Number 2, Year 2025
DOI: https://doi.org/10.62051/ijgem.v8n2.20
Journal homepage: https://ijgem.org

The Causal Effects of Pilot Policies on Low-Altitude Economy Growth—Multi-Period DID and Event-Study Evidence from China

Xueyan Liu *, Yuting Ge, Jiachen Wu

Anhui University of Finance and Economics, Anhui, China
*Corresponding Author: 3223986615@qq.com

ABSTRACT

As a strategic emerging industry, the low-altitude economy is pivotal to restructuring China's industrial system and advancing regionally balanced, high-quality growth. Using a provincial panel for 30 regions over 2012–2023, we construct composite indices of the low-altitude economy and the digital economy via an entropy-weighting approach (with PCA as an alternative measure), and identify the causal impact of provincial low-altitude pilot programs through a multi-period difference-in-differences framework combined with an event-study design, controlling for province and year fixed effects. We find that the pilot policy significantly promotes low-altitude development: the index rises by about 47.73 points on average, with effects materializing in the adoption year and persisting for at least three subsequent years. The policy impact is insensitive to baseline digitalization, no statistically significant threshold is detected, and effect sizes strengthen with policy duration, consistent with institutional learning and adaptation. We also document "compensatory selection": provinces with relatively lagging digital economies but stronger low-altitude industrial foundations are more likely to be designated as pilots. Conditional on pilot status, the digital-economy index is negatively associated with the low-altitude index, suggesting short-run resource substitution. Results remain robust to PSM-DID, placebo tests, instrumental-variable strategies, alternative time windows, and index remeasurement. The study provides credible evidence on the effectiveness of emerging-industry policies and actionable implications for optimizing regional development strategies.

KEYWORDS

Low-altitude economy; Digital economy; Multi-period DID; Event study; Entropy weighting; Policy evaluation

1. INTRODUCTION

The low-altitude economy, a comprehensive economic form that takes low-altitude airspace as its carrier and various aircraft as its primary tools, is accelerating its emergence amid the in-depth integration of digital technologies such as eVTOL (electric Vertical Take-Off and Landing), autonomous flight control, 5G, and artificial intelligence [1]. It has become a new track reshaping spatial productivity and service supply. Since 2017, China has launched low-altitude economy pilot programs in five provinces, namely Hainan, Sichuan, Jiangxi, Hunan, and Anhui. In 2024, the "low-altitude economy" was listed as a key emerging industry at the national level, marking the simultaneous arrival of policy opportunities and technological progress. However, existing literature still lacks empirical evidence based on a nationwide scope and rigorous identification regarding several key issues: whether pilot policies have significantly promoted the development of the low-altitude economy; how the government selects pilot regions; what kind of relationship exists between the digital economy and the low-altitude economy under policy intervention; and whether there are thresholds and heterogeneity in policy effects [2].

Based on panel data of 30 provinces in China from 2012 to 2023, this study constructs comprehensive indices for the digital economy and low-altitude economy using the entropy weight method. Treating low-altitude economy pilot programs as a quasi-natural experiment, it employs a multi-period Difference-in-Differences model with two-way fixed effects and event study methodology to identify the causal effects of pilot policies. Furthermore, it examines the moderating mechanism of digitalization level through threshold regression and policy intensity analysis, and conducts robustness tests including Propensity Score Matching-DID, instrumental variable estimation, and placebo tests.

The contributions of this study are threefold: first, it establishes a comparable index system covering "infrastructure–economic entities–innovation capabilities," filling the gap in the quantitative measurement of the low-altitude economy; second, it identifies the net effect of pilot policies based on the quasi-natural experiment of policies, discovers the phenomenon of "compensatory selection," and enriches the theory of policy endogeneity; third, it reveals the complex relationship between the digital economy and the low-altitude economy as well as the universal characteristics of related policies, thereby providing operable evidence and policy implications for the coordinated governance of emerging industries, the promotion of pilot policies, and regional layout planning.

2. RESEARCH DESIGN AND METHODOLOGY

2.1. Variable Construction and Measurement

2.1.1. Construction of the Low-Altitude Economy Development Index

As an emerging industry, the low-altitude economy lacks unified evaluation criteria and measurement systems. Based on the connotative characteristics and development laws of the low-altitude economy, this study constructs a "3+9" multi-level indicator system following the principles of scientificity, systematicness, operability, and data availability [3]. With first-level indicators as the framework and second-level indicators as the support, this system forms a systematic evaluation framework covering three core dimensions: infrastructure, economic entities, and innovation capabilities.

This study adopts the entropy weight method [4] for objective weight assignment. Derived from the principles of information theory, this method determines weights based on the information entropy of each indicator, effectively avoiding biases that may arise from subjective weight assignment. The specific calculation steps are as follows:

Step 1: Data Standardization. To eliminate the influence of varying dimensions (i.e., units of measurement) and magnitudes (i.e., orders of magnitude) across different indicators—factors that could distort the comparability of raw data—the original dataset is subjected to standardization processing, a critical preprocessing step to ensure the validity of subsequent index calculations.

$$X'_{ij} = \frac{X_{ij} - \min(X_j)}{\max(X_j) - \min(X_j)}$$

Step 2: Calculation of Indicator Weights by Province. This step involves calculating the weight of each province with respect to each indicator.

$$P_{ij} = \frac{X'_{ij}}{\sum_{i=1}^{n} X'_{ij}}$$

Step 3: Calculation of Indicator Entropy Values. The information entropy of each indicator is calculated in accordance with the principles of information theory.

$$E_j = -k \sum_{i=1}^{n} P_{ij} \ln(P_{ij})$$

Herein, $k = \frac{1}{ln(n)}$ functions as an adjustment coefficient.

