

Policy-industrial capital collaboration and firm innovation in the low-altitude economy: Evidence from government-guided funds' equity participation in China

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Policy-industrial capital collaboration and firm innovation in the low-altitude economy: Evidence from government-guided funds' equity participation in China

Lei Yi, Xinyi Liao*

Abstract

Supporting innovation in emerging industries through public investment while aligning long-term industrial development objectives with market-based investment incentives is a key challenge in industrial policy design. The global expansion of low-altitude aviation applications brings this challenge into sharper focus: long technology development cycles and substantial uncertainty require both sustained funding and the effective integration of policy-oriented capital with industrial resources. This study examines whether joint equity participation by government-guided funds (a policy-oriented venture capital instrument) and industrial capital (equity capital supplied by established operating companies) in subfunds promotes firm innovation in China's low-altitude economy. Using data on Chinese A-share listed low-altitude economy firms from 2006--2024, this study employs a staggered difference-in-differences model and examines the moderating roles of compensation mechanisms (contractual risk-reward arrangements for co-investors) and industrial relatedness. The results show that jointly backed fund investment significantly enhances firm innovation. Compensation mechanisms and industrial relatedness strengthen this effect, suggesting that appropriate risk-return arrangements and closer resource matching help realize the complementary advantages of policy capital and industrial capital. Heterogeneity analyses indicate that the effect is primarily observed among non-state-owned firms and firms with lower dependence on airworthiness certification, and is more pronounced in regions hosting the first batch of low-altitude aviation pilot sites. This study extends research on the role of capital in low-altitude economy innovation by providing firm-level evidence. The findings inform the design and operation of government-guided funds and the mobilization of industrial investors' resources, and offer insights for other economies designing public investment instruments to support emerging industries.

Introduction

Recent advances in unmanned aerial vehicles (UAVs), electric vertical take-off and landing (eVTOL) aircraft and intelligent airspace management have extended low-altitude aviation into logistics, urban transport and public services. As the prospects for these applications have become clearer, major advanced economies have incorporated low-altitude aviation into their

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transport and industrial strategies, supporting research and development (R&D) and adapting regulatory frameworks to facilitate market entry. For example, following the Advanced Air Mobility Coordination and Leadership Act of 2022, the United States released its first national advanced air mobility strategy and accompanying action plan in 2025. These documents set out 40 recommendations covering areas such as airspace, infrastructure and safety, to coordinate government agencies and support industry deployment. The European Union's Drone Strategy 2.0 similarly combines technology development, market access and financing support to advance the commercialization of drones and related aviation services. Together, these initiatives indicate that low-altitude aviation is regarded both as a frontier of aviation technology and as an emerging source of industrial development and public services. Its development therefore requires progress in technology, institutions and markets.

Against this international background, China has brought low-altitude aviation and its associated manufacturing, operations and supporting services within an integrated development framework known as the 'low-altitude economy', while steadily increasing its policy priority. The low-altitude economy featured in the Government Work Report in both 2024 and 2025 and was designated one of six emerging pillar industries in 2026. The continuity of national planning and industrial policy indicates a shift from preliminary technology development towards large-scale applications and commercial deployment. According to statistics and projections from the Civil Aviation Administration of China (CAAC), the market reached RMB 1.5 trillion by the end of 2025 and is projected to reach RMB 3.5 trillion by 2035. By the end of 2025, China had 3.287 million registered UAVs, an increase of 295.1% from 832,000 at the end of 2021. These figures point to an established base of UAV applications, making China an important setting in which to study the development of the low-altitude economy.

The growing strategic importance of the low-altitude economy has attracted increasing scholarly attention. International research typically examines specific technologies and applications, including urban air mobility (UAM), advanced air mobility (AAM), electric vertical take-off and landing aircraft (eVTOL) and drone delivery. One strand investigates market demand and public acceptance of new low-altitude transport services (Al Haddad et al., 2020; Kalakou et al., 2023; Coppola et al., 2024). Another study examines service applications, infrastructure provisions and social and environmental consequences from the perspectives of commercialization and social sustainability (Zhao et al., 2022; Kellermann et al., 2023). Research that explicitly uses the concept of the low-altitude economy focuses predominantly on China and addresses three broad themes. The first concerns the institutional conditions that support or constrain its development (Zhou and Zhang, 2025; Lin and Gao, 2026). The second examines innovation ecosystems and coordination among participants, exploring how

application-driven innovation and symbiotic evolution among innovation actors advance low-altitude industries (Ren and Wang, 2025). The third investigates the firm-level effects of policy and financial support, including the effects of airspace opening and regional financial development on innovation and investment and financing behavior (Zhao et al., 2025; Hu et al., 2025). Together, these studies have advanced the understanding of the conditions underlying the low-altitude economy and its economic consequences, with increasing attention given to firm innovation. However, how firms sustain innovation under technological and market uncertainty and the support required to do so remain insufficiently understood.

Technological innovation depends heavily on external financing (Brown et al., 2009) and industry-specific resources (Marcon & Ribeiro, 2021). The low-altitude economy is a strategically important emerging sector, but it also inherits features of aviation, such as long engineering development cycles, stringent airworthiness requirements and high costs of safety failures (Vértesy, 2017; Roca et al., 2017). These features create substantial uncertainty during research and development (R&D), pilot-scale testing, airworthiness certification and commercialization while extending the time needed to realize returns on innovation. Although conventional independent venture capital (IVC) can alleviate financing constraints (Zhang et al., 2024), fund lifetimes, exit pressure and financial return objectives can limit investors' tolerance for innovation failure (Tian & Wang, 2014; Barrot, 2017; Yao & O'Neill, 2022). When assessing low-altitude projects with immature technologies and uncertain short-term returns, IVC investors may rely more on ex ante screening to control risk than on sustained commitments to long-term innovation development (Gompers et al., 2020). This creates a need for capital with a longer investment horizon and the capacity to provide industrial resources. Government-guided funds offer a relevant starting point.

Government-guided funds are policy-oriented venture capital funds established through government investment alone or jointly with private capital. They typically employ market-based instruments, such as equity investment, to channel private capital toward priority sectors and underserved areas of economic and social development (Colombo et al., 2016; Grilli & Murtinu, 2014). Advanced economies introduced government-backed venture capital programs to address gaps in the financing available to growing firms. Examples include the U.S. Small Business Administration's Small Business Investment Company (SBIC) program, Israel's Yozma program and Australia's Innovation Investment Fund (IIF). Although their funding arrangements and management structures differ, these programs share the aim of using public support to expand venture capital supply and assist innovative firms (Colombo et al., 2016). In China, government-guided funds have become an important policy instrument for industrial development and innovation. An important operating model is equity participation in subfunds:

government-guided funds establish or invest in subfunds alongside other investors, thereby supporting firms indirectly. Under this model, the resources of the other investors may influence policy outcomes. Industrial capital, defined here as equity capital supplied by companies with established industrial operations, can potentially support investee firms through technological expertise, industry relationships and market access, as well as financing. However, a company's participation in a subfund does not ensure that these resources will be available for investee firms' innovation. This study therefore examines whether investment through subfunds jointly backed by government-guided funds and industrial capital promotes innovation among low-altitude economy firms.

Research on investment and financing in the low-altitude economy is largely rooted in Chinese-language scholarship and focuses on support from patient capital, fiscal and tax policies, and finance for science and technology (Lyu & Yu, 2025; Li & Lu, 2026). Empirical evidence on how venture capital affects innovation in low-altitude economy firms remains limited. Moreover, government support and market-based capital are generally examined separately, leaving coordination among different investors insufficiently explained. Although many studies report positive effects of government-guided funds on innovation (Li et al., 2024a; Li et al., 2024b; Yu et al., 2024), these effects vary with firms' position in the value chain, the role of government capital in syndicated investments and the extent of local government intervention (Xia et al., 2025b; Fan & Huang, 2026). The effects of industrial capital on portfolio firm innovation also remain contested, with studies reporting innovation-enhancing (Chemmanur et al., 2014), innovation-inhibiting (Colombo & Shafi, 2016) and insignificant effects (Lahr & Mina, 2016).

