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Exploring the Mechanisms Through Which Sci-Tech Finance Drives China's Low-Altitude Economy

探索科技金融推动中国低空经济发展的机制

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Abstract. This study examines the impact of science and technology finance on the development of China's low-altitude economy, an emerging sector that plays a crucial role in the Fourth Transportation Revolution. Using a sample of 428 Chinese A-share listed firms in the industry from 2013 to 2023, this research constructs a comprehensive evaluation framework based on the structure–conduct–performance (SCP) paradigm. The empirical analysis employs fixed-effects models and mediation tests to investigate both direct and indirect effects. The results indicate that science and technology finance significantly promotes the development of the low-altitude economy, and this relationship remains robust after multiple robustness tests and endogeneity corrections. In addition, science and technology finance indirectly stimulates industry development by improving firms' access to credit resources. The findings further show that regions with more developed financial ecosystems experience stronger promotion effects, while non-state-owned enterprises utilize financial resources more efficiently than state-owned enterprises. These results reveal the dual transmission mechanisms through which science and technology finance supports the growth of China's low-altitude economy and provide empirical evidence for strengthening financial support policies for strategic emerging industries.

Keywords: Sci-tech finance; Low-altitude economy; Credit Accessibility

摘要： 本研究探讨科技金融对中国低空经济发展的影响。低空经济作为第四次交通革命中的新兴产业，在推动产业升级与经济发展方面具有重要作用。以2013—2023年中国低空经济相关行业的428家A股上市公司为研究样本，本文基于结构—行为—绩效（SCP）范式构建综合评价框架。实证分析采用固定效应模型和中介效应检验，以考察科技金融的直接与间接影响。研究结果表明，科技金融显著促进了低空经济的发展，并且在多种稳健性检验和内生性修正之后，这一结论依然成立。此外，科技金融还通过改善企业获取信贷资源的能力，间接推动行业发展。研究进一步发现，在金融生态体系更为完善的地区，科技金融对低空经济发展的促进作用更加显著；同时，相较于国有企业，非国有企业在利用金融资源方面表现出更高的效率。总体而言，研究揭示了科技金融支持中国低空经济发展的双重传导机制，并为加强战略性新兴产业的金融支持政策提供了重要的实证依据。

关键词： 科技金融；低空经济；信贷可获得性

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1. Introduction

The world is currently entering the era of the "Fourth Transportation Revolution," largely driven by the rapid development of the low-altitude economy. This emerging sector refers to a comprehensive economic ecosystem centered on manned and unmanned low-altitude flight activities, promoting the integrated development of multiple related industries. Its core components include unmanned aerial vehicle (UAV) logistics, urban air mobility, emergency rescue services, and aerial remote sensing, all supported by high-end manufacturing and infrastructure systems such as navigation, communication networks, and precision data services. These characteristics highlight the technology-intensive and cross-sectoral nature of the low-altitude economy. Beyond representing a new frontier for the aerospace and transportation industries, it has also become a strategic arena in global technological competition. Recognizing its strategic significance, China has incorporated the low-altitude economy into the "strategic emerging industrial system" outlined in the 14th Five-Year Plan for General Aviation Development, while implementing regulatory frameworks such as the Interim Regulations on Flight Management of Unmanned Aerial Vehicles to facilitate the transition from pilot experimentation to large-scale commercial deployment.

Despite its promising prospects, the development of the low-altitude economy faces substantial financial challenges. The sector is characterized by high technological intensity, significant capital requirements, and long innovation cycles, making traditional financing mechanisms insufficient for supporting its high-risk and high-investment environment. As a result, financing constraints have become a major barrier to transforming pilot projects into commercially viable operations. Recent studies increasingly emphasize the importance of financial innovation and supportive policy instruments in alleviating these constraints. For instance, green credit policies have been shown to stimulate green technological innovation (Xu & Lin, 2025), while inclusive finance combined with technological advancement enhances total factor productivity (Dong et al., 2025). In addition, emerging governance tools such as artificial intelligence can improve environmental, social, and governance (ESG) performance by strengthening corporate information environments (Zhou et al., 2025). These findings suggest that the development of emerging industries depends not only on capital availability but also on the synergistic interaction between financial instruments and governance mechanisms.

Within this context, science and technology finance plays a crucial role as an institutional arrangement designed to support the entire innovation cycle. By integrating financial instruments, institutions, and services, science and technology finance helps disperse innovation risks and direct financial resources toward strategic industries through mechanisms such as venture capital investment and science and technology credit. By improving firms' access to financing and facilitating resource allocation for innovation activities, it serves as a critical bridge linking financial innovation with industrial upgrading. Consequently, examining the role of science and technology finance in promoting the development of the low-altitude economy holds significant theoretical and practical relevance.

2. Materials and Methods

The structure–conduct–performance (SCP) paradigm provides an important analytical framework for understanding how science and technology finance enables the development of emerging industries (Bain, 1959). According to this paradigm, market structure influences firm conduct, which subsequently determines industry performance. As an institutional arrangement designed to support technological innovation, science and technology finance reshapes financial structures through policy incentives and

market-oriented financial instruments, thereby directing resources toward strategic industries (Hsu et al., 2014). These structural adjustments influence firms' financing and investment behavior and ultimately improve industrial performance.

Within the SCP framework, two major transmission mechanisms can be identified. The first is a direct "Structure–Performance" pathway, in which improvements in financial supply structures directly enhance industrial development. The second is an indirect "Structure–Conduct–Performance" pathway, where financial structural optimization influences corporate financing behavior and investment decisions, which subsequently improve industry outcomes. Recent research on financial technology further enriches this perspective. Digital and intelligent financial services enhance the capacity of science and technology finance to support the development of emerging industries such as the low-altitude economy (Gomber et al., 2018). Meanwhile, more sophisticated credit assessment tools expand firms' financing channels and improve credit accessibility (Bollaert et al., 2021), thereby strengthening the mediating mechanisms proposed in the SCP paradigm.

From the perspective of the direct structural effect, science and technology finance can inject diversified financial resources—including credit, equity investment, and insurance—into the low-altitude economy by optimizing financial supply through specialized institutions and technology-oriented capital markets. This structural improvement expands financing channels and enables firms to overcome early-stage resource constraints, thereby increasing investment in technological research and development (R&D) as well as market expansion. Such investments contribute to industrial scale expansion and technological upgrading (King & Levine, 1993). Moreover, external equity financing has been shown to promote innovation and industrial growth (Brown et al., 2009), while government funding can alleviate financing constraints and stimulate corporate innovation activities (Howell, 2017). Based on this reasoning, the following hypothesis is proposed:

H1. *Science and technology finance exerts a significant direct enabling effect on the development of China's low-altitude economy.*

Beyond this direct effect, the SCP framework suggests that science and technology finance may also influence industrial development through changes in corporate behavior. By improving financial structures, science and technology finance enhances credit accessibility through mechanisms such as investment–loan linkages, intellectual property pledge financing, and government-supported industrial investment funds. At the same time, government risk-compensation mechanisms and financial support policies help expand firms' internal and external financing channels. These mechanisms collectively influence corporate financing behavior (Amore et al., 2013; Beck et al., 2005). As firms obtain greater financial resources, they can increase investment in R&D, production expansion, and technological upgrading, thereby transforming structural financial advantages into measurable improvements in industrial performance. Accordingly, the following hypothesis is proposed:

H2. *Financing conditions and credit accessibility serve as key intermediary mechanisms through which science and technology finance promotes the development of the low-altitude economy.*

The effectiveness of science and technology finance may also vary across different structural environments. From a regional perspective, areas with more developed financial ecosystems possess stronger financial infrastructure and more mature financial markets, allowing them to better leverage optimized financial structures and amplify the enabling effects of science and technology finance (Guiso et al., 2009).

From an ownership perspective, non-state-owned enterprises—historically disadvantaged in traditional financial systems—often respond more strongly to financial reforms aimed at correcting resource misallocation. Consequently, improvements in financing access may lead to greater performance gains for these firms compared with state-owned enterprises (Brandt & Li, 2003). Based on this reasoning, the following hypothesis is proposed:

H3. *The empowering effect of science and technology finance exhibits structural heterogeneity depending on regional financial ecosystems and firm ownership characteristics.*

To empirically test these hypotheses, this study constructs a panel dataset consisting of 428 Chinese A-share listed companies involved in the low-altitude economy sector over the period 2013–2023. Focusing on A-share firms ensures strong representativeness, as these companies cover key segments of the industrial chain, including aircraft manufacturing, operational services, and core component production. Data cleaning procedures excluded firms labeled ST (Special Treatment), *ST (Delisting Risk Warning), and PT (Particular Transfer), as well as observations with missing values for key variables. The final unbalanced panel dataset contains 1,460 firm-year observations, with all data obtained from the Wind database.

Table 1. Low-altitude Economy Development Level

Primary Indicator	Secondary Indicator	Tertiary Indicator	Direction
Structure	Market size	Herfindahl index	+
	Size structure	Mean of natural logarithm of total assets	+
		Standard deviation of logarithm of total assets	−
Conduct	Barrier to entry	Capital intensity	+
	Technological innovation	Percentage of R&D staff	+
	Activity of fixed asset investment	Cash paid for fixed assets purchased / total assets	+
	Financing and investment behavior	Cash received from borrowings / total assets	+
	Market expansion	Increase rate of business revenue	+
		Average accounts receivable turnover ratio	+
Performance	Profitability	Return on equity	+
		Net operating rate	+
	Value creation capability	Return on invested capital	+
		Earnings before interest, taxes, depreciation, and amortization (EBITDA)	+
	Growth and sustainability	Net profit growth rate	+
		Sustainable growth rate	+

The dependent variable in this study is the development level of China's low-altitude economy industry, measured by constructing a Low-Altitude Economy Development Index (LAE). Guided by the SCP paradigm, the index incorporates three dimensions: market structure, firm conduct, and economic performance. The market structure dimension includes indicators such as the Herfindahl index of industry

concentration, the mean and standard deviation of the logarithm of total assets to capture firm size distribution, and capital intensity to reflect entry barriers. The firm conduct dimension measures innovation and operational behavior using indicators such as the proportion of R&D personnel, capital investment intensity, borrowing inflows relative to assets, revenue growth, and accounts receivable turnover. The performance dimension evaluates profitability and growth potential using return on equity, net profit margin, return on invested capital, net profit growth rate, sustainable growth rate, and earnings before interest, taxes, depreciation, and amortization (EBITDA). These fifteen indicators are synthesized using the entropy method to construct a comprehensive LAE index.

Table 2. Science and Technology Finance Indicators

Primary Indicator	Secondary Indicator	Note	Direction
Science and technology input	Government financial investment in science and technology (public subsidy)	Government subsidy as a percentage of total assets	+
	R&D expenditure	R&D expenditure as a percentage of total assets	+
Financial support	Technology loans from financial institutions (money borrowed long term)	Long-term borrowing as a percentage of total assets	+
	Capitalization of R&D investment	Proportion of capitalized R&D investment	+

The core explanatory variable is science and technology finance (TF). Its measurement reflects the dual attributes of technological support and financial resource allocation within China's policy framework. Two dimensions are considered. The technology input dimension is measured by the ratio of government subsidies to total assets and the ratio of R&D expenditure to total assets (Cazavan-Jeny et al., 2011), capturing both fiscal support and corporate innovation investment. The financial support dimension is measured by the ratio of long-term borrowing to total assets and the proportion of capitalized R&D expenditure relative to total R&D expenditure, reflecting firms' access to financial markets and strategic allocation of innovation resources. These indicators jointly capture both government guidance and market-driven financial support, and the entropy method is used to synthesize them into a composite TF index.

To control for other factors that may influence industrial development, several firm-level and regional-level control variables are included. Firm-level controls include firm age (FirmAge), the proportion of independent directors (IndDirRatio), and the shareholding ratio of the top ten shareholders (Top10Shr), reflecting firm life-cycle characteristics, governance quality, and ownership structure. Regional-level controls include gross domestic product per capita (GDPpc) and financial development (FinDev), which account for differences in regional economic conditions and financial ecosystems.

Table 3. Control Variables

Variable Term	Variable	Explanation
Years of service	*FirmAge*	ln (Observation Year − Year of Establishment + 1)
Independent director proportion	*IndDirRatio*	Number of independent directors
Top 10 shareholders' share	*Top10Shr*	Shareholding of top 10 shareholders / total shares × 100

Economic level	development	*GDPpc*	ln (GDP per capita)
Financial level	development	*FinDev*	Year-end balance of deposits and loans in financial institutions / regional GDP

Finally, mediation analysis is conducted to explore the financial transmission mechanisms through which science and technology finance influences the development of the low-altitude economy. Two financial channels are considered. The first is financing constraints, measured using the KZ index (Kaplan & Zingales, 1997), which captures firms' internal financing conditions based on cash flow, leverage, and liquidity indicators. The second is credit accessibility, measured using the FC index (Hadlock & Pierce, 2010), which evaluates firms' capacity to obtain external debt financing. By distinguishing between internal financial health and external credit capacity, these complementary indicators provide a robust framework for tracing the transmission mechanisms through which science and technology finance supports industrial development.

To test Hypothesis 1, the following baseline regression model is specified:

$$LAE_{it} = \alpha_0 + \alpha_1 TF_{it} + \alpha_2 Controls_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (1)$$

where

- *i* represents the firm,
- *t* represents the year,
- LAE_it is the development level of the low-altitude economy,
- TF_it represents science and technology finance,
- Controls_it denotes the control variables,
- μ_i represents firm fixed effects,
- δ_t denotes time fixed effects, and
- ε_it is the random error term.

To test Hypothesis 2, the mediation effect model is constructed as follows:

First-stage mediation equation

$$Med_{it} = \beta_0 + \beta_1 TF_{it} + \beta_2 Controls_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (2)$$

Second-stage mediation equation

$$LAE_{it} = \gamma_0 + \gamma_1 TF_{it} + \gamma_2 Med_{it} + \gamma_3 Controls_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (3)$$

where

Med_it represents the mediating variables, including:

- KZ (financing constraints index)
- FC (credit accessibility index)

All other parameters retain the same definitions as in Equation (1).

3. Result and Discussion

Table 4 reports the descriptive statistics of the core variables used in this study. The results indicate substantial variation in both the development level of China's low-altitude economy (LAE) and science and technology finance (TF) across firms and regions. This variation reflects the uneven distribution of industrial development and financial resource allocation within the sector. Overall, the distributions of both firm-level

and regional-level variables fall within reasonable and expected ranges, suggesting that the dataset is suitable for subsequent econometric analysis.

Table 4. Descriptive statistics of core variables

Variable Class	Variable	Obs	Mean	Std Dev	Min	Max
Explained	LAE	1460	0.255	0.089	0.061	0.503
Explanatory	TF	1460	0.132	0.153	0.005	0.685
Controlled	FirmAge	1460	55.48	15.28	23.87	94.59
	IndDirRatio	1460	2.988	0.309	2.079	3.611
	Top10Shr	1460	37.65	5.835	33.3	60
	GDPpc	1460	11.98	0.696	10.3	13.16
	FinDev	1460	4.615	1.645	1.507	7.976
Meta	KZ	1406	1.273	2.107	-10.02	7.001
	FC	1406	0.513	0.28	0	0.993

Table 5 presents the baseline regression results examining the relationship between science and technology finance and the development of China's low-altitude economy. After controlling for firm and year fixed effects, the coefficient of TF is significantly positive. This finding indicates that science and technology finance plays a crucial role in promoting the development of the low-altitude economy. In other words, enhanced financial support targeted at technological innovation significantly stimulates industrial expansion and technological advancement in the sector. These results provide empirical support for Hypothesis 1.

Table 5. Benchmark regression of the impact of science and technology finance on the development of China's low-altitude economy industry

Variable	LAE (1)	LAE (2)
TF	0.0427***	0.0396**
	(2.6734)	(2.5318)
FirmAge		0.0006*
		(1.8797)
IndDirRatio		-0.0197
		(-0.3708)
Top10Shr		-0.0005
		(-1.2000)
GDPpc		-0.0526**
		(-2.1685)
FinDev		0.0059
		(0.989)
_cons	0.2493***	0.8994***
	(118.3188)	(2.6225)
Firm FE	Yes	Yes
Year FE	Yes	Yes
R^2	0.851	0.855
N	1460	1460

Table 6. Mechanism Mediation Test

Variable	FC	LAE	KZ	LAE
TF	-0.0881*	0.0317**	1.6784***	0.0309**
	(-1.7181)	(2.0742)	(2.3123)	(1.9913)
FirmAge	0.0018**	0.0005	-0.0375***	0.0005
	(2.2018)	(1.2507)	(-3.3872)	(1.338)
IndDirRatio	-0.5423***	-0.0652	2.6637*	-0.05
	(-4.1113)	(-1.1640)	(1.7112)	(-0.9006)
Top10Shr	0.0001	-0.0019	-0.0098	-0.0004
	(0.0653)	(-1.0629)	(-0.0983)	(-1.0611)
GDPpc	0.2117***	-0.0463**	0.6258	-0.0467**
	(2.8138)	(-2.0569)	(0.7234)	(-2.4633)
FinDev	-0.0227	0.0074	0.1435	0.008
	(-1.1814)	(1.3363)	(0.646)	(1.4157)
FC		-0.0413***		
		(-3.0956)		
KZ				0.0027***
				(2.6054)
_cons	-0.3783	0.9762***	-12.9295	1.0265***
	(-0.3719)	(2.8988)	(-1.1684)	(3.0001)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
R^2	0.885	0.864	0.631	0.864
N	1406	1406	1406	1406

To further explore the transmission mechanism underlying the impact of science and technology finance, mediation analysis is conducted and the results are reported in Table 6. The findings indicate that science and technology finance promotes the development of China's low-altitude economy through intermediary channels related to financial accessibility and credit allocation. Specifically, improvements in financing conditions enable firms to obtain additional financial resources, which in turn facilitates greater investment in technological innovation and industrial expansion. These results confirm the presence of a mediating mechanism and provide empirical support for Hypothesis 2.

Table 7. Regional heterogeneity based on financial development

Variable	LAE (Low FinDev)	LAE (High FinDev)
TF	-0.0009	0.0415**
	(-0.0321)	(2.2488)
FirmAge	-0.0002	0.0010**
	(-0.6279)	(3.7658)
IndDirRatio	-0.0355	-0.0624
	(-0.7575)	(-1.1985)
Top10Shr	-0.0004	-0.0004
	(-0.7941)	(-0.7549)
GDPpc	-0.0250	-0.0524**
	(-0.8770)	(-2.9883)
FinDev	0.0211**	-0.0016
	(2.1457)	(-0.2402)

Variable	LAE (Low FinDev)	LAE (High FinDev)
_cons	0.5959	1.2795***
	(1.4930)	(4.0712)
Firm FE	Yes	Yes
Year FE	Yes	Yes
R^2	0.821	0.888
N	717	726

The heterogeneity analysis presented in Table 7 examines whether the effects of science and technology finance differ across regions with varying levels of financial development. The results reveal that the enabling effect of science and technology finance is significantly stronger in regions with more developed financial ecosystems. This finding suggests that a well-established financial infrastructure enhances the effectiveness of science and technology finance policies by improving resource allocation efficiency and facilitating access to financial services.

Table 8. Property rights heterogeneity based on enterprise ownership

Variable	LAE (Non-SOE)	LAE (SOE)
TF	0.0480**	0.0458**
	(1.9906)	(2.2529)
FirmAge	0.0009**	0.0002
	(2.3687)	(0.2331)
IndDirRatio	0.038	0.1167*
	(0.5497)	(1.7241)
Top10Shr	-0.0004	-0.0004
	(-0.6524)	(-0.8109)
GDPpc	-0.0516	-0.042
	(-1.6451)	(-0.7206)
FinDev	0.0045	0.0097
	(0.5586)	(0.8278)
_cons	0.7085	0.3277
	(1.5564)	(0.3805)
Firm FE	Yes	Yes
Year FE	Yes	Yes
R^2	0.851	0.862
N	1029	425

Consistent with the regional heterogeneity analysis, the results reported in Table 8 further demonstrate ownership-based heterogeneity. Specifically, the positive impact of science and technology finance on the development of the low-altitude economy is more pronounced among non-state-owned enterprises. This suggests that science and technology finance policies help alleviate financing constraints faced by private firms and improve the allocation of financial resources, thereby enhancing the vitality and innovation capacity of China's private sector. These findings provide further support for Hypothesis 3.

Table 9. Robustness tests

Variable	LAE
TF1	0.0509**
	(2.4077)
FirmAge	0.0006*
	(1.856)
IndDirRatio	-0.0197
	(-0.3722)
Top10Shr	-0.0005
	(-1.2101)
GDPpc	-0.0526**
	(-2.1690)
FinDev	0.0059
	(0.9934)
_cons	0.9006***
	(2.6315)
Firm FE	Yes
Year FE	Yes
R^2	0.855
N	1460

To ensure the reliability of the empirical findings, several robustness tests are conducted. First, the model is re-estimated using the financial dimension of science and technology finance (TF1) as the alternative core explanatory variable. The results, presented in Table 9, remain consistent with the baseline regression results, confirming the robustness of the main conclusions.

Furthermore, to address potential endogeneity concerns, this study adopts an instrumental variable approach using one-period lagged science and technology finance as the instrument. This choice is consistent with the implementation lag commonly observed in policy-driven financial support mechanisms in China. The results of the two-stage least squares (2SLS) estimation reported in Table 10 show that the promoting effect of science and technology finance on the development of the low-altitude economy remains statistically significant. Moreover, the estimated coefficient becomes larger after correcting for endogeneity, strengthening the causal interpretation of the relationship within the Chinese institutional context.

Table 10. Endogeneity tests

Variable	(1) TF	(2) LAE
L1_TF	0.2761***	
	(5.5777)	
TF		0.1605**
		(2.422)
FirmAge	0	0.0005
	(-0.0164)	(1.4311)
IndDirRatio	0.025	-0.0206
	(0.2105)	(-0.3174)
Top10Shr	-0.0002	-0.0004
	(-0.2340)	(-0.8686)
GDPpc	-0.0137	-0.0467*
	(-0.3066)	(-1.7252)
FinDev	0.0002	0.0113

Variable	(1) TF	(2) LAE
	(0.0166)	(1.634)
_cons	0.1946	
	(0.2842)	
Firm FE	Yes	Yes
Year FE	Yes	Yes
N	1142	1097
Underidentification (LM)	14.25	
Weak identification (F)	31.1	
Overidentification (J)	0	

4. Conclusions and Implications

This study provides empirical evidence that science and technology finance significantly promotes the development of China's low-altitude economy through multiple transmission mechanisms. The benchmark regression results demonstrate that science and technology finance contributes positively to industrial development. This finding remains robust after addressing potential endogeneity concerns and conducting several robustness checks. Furthermore, the mechanism analysis confirms the existence of two major mediation pathways through which science and technology finance stimulates industrial growth. The heterogeneity analysis further reveals that regions with more developed financial ecosystems experience a stronger enabling effect, while non–state-owned enterprises are able to utilize financial resources more efficiently than state-owned enterprises. This paper makes three primary contributions to the finance and industrial development literature. First, from a theoretical perspective, it integrates the structure–conduct–performance (SCP) paradigm with financial intermediation theory, thereby clarifying how science and technology finance influences the development of the low-altitude economy through changes in firm-level financing behavior. This integration expands the theoretical foundation for understanding how financial systems support the real economy. Second, from an empirical perspective, this study constructs a composite index of science and technology finance and applies fixed effects models, mediation analysis, and instrumental variable estimation to identify causal relationships. These empirical approaches provide robust evidence regarding the role of financial resource allocation in promoting industrial performance. Third, from a policy perspective, the study highlights the moderating roles of regional financial ecosystems and ownership structure, offering valuable insights for the design of science and technology finance policies not only in China but also in other emerging economies.

Based on the empirical findings, several policy recommendations can be proposed to further accelerate the development of the low-altitude economy. First, a coordinated national–regional policy framework for science and technology finance should be established. Such a framework should combine direct government support with market-oriented financial mechanisms, including improved credit risk assessment systems that better accommodate innovation-oriented enterprises. Second, the development of regional financial infrastructure should be incorporated into strategic planning for the low-altitude economy. In particular, policymakers should promote digital finance and other emerging financial instruments, especially in central and western regions where financial development remains relatively limited. Third, policy implementation should adhere to the principle of ownership neutrality. Mechanisms such as bank–enterprise matching platforms and financial information-sharing systems can be introduced to improve private firms' access to science and technology finance, thereby enhancing the vitality and innovation capacity of the low-altitude economy.

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