

# Can the Low-Altitude Economy Pilot Policy Promote the Upgrading of Urban Industrial Structure?

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**Abstract:** The low-altitude economy serves as a vital engine for cultivating new quality productive forces. Based on panel data covering 291 prefecture-level cities in China from 2017 to 2023, this study utilizes the introduction of national-level planning in 2021 as a quasi-natural experiment to empirically examine the impact of low-altitude economic policies on urban industrial upgrading using a Difference-in-Differences (DID) approach. The findings indicate that these policies significantly promote industrial upgrading in pilot cities, a conclusion that remains robust after addressing endogeneity via the instrumental variable (IV) method and conducting a series of robustness checks. Regarding the underlying mechanisms, the policy exerts its influence primarily by improving resource allocation efficiency rather than through technological innovation. Heterogeneity analysis further reveals that the promotional effect is more pronounced in the central and western regions compared to the eastern region. This research provides micro-level evidence for evaluating the macro-economic effects of the low-altitude economy.

**Keywords:** Low-Altitude Economy, Industrial Upgrading, Difference-in-Differences Method, Resource Allocation Efficiency, Regional Heterogeneity.

## 1. Introduction and Literature Review

Against the backdrop of global economic transformation, the low-altitude economy (LAE) has emerged as a new engine for regional economic leaps. The integration of emerging technologies into low-altitude networks has accelerated shifts in technological innovation paradigms (Liang, 2026); simultaneously, the LAE facilitates a transition toward high-value-added industries through spatial restructuring and multi-sectoral integration (Xia & Li, 2026). The inclusion of the low-altitude economy in the National Comprehensive Three-Dimensional Transportation Network Planning Outline in 2021 marked its elevation to a national strategic priority, signaling a new phase of policy-driven development (Zi, 2024). Evaluating the causal effect of this policy on urban industrial upgrading is of paramount importance for developing new quality productive forces tailored to local conditions.

Assessing the industrial upgrading effects of macro-policies is a focal point of contemporary scholarship. The Difference-in-Differences (DID) method has been extensively applied to policy evaluations regarding innovative city initiatives (Li et al., 2025), environmental tax reforms (Xiang & Zhao, 2023), and the establishment of National High-tech Zones (Yuan & Zhu, 2018). Seminal literature reveals that policy effectiveness hinges heavily on the improvement of resource allocation efficiency, and central and western regions often exhibit a stronger "late-mover advantage" due to industrial transfer.

In the field of LAE, international scholars note that Urban Air Mobility (UAM) enhances regional mobility (Garrow et al., 2021), while its commercial ecosystem fosters deep integration between manufacturing and modern services (Cohen et al., 2021). Removing barriers related to airspace and infrastructure remains the core challenge to unleashing this potential (Straubinger et al., 2020). Domestic research has progressed from conceptual frameworks (Shen, 2025) and internal logic (Zhou, 2024) to measurement indices (Liu et al.,

2025; Ouyang, 2025) and systemic perspectives (Song, 2024). Li (2026) suggests that the connection of systemic elements under multi-dimensional drivers generates value spillovers. Empirically, Huang and Chen (2025) used provincial data to show that the LAE index drives industrial upgrading, while Li and Chen (2026) utilized city-level data to confirm the positive impact of low-altitude pilot policies on carbon reduction.

However, existing research leaves room for expansion: first, quantitative investigations of the LAE and industrial upgrading rely heavily on macro indices, lacking quasi-natural experimental evidence to mitigate endogeneity; second, there is a lack of direct causal testing of the core mechanism involving the amelioration of resource misallocation; third, there is an urgent need for city-level verification of spatial heterogeneity that may disrupt traditional gradient development patterns.

In light of this, this paper treats the 2021 national planning as a quasi-natural experiment and utilizes panel data from 291 Chinese prefecture-level cities (2017–2023) to assess industrial upgrading effects via the DID method. The marginal contributions of this study are as follows: **Advancement in Perspective and Methodology:** This study is the first to employ a quasi-natural experiment at the micro-city level to identify the net effect of LAE policies on industrial upgrading. **Innovation in Identification Strategy:** We introduce "historical average wind speed" and "average urban slope" as a joint instrumental variable (IV-2SLS) to isolate geographical endogeneity.