To address these research gaps, we use a staggered difference-in-differences model and data on Chinese A-share listed low-altitude economy firms from 2006--2024 to examine the innovation effects of jointly backed fund investment and the factors that moderate these effects. The study makes three contributions. First, whereas existing research has focused primarily on the low-altitude economy through macro-level policy, regional development and industrial ecosystems, this study extends the firm-level perspective and provides evidence on financing for innovation. Second, rather than treating government-guided funds and industrial capital as separate investors, we bring their participation and firm innovation into a common framework to advance the understanding of investment involving heterogeneous capital providers. Third, by examining compensation mechanisms and industrial relatedness, we identify the institutional arrangements and industrial relationships under which the innovation effect is more pronounced. The findings inform the design of government-guided funds and the allocation of industrial capital in China, while also providing evidence relevant to other economies using

public investment instruments to support emerging industries.

Research hypotheses

Financing constraints on innovation in China's low-altitude economy involve not only insufficient funding but also mismatches between capital supply and demand and a lack of adaptive risk-sharing mechanisms (Zhang & Xu, 2024). Government-guided funds provide a distinctive funding structure for addressing these problems. Research suggests that they can increase innovation inputs and outputs by easing R&D financing constraints, attracting technical talent, facilitating syndicated investment, providing policy certification and improving corporate governance (Li et al., 2024a; Yu et al., 2024; Zhao & Zhang, 2025; Zhang & Zhou, 2025). Government-guided funds also combine policy objectives with an investment function. From an industrial policy perspective, public investment can both address financing gaps and influence the direction of innovation by supporting technologies with long-term potential (Mazzucato, 2016). Their investment objectives therefore extend beyond financial returns to include technological innovation and the development of strategic emerging industries. Compared with purely market-oriented capital, this policy orientation implies greater tolerance for strategically important innovation projects with long R&D cycles and uncertain short-term returns, making these funds well suited to the needs of the low-altitude economy.

Neoliberal perspectives are sceptical of government intervention in markets. Grilli and Murtinu (2014) argue that governments lack the capabilities needed to support high-technology firms directly and that IVC is better placed to develop firms' innovation capabilities. Industrial policy implementation also requires investment expertise and industry knowledge, alongside clear oversight to prevent investments from diverging from policy objectives (Rodrik, 2014). The equity participation model of government-guided funds addresses this concern: government-guided funds participate as limited partners (LPs), contributing capital to subfunds alongside other investors, whereas professional fund managers, who act as general partners (GPs), undertake project selection, investment decisions and post-investment management (Fan & Huang, 2026). This structure can leverage public funding and draw on professional GPs to improve technology project selection and capital allocation, providing professionally managed, market-oriented support for high-risk, long-term innovation (Zhao & Zhang, 2025).

Under this model, government-guided funds are generally not responsible for day-to-day project management. Instead, they influence the funding characteristics, investment orientation and incentives of subfunds, thereby shaping GP behavior. However, this structure also entails agency risk (Xu, 2022). The low-altitude economy spans multiple industries, requiring

investors to assess technological feasibility and the alignment of supply chains, production, customer demand and applications. GPs may lack the specialized expertise needed for these assessments and respond by avoiding risk and directing funds toward non-target industries. Compared with general institutional investors, industrial capital is embedded in operating businesses whose parent companies possess technical knowledge, production experience and market networks. These attributes make industrial capital a well-suited LP partner for government-guided funds seeking to support innovation in low-altitude economy firms. Research on corporate venture capital (CVC) suggests that corporate investors provide value-added services throughout the innovation process (Pierrakis & Saridakis, 2019; Yi et al., 2023), as resources accumulated by large corporations can compensate for the limitations of purely financial capital (Shuwaikh & Dubocage, 2022). When industrial capital participates as an LP, its industry-specific resources become available to the fund. This gives professional GPs a richer information base for project selection and postinvestment management and improves their ability to identify and support innovative low-altitude projects.

Joint equity participation by government-guided funds and industrial capital changes the fund's resource base and brings public policy objectives and commercial investment logics together within one organization. Research on multiple institutional logics suggests that their organizational effects depend on whether they prescribe compatible courses of action; their coexistence alone does not establish either conflict or complementarity (Besharov & Smith, 2014). In this setting, government-guided funds provide policy-oriented finance, industrial investors offer potential industry knowledge and collaborative resources, and professional management teams undertake investment management and resource coordination. Where these objectives converge around firm innovation, this division of responsibilities can combine long-term financing with industrial resources and strengthen the fund's ability to nurture innovative projects.

We therefore propose the following hypothesis:

H1: Jointly backed fund investment promotes innovation in low-altitude economy firms.

Under the subfund equity participation model, government-guided funds and industrial capital have different investment objectives, with the latter pursuing both strategic synergies and financial returns (Dushnitsky & Lenox, 2005). When subfunds are required to allocate more capital to early-stage, high-risk or strongly policy-oriented projects, corporate investors may face greater investment risks and opportunity costs. Moreover, the social benefits of innovation, including industrial upgrading and technological spillovers, cannot be fully captured as investment returns. Allocating risks and returns solely on market terms may therefore weaken

corporate investors' incentives to remain involved and fund managers' incentives to support long-term innovation (Ni et al., 2024). From an industrial policy perspective, policy effectiveness depends both on implementation capacity and on appropriate incentives and constraints for participants (Rodrik, 2014).

In practice, government-guided funds at different administrative levels in China supplement market-based profit and risk sharing with compensation mechanisms, including fixed-return arrangements, profit-sharing concessions and loss compensation (Dong et al., 2018)¹, to increase other investors' risk tolerance and thereby support innovation. From a policy instrument perspective, compensation mechanisms are not merely contractual provisions for distributing returns; they are also tools through which public policy influences investor behavior. The operation of policy instruments shapes relationships among participants and can produce behavioral effects that are not determined solely by the original policy objectives (Lascoumes & Le Galès, 2007). Since public investors and other capital providers need not have the same return requirements, allocating profits and losses strictly in proportion to capital contributions may not satisfy all participants' participation constraints. Research shows that profit distribution arrangements and managerial remuneration structures affect the expected returns of investors and managers, respectively, with their effects depending on the specific contractual design (Jääskeläinen et al., 2007). Although the effectiveness of particular arrangements remains debated, research generally suggests that compensation mechanisms can alter the expected returns and risk-bearing capacity of investors participating in policy-oriented investments, helping reconcile public policy objectives with private investment objectives (Jääskeläinen et al., 2007; Yin et al., 2024; Shi et al., 2026).

The positive moderating role of compensation mechanisms may be particularly relevant to low-altitude investment. The innovation effect of jointly backed fund investment depends both on government capital's willingness to bear long-term innovation risk and on industrial capital's ability to identify technological opportunities and provide industry-specific resources. Compensation mechanisms connect the incentives of these participants. Without appropriate adjustments to risk and return allocation, additional policy constraints may discourage corporate investors and professional managers, preventing the potential complementarities of heterogeneous capital providers from extending beyond the funding structure. By reallocating returns and losses through profit-sharing concessions and compensation, government-guided funds can reduce the opportunity cost of corporate participation in long-term innovation and strengthen GPs' incentives to identify, develop and support innovative projects. Such arrangements can help translate government capital's long-term orientation and industrial capital's expertise into support for firm innovation.

We therefore propose the following hypothesis:

H2: Compensation mechanisms positively moderate the relationship between jointly backed fund investment and innovation in low-altitude economy firms.

A distinctive advantage of industrial capital over general institutional capital is access to resources accumulated through the parent company's operations, including specialized knowledge, market channels and technological resources (Chemmanur et al., 2014). The innovation effect of jointly backed fund investment may therefore depend on how closely these resources match portfolio firms' innovation needs. Greater industrial relatedness between a corporate investor's parent company and a portfolio firm increases their shared understanding of technological knowledge, product markets and value-chain activities. Research has identified benefits for innovation, including greater innovation investment (Wang et al., 2021), stronger innovation resilience (Wang & Lyu, 2024), and increased knowledge disclosure and transfer (Veer et al., 2022). In our setting, participation as a subfund LP does not entail direct involvement in a portfolio firm's R&D or governance. Rather, it enables the corporate investor to provide professional GPs with more relevant industry information and expert assessments, reducing the information costs of evaluating complex technological projects and improving the fund's capacity to support innovation. Industrial relatedness facilitates this process.

