

Article

How Does the Establishment of Government Industrial Funds Affect Enterprise Innovation in China? A Perspective from “Bridging the Equity Gap”

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Abstract

Focusing on the role of government industrial funds in bridging the equity gap, in this paper, we examine how the establishment of government industrial funds (GIFs) affects enterprise innovation and the underlying mechanism of the guiding and synergistic effects on social capital. By conducting an empirical study employing a fixed-effect model comprising panel data of Chinese industrial enterprises covering the recent period of 2014 to 2024, we found that GIFs play a positive role in promoting local enterprise innovation. We also provide supporting evidence that China's GIFs are effectively designed in bridging the equity gap, which hinders innovation, and that they are productive in alleviating the structural friction of the venture capital market. The findings of this study also offer some new evidence regarding the influence of fund-level characteristics on the innovation-promoting effect of GIFs, which has not been previously explored for the Chinese context. Our research also reveals the “seeding” role and “patient capital effect” of GIFs, which guide social capital to gather towards early-stage and long-term funds, improve the structural supply shortage in the local venture capital market, and thereby alleviate the financing gap for corporate innovation. The focus on early-stage and long-term capital is an innovative perspective of this paper. Our results also indicate that private capital, as an important participant in government industrial funds, can positively moderate the innovation-promoting effect of government industrial funds. The impact of funds' internal governance mechanisms on their innovation-promoting effect is also one of the unique contributions of this paper.

Keywords: enterprise innovation; government industrial funds; market friction; equity gap; venture capital



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1. Introduction

Capital is a key factor influencing enterprise innovation. Given that innovation activities require sustained investment and enterprises need to balance daily operational expenses with long-term investments, such as research and development expenses, it is difficult to fully meet the capital expenditure required for technological innovation through internal funds; rather, it needs to be supplemented through external financing. The external funding sources of enterprises mainly include equity financing and debt financing. However, traditional banking often requires enterprises to provide credit enhancement measures, such as fixed asset collateral and guarantees from shareholders during financing, making it difficult for the credit market to effectively support innovative enterprises in the entrepreneurial and growth stages. As an emerging form of equity investment, venture

capital is more aligned with the financing needs of innovative and entrepreneurial enterprises due to its high risk–return preference, and thus plays a significant role in bridging the capital supply gap for innovation activities. However, more recent research has also highlighted the gap in the provision of equity financing (Wilson et al., 2018). The equity gap problem is an outcome of market failure arising from informational asymmetry between entrepreneurs and potential investors (Busenitz et al., 2005). These issues are particularly severe in knowledge-intensive enterprises that have higher sunk cost investments, longer development timelines, and rapid technological changes. In pursuit of predictable returns, private venture capital typically demands projects that are easily comprehensible and not requiring confidentiality, which may exclude innovative enterprises heavily reliant on proprietary technology from accessing financing (Mason, 2016). Simultaneously, private capital exhibits pronounced stage preference in resource allocation, leading to structural failures in the venture capital market.

As entrepreneurial activities increasingly contribute to innovation and economic growth, policymakers across countries have begun to focus on implementing policies that enhance innovation financing by influencing the incentives and returns of venture capital, supporting and guiding the venture capital market (Jääskeläinen et al., 2007). There is considerable diversity among governments in terms of the types of fiscal resource allocation to the venture capital industry (Colombo et al., 2014), including providing financial support to venture capital firms and owning and operating venture capital firms (Brander et al., 2015). One of the main ways for a government to support newly established innovative companies within its territory and promote the creation and development of technology-based companies is through government investment funds (S. Y. Yang et al., 2022). As part of the government's efforts to bridge the gap in early-stage investment funding, the establishment of government venture capital funds has become commonplace in many European countries (Grilli & Murtinu, 2014; Bertoni & Tykvová, 2015; Guerini & Quas, 2016). Government venture capital funds are also widely present in other mature markets, such as Australia (Cumming, 2007) and South Korea (Oh et al., 2022).

In China, the primary type of government venture capital is government industrial funds (hereinafter referred to as GIFs or industrial funds). The development of China's government industrial funds can be traced back to 2002 when the Zhongguancun Committee established the Zhongguancun Venture Capital Guidance Fund (S. Yang & Cui, 2021). GIFs in China have experienced rapid growth following the issuance of the "Interim Measures for the Administration of Government-funded Industrial Investment Funds" by the National Development and Reform Commission in 2016. Government industrial funds in China primarily refer to equity investment funds and venture capital funds that include government funds in their capital structure and mainly invest in non-publicly traded corporate equities. These funds can be fully funded by the government, co-funded with social capital, or invested in existing qualified industrial investment funds. Adopting the principles of market-oriented operation and professional management, government industrial funds operate independently through limited partnerships or corporate structures, fully leveraging their role in implementing industrial policies, guiding private investment, and stabilizing economic growth. According to data from the Qingke database, as of the end of 2023, the subscription scale of Chinese government industrial funds exceeded RMB 7 trillion, accounting for 5.6% of China's GDP for that year and constituting an important component of China's venture capital market.