**In-depth Mechanism and Heterogeneity Analysis:** We confirm that in the initial policy stages, industrial leaps are driven primarily by "improving resource allocation efficiency" rather than direct technological breakthroughs. Furthermore, the LAE shows greater potential in central and western regions, providing robust empirical support for optimizing industrial layouts and preventing redundant construction.

## 2. Theoretical Mechanism and Research Hypotheses

### 2.1. Direct Impact of the Low-Altitude Economy Policy on Urban Industrial Upgrading

As an emerging economic form reliant on low-altitude airspace and integrating general aviation, unmanned aerial vehicles, electric vertical takeoff and landing (eVTOL) aircraft, and supporting industries, the low-altitude economy exhibits several distinctive characteristics, including technology intensity, an extended industrial chain, and a rich array of application scenarios. The development of this economic form, on the one hand, can directly stimulate the agglomeration of related industries such as aircraft manufacturing, navigation and communication, and operational services. On the other hand, through the continuous expansion of application scenarios such as low-altitude logistics, low-altitude cultural tourism, emergency rescue, and urban governance, it can facilitate the deep integration of advanced manufacturing and modern service industries, thereby propelling the evolution of urban industrial structure toward both advancement and rationalization. Concurrently, the promulgation of the low-altitude economy policy carries pronounced signaling and institutional supply effects. Such effects not only help stabilize the expectations of market entities but also attract accelerated inflows of capital, technology, and talent, thereby further unleashing the endogenous momentum inherent in industrial upgrading. Based on the foregoing analysis, this paper proposes the following hypothesis:

H1: The low-altitude economy policy can significantly promote industrial upgrading in pilot cities.

### 2.2. Transmission Mechanisms of the Low-Altitude Economy Policy Affecting Industrial Upgrading

Industrial upgrading depends on the efficient allocation of production factors. Low-altitude economic policies do not merely cultivate emerging industries directly; they also guide core factors—such as capital and technology—toward high-value-added sectors. By reducing institutional transaction costs, these policies effectively alleviate the "crowding-out" effect caused by inefficient traditional industries, thereby facilitating the transfer of resources toward high-productivity departments. On the other hand, the low-altitude economy possesses strong technology spillovers and industrial linkage effects, which can bolster urban innovation capabilities. However, constrained by the current nascent stage of development, the policy exerts its enabling influence in the short term primarily through the improvement of resource allocation efficiency. The technological innovation effect may serve as a secondary channel and exhibit a certain degree of time lag. Based on the analysis above, this paper proposes the following:

H2a: The low-altitude economy policy can significantly enhance the level of urban technological innovation.

H2b: The low-altitude economy policy can significantly improve the efficiency of urban resource allocation and promote urban industrial upgrading by mitigating resource misallocation.

### 2.3. Regional Heterogeneity of the Impact of the Low-Altitude Economy Policy on Industrial Upgrading

Substantial disparities exist across different regions of China in terms of airspace resources, industrial foundations, infrastructure levels, and market demand. Consequently, the effects of implementing the low-altitude economy policy are likely to exhibit pronounced regional heterogeneity. While the eastern region possesses a relatively robust economic base and a more advanced industrial structure, it simultaneously confronts practical challenges such as constrained airspace resources, high-density urban spatial configurations, and limitations on application scenarios. The development of the low-altitude economy in this region is susceptible to constraints arising from rising congestion costs and the law of diminishing marginal returns. In contrast, the central and western regions enjoy relatively abundant airspace resources and more expansive land space. Coupled with the pressing need to accommodate industrial relocation and cultivate emerging industries, the low-altitude economy holds greater potential as a potent lever for these regions to overcome development constraints and achieve leapfrog industrial upgrading. In particular, the central region, which possesses both locational advantages and substantial industrial carrying capacity, may exhibit an even more pronounced potential for policy responsiveness. In light of these considerations, this paper proposes the following hypothesis:

H3: The promotional effect of the low-altitude economy policy on urban industrial upgrading exhibits significant regional heterogeneity. Compared with the eastern region, this effect is stronger in the central and western regions, particularly in the central region.

## 3. Research Design

### 3.1. Model Specification

This paper employs a two-way fixed effects difference-in-differences model, treating the promulgation of the National Comprehensive Three-dimensional Transportation Network Planning Outline in 2021 as the policy shock. The benchmark model is specified as follows:

$$AIS_{it} = \alpha_0 + \alpha_1 DID_{it} + \sum \beta_k Controls_{kit} + \mu_i + \lambda_t + \varepsilon_{it}(1)$$

Where subscripts  $i$  and  $t$  denote city and year, respectively;  $AIS_{it}$  represents the level of industrial upgrading;  $DID_{it} = Treat_i \times Post_t$  is the core explanatory variable, with  $Treat_i$  indicating pilot cities and  $Post_t$  equal to 1 for 2021 and thereafter;  $\alpha_1$  captures the net policy effect;  $Controls$  is a vector of control variables; and  $\mu_i$  and  $\lambda_t$  denote city and year fixed effects, respectively.

### 3.2. Variable Selection and Description

#### 3.2.1. Dependent Variable: Industrial Upgrading (AIS)

Following Gan Chunhui et al. (2011), industrial upgrading is measured by the industrial structure advancement index, computed as a weighted sum of the value-added shares of the three sectors with weights 1, 2, and 3:

$$AIS_{it} = \sum_{j=1}^3 j \times P_{ijt} = 1 \times P_{i1t} + 2 \times P_{i2t} + 3 \times P_{i3t} (2)$$

#### 3.2.2. Core Explanatory Variable: Low-Altitude Economy Policy Shock (DID)

The interaction term  $DID_{it} = Treat_i \times Post_t$  is constructed, where  $Treat_i$  equals 1 for pilot cities and

$Post_t$  equals 1 for 2021 and thereafter.

### 3.2.3. Control Variables

The control variables include: economic development level ( $ln\_gdp$ ), population size ( $ln\_pop$ ), financial development ( $Fin$ ), government science and technology investment ( $Gov\_tech$ ), trade openness ( $Trade$ ), informatization scale ( $Internet$ ), and human capital ( $Human\_Cap$ ).

### 3.2.4. Mechanism Variables

Technological innovation ( $ln\_patent$ ) is measured as the natural logarithm of the total number of patent applications in a city plus one (Jiang Hongli, 2025). The resource misallocation index ( $Misalloc\_Eff$ ) is constructed by estimating capital and labor price distortion coefficients based on a Cobb–Douglas production function and the Solow residual method, and taking the weighted average of their absolute values (Gao Shan, 2024). Larger values indicate more severe misallocation.

## 3.3. Data Sources and Descriptive Statistics

The descriptive statistical analysis reveals that the Industrial Structure Advancement Index (AIS) ranges from a minimum of 2.015 to a maximum of 2.715, with a mean value of 2.369, indicating the presence of substantial inter-city disparities in the level of industrial structure advancement. The mean value of the low-altitude economy pilot policy variable (DID) is 0.252, signifying that approximately 25.2% of the observations in the sample period fall under the policy implementation regime, which aligns with the practical feature of the pilot policy's progressive rollout. The value ranges of both mechanism variables and control variables lie within reasonable bounds, and no extreme outliers are present to distort the analysis (all continuous variables have been winsorized at the 1st and 99th percentiles). These characteristics provide a sound data foundation for the subsequent empirical analysis.

## 4. Empirical Results and Analysis

### 4.1. Benchmark Regression

Table 1 reports the benchmark regression results for the impact of the low-altitude economy policy on industrial upgrading. To absorb unobservable individual heterogeneity and macroeconomic temporal shocks, all regressions strictly control for both city and year two-way fixed effects, and standard errors are clustered at the city level.

Column (1) presents the results without the inclusion of control variables. The coefficient of the core explanatory variable DID is positive and statistically significant at the 1% level. Column (2) introduces a vector of control variables, after which the estimated coefficient of DID stands at 0.013 and remains statistically significant at the 1% level. In terms of economic interpretation, this result indicates that, ceteris paribus, the implementation of the low-altitude economy policy significantly increases the industrial structure advancement index of pilot cities by an average of 0.013 units. This finding corroborates that the low-altitude economy can effectively propel the local industrial structure toward high-end advancement, thereby validating Hypothesis H1. Furthermore, the results suggest that market demand, the credit environment, government support for innovation, and robust digital infrastructure constitute critical external conditions driving modern industrial upgrading.

**Table 1.** Benchmark Regression Results

	(1)	(2)
	Basic	Full
DID	0.015***	0.013***
	(3.084)	(2.719)
_cons	2.365***	1.309
	(1867.555)	(1.595)
Base Controls	Yes	Yes
City FE	Yes	Yes
Year FE	Yes	Yes
N	2037	2037
Adj.R <sup>2</sup>	0.946	0.949

Note: \*\*\*, \*\*, and \* denote statistical significance at the 1%, 5%, and 10% levels, respectively; t-statistics are reported in parentheses. The same applies to subsequent tables.

### 4.2. Parallel Trends and Dynamic Effects Test

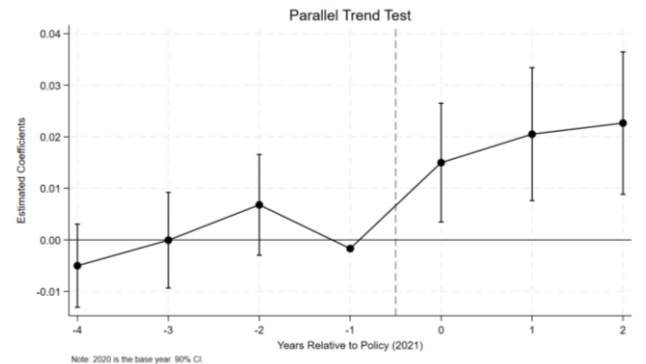
To examine parallel trends and dynamic effects, this paper adopts an event study approach and specifies the following model:

$$AIS_{it} = \beta_0 + \sum_{k \leq -2} \beta_k \times DID_{i,t_0+k} + \gamma X_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (3)$$

Where  $t_0 = 2021$  denotes the year of policy implementation, and  $k$  indicates the number of years relative to the policy year, with  $k = -1$  serving as the reference period. As illustrated in Figure 1, for the pre-policy period ( $k \leq -2$ ), the 90% confidence intervals of the estimated coefficients  $\beta_k$  all encompass zero, thereby satisfying the parallel trends assumption. In the year of policy implementation and thereafter, the coefficients are significantly positive and exhibit an upward trajectory, indicating that the policy effect is both immediate and persistent.

### 4.3. Placebo Test

To rule out interference from unobservable stochastic factors, this paper conducts a placebo test by randomly generating fictitious policy shocks and re-estimating the benchmark regression 500 times. As shown in Figure 2, the estimated coefficients from the random assignments cluster around zero and are largely statistically insignificant. In contrast, the actual estimated coefficient of 0.013 lies distinctly outside this distribution, indicating that the policy effect is not driven by chance factors. Thus, the results pass the placebo test.



**Figure 1.** Parallel Trends Test

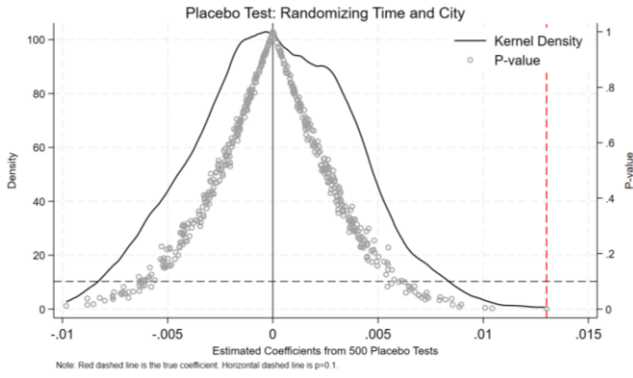


Figure 2. Placebo Test

#### 4.4. Robustness Tests

To verify the reliability of the findings, this paper conducts robustness checks from the following four aspects (results presented in Table 2): (1) replacing the dependent variable by re-measuring industrial upgrading using an alternative industrial advancement index; (2) incorporating additional macroeconomic control variables, namely the degree of government intervention and the level of educational expenditure; (3) modifying the winsorization thresholds to the upper and lower 5th percentiles; and (4) applying a PSM-DID approach with one-to-one nearest neighbor matching to mitigate sample selection bias. As shown in Table 2, the DID coefficient remains significantly positive across all specifications, confirming the robustness of the benchmark findings.

Table 2. Robustness Tests

	(1)	(2)	(3)	(4)
	Replace DepVar (ind_adv)	Add Controls	Winsorize 5%	PSM-DID
DID	0.052** (1.969)	0.013*** (2.736)	0.013*** (2.884)	0.009* (1.837)
Gov_Interv		-0.121* (-1.887)		
Edu_Exp		0.408 (1.126)		
N	2037	2037	2037	1659
Base Controls	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Adj.R <sup>2</sup>	0.934	0.949	0.940	0.955

#### 4.5. Endogeneity Treatment

To mitigate potential endogeneity bias arising from the selection of pilot cities, this paper follows Tan Ying (2025) and Li Ming (2019) in employing the interaction terms between the post-policy time dummy and two geographic variables—namely, "urban average slope" and "historical mean wind speed" (denoted as IV\_Slope and IV\_Wind)—as joint instrumental variables. The rationale for this choice is twofold: gentle terrain and favorable wind conditions not only reduce low-altitude infrastructure costs and safeguard flight operations (relevance), but also constitute long-term, stable natural endowments that do not directly affect contemporaneous industrial structure (exogeneity). The IV-2SLS estimation results, reported in Table 3, indicate a first-stage F-statistic of 2,067.27, substantially exceeding the

conventional critical value and thereby dispelling concerns of weak instruments. In the second stage, the DID coefficient remains significantly positive, consistent with the benchmark regression. The Hansen J test yields a \*p\*-value of 0.375, failing to reject the null hypothesis that the instrumental variables are exogenous. Collectively, these findings further corroborate the robustness of the core conclusion.

Table 3. Endogeneity Test

	(1)	(2)
	First-Stage	Second-Stage
DID		0.012** (2.354)
iv_slope	0.030*** (19.367)	
iv_wind	0.133*** (25.093)	
N	2037	2037
Base Controls	Yes	Yes
City FE	Yes	Yes
Year FE	Yes	Yes
Adj.R <sup>2</sup>	0.979	0.069
KP_F		2067.27
Hansen_P		0.375

### 5. Further Analysis

#### 5.1. Mechanism Test

To further identify the transmission mechanisms, this paper specifies the following model:

$$Mech_{it} = \alpha_0 + \alpha_1 DID_{it} + \gamma X_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (4)$$

Where  $Mech_{it}$  denotes the mechanism variables, namely technological innovation ( $\ln\_patent$ ) and the resource misallocation index ( $Misalloc\_Eff$ ), respectively. As reported in Table 4, the coefficient of  $DID$  on resource misallocation is significantly negative, indicating that the policy significantly alleviates factor misallocation, thereby corroborating Hypothesis H2. The coefficient on technological innovation is statistically insignificant, suggesting that during the initial phase of implementation, the policy drives industrial upgrading primarily through improvements in resource allocation efficiency, whereas technological spillover effects have yet to materialize.

Table 4. Mechanism Test

	(1)	(2)
	$\ln\_patent$	$Misalloc\_Eff$
DID	0.002 (0.078)	-0.057*** (-5.264)
		(-0.536) (-1.085)
_cons	11.681*** (4.759)	-0.328 (-0.341)
N	2037	2037
Adj.R <sup>2</sup>	0.985	0.867

#### 5.2. Regional Heterogeneity Analysis

Given the substantial disparities across different regions of China in terms of economic foundations and airspace endowments, this paper partitions the full sample into three

major regions—namely, the eastern, central, and western regions—and conducts heterogeneity regressions accordingly.

The regression results presented in Table 5 indicate that the low-altitude economy policy exerts a positive effect on industrial upgrading across all regions. However, the magnitude and statistical significance of the coefficients exhibit pronounced tiered variations. Specifically, the coefficient for the eastern region is 0.009, whereas the coefficients for the central and western regions are 0.020 and 0.019, respectively, and are statistically significant at the 1% and 5% levels, respectively. These findings corroborate Hypothesis H3 of this paper. The economic rationale underlying this pattern is as follows: the industrial structure of the eastern region has already attained a relatively advanced level and is constrained by dense urban architecture and congested civil aviation corridors, resulting in diminishing marginal returns to low-altitude application scenarios. In contrast, the central and western regions possess expansive airspace resources and an acute need for emerging industries to overcome geographical barriers. The low-altitude economy policy has fully activated the latecomer advantages of the central and western regions, effectively facilitating the accommodation of industrial relocation and exhibiting a pronounced catalytic effect.

**Table 5.** Heterogeneity Analysis

	(1)	(2)	(3)
	East	Central	West
DID	0.009*	0.020***	0.019**
	(1.859)	(2.690)	(2.084)
_cons	0.242	2.112**	2.743***
	(0.168)	(2.085)	(3.338)
Base Controls	Yes	Yes	Yes
City FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
N	714	700	623
Adj.R <sup>2</sup>	0.969	0.937	0.947

## 6. Conclusion and Policy Implications

### 6.1. Research Conclusions

Based on panel data of 291 prefecture-level cities in China spanning 2017–2023, this study treats the introduction of the low-altitude economy policy in 2021 as a quasi-natural experiment and employs a difference-in-differences approach to evaluate its impact on urban industrial upgrading. The findings are as follows. First, the low-altitude economy policy significantly promotes the advancement of industrial structure in pilot cities, and this conclusion remains robust after a series of tests, including parallel trends and placebo tests, replacement of variables, PSM-DID estimation, and instrumental variable (IV-2SLS) analysis. Second, mechanism analysis reveals that the policy promotes industrial upgrading primarily by improving resource allocation efficiency, whereas the technological innovation effect is not yet significant during the initial stage of policy implementation. Third, heterogeneity analysis indicates that the policy exerts a stronger catalytic effect on industrial upgrading in the central and western regions than in the eastern region, exhibiting pronounced spatial asymmetry.

### 6.2. Policy Implications

First, steadily advance the construction of low-altitude economy pilot zones, expand the pilot scope in a timely manner, and accelerate the development of infrastructure such as takeoff and landing sites and communication, navigation, and surveillance systems, thereby consolidating the foundation for industrial upgrading. Second, dismantle barriers to factor mobility, deepen airspace management reforms, and guide the flow of capital and talent toward high-productivity segments. At the same time, guard against redundant construction induced by fiscal subsidies and instead stimulate the development of the industrial chain through the opening of application scenarios. Third, implement a differentiated spatial layout based on regional endowments. The central and western regions should capitalize on their ample airspace resources, expand distinctive application scenarios such as drone logistics and agricultural and forestry plant protection, and accommodate industrial relocation. The eastern region should concentrate on core component research and development and standard setting, ascending to higher-value-added segments of the industrial chain. Through such coordinated and differentiated strategies, a synergistic optimization of the national industrial structure can be achieved.

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