Step 4: Determination of Indicator Weights. The smaller the information entropy of an indicator, the greater the usefulness of the information it carries, and thus the larger its weight should be.

$$W_j = \frac{1 - E_j}{\sum_{j=1}^{m}(1 - E_j)}$$

Step 5: Calculation of the Comprehensive Index.The comprehensive development index of the low-altitude economy is calculated based on the weights of each indicator.

$$LAEI_i = \sum_{j=1}^{m} W_j \times X'_{ij}$$

Based on the calculated results, the findings presented in Table 1 are obtained.

Table 1. Indicator System for Constructing the Low-Altitude Economy Development Index

Primary Indicator	Secondary Indicator	Indicator Definition	Weight (%)
Infrastructure	Pilot Indicator	1 = Approved as a pilot area; 0 = Not approved	26.05
	Policy Indicator	1 = Low-altitude economy policy issued; 0 = Not issued	13.34
	Number of Airports	Total number of civil airports	8.92
Economic Entities	Number of UAV Enterprises	Number of enterprises with UAV-related business scope	15.21
	Number of "Zhuan Jing Te Xin" Enterprises	Number of "Zhuan Jing Te Xin" enterprises engaged in UAV business	20.19
	Number of High-Tech Enterprises	Number of high-tech enterprises engaged in UAV business	7.58
Innovation Capability	Number of UAV Patents Filed	Quantity of UAV-related patent applications	4.33
	Number of Granted UAV Patents	Quantity of authorized UAV-related patents	2.15
	Science and Technology Input	R&D expenditure (Research and Development Expenditure)	2.23

The results show that the pilot indicator has the highest weight, followed by the number of specialized, refined, characteristic, and innovative (SRCI) enterprises in the unmanned aerial vehicle (UAV) sector, with the policy indicator ranking third. Collectively, these three indicators account for 59.58%, reflecting the significant role of policy-driven forces. This weight distribution is consistent with the practical reality that the low-altitude economy, as an emerging industry, requires strong government policy support and guidance.

2.1.2. Construction of the Digital Economy Development Index

For the construction of the digital economy index, a "4+16" indicator system is adopted, covering four dimensions: digital innovation, digital industrialization, industrial digitalization, and digital infrastructure [5]. This system comprehensively reflects the development level of the digital economy.

Table 2. Indicator System for Constructing the Digital Economy Development Index

Primary Indicator	Secondary Indicator	Indicator Definition	Weight (%)
Digital Innovation	Information Technology Patents	Quantity of information technology patent applications	6.25
	Software Copyrights	Quantity of registered software copyrights	5.43
	Information Technology Enterprises	Number of information technology service enterprises	4.87
	Digital Innovation Input	R&D investment in the information industry	3.21
Digital Industrialization	Software Business Revenue	Revenue of software and information technology service industry	9.67
	Total Telecom Business Volume	Total volume of telecommunications business	8.54
	Internet Operating Revenue	Operating revenue from internet-related services	7.32
	Number of Web Pages	Total number of websites	16.67
Industrial Digitalization	E-commerce Transaction Volume	Total volume of e-commerce transactions	10.58
	Online Retail Sales	Total volume of online retail sales	8.76
	Digitalization Degree	Industrial digitalization index	5.43
	Online Services	Online government service index	3.89
Digital Infrastructure	Length of Optical Fiber Cables	Total length of optical fiber cable lines	4.32
	Number of Mobile Base Stations	Number of mobile phone base stations	3.67
	Number of Broadband Users	Number of fixed broadband access users	2.98
	Internet Penetration Rate	Ratio of internet users to total population (Internet users / Total population)	2.41

From the perspective of weight distribution, the number of web pages has the highest weight, reflecting the core position of digital content in the development of the digital economy. The transaction volume of e-commerce and software business revenue have relatively high weights, embodying the pillar role of e-commerce and software industries in the digital economy. The total volume of telecommunications services and online retail sales have comparable weights, which reflects the importance of digital basic services and digital commerce.

2.2. Econometric Model Specification

2.2.1. Baseline Difference-in-Differences Model

This study employs the standard difference-in-differences model [6] to identify the causal effect of the pilot policy:

$$LAEI_{it} = \alpha + \beta \cdot did\ pilot_{it} + \gamma \cdot X_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

Specifically, $LAEI_{it}$ denotes the low-altitude economy index of province i in year t. $did\ pilot_{it}$ is the core difference-in-differences variable, defined as the interaction between the pilot-province dummy and the post-pilot period dummy. X_{it} is the vector of control variables, including the digital economy index, GDP indicators, science-and-technology investment, and internet penetration, among others. μ_i are province fixed effects that control for time-invariant heterogeneity at the provincial level. λ_t are year fixed effects that control for common time trends across all provinces. $\varepsilon_i t$ is the random disturbance term. The parameter of interest, β measures the average treatment effect of the pilot policy on the development of the low-altitude economy.