The effectiveness of government participation in the venture capital market, as well as the relationship and impact mechanism between government industrial funds and corporate innovation, are currently highly discussed topics among scholars both domestically and internationally. In recent years, they have conducted exploratory research on the

impact of the government industrial funds on corporate innovation, but the conclusions are not unified. Some foreign studies suggest that successful technological innovation in enterprises is driven by government investment funds (Lerner, 2010; Cumming, 2007; Howell, 2017), while other studies conclude that government fund investment has no significant impact on corporate innovation (Köppel et al., 2025; Grilli & Murtinu, 2014). Research on Chinese government industrial funds has gradually expanded in recent years. While the main conclusion is that government industrial funds can support corporate innovation (Y. Li et al., 2024; Wang et al., 2026; S. Y. Yang et al., 2022), there are still many understudied areas concerning the mechanism and path of the action of industrial funds. Previous research on industrial funds and corporate innovation has primarily focused on the mechanisms at the micro-enterprise level, including improving corporate financing capabilities (Qiang et al., 2021) and exerting supervisory effects (Zhang & Zheng, 2021). Studying how to leverage the guiding and synergistic effects of industrial funds on social capital to influence corporate innovation from the macro-level capital supply perspective is a novel angle. Furthermore, previous research on government industrial funds and corporate innovation primarily focused on A-share listed companies (Hao et al., 2025; G. Li et al., 2024), which are generally in the mature development stage. Starting from the function of industrial funds in bridging the equity gap, there is little research on how industrial funds can promote early- and long-term investment and affect corporate innovation. This macro-level effect can be better understood by studying large sample data including unlisted companies, which is a research gap to be explored.

In this study, we focus on the role of government industrial funds in bridging the equity gap, examining how the establishment of such funds promotes corporate innovation by exerting a guiding and synergistic effect on social capital. The underlying data of this study include an innovative dataset from 58,147 industrial enterprises detailed in the China Industrial Enterprise Database, as well as a manually constructed and relatively complete industrial fund database, which are merged into city-time panel data through coding. We employed a fixed-effect model to examine the impact of the establishment of government industrial investment funds on corporate innovation, and whether GIFs play a guiding and synergistic role in bridging the equity gap. Our empirical research provided convincing evidence that GIFs play a positive role in promoting the innovation of local enterprises, demonstrating the robustness of our findings through various testing methods. We also conducted a variety of heterogeneity tests to examine cross-sectional differences in the regions, enterprises, innovation natures and fund structures. Through mechanism testing, we found that government industrial funds alleviate the innovation capital gap of enterprises and promote enterprise innovation by guiding the aggregation of social capital and adjusting investment risk preferences. When government capital and the professional experience of private investment institutions are better coordinated, this promoting effect becomes even more significant.

Our research contributes to the existing literature in three ways. First, we start from the characteristics of management models and fundraising methods of Chinese government industrial funds, and systematically explore how the Chinese government industrial funds address market failures in the venture capital market, thereby promoting enterprise innovation. Previous articles have seldom focused on the operational mechanisms of Chinese government industrial funds in addressing market structural failure from a macro perspective. Our research thus provides a new perspective for analyzing the capital-raising activities of the China venture capital market and innovatively incorporates the interaction of social capital and GIFs into the analytical framework of corporate innovation, thereby enriching the research on the policy effects of GIFs.

Secondly, in this paper, we not only comprehensively examine the impact of factors such as regional development, marketization environment, and enterprise characteristics on the effectiveness of government industrial funds, but also innovatively focus on the impact of fund-level characteristics on the promotion of innovation by government industrial funds, capturing the heterogeneity of fund manager characteristics and fund-based operational characteristics, which has not been previously examined for the Chinese context.

Most importantly, in this paper we verify the guiding and synergistic effects of GIFs on social capital in promoting corporate innovation. Through an analysis of the investment strategies and investment cycles of funds, we examine the “seeding” effect of Chinese government industrial funds in bridging early-stage financing gaps. In addition, we examine how industrial funds guide social capital to engage in long-term investments, thereby increasing the long-term capital supply required for innovation and supporting enterprise innovation. The focus on early-stage and long-term capital is an innovative perspective of this paper. We also verify the synergy mechanism by examining the degree of social capital participation, linking the funds’ internal governance mechanisms on their innovation-promoting effect, which is another unique contribution of this paper.