However, greater industrial relatedness may also turn resource synergies into competition in the product and technology markets. As business overlap increases, a portfolio firm's core technologies, customer relationships and prospective markets may compete directly with the corporate investor's existing operations (Shan, 2025). This can incentivize knowledge appropriation (Colombo & Shafi, 2016; Jeon & Maula, 2022), whereas concerns about knowledge leakage and technological appropriation may reduce the portfolio firm's willingness to share knowledge and collaborate openly (Dushnitsky & Shaver, 2009). Although professional GPs provide a degree of organizational separation between corporate LPs and low-altitude economy firms under the subfund equity participation model, preventing the direct governance involvement associated with direct CVC investment, extensive business overlap may still create strategic conflicts and restrict resource sharing. Through this competitive channel, industrial relatedness may therefore weaken the innovation effect.

We therefore propose the following hypotheses:

H3a: Industrial relatedness positively moderates the relationship between jointly backed fund investment and innovation in low-altitude economy firms.

H3b: Industrial relatedness negatively moderates the relationship between jointly backed fund investment and innovation in low-altitude economy firms.

Research design

Sample selection and data sources

Considering the research objectives and data availability, we examine listed firms classified as belonging to the low-altitude economy by the Chinese financial database iFind. Firms receiving jointly backed fund investment exactly once from 2006–2024 constitute the treatment group, whereas firms that did not receive such investment constitute the control group. The sample begins in 2006 because China's capital market previously operated under a split-share structure, and listed firms had largely completed the split-share structure reform by 2006, moving toward a unified framework for share tradability. The sample ends in 2024 because innovation is measured via patent data. The approximately two-year lag between patent filing and publication in China necessitates the exclusion of recent years to address truncation concerns (Zhu et al., 2019).

Investment event data come from CVSource, which records investor and investee information, transaction dates and equity stakes. We identify investments by subfunds jointly backed by government-guided funds and industrial capital in three steps. First, we retrieve the lists of government-guided funds and the management organizations of their associated subfunds and match these against the investment records to identify government-guided fund investment events. Second, we retrieve the LP lists of these subfunds and retain investment events involving subfunds with corporate LPs supplying industrial capital. Third, we identify events in which the investee is a low-altitude economy firm and construct the treatment and control samples. After excluding anomalous observations and observations with missing values, the sample comprises 419 firms.

The other variables are obtained from two main sources. First, firm characteristics and financial indicators come primarily from the CSMAR, which provides information on listed firms' assets, liabilities and directors. Second, patent data are collected from the patent search website of the China National Intellectual Property Administration. These records include inventor information and patent types and are aggregated to calculate firm-level patent application counts. To reduce the influence of extreme values, continuous variables are winsorized at the 1st and 99th percentiles.

Variable definitions

(1) Dependent variable

Firm innovation (*Innovation*). Following prior research (Moshirian et al., 2021; Shao & Wang, 2023), we use invention patenting as a proxy for innovation, measured as the natural logarithm

of one plus the number of invention patent applications filed by a firm in a given year.

(2) Explanatory variables

Jointly backed fund investment (*DID*). The explanatory variable is the interaction between a treatment group indicator and a post-investment indicator. For firms receiving investment through a subfund jointly backed by government-guided funds and industrial capital, *DID* equals one in post-investment years and zero otherwise.

(3) Moderating variables

Compensation mechanisms (*Compensation*). Following prior research (Dong et al., 2018), we identify compensation mechanisms from the management rules published by the authorities responsible for government-guided funds. This binary variable equals one when a fund adopts any of five arrangements: a fixed-return arrangement, profit-sharing concessions, loss compensation, a fixed-return arrangement combined with profit-sharing concessions, or a fixed-return arrangement combined with loss compensation. It equals zero when no compensation mechanism is adopted or when the fund operates entirely on market terms.

Industrial relatedness (*Similarity*). Related studies often measure interfirm relatedness via industry-code matching or latent Dirichlet allocation (LDA) topic models. These methods can provide coarse-grained results, lose information and perform poorly with short texts. Following the BERT-based text similarity approach of Xia et al. (2025a), we use the paraphrase-multilingual-MiniLM-L12-v2 model within the Sentence-BERT framework to encode descriptions of the principal businesses of investors and investees into embedding vectors². We then calculate the cosine similarity between these vectors as a measure of industrial relatedness. Equation (1) presents the calculation, where e_i is the business description embedding for low-altitude economy firm i , e_j is the corresponding embedding for corporate LP j , and $Similarity_{i,j}$ denotes their industrial relatedness.

$$Similarity_{i,j} = \cos(e_i, e_j) = \frac{e_i \cdot e_j}{\|e_i\| \|e_j\|} \quad (1)$$

When a subfund f has multiple corporate LPs, we calculate the text similarity between the portfolio firm and each corporate LP separately and take their arithmetic mean, $Similarity_{i,f}$, as the relatedness between the fund and the portfolio firm. Equation (2) presents this calculation, where N_f denotes the number of corporate LPs in government-guided fund f . The indicator ranges from -1 to 1; higher values indicate greater overlap in products, technologies or business activities and thus stronger industrial relatedness.

$$Similarity_{i,f} = \frac{1}{N_f} \sum_{j=1}^{N_f} Similarity_{i,j} \quad (2)$$

(4) Control variables

Following related research, we control for firm operating characteristics to reduce omitted-variable bias. These include firm size (*Size*), leverage (*Lev*), return on assets (*ROA*), asset turnover (*ATO*), operating cash flow ratio (*Cashflow*), fixed asset ratio (*FIXED*), revenue growth (*Growth*), Tobin's Q (*TobinQ*) and firm age (*Firm_Age*). We also include an indicator (*VC*) to control for participation by other venture capital investors. Table 1 provides the variable definitions.

Tab. 1 Description and definition of variables

Type	Variable	Symbol	Definition
Dependent variable	Firm innovation	<i>Innovation</i>	ln(Invention patent applications + 1)
Explanatory variable	Jointly backed fund investment	<i>DID</i>	1 in years after jointly backed fund investment; 0 otherwise
Moderators	Compensation mechanisms	<i>Compensation</i>	1 if the government-guided fund has a compensation mechanism; 0 otherwise
	Industrial relatedness	<i>Similarity</i>	Similarity between the principal businesses of corporate investors and portfolio firms
Controls	Other venture capital participation	<i>VC</i>	1 if other venture capital investors participate in the year; 0 otherwise
	Firm size	<i>Size</i>	ln(Total assets)
	Leverage	<i>Lev</i>	Total liabilities/Total assets
	Return on assets	<i>ROA</i>	Net profit/Average total assets
	Asset turnover	<i>ATO</i>	Revenue/Average total assets
	Operating cash flow ratio	<i>Cashflow</i>	Net operating cash flow/Total assets
	Fixed asset ratio	<i>FIXED</i>	Net fixed assets/Total assets
	Revenue growth	<i>Growth</i>	(Current revenue – Previous revenue)/Previous revenue
	Tobin's Q	<i>TobinQ</i>	(Market value of equity + Liabilities)/Total assets
	Firm age	<i>Firm_Age</i>	ln(Observation year – Founding year + 1)

Model specification

To test H1, we employ a staggered difference-in-differences model that uses variation between firms receiving and not receiving jointly backed fund investment and changes before and after investment to identify the effect of jointly backed fund investment on innovation. The specification is presented in Eq. (3), where $Innovation_{i,t}$ denotes innovation in year t for sample firm i ; $DID_{i,t}$ equals one if firm i has received jointly backed fund investment by year t and zero otherwise. $X'_{i,t}$ denotes the control variables, λ_i represents firm fixed effects, μ_t represents year fixed effects, and $\varepsilon_{i,t}$ is the error term. The coefficient of interest is β ; a significantly positive estimate indicates that jointly backed fund investment increases innovation in low-altitude economy firms.

For the moderation analysis, we specify Eq. (4) to test H2, H3a and H3b. Here, $MD_{i,t}$

represents either $Compensation_{i,t}$ or $Similarity_{i,t}$, and the remaining variables are defined as in Eq. (3). The coefficient of interest is β_3 ; a significantly positive estimate indicates that the corresponding moderator strengthens the innovation effect of jointly backed fund investment.

$$Innovation_{i,t} = \alpha + \beta DID_{i,t} + \mathbf{X}'_{i,t}\boldsymbol{\gamma} + \lambda_i + \mu_t + \varepsilon_{i,t} \quad (3)$$

$$Innovation_{i,t} = \alpha + \beta_1 DID_{i,t} + \beta_2 MD_{i,t} + \beta_3 DID_{i,t} \times MD_{i,t} + \mathbf{X}'_{i,t}\boldsymbol{\gamma} + \lambda_i + \mu_t + \varepsilon_{i,t} \quad (4)$$

Descriptive statistics

Table 2 reports the descriptive statistics. The innovation measure ranges from 0--8.464, indicating substantial variation across firms. The mean of the jointly backed fund investment indicator is 0.045, reflecting the infrequency of these investments. The control variables also vary, with values within reasonable ranges.

The moderating variables have substantive economic meaning only for firms receiving jointly backed fund investment, as control firms have no corresponding investment fund. To construct the interaction terms while retaining control-group observations, we assign both moderators a value of zero for control firms. Their full-sample means are consequently affected by numerous structural zeros and do not directly describe compensation mechanisms or industrial relatedness among the relevant funds. Additional statistics for treated firms show that 58.1% of the funds have compensation mechanisms. Industrial relatedness has a mean of 0.402, a median of 0.425, a standard deviation of 0.120, and a range of 0.109 – 0.762. These statistics indicate substantial variation in compensation arrangements and industrial relatedness across investment funds.

Tab. 2 Descriptive statistics of the main variables

Variable	N	Mean	Median	SD	Min	Max
<i>Innovation</i>	4,530	1.711	1.609	1.611	0.000	8.464
<i>DID</i>	4,530	0.045	0.000	0.207	0.000	1.000
<i>Compensation</i>	4,530	0.047	0.000	0.213	0.000	1.000
<i>Similarity</i>	4,530	0.038	0.000	0.126	0.000	0.762
<i>VC</i>	4,530	0.357	0.000	0.479	0.000	1.000
<i>Size</i>	4,530	22.165	21.945	1.313	19.406	26.452
<i>Lev</i>	4,530	0.423	0.412	0.203	0.027	0.935
<i>ROA</i>	4,530	0.038	0.038	0.059	-0.375	0.244
<i>ATO</i>	4,530	0.636	0.565	0.393	0.054	3.106
<i>Cashflow</i>	4,530	0.036	0.036	0.061	-0.226	0.278
<i>FIXED</i>	4,530	0.175	0.144	0.136	0.002	0.769
<i>Growth</i>	4,530	0.171	0.116	0.374	-0.676	3.808
<i>TobinQ</i>	4,530	2.008	1.668	1.154	0.789	16.647
<i>Firm_Age</i>	4,530	2.880	2.944	0.393	1.099	3.664

Empirical analysis

Baseline regression

To test H1, we estimate Eq. (3) and report the results in Table 3. Column (1) excludes the control variables, and the coefficient of *DID* is positive and significant at the 1% level. Column (2) excludes year and firm fixed effects, and the coefficient of *DID* is again positive and significant at the 1% level. Column (3) includes both the control variables and year and firm fixed effects; the coefficient of *DID* remains positive and significant at the 1% level. These results support H1, indicating that jointly backed fund investment significantly increases innovation in low-altitude economy firms. A possible explanation is that government-guided funds and industrial capital provide complementary funding characteristics and resources. Government capital's policy orientation and risk-bearing capacity strengthen subfunds' willingness to support long-term, high-risk innovation, while industrial capital's knowledge and specialized resources improve their ability to identify and support innovative projects. Professional GPs transmit these benefits to portfolio firms through investment management, thereby improving firm innovation.

Tab. 3 Baseline regression results

Variable	(1) <i>Innovation</i>	(2) <i>Innovation</i>	(3) <i>Innovation</i>
<i>DID</i>	0.739*** (3.853)	0.638*** (5.770)	0.658*** (3.404)
<i>VC</i>		0.015 (0.306)	-0.013 (-0.461)
<i>Size</i>		0.452*** (20.052)	0.146* (1.786)
<i>Lev</i>		-1.291*** (-8.166)	0.330 (1.192)
<i>ROA</i>		0.956** (2.011)	0.507 (1.231)
<i>ATO</i>		0.112* (1.686)	-0.261 (-1.453)
<i>Cashflow</i>		0.205 (0.496)	0.033 (0.122)
<i>FIXED</i>		-0.648*** (-3.663)	0.262 (0.767)
<i>Growth</i>		-0.171*** (-2.616)	-0.064 (-1.594)
<i>TobinQ</i>		0.093*** (4.328)	-0.012 (-0.591)
<i>Firm_Age</i>		-0.049 (-0.807)	0.298 (0.952)
<i>Constant</i>	1.678*** (194.362)	-7.813*** (-16.269)	-2.411 (-1.247)
<i>Year fixed effects</i>	Yes	No	Yes
<i>Firm fixed effects</i>	Yes	No	Yes
<i>N</i>	4,530	4,530	4,530
<i>Adj R²</i>	0.758	0.107	0.762

Note: t statistics are reported in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively. The same notation applies to subsequent tables.

Robustness checks

(1) Parallel trends test

The validity of difference-in-differences estimation requires the parallel trends assumption, assessed here by examining whether trends in the outcome differ significantly between treated and control firms before investment. We conduct an event-study analysis, using the year immediately before fund investment was jointly backed as the reference period. Because observations five or more years before and after investment are sparse, we group them into the corresponding endpoint categories. The model is specified in Eq. (5):

$$Innovation_{i,t} = \alpha + \sum_{k=-5, k \neq -1}^5 \beta_k DID_{i,t}^k + \mathbf{X}'_{i,t} \boldsymbol{\gamma} + \lambda_i + \mu_t + \varepsilon_{i,t} \quad (5)$$

Here, k denotes the year of jointly backed fund investment. Figure 1 presents the estimates, with event periods on the horizontal axis and estimated DID coefficients on the vertical axis. *current* denotes the investment year, *preN* denotes the N th year before investment, and *lasN* denotes the N th year after investment. The confidence intervals are set at 95%. The pre-investment coefficients are statistically insignificant, indicating that there are no statistically detectable differences between treated and control firms before investment. The post-investment coefficients increase markedly and are significantly positive. Overall, these results support the parallel trends assumption.

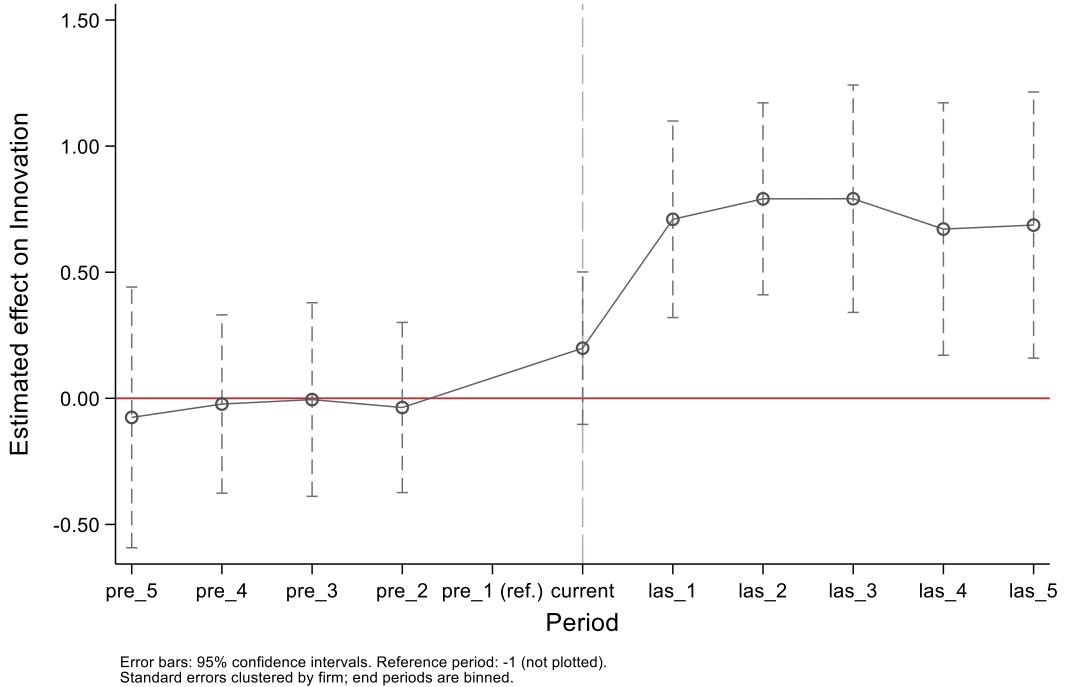


Fig. 1 Parallel trends test

(2) Placebo test

We conduct a placebo test to assess whether an effect of the observed magnitude could arise

under randomly assigned treatment status. Specifically, we randomly construct placebo treatment and control groups from the original sample and re-estimate the model 1,000 times. Figure 2 presents the distribution of the estimates, with estimated *DID* coefficients on the horizontal axis, kernel density on the left vertical axis and p values on the right vertical axis. The placebo coefficients are concentrated around zero and differ markedly from the baseline estimate. Most coefficients are statistically insignificant at the 10% level. These results support the robustness of the baseline findings in the placebo exercise.

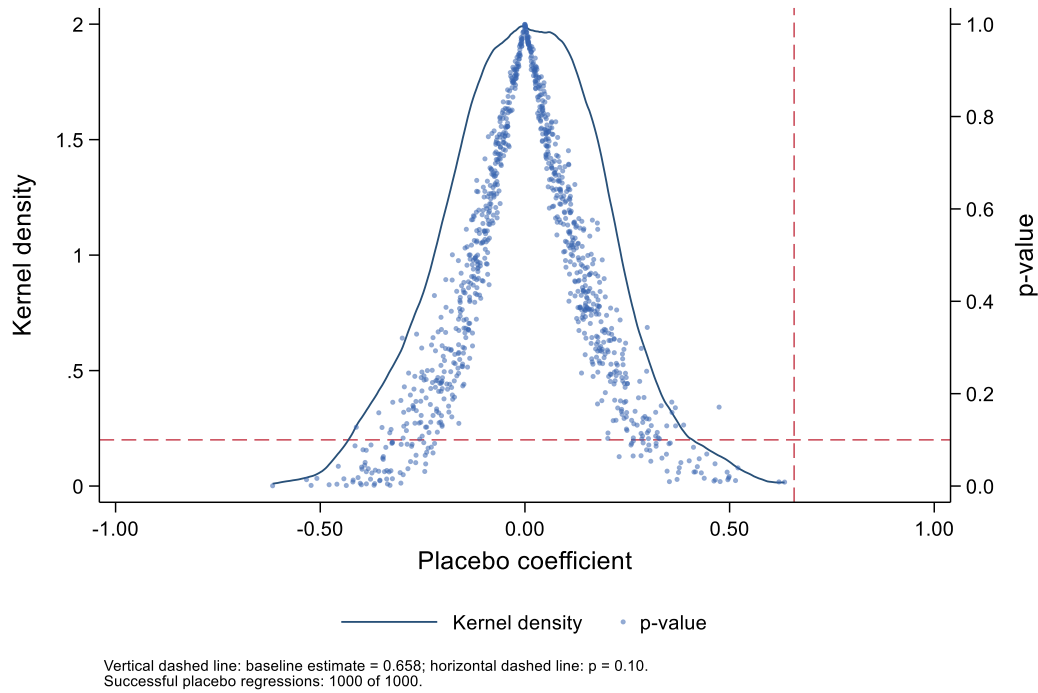


Figure 2 Placebo test

(3) Alternative estimators allowing for treatment effect heterogeneity

In staggered difference-in-differences settings, the conventional *DID* estimate combines comparisons across treatment timings, and treatment effect heterogeneity can introduce problematic weighting and estimation bias (Goodman-Bacon, 2021). We therefore implement stacked difference-in-differences following Wing et al. (2024). Separate event windows are constructed for each treatment cohort using untreated observations as controls, and the resulting cohort-specific datasets are stacked for estimation.

We also use the interaction-weighted estimator of Sun and Abraham (2021), which estimates interactions between treatment cohort and event time to address contamination across cohorts in conventional models. Table 4 shows that both methods yield positive and statistically significant estimates. The Sun–Abraham result refers specifically to the effect one period after treatment, rather than the average effect over the entire post-treatment period.

(4) Additional robustness checks

To assess potential sample selection concerns, we apply nearest-neighbor propensity score matching separately by year and re-estimate the difference-in-differences model on the matched sample. As shown in Table 4, the coefficient of *DID* remains positive and statistically significant at the 10% level.

We conduct further checks using alternative outcome measures, sample periods and control-variable definitions. First, we replace the innovation measure with an indicator based on all patent applications, including invention, utility model and design patents. Second, because the market environment, infrastructure and institutional arrangements were less developed in the industry's early years, we use 2016 as a cut-off³ and re-estimate the model for 2017–2024. Third, to assess sensitivity to the heightened attention to the sector in 2024⁴, we exclude that year and use observations from 2006–2023. Fourth, we replace the original measures of firm size, profitability and age with employee numbers, return on equity and years since listing, respectively. Table 4 shows that the estimates remain positive and statistically significant at the 10% level or better across all robustness checks.

Table 4 Robustness checks

Robustness check	Estimate (t-statistic)	Observations
Stacked DID	0.565***(3.793)	23,502
S-A DID	0.541***(3.088)	4,530
PSM-DID	0.519*(1.833)	1,744
Alternative outcome: all patent applications	0.508***(3.116)	4,530
Sample restricted to 2017–2024	0.682***(3.934)	2,792
Excluding 2024	0.625***(2.865)	4,112
Alternative control-variable measures	0.651***(3.607)	4,530

Moderating effects

The preceding analysis identifies a positive innovation effect of jointly backed fund investment, but this effect may depend on compensation mechanisms and industrial relatedness. Compensation mechanisms shape the incentives of corporate investors and fund managers, whereas industrial relatedness influences how effectively corporate investors' resources can be transferred to portfolio firms.

To test H2, H3a and H3b, we estimate Eq. (4) and report the results in Table 5. Column (1) presents the moderation analysis for compensation mechanisms. The interaction term *DID * Compensation* is positive and significant at the 5% level, supporting H2. This result indicates that jointly backed fund investment has a stronger innovation effect when government-guided funds adopt compensation mechanisms. A possible explanation is that contractual arrangements such as profit-sharing concessions and compensation reallocate investment returns and risks, reducing the opportunity costs and risk concerns of corporate investors participating in long-

term innovation. These arrangements can strengthen corporate investors' and fund managers' incentives to identify, develop and support innovative projects, allowing government capital's long-term orientation and industrial capital's expertise to be translated more effectively into innovation support.

Column (2) reports the moderation analysis for industrial relatedness. The coefficient of *DID * Similarity* is positive and significant at the 5% level, supporting H3a rather than H3b. This finding indicates that the innovation effect of jointly backed fund investment is stronger when corporate investors and low-altitude economy firms are more closely related. Greater relatedness implies a shared understanding of technological knowledge, product markets and value-chain activities, enabling corporate investors to provide GPs with more relevant industry information and technological assessments. This can reduce the information costs of evaluating complex projects and improve the match between fund resources and firms' innovation needs. The results suggest that the knowledge complementarities and resource synergies associated with industrial relatedness outweigh the potential competition and knowledge appropriation effects. One possible explanation concerns the subfund equity participation model: corporate investors participate only as LPs rather than directly owning and managing portfolio firms, whereas professional GPs make investment decisions and undertake postinvestment management. This structure creates a degree of governance separation between corporate investors and portfolio firms, potentially reducing the appropriation risks associated with direct governance involvement in CVC investment.

Tab. 5 Moderating effects regression results

Variable	(1) <i>Innovation</i>	(2) <i>Innovation</i>
<i>DID</i>	0.292* (1.712)	0.259* (1.766)
<i>DID * Compensation</i>	0.733** (2.512)	
<i>DID * Similarity</i>		1.034** (2.072)
<i>Controls</i>	Yes	Yes
<i>Year fixed effects</i>	Yes	Yes
<i>Firm fixed effects</i>	Yes	Yes
<i>N</i>	4530	4530
<i>Adj R²</i>	0.763	0.762

Note: the standalone effects of compensation mechanisms and industrial relatedness are absorbed by firm fixed effects because these variables are time invariant within firms.

Heterogeneity analysis

Low-altitude economy firms differ substantially in their institutional constraints, regional development conditions and resource endowments, potentially generating heterogeneous innovation effects of jointly backed fund investment. We therefore conduct subgroup analyses by dependence on airworthiness certification, regional low-altitude aviation pilot infrastructure

and firm ownership.

(1) Dependence on airworthiness certification

Beyond technological development and engineering validation, some low-altitude products, including general aviation aircraft, complete unmanned aircraft and eVTOL aircraft, must undergo stringent airworthiness certification before production and commercial deployment. In contrast, the core products of firms that supply general materials and components, ground-based information platforms or operational services are typically not directly subject to civil aviation product airworthiness certification. Strict safety standards and certification procedures may constrain innovation output and limit the short-term conversion of financial and industry-specific resources into observable innovations. The effect of jointly backed fund investment may therefore vary with firms' dependence on airworthiness certification. Drawing on the certification scope specified in the CAAC's Regulations on the Certification of Civil Aviation Products and Parts (CCAR-21--R4), we divide firms into high and low-dependence groups according to whether their principal products are directly subject to type certification, production approval, airworthiness certification or related parts approval procedures.

Table 6, column (1), reports the results for firms with high dependence on airworthiness certification, for which the coefficient of *DID* is not statistically significant. Column (2) reports the results for the low-dependence group, where the coefficient of *DID* is positive and significant at the 1% level. These results suggest that the innovation effect is primarily observed among firms with lower degrees of certification dependence. One possible explanation is that highly dependent firms require more stringent technical validation and face simultaneous constraints related to technological feasibility, safety standards and certification procedures, making it difficult for financial and industrial resources to generate observable innovation output in the short term. Firms with lower degrees of certification dependence have greater flexibility in product development and commercialization, allowing the funding, industry information and technological resources supplied through jointly backed funds to support R&D more quickly. These findings also suggest that technological validation and regulatory conditions should be considered when assessing the innovation effects of capital support in emerging industries. Clear and predictable certification pathways may provide complementary support in safety-sensitive sectors.

(2) Regional pilot status

Innovation in low-altitude economy firms depends not only on internal resources but also on regional airspace coordination, infrastructure, flight supervision and access to operational applications. In October 2020, following preliminary reviews, presentations and site

inspections, the CAAC approved the first batch of 13 civil unmanned aviation pilot bases (pilot zones), tasking these locations with experimenting in governance, regulation and demonstration activities. These early pilot locations typically have stronger initial capabilities, which can facilitate the conversion of fund-provided capital and industrial resources into innovation. We therefore divide firms according to whether they are located in one of these first-batch pilot areas to examine regional heterogeneity.

Table 6, column (3), presents the results for firms in first-batch pilot areas, with a positive coefficient on *DID* significant at the 1% level. Column (4) reports the results for other areas, where the coefficient of *DID* is positive and significant at the 5% level. Because both estimates are significantly positive, we conduct a bootstrap test of the difference between the two *DID* coefficients. The difference is 0.343, with a p value of 0.084, indicating significance at the 10% level and a stronger innovation effect in first-batch pilot areas. A possible explanation is that these locations provide better-developed testing and validation facilities, reducing the costs of technological testing and application validation and improving coordination among capital, technology and application resources. The result also suggests that regional testing capacity, industrial capabilities and institutional conditions may shape the effects of capital support, providing a basis for further research on the coordination of financial support with pilot and demonstration programs.

(3) Firm ownership

Firms with different ownership structures face different financing conditions, access to policy resources and market constraints, potentially affecting the marginal benefits of jointly backed fund investment. State-owned firms generally have more stable financing channels, whereas non-state-owned firms face tighter financing constraints when undertaking high-risk, long-term innovation (Guariglia & Liu, 2014). The policy credibility of government-guided funds and the specialized resources of industrial capital may therefore provide greater marginal benefits to non-state-owned firms. We divide the sample into state-owned and non-state-owned firms to examine this possibility.

Table 6, column (5), presents the estimates for state-owned firms, where the coefficient of *DID* is not statistically significant. Column (6) reports the estimates for non-state-owned firms, where the coefficient of *DID* is positive and significant at the 1% level. These results suggest that the innovation effect of jointly backed fund investment is primarily observed among non-state-owned firms. A possible explanation is that these firms initially have more limited access to financing, policy information and industrial resources. Joint participation by government-guided funds and industrial capital can provide credibility, long-term funding and industry-

specific resources, improving their conditions for innovation. State-owned firms already have stronger financing capacity and access to policy resources, so the additional benefits may be smaller, and the innovation effect is not statistically significant. The result also suggests that the contribution of policy-oriented capital may vary with firms' existing financing channels and resources. Policy design could therefore take account of existing resources and potential support needs, rather than relying solely on a uniform funding standard.

Table 6 Heterogeneity analysis results

Variable	High-dependence	Low-dependence	First-batch pilot areas	Other -areas	State-owned	Non-state-owned
	(1)	(2)	(3)	(4)	(5)	(6)
	<i>Innovation</i>	<i>Innovation</i>	<i>Innovation</i>	<i>Innovation</i>	<i>Innovation</i>	<i>Innovation</i>
<i>DID</i>	0.081 (0.359)	1.030*** (4.057)	0.802*** (3.064)	0.459** (2.051)	0.525 (1.472)	0.616*** (3.200)
<i>Controls</i>	Yes	Yes	Yes	Yes	Yes	Yes
<i>Year fixed effects</i>	Yes	Yes	Yes	Yes	Yes	Yes
<i>Firm fixed effects</i>	Yes	Yes	Yes	Yes	Yes	Yes
<i>N</i>	1168	3362	2674	1856	1604	2926
<i>Adj R²</i>	0.718	0.779	0.732	0.802	0.805	0.731

Summary and conclusion

Using a sample of Chinese A-share listed low-altitude economy firms from 2006--2024, this study applies a staggered difference-in-differences model to examine the innovation effects of joint equity participation by government-guided funds and industrial capital and the moderating roles of compensation mechanisms and industrial relatedness. Joint equity participation significantly increases firm innovation, and both moderators strengthen this effect. Heterogeneity analysis shows that the positive effect is concentrated among firms with lower dependence on airworthiness certification and non-state-owned firms, and is more pronounced in areas with a foundation established by the first batch of low-altitude pilot programs. These findings suggest that the innovation effect depends not only on capital supply but also on the difficulty of translating innovation into practical applications, regional industrial capabilities and firms' existing resources. The study provides firm-level evidence on how policy-oriented and industrial capital jointly support innovation in emerging industries. It also identifies fund contracts, investor resource alignment, and firm and regional conditions as important dimensions for understanding the boundaries of this effect.

For policy practice, the findings suggest that the design of government-guided funds should address both fundraising and the capacity to support innovation. When selecting industrial investors, fund sponsors could consider their industry experience, specialized resources and alignment with the fund's investment focus, as well as their financial commitments. They could also specify how these resources are to be made available to investee firms through fund managers. The positive moderating effect of compensation mechanisms suggests that risk–

return allocation should be linked to incentives for long-term innovation. Its positive relationship with innovation also indicates that risk–return allocation warrants attention in evaluations of fund operations. However, this study does not compare the effectiveness or fiscal costs of different compensation instruments. It therefore cannot establish that more generous compensation is always preferable or identify a universally optimal arrangement. Such provisions require assessment in relation to project risk, investment horizons and managerial incentives and constraints. For other economies using policy-oriented capital to support emerging industries, the relevant insight is that the effects of public funding should be understood through its organization and participants' behavior, rather than judged solely by the amount invested. What may be transferable is an approach to coordinating policy objectives, professional investment management and industrial resources, rather than the direct adoption of a particular Chinese fund model. Its applicability needs to be assessed against local public investment institutions, fund governance capacity and industrial capabilities.

This study has several limitations. First, the sample is restricted to Chinese listed firms associated with the low-altitude economy. Their financing conditions, governance structures and innovation capabilities may differ from those of unlisted start-ups, limiting generalization to other firms and institutional settings. Second, firm-wide invention patent applications cannot distinguish low-altitude technologies from innovations in other business areas and do not fully capture patent quality or commercialization outcomes. Finally, fund investment and funding structures are not randomly determined, and the research design cannot fully rule out time-varying selection factors. Analyses of compensation mechanisms and business similarity also cannot substitute for direct observations of resource transfer. Future research could combine fund contracts, historical LP structures and post-investment collaboration data to compare different capital configurations and trace technological cooperation, supply chain connections and long-term innovation outcomes. This would help identify the conditions under which joint participation by policy capital and industrial capital is effective, as well as its potential costs.

Notes

- 1 Government-guided funds in China adopt five types of compensation mechanisms: fixed-return arrangements, profit-sharing concessions, loss compensation, fixed-return arrangements combined with profit-sharing concessions, and fixed-return arrangements combined with loss compensation. Under a fixed-return arrangement, the government-guided fund recovers its principal (together with a relatively low fixed interest return) irrespective of whether the investment is profitable, whereas the fund manager and other LPs receive investment gains or bear losses. Under profit-sharing concessions, the government-guided fund transfers part of its investment profits to the fund manager and other LPs when the investment is profitable, increasing their share of returns; losses are shared among these participants when the investment is unprofitable. Under loss compensation, the government-guided fund bears a larger share of investment losses, reducing the losses borne by the fund manager and other LPs; investment profits are shared among these participants when the investment is profitable.
- 2 Sentence-BERT is an extension of BERT designed to generate semantically informative sentence embeddings. Unlike conventional BERT models, Sentence-BERT is fine-tuned via Siamese and triplet network structures to produce fixed-length embeddings suited to semantic comparison tasks, such as text similarity assessment. The paraphrase-multilingual-MiniLM-L12-v2 model is a specific pre-trained model developed within the Sentence-BERT framework.

- 3 In 2016, the General Office of China's State Council issued the Guiding Opinions on Promoting the Development of the General Aviation Industry (State Council General Office Document No. 38 of 2016), setting out coordinated measures for aircraft research and manufacturing, operational services and infrastructure development. The document provided more explicit policy support for industries associated with low-altitude aviation. Using this policy milestone as the cut-off, we restrict the sample to 2017–2024 as a robustness check to assess whether the baseline findings are sensitive to the inclusion of observations from before and during the year of its issuance.
- 4 In 2024, the low-altitude economy was included in China's Government Work Report for the first time and identified as a new driver of growth, reflecting increased national policy attention to the sector. This policy signal may have influenced firms' expectations about future opportunities and their innovation decisions. As a robustness check, we therefore exclude observations for 2024 and re-estimate the model using the 2006–2023 sample to assess whether the baseline findings are sensitive to the inclusion of that year.

References

- Al Haddad, C., Chaniotakis, E., Straubinger, A., Plötner, K., & Antoniou, C. (2020). Factors affecting the adoption and use of urban air mobility. *Transportation research part A: policy and practice*, 132, 696-712.
- Barrot, J. N. (2017). Investor horizon and the life cycle of innovative firms: Evidence from venture capital. *Management Science*, 63(9), 3021-3043.
- Besharov, M. L., & Smith, W. K. (2014). Multiple institutional logics in organizations: Explaining their varied nature and implications. *Academy of management review*, 39(3), 364-381.
- Brown, J. R., Fazzari, S. M., & Petersen, B. C. (2009). Financing innovation and growth: Cash flow, external equity, and the 1990s R&D boom. *The journal of finance*, 64(1), 151-185.
- Chemmanur, T. J., Loutschina, E., & Tian, X. (2014). Corporate venture capital, value creation, and innovation. *The Review of Financial Studies*, 27(8), 2434-2473.
- Coppola, P., De Fabiis, F., & Silvestri, F. (2024). Urban Air Mobility (UAM): Airport shuttles or city-taxis?. *Transport Policy*, 150, 24-34.
- Colombo, M. G., Cumming, D. J., & Vismara, S. (2016). Governmental venture capital for innovative young firms. *The Journal of Technology Transfer*, 41(1), 10-24.
- Colombo, M. G., & Shafi, K. (2016). Swimming with sharks in Europe: when are they dangerous and what can new ventures do to defend themselves?. *Strategic Management Journal*, 37(11), 2307-2322.
- Dong, J. W., Wang, H., Shi, G. P., & Guo, L. H. (2018). The impact of GVCGFs equity participation in VC funds on enterprise innovation. *Studies in Science of Science*, 36(8), 1474-1486. DOI:10.16192/j.cnki.1003-2053.2018.08.015. (In Chinese)
- Dushnitsky, G., & Lenox, M. J. (2005). When do firms undertake R&D by investing in new ventures?. *Strategic Management Journal*, 26(10), 947-965.
- Dushnitsky, G., & Shaver, J. M. (2009). Limitations to interorganizational knowledge acquisition: The paradox of corporate venture capital. *Strategic Management Journal*, 30(10), 1045-1064.
- Fan, M. X., & Huang, K. G. (2026). Gold or green finger? Government involvement in venture capital investments and target firms' green innovations. *Research Policy*, 55, 105506.
- Gompers, P. A., Gornall, W., Kaplan, S. N., & Strebulaev, I. A. (2020). How do venture capitalists make decisions?. *Journal of Financial Economics*, 135(1), 169-190.
- Goodman-Bacon, A. (2021). Difference-in-differences with variation in treatment timing. *Journal of econometrics*, 225(2), 254-277.
- Grilli, L., & Murtinu, S. (2014). Government, venture capital and the growth of European high-tech entrepreneurial firms. *Research Policy*, 43(9), 1523-1543.
- Guariglia, A., & Liu, P. (2014). To what extent do financing constraints affect Chinese firms' innovation activities? *International Review of Financial Analysis*, 36, 223-240.
- Hu, Y., Zhao, N., Shangguan, X., Zhu, Z., Gou, J., Paraman, P., & Dong, Y. (2025). How does regional financial development affect the investment and financing behaviors of low-altitude economy enterprises?—An empirical study based on the expansion of city commercial banks. *International Review of Economics & Finance*, 104694.
- Jääskeläinen, M., Maula, M., & Murray, G. (2007). Profit distribution and compensation structures in publicly and privately funded hybrid venture capital funds. *Research Policy*, 36(7), 913-929.
- Jeon, E., & Maula, M. (2022). Progress toward understanding tensions in corporate venture capital: A systematic review. *Journal of Business Venturing*, 37(4), 106226.
- Kalakou, S., Marques, C., Prazeres, D., & Agouridas, V. (2023). Citizens' attitudes towards technological innovations: The case of urban air mobility. *Technological Forecasting and Social Change*, 187, 122200.
- Kellermann, R., Biehle, T., & Mostofi, H. (2023). Modelling public attitude towards drone delivery in Germany. *European Transport Research Review*, 15(1), 38.
- Lahr, H., & Mina, A. (2016). Venture capital investments and the technological performance of portfolio firms. *Research Policy*, 45(1), 303-318.
- Lascombes, P., & Le Galès, P. (2007). Introduction: Understanding public policy through its instruments—From the nature of instruments to the sociology of public policy instrumentation. *Governance*, 20(1), 1-21.
- Li, G., Zhang, J., Wang, Y., & Zhao, Z. (2024a). Can government-guided funds promote corporate technology innovation? Evidence from the new energy automobile industry. *International Review of Economics & Finance*, 96, 103667.
- Li, J. H., & Lu, X. X. (2026). How Can Fiscal and Tax Policies Promote the Low-altitude Economy: Subsidy Incentives or Institutional Empowerment. *Journal of Wuhan University(Philosophy and Social Sciences)*, 79(2), 145-156. DOI:10.14086/j.cnki.wujss.2026.02.012. (In Chinese)
- Li, J. J., Fung, H. G., & An, S. (2024b). Government venture capital funds: Balancing the impact of social and financial goals on startups.

- China Economic Review, 85, 102185.
- Lin, S., & Gao, Z. (2026). Governing the regional low-altitude economy: State-led development in emerging transport systems. *Transport Policy*, 104142.
- Lyu, W. Q., & Yu Z. Y. (2025). Research on the Internal Logic, Realistic Dilemma and Practice Path of Financial Technology Innovation Empowering Low-altitude Economic Development. *Contemporary Economic Management*, 47(7), 89-96. DOI:10.13253/j.cnki.ddjgl.2025.07.010. (In Chinese)
- Marcon, A., & Ribeiro, J. L. D. (2021). How do startups manage external resources in innovation ecosystems? A resource perspective of startups' lifecycle. *Technological Forecasting and Social Change*, 171, 120965.
- Mazzucato, M. (2016). From market fixing to market-creating: a new framework for innovation policy. *Industry and innovation*, 23(2), 140-156.
- Moshirian, F., Tian, X., Zhang, B., & Zhang, W. (2021). Stock market liberalization and innovation. *Journal of Financial Economics*, 139(3), 985-1014.
- Ni, X., Zheng, T., Gao, F., & Zhao, H. (2024). Stimulating start-up investment through Government-Sponsored venture capital: Theory and Chinese evidence. *Journal of Systems Science and Complexity*, 37(5), 2021-2053.
- Pierrakis, Y., & Saridakis, G. (2019). The role of venture capitalists in the regional innovation ecosystem: A comparison of networking patterns between private and publicly backed venture capital funds. *The Journal of Technology Transfer*, 44(3), 850-873.
- Ren, X., & Wang, J. (2025). Symbiotic evolution mechanism of urban air mobility industrial innovation ecosystem: Evidence from low altitude air mobility in Shenzhen. *Journal of Air Transport Management*, 124, 102750.
- Roca, J. B., Vaishnav, P., Morgan, M. G., Mendonça, J., & Fuchs, E. (2017). When risks cannot be seen: Regulating uncertainty in emerging technologies. *Research Policy*, 46(7), 1215-1233.
- Rodrik, D. (2014). Green industrial policy. *Oxford review of economic policy*, 30(3), 469-491.
- Shan, H. (2025). Corporate venture capital and the boundaries of the firm. *Journal of Business Venturing*, 40(4), 106500.
- Shao, K., & Wang, X. (2023). Do government subsidies promote enterprise innovation?—evidence from Chinese listed companies. *Journal of Innovation & Knowledge*, 8(4), 100436.
- Shi, G., Tao, Y., Hsu, Y. T., & Feng, T. (2026). Managerial oversight and policy alignment: evidence from management fee premiums in Chinese government venture capital. *Managerial Auditing Journal*, 1-26.
- Shuwaikh, F., & Dubocage, E. (2022). Access to the corporate investors' complementary resources: A leverage for innovation in biotech venture capital-backed companies. *Technological Forecasting and Social Change*, 175, 121374.
- Sun, L., & Abraham, S. (2021). Estimating dynamic treatment effects in event studies with heterogeneous treatment effects. *Journal of econometrics*, 225(2), 175-199.
- Tian, X., & Wang, T. Y. (2014). Tolerance for failure and corporate innovation. *The Review of Financial Studies*, 27(1), 211-255.
- Vértesy, D. (2017). Preconditions, windows of opportunity and innovation strategies: Successive leadership changes in the regional jet industry. *Research Policy*, 46(2), 388-403.
- Veer, T., Yang, P., & Riepe, J. (2022). Ventures' conscious knowledge transfer to close partners, and beyond: A framework of performance, complementarity, knowledge disclosure, and knowledge broadcasting. *Journal of business venturing*, 37(3), 106191.
- Wang, L., Huang, H., & An, Y. (2021). Technological fit, control rights allocation, and innovation performance of corporate venture capital-backed enterprises. *Venture Capital*, 23(3), 229-255.
- Wang, L. & Lyu, S. H. (2024). Corporate Venture Capital, Technology Fit, and Innovation Resilience of Invested Enterprises. *Collected Essays on Finance and Economics*, (7), 48-58. DOI:10.13762/j.cnki.cjlc.2024.07.005. (In Chinese)
- Wing, C., Freedman, S. M., & Hollingsworth, A. (2024). Stacked difference-in-differences (No. w32054). National Bureau of Economic Research.
- Xia, D., Cassiman, B., & Wehrheim, D. (2025a). Escaping product market rivalry through innovation. *Management Science*. Advance online publication.
- Xia, Z., Hua, X., Wang, Y., & Peng, J. (2025b). Leading or facilitating? The appropriate role of governmental venture capital in China. *Research in International Business and Finance*, 76, 102807.
- Xu, M. (2022). Government Venture Capital, Agency Problems and Enterprise Innovation: Evidence from the Intervention of Government Guidance Funds. *Nankai Economic Studies*, (2), 51-67. DOI:10.14116/j.nkes.2022.02.004. (In Chinese)
- Yao, T., & O'Neill, H. (2022). Venture capital exit pressure and venture exit: A board perspective. *Strategic Management Journal*, 43(13), 2829-2848.
- Yi, R., Wang, H., Lyu, B., & Xia, Q. (2023). Does venture capital help to promote open innovation practice? Evidence from China. *European Journal of Innovation Management*, 26(1), 1-26.
- Yin, H., Liu, J., & Zeng, N. (2024). How to promote the digital business model innovation of high-tech SMEs through government venture capital? An evolutionary game perspective. *Managerial and Decision Economics*, 45(5), 3193-3216.
- Yu, C., Wang, M., Fu, C., & Song, J. (2024). The effect of state-owned venture capital on enterprise innovation: Evidence from China. *Finance Research Letters*, 67, 105804.
- Zhang, J. X., & Xu, Q. (2024). Restrictive Factors and Countermeasures for Industrial Chain Development of Low-Altitude Economy. *Economic Review Journal*, (8):63-70. DOI:10.16528/j.cnki.22-1054/f.202408063. (In Chinese)
- Zhang, Y., Meng, Q., & Liu, D. (2024). Venture capital and technology commercialization: evidence from China. *The Journal of Technology Transfer*, 49(6), 2336-2388.
- Zhang, Y., & Zhou, Y. (2025). The impact of government industrial funds on the innovation of SMEs in China. *Journal of Asian Economics*, 97, 101898.
- Zhao, C., & Zhang, L. (2025). Can government-guided funds promote innovation output in strategic emerging enterprises? Evidence from China. *PLOS ONE*, 20(10), e0334826.
- Zhao, L., Chen, Y., & Wahab, M. I. M. (2025). The impact of low-altitude airspace opening policy on aviation manufacturing innovation:

A double machine learning approach. *Transportation Research Part A: Policy and Practice*, 200, 104660.

Zhao, P., Post, J., Wu, Z., Du, W., & Zhang, Y. (2022). Environmental impact analysis of on-demand urban air mobility: A case study of the Tampa Bay Area. *Transportation Research Part D: Transport and Environment*, 110, 103438.

Zhou, W., & Zhang, J. D. (2025). First-mover alliance: mission-oriented innovation policy implementation in Shenzhen's low-altitude economy. *Cambridge Journal of Regions, Economy and Society*, 18(3), 647-662.

Zhu, J., Fan, Y., Deng, X., & Xue, L. (2019). Low-carbon innovation induced by emissions trading in China. *Nature communications*, 10(1), 4088.

Data availability:

Data and code associated with this study has been deposited at:

GitHub: <https://github.com/LEIYIYL/low-altitude-economy-replication>.

Zenodo: <https://zenodo.org/records/22920382>

Some underlying data are subject to third-party licensing restrictions and must be obtained from the respective data providers under their access requirements.

Author contributions

Lei Yi: Conceptualization, Methodology, Software, Formal analysis, Resources, Writing—Original Draft. Xinyi Liao: Conceptualization, Methodology, Validation, Resources, Writing—Review & Editing.

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The authors declare that they have no competing interests.

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