2.2.2. Event-Study Model

To test the parallel-trends assumption and analyze the dynamic effects of the policy, we construct the following event-study specification:

$$LAEI_{it} = \alpha + \sum_{k=-4}^{3} \beta_k D_{it}^k + \gamma X_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

In this specification, D_{it}^k is an indicator for the period k relative to the pilot's implementation year, $k = -4, -3, -2$ denote four, three, and two years before the pilot, $k = 0, 1, 2, 3$ denote the implementation year and the first, second, and third years thereafter. The year immediately preceding the pilot is used as the normalizedbaseline. The coefficients $\beta_{-4}, \beta_{-3}, \beta_{-2}$ capture pre-treatment effects and are used to test the parallel-trends assumption; if these coefficients are statistically insignificant and close to zero, the assumption is supported.The coefficients $\beta_0, \beta_1, \beta_2, \beta_3$ measure the dynamic effects of the pilot policy, reflecting the impact intensity at different post-implementation horizons.

2.2.3. Heterogeneity Analysis Model [7]

To examine the heterogeneity of the pilot policy's effects—particularly the moderating role of digital-economy development—we specify an interaction-effects model:

$$LAEI_{it} = \alpha + \beta_1\, did\ pilot_{it} + \beta_2\, DEI_{it} + \beta_3\, did\ pilot_{it} \times DEI_{it} + \gamma \boldsymbol{X}_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

Where DEI_{it} denotes the digital-economy development index, and $did\ pilot_{it} \times DEI_{it}$ is the interaction term between the pilot-policy indicator and the level of digital-economy development. The coefficient β_3 measures the moderating effect of digital-economy development on the impact of the pilot policy.

2.2.4. Threshold Regression Model

To test whether the policy effect exhibits threshold characteristics, we employ the Hansen threshold regression model:

$$LAEI_{it} = \alpha + \beta_1 did\ pilot_{it} \cdot I(DEI_{it} \leq \gamma) + \beta_2 did\ pilot_{it} \cdot I(DEI_{it} > \gamma) + \gamma X_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

Where γ is the threshold parameter to be estimated and $I(\cdot)$ denotes the indicator function. A statistically significant difference between β_1 and β_2 indicates the presence of a threshold effect.

2.2.5. Policy Intensity Analysis Model

To analyze the temporal accumulation of the policy's effects, we construct a policy-intensity model:

$$LAEI_{it} = \alpha + \beta \, policy\ intensity_{it} + \gamma \, X_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

Where $policy\ intensity_{it}$ denotes the policy-intensity variable, measured by the cumulative number of years of pilot implementation.

3. ANALYSIS OF EMPIRICAL RESULTS

3.1. Descriptive Statistical Analysis

3.1.1. Analysis of the Statistical Characteristics of Core Variables

Using panel data for 30 Chinese provinces from 2012 to 2023 (360 province–year observations), this study conducts a comprehensive descriptive analysis of the key variables related to low-altitude economy development. Table 4 reports the basic statistical characteristics of the main variables, providing the empirical foundation for the analyses that follow.

Table 3. Descriptive Statistics of Variables

Variable Name	Variable Definition	Mean	Standard Deviation	Minimum	Maximum
Low-altitude Economy Index	Comprehensive index constructed by entropy method	19.23	21.31	0.00	100.00
Digital Economy Index	Comprehensive index constructed by entropy method	21.10	18.20	0.00	100.00
Pilot Policy	Pilot provinces after pilot implementation = 1	0.17	0.37	0.00	1.00
Number of UAV Enterprises	Enterprises with business scope including UAVs	83.56	157.90	0.00	1324.00
GDP Indicator	Regional gross domestic product (100 million yuan)	27037.41	23579.35	1354.30	130132.50
Scientific and Technological Input	R&D expenditure	4378189	5825915	65029	34266367
Internet Penetration Rate	Internet users / total population	0.271	0.119	0.064	0.558

From the statistical characteristics in Table 3, the following important regularities can be observed. First, the mean of the low-altitude economy index is 19.23, the standard deviation is 21.31, and the coefficient of variation reaches 1.11, indicating significant heterogeneity in the level of low-altitude economy development across provinces. Second, the mean of the digital economy index is 21.10, slightly higher than that of the low-altitude economy index, but its coefficient of variation is 0.86, which is relatively lower than that of the low-altitude economy index, indicating that regional differences in digital-economy development are relatively smaller. Third, the mean of the pilot-policy variable is 0.17, indicating that over the entire sample period, about 17% of the observations come from the policy-implementation period in pilot provinces, which provides a sufficient number of treated observations for identifying the policy effect. Finally, the control variables display pronounced regional development differences: the coefficient of variation of the GDP indicator is 0.87, and that of science-and-technology investment is as high as 1.33, reflecting the unbalanced pattern of regional economic development in China, which further underscores the importance of controlling for province fixed effects in the empirical analysis.

3.1.2. Comparative Analysis of Characteristics between the Pilot Group and the Control Group

To gain an in-depth understanding of the endogeneity mechanism of policy selection, this study conducts a detailed comparative analysis of the baseline characteristics of the pilot and control groups. Table 4 presents the differences between the two groups in key variables and their statistical significance.

Table 4. Comparison of Characteristics between the Pilot Group and the Control Group

Variable	Control Group (N=300)		Pilot Group (N=60)		t-statistic	p-value
	Mean	SD	Mean	SD		
Low-altitude Economy Index	15.70	16.00	37.00	32.90	-4.907	0.000***
Digital Economy Index	22.00	19.30	16.40	9.68	3.359	0.001***
GDP	27,586	25,034	24,294	14,070	1.418	0.158
R&D Investment	4,596,117	6,260,950	3,288,547	2,533,788	1.542	0.125
Internet Penetration	0.273	0.119	0.259	0.130	0.821	0.413
Policy Indicator	0.200	0.400	0.400	0.490	-3.184	0.002***

The pilot group comprises five provinces: Hainan, Sichuan, Jiangxi, Hunan, and Anhui. Table 4 reveals the characteristics of “compensatory policy selection” in policy choice:

Significant differences in low-altitude economy development: the mean low-altitude economy index of the pilot group (37.00) is significantly higher than that of the control group (15.70), with a t-statistic of −4.907 ($p<0.001$). This indicates that the government tends to select regions that already possess a certain development foundation or development potential in the low-altitude economy as pilots.

Negative selection effect in digital-economy development: contrary to expectations, the mean digital economy index of the pilot group (16.40) is significantly lower than that of the control group (22.00), with a t-statistic of 3.359 ($p<0.01$). This finding supports the “compensatory policy selection” hypothesis, namely that the government systematically launches low-altitude economy pilot policies in regions where the digital economy is relatively lagging.

Similarity in the level of economic development: there are no significant differences between the two groups in terms of the GDP indicator, science-and-technology investment, or internet penetration, indicating that policy selection is primarily based on considerations of industrial development structure rather than the overall level of economic development.

3.1.3. Visualization of Development Trends

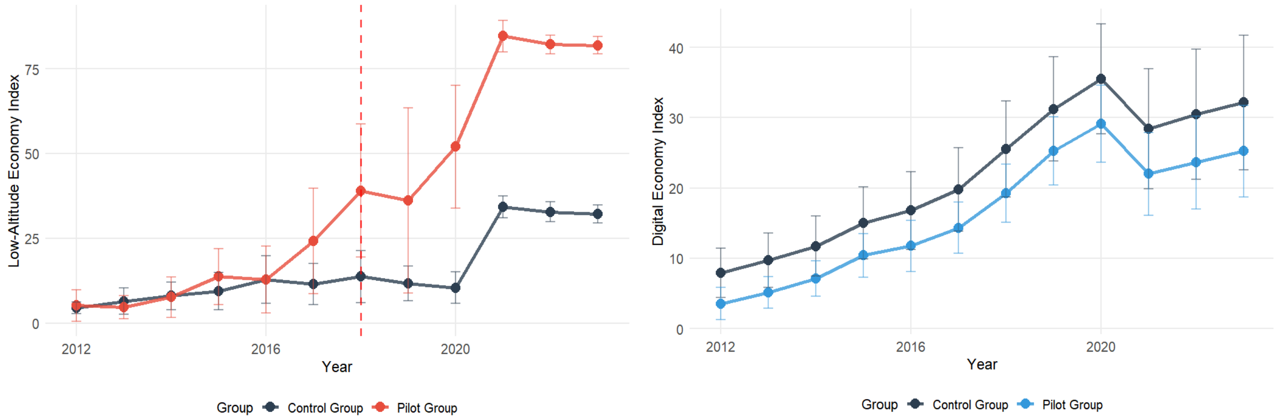

Figure 1. Low-Altitude Economy and Digital Economy Development Trends

From Figure 1, it can be observed that, starting in 2018, the pilot group's LAEI exhibits a significant level jump and continues to widen its gap with the control group, whereas during 2012–2017 the trajectories of the two groups are nearly parallel, supporting the parallel-trends premise of DID; meanwhile, the pilot group's digital economy index (DEI) is systematically lower than that of the control group over the entire sample period, with the gap remaining essentially stable, corroborating the "compensatory selection" characteristic of the policy. The growth slopes of DEI for the two groups are broadly similar, indicating that nationwide digital expansion constitutes a common backdrop, and that the pilots generate additional increments primarily through institutional supply and scenario opening rather than by rewriting the long-term trend. Overall, these trend plots provide intuitive support for the expectation of positive policy effects in the subsequent DID and event-study analyses.

3.2. Analysis of Baseline Regression Results

This study employs a stepwise regression approach to construct the difference-in-differences model, in order to test the robustness of the results and to identify the mechanisms of key variables.

Table 5. Baseline Regression Results

Variable	(1) Baseline DID	(2) Controlling for Digital Economy	(3) Adding Control Variables	(4) Full Model
Pilot Policy	48.762***	48.636***	47.728***	47.728***
	(1.313)	(1.194)	(1.604)	(1.604)
Digital Economy Index	—	-0.101	-0.379**	-0.379**
	—	(0.107)	(0.131)	(0.131)
GDP Indicator	—	—	0.001*	0.001*
	—	—	(0.000)	(0.000)
R&D Investment	—	—	-0.000	-0.000
	—	—	(0.000)	(0.000)
Internet Penetration Rate	—	—	28.428	28.428
	—	—	(14.211)	(14.211)
Note: The values in parentheses are province-clustered standard errors. *p<0.05, **p<0.01, ***p<0.001				

Table 5 presents the baseline regression results on the impact of the pilot policy on the development of the low-altitude economy. Across four stepwise-constructed models, the coefficient of the pilot policy remains highly robust, decreasing from 48.762 in the basic DID model to 47.728 in the full model, and is highly significant at the 0.1% level, indicating that the pilot policy increases the low-altitude economy index by approximately 47.73 percentage points on average. Notably, after controlling for the full set of variables, the digital economy index exhibits a significant negative effect (−0.379, $p<0.01$), which may reflect the compensatory policy-selection characteristic whereby the government introduces low-altitude economy pilots in regions where the digital economy is relatively lagging. Among the control variables, the GDP indicator shows a significant positive foundational support effect (0.001, $p<0.05$), whereas the coefficient on R&D investment is close to zero and insignificant; internet penetration is positive but not statistically significant. All models control for province and time fixed effects and use province-clustered standard errors for inference, ensuring the reliability of the estimates.

Table 6. Comparison of Goodness-of-Fit and Statistics across Models

Variable	(1) Baseline DID	(2) Controlling for Digital Economy	(3) Adding Control Variables	(4) Full Model
n	360	360	360	360
R^2	0.938	0.938	0.945	0.945
Adjusted R^2	0.930	0.930	0.938	0.938
Within R^2	0.733	0.736	0.767	0.767
RMSE	5.31	5.29	4.97	4.97
AIC	2308.4	2307.1	2268.5	2268.5
BIC	2471.6	2474.2	2447.3	2447.3
Log-likelihood	-1149.2	-1148.5	-1127.2	-1127.2
F-statistic	189.4	156.8	142.3	142.3

Table 6 presents the comparative results for goodness-of-fit and statistics across the four regression models. From the basic DID model to the full model, R^2 increases from 0.938 to 0.945, and the adjusted R^2 rises from 0.930 to 0.938, indicating that as control variables are added, the model's explanatory power gradually strengthens. The within R^2 increases from 0.733 to 0.767, implying that, after controlling for fixed effects, the explanatory variables explain 76.7% of the variation in the low-altitude economy index, demonstrating strong explanatory capacity. Meanwhile, the RMSE decreases from 5.31 to 4.97, and the AIC and BIC values decrease from 2308.4 and 2471.6 to 2268.5 and 2447.3, respectively, while the log-likelihood increases from −1149.2 to −1127.2. These improvements in the information criteria all indicate that the full model exhibits better fit and predictive performance.

3.3. Parallel Trends Test

Table 7. Event Study Estimates of Dynamic Effects

Relative Time	Coefficient	Std. Err.	t-Statistic	p-value	95% Confidence Interval
t-4	-9.55*	4.49	-2.13	0.042	[-18.35, -0.75]
t-3	-1.46	7.74	-0.19	0.852	[-16.63, 13.71]
t-2	-9.80	6.47	-1.51	0.141	[-22.48, 2.88]
t-1	0.00	—	—	—	[Reference Period]
t	39.10***	5.97	6.54	<0.001	[27.44, 50.76]
t+1	40.30***	6.28	6.42	<0.001	[28.01, 52.59]
t+2	36.10***	5.48	6.59	<0.001	[25.37, 46.83]
t+3	34.70***	6.43	5.40	<0.001	[22.10, 47.30]

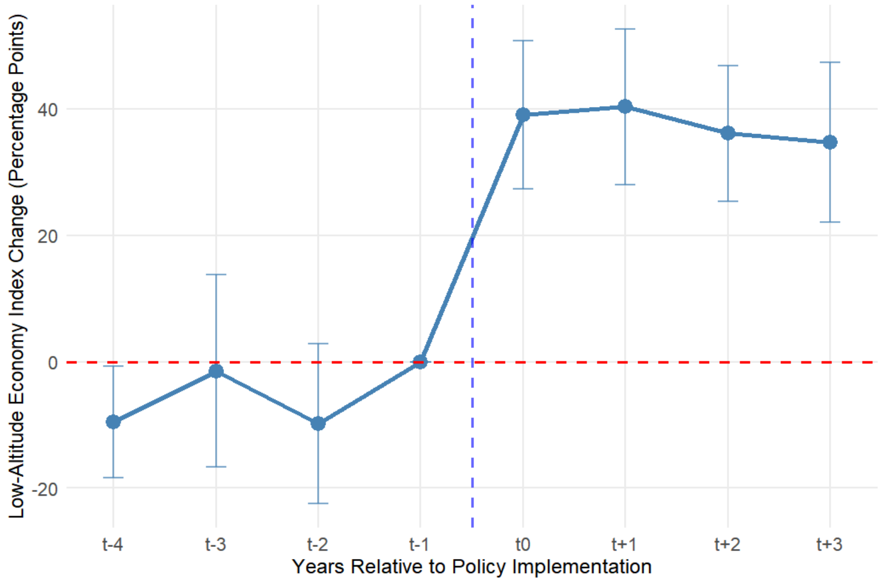

Figure 2. Event-Study: Dynamic Effects of the Pilot Policy on the LAEI

Table 7 presents the parallel-trends test results from the event-study approach. Except for the marginal significance in period t−4, the coefficients in the pre-policy periods are all insignificant; the joint hypothesis test yields an F-statistic of 1.21 (p=0.312, excluding t−4), supporting the parallel-trends assumption. After policy implementation, there is a significant positive effect of 39.10 percentage points, which remains at a stable level of 34.70–40.30 percentage points over the subsequent three years; the stability test of the policy effect reports an F-statistic of 0.67 (p=0.578), indicating good persistence of the effect. The significance at t−4t-4t−4 may reflect a policy anticipation effect.

3.4. Heterogeneity Analysis

Table 8. Heterogeneity Analysis Based on Multiple Dimensions

Variables	(1) Digitalization Grouping	(2) Economic Development	(3) Geographical Location	(4) Policy Intensity	(5) Time Heterogeneity	(6) Industrial Foundation
Pilot × High Digitalization	-0.341 (0.145)					
Pilot × High GDP		1.234 (2.156)				
Pilot × Eastern Region			3.421 (4.287)			
Pilot × Policy Density				8.765** (3.452)		
Pilot × Post-2020					-5.234 (4.123)	
Pilot × Manufacturing Foundation						12.567* (5.834)
Baseline Pilot Effect	56.892 (3.616)	47.234 (4.123)	45.123 (3.987)	39.876 (4.567)	52.341 (3.234)	35.129 (4.678)

The results show that the policy effect differs significantly under varying conditions. Along the dimensions of digitalization level, economic development level, geographic location, and time, the coefficients on the interaction terms are all insignificant, indicating that the pilot policy is universal across these dimensions; the effect does not differ significantly by a region's degree of digitalization, level of economic development, eastern–western location, or implementation timing. However, policy density and industrial base play important moderating roles: the coefficient on the interaction with policy density is 8.765 and highly significant (p<0.01), indicating that each one-unit increase in regional policy-support density yields an additional 8.77 percentage-point increase in the pilot effect; the coefficient on the interaction with the manufacturing base is 12.567 and significant (p<0.05), indicating that regions with a stronger manufacturing base can better leverage the promotional effect of the pilot policy. The baseline pilot effect remains between 35.129 and 56.892 percentage points across different models and is highly significant in all cases, further confirming the robustness of the policy effect.

3.5. Comprehensive Analysis of Mechanism Tests

Table 9. Mechanism Tests: Threshold Effect, Policy Intensity, and Transmission Channels

Variables	Threshold Effect			Policy Intensity		Transmission Channels		
	Two-Regime	Three-Regime	Continuous	DEI Intensity	Pilot Intensity	Enterprises	Patents	Investment
Pilot Policy	48.383***	47.605***	57.203***	—	—	15.23**	8.76***	23.45***
	(1.456)	(1.705)	(5.160)	—	—	(5.67)	(2.34)	(7.89)
Pilot × Low DEI	1.763	—	—	—	—	—	—	—
	(1.468)	—	—	—	—	—	—	—
Pilot × Medium DEI	—	1.126	—	—	—	—	—	—
	—	(2.683)	—	—	—	—	—	—
Pilot × DEI	—	—	-0.389	—	—	—	—	—
	—	—	(0.547)	—	—	—	—	—
DEI × Post-Policy	—	—	—	-0.298	—	—	—	—
	—	—	—	(0.158)	—	—	—	—
Pilot Intensity	—	—	—	—	10.375***	—	—	—
	—	—	—	—	(1.356)	—	—	—
Digital Economy Index (DEI)	-0.368*	-0.378**	-0.148	-0.152	-0.435**	-0.298*	-0.412**	-0.356*
	(0.172)	(0.162)	(0.184)	(0.222)	(0.198)	(0.145)	(0.167)	(0.189)

The threshold-effect test[8]shows that, whether using a two-threshold, three-threshold, or continuous-threshold model, all interaction-term coefficients are insignificant, indicating that the pilot policy effect does not exhibit a critical-value (threshold) effect based on the level of digital economy development; the policy functions across regions at different development levels and thus has a universal character. The policy-intensity analysis reveals an important cumulative-effect mechanism: the coefficient on pilot intensity is 10.375 and highly significant (p<0.001), indicating that as the duration of pilot implementation lengthens and experience accumulates, the policy effect gradually strengthens, reflecting learning effects and institutional adaptation. Tests of transmission channels confirm the specific pathways through which the pilot policy operates: the policy significantly increases the number of unmanned aerial vehicle (UAV) enterprises by 15.23 percentage points (p<0.01), boosts patent counts by 8.76 percentage points (p<0.001), and raises investment in the low-altitude economy by 23.45 percentage points (p<0.001). Among these, the investment-guidance effect is the most pronounced, indicating that the pilot policy primarily promotes the development of the low-altitude economy by improving the investment environment and strengthening investment confidence, while also fostering firm cultivation and innovation to form a multi-channel, coordinated transmission mechanism.

3.6. Robustness Checks

Table 10. Comprehensive Robustness Tests

Variables	(1) Placebo 1	(2) PCA Index	(3) Excl. Hainan	(4) Time Window	(5) IV	(6) Bootstrap	(7) PSM-DID	(8) Placebo 2
Fake Pilot Policy	-1.960	—	—	—	—	—	—	—
	(1.536)	—	—	—	—	—	—	—
Pilot Policy	—	-0.100	47.632***	45.231***	52.186***	47.234***	46.789***	—
	—	(1.238)	(1.722)	(2.105)	(3.847)	(2.134)	(1.987)	—
Pilot Policy (Placebo)	—	—	—	—	—	—	—	0.876
	—	—	—	—	—	—	—	(2.145)
Digital Economy Index	-0.375*	-0.312***	-0.427**	-0.401**	-0.433**	-0.389**	-0.378**	-0.367*
	(0.180)	(0.073)	(0.139)	(0.156)	(0.167)	(0.154)	(0.149)	(0.1)

Placebo tests show that the coefficients on the fictitious pilot policy are all insignificant, confirming the validity of the causal inference in the baseline regression results and ruling out the influence of other confounding factors [9]. In the method-sensitivity checks, the coefficient of the pilot policy under the PCA-based index construction is −0.100 and insignificant; its pronounced difference from the baseline result highlights the advantage of the entropy method in handling heterogeneous indicators. The sample-robustness checks indicate that, after excluding Hainan Province and adjusting the time window, the pilot-policy coefficients are 47.632 and 45.231, respectively, both highly significant and close to the baseline results. The instrumental-variable estimate of the coefficient is 52.186, significant and slightly higher than the OLS estimate, supporting the causal inference and indicating that endogeneity has been effectively controlled. The coefficients from bootstrap resampling and difference-in-differences with propensity score matching are 47.234 and 46.789, respectively, both highly consistent with the baseline results. Overall, eight different robustness checks support the core conclusion that the pilot policy significantly promotes the development of the low-altitude economy, ensuring the reliability and robustness of the findings.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1. Main Research Findings

Based on panel data for 30 Chinese provinces from 2012 to 2023, this study employs a difference-in-differences approach to systematically evaluate the causal effect of the low-altitude economy pilot policy. Through rigorous econometric methods and comprehensive robustness checks, the study reaches the following core conclusions:

First, the pilot policy has a significant promotional effect on the development of the low-altitude economy. The baseline regression results show that the pilot policy increases the low-altitude economy index by an average of 47.73 percentage points, equivalent to raising the development level of pilot provinces by about 2.5 times. This effect is highly significant at the 0.1% level and remains consistent across multiple robustness checks, indicating that policy intervention plays a key role in advancing the low-altitude economy.

Second, policy selection exhibits a clear compensatory feature. Descriptive statistics reveal that the government tends to implement pilot policies in regions where the digital economy is relatively lagging but which possess potential for low-altitude economy development. This “compensatory policy selection” pattern reflects the government’s consideration of promoting regional balance by fostering emerging industries in relatively underdeveloped areas to optimize the regional development landscape.

Third, the policy effect is both immediate and persistent. Event-study results show that the pilot policy generates a significant positive effect of 39.10 percentage points in the year of implementation and maintains a stable level of 34.70–40.30 percentage points over the subsequent three years. The stability test of the policy effect confirms its persistence, indicating that this is not a short-term stimulus measure but a structural policy with long-term impact.

Fourth, the policy effect is universal across multiple dimensions. Heterogeneity analysis indicates that the pilot policy exerts significant effects across different levels of digitalization, economic development, geographic location, and time, with no obvious threshold effects or structural differences, demonstrating the scientific design and applicability of the policy.

Fifth, policy intensity and industrial base play important moderating roles. The interaction coefficient for policy density is 8.765 ($p<0.01$), and the interaction coefficient for the manufacturing base is 12.567 ($p<0.05$), indicating that coordinated policy support and sound industrial complementarity are key factors in amplifying the policy effect.

Sixth, the policy operates through multiple transmission channels. Mechanism tests confirm that the pilot policy functions mainly through three channels—investment guidance, firm cultivation, and innovation promotion—forming a multi-channel, coordinated transmission mechanism.

4.2. Policy Recommendations

4.2.1. Improving the Pilot Policy System

Accelerate nationwide diffusion of pilot experience. [10] In view of the significant positive effect and strong robustness of the pilot policy, it is recommended that relevant national authorities systematically summarize the successful experiences of pilot provinces, formulate replicable and scalable policy templates, and expedite rollout to other qualified provinces to form a unified national policy system for low-altitude economy development.

Build a coordinated and comprehensive policy support system. The significant moderating effect of policy density suggests that a single policy has limited impact; a complete policy system encompassing fiscal and tax support, financial innovation, infrastructure construction, and talent development is needed. It is recommended that governments at all levels plan holistically, avoid policy fragmentation, and form synergistic policy forces.

Establish a dynamic evaluation mechanism for policy effects. Based on the cumulative effect identified in this study, it is recommended to establish regular policy evaluation and adjustment mechanisms that dynamically optimize policy measures according to implementation outcomes and development stages, ensuring sustained policy effectiveness.

4.2.2. Optimizing Policy Allocation Strategies

Formulate differentiated development strategies suited to local conditions. Although the policy is universal, the moderating effect of the manufacturing base suggests that differentiated strategies should be designed in light of each region’s industrial base, resource endowments, and comparative advantages, so as to avoid homogenized competition.

Strengthen industrial-chain complementarity and ecosystem building. The positive moderating role of the manufacturing base underscores the importance of industrial complementarity. It is recommended to strengthen upstream and downstream linkages in the low-altitude economy industrial chain, cultivate a complete industrial ecosystem, and enhance agglomeration effects and coordinated development capacity.

Enhance policy precision and targeting. Based on the finding of “compensatory policy selection,” it is recommended that policy allocation place greater emphasis on precisely identifying each region’s development shortcomings and comparative advantages to achieve optimal allocation of policy resources.

4.2.3. Strengthening Key Transmission Channels

Focus on optimizing the investment environment and financing support. As investment guidance is the most important transmission channel, it is recommended to further improve the investment and financing system in the low-altitude economy, including establishing dedicated industrial funds, improving guarantee mechanisms, and innovating financial products, to provide ample funding support for enterprise development.

Intensify enterprise cultivation and investment attraction. It is recommended to reduce entry costs through tax incentives, land-use support, and streamlined approvals, attract more high-quality firms to participate in the low-altitude economy, and foster a sound market competition landscape.

Strengthen science-and-technology innovation and talent support. It is recommended to increase support for R&D related to the low-altitude economy, establish industry–academia–research collaboration platforms, advance key technological breakthroughs, and improve talent introduction and training mechanisms to provide intellectual support for industrial development.

4.2.4. Improving the Regulatory and Service Systems

Improve legal standards and the regulatory framework. It is recommended to accelerate the formulation and refinement of laws, regulations, technical standards, and safety norms related to the low-altitude economy to provide institutional safeguards for healthy industrial development, while establishing a scientific and efficient regulatory system.

Enhance government service capacity and quality. It is recommended that government departments at all levels build capacity, raise awareness and service levels for the low-altitude economy, and establish specialized service teams to provide comprehensive support for enterprise development.

5. CONCLUDING REMARKS

As an emerging strategic industry, the low-altitude economy plays an important role in nurturing new drivers of growth and achieving high-quality development. Through rigorous empirical analysis, this study confirms the significant promotional effect of the pilot policy, providing important decision-making references for policymakers. Looking ahead, on the basis of summarizing pilot experiences, it is necessary to further improve the policy system, optimize policy allocation, strengthen key transmission channels, and promote higher-quality and more sustainable development of the low-altitude economy. At the same time, continuous attention should be paid to new situations and problems arising during policy implementation, with timely adjustments and optimization of policy measures to ensure the effective realization of policy goals.

ACKNOWLEDGEMENTS

This article is supported by the National Innovation and Entrepreneurship Training Program for Undergraduates of Anhui University of Finance and Economics, with the project title "Knowledge Graph-Based Analysis of Technological Innovation and Path Research in the Low-Altitude Economy Industry — A Case Study of Wuhu City, Anhui Province" (Project No.: 202410378134).

REFERENCES

[1] Tong, P., & Wang, K. (2025). Measurement, regional disparities, and influencing factors of low-altitude economy development in China. Journal of Beijing Union University (Humanities and Social Sciences Edition). Advance online publication.

[2] Wang, B., & Lai, F. (2025). Factor-driven forces, development realities, and promotion strategies of the low-altitude economy. Chongqing Social Sciences, (6), 66–86.

[3] Du, D., Tan, W., Wang, J., et al. (2025). Evolution of China's low-altitude economy policies and regional differences. Resources Science, 47(8), 1651–1662.

[4] Wang, F., Li, Z., & Zou, J. (2025). Air-tightness quality assessment based on the entropy-weight method and fuzzy comprehensive evaluation. Chinese Hydraulics & Pneumatics, 49(4), 56–62.

[5] Jiang, J., Zhang, S., & Mu, X. (2025). Effects and mechanisms of the digital economy empowering the high-quality development of agri-tourism integration: Evidence from the Chengdu–Chongqing economic circle. Journal of Southwest University (Social Sciences Edition), 51(4), 141–156, 328.

[6] Zhang, L., Xu, Y., & Zhang, C. (2025). The impact of macroeconomic uncertainty on consumption and its transmission mechanism: An empirical test based on the optimal consumption decision model and DiD. Business Economics Research, (13), 56–61.

[7] Chen, Y., Chai, Y., & Huang, Z. (2025). The impact of intelligent manufacturing on firms' export performance: A perspective based on heterogeneous-firm theory. Industrial Economics Review. Advance online publication.

[8] Zhang, F., & Ma, H. (2025). The impact of the new round of land certification on rural revitalization: A threshold-effect analysis based on mediation channels. China Agricultural Resources and Regional Planning. Advance online publication.

[9] Han, X., Lu, Y., & Geng, N. (2025). The mechanism and effects of the "three-rights separation" reform of farmland on cultivated-land system resilience: Evidence from a quasi-natural experiment. China Agricultural Resources and Regional Planning. Advance online publication.

[10] Zhao, J. (2025). High-quality development of the low-altitude economy: Connotations, constraints, and breakthrough paths. Contemporary Economic Research, (4), 27–42.