The structure of this paper is as follows: Section 2 develops the theoretical framework and outlines the research hypotheses. Section 3 details the research design, including data sources, variable definitions and the methodology. Section 4 presents the results and analysis of the empirical test, encompassing baseline regressions, robustness tests, heterogeneity analysis and mechanism tests. Section 5 concludes the study with a summary of the findings.

2. Theoretical Background and Hypotheses

2.1. *Impact of the GIF Establishment on the Innovation of Local Enterprises*

The rationality of government participation in the venture capital market derives from the theory of market friction in capital supply and demand for innovative enterprises. The cause of market friction lies in the information asymmetry between venture capital institutions and enterprises, as well as the characteristics of technological spillovers and uncertainty of future returns associated with enterprise innovation activities (Hall, 2002; Amit et al., 1998). Information asymmetry can lead to a mismatch between the funds of investment institutions and high-quality innovative projects of enterprises, potentially reducing the likelihood and amount of external financing available to enterprises. The positive externalities of enterprise innovation make it difficult for enterprises to recoup the costs of their innovation activities through the generated returns. If the investment projects are solely determined by venture capital institutions based on market principles, the financing gap of innovative enterprises will still be difficult to fundamentally alleviate. The venture capital market also suffers from structural failures in the allocation of innovative resources (Cosh et al., 2009), primarily due to the stage preference exhibited by private venture capital in resource allocation, which may lead early-stage high-tech startups finding it difficult to obtain initial financing due to the high demand for technological confidentiality and unproven business models, known as the “first equity gap” (Murray & Lott, 1995; Lockett et al., 2002). The staged financing process of startups may lead to a broken capital chain due to the existing investors’ inability to provide follow-up funding and new investors’ inability to match the needs of the enterprise, resulting in the “second equity gap” (Wilson et al., 2018).

The insufficient capital supply and structural failures in the venture capital market constitute the rationale for the government to establish venture capital funds to participate in the market. Government venture capital uses public funds to bridge the gap in private investment (Lerner, 2002) and simultaneously achieve policy objectives such as promoting

technological innovation and regional economic development (Leleux & Surlemont, 2003). GIFs operate in a market-oriented manner and combine government industrial policies to leverage the advantages of both government funds and market mechanisms. Without replacing the market as a fundamental premise, GIFs may promote further development and improvement of the market without leading to speculative activities compared with direct government subsidies.

From the perspective of the fund's establishment purpose, government industrial funds are positioned as long-term and patient capital. The fund's performance objectives integrate diversified and long-cycle assessment indicators that foster innovation and drive industrial development, creating a market environment that encourages innovation and tolerates failure, and can guide more social capital to invest in innovative enterprises. Meanwhile, from the perspective of the structural design of government industrial funds, the model of joint funding by the government and social capital, with professional managers entrusted, is conducive to leveraging synergistic effects and governance advantages, reducing efficiency losses caused by government administrative intervention, promoting the fund to better achieve functional objectives, and promoting entrepreneurship and innovation.

Therefore, we propose the following hypothesis:

Hypothesis 1. *The establishment of government industrial funds has a positive impact on local enterprises' innovation.*

Building on the theoretical foundations above, in the context of China's newly developed equity market, we have further developed two possible mechanisms to illustrate the relationship between the establishment of GIFs and local enterprise innovation. We present these proposed mechanisms in the next two subsections.

2.2. Guiding Effect of Government Industrial Funds on Other Social Capital

The core economic role of government industrial funds is primarily manifested in filling equity gaps, increasing the level of capital supply in the venture capital industry, and lowering the financing threshold for high-tech startups (Soleimani Dahaj & Cozzarin, 2019), thereby promoting corporate innovation. The deeper role of government industrial funds lies in exerting a guiding effect, encouraging the investment of private capital in innovative enterprises and promoting innovation (Cumming, 2007). The essence of the guiding effect lies in increasing credit through fiscal funds, reducing information asymmetry and uncertainty in investment activities between social capital and enterprises, encouraging information dissemination between enterprises and venture capital institutions, lowering the marginal innovation cost of private capital, and promoting the development of the local venture capital market. The vibrancy of venture capital not only brings broadened financing channels and financial support, but also promotes technological innovation in enterprises by providing diversified value-added services such as linking industries, resource introduction, strategic guidance, and supervision and management.

In terms of expanding the scale of the venture capital industry, the mechanism of the guiding effect of the government industrial funds primarily stems from the "seeding" hypothesis and the virtuous cycle effect (Lerner, 2010). The establishment and development of GIFs have indicated the direction of local government economic development planning and the emphasis placed on regional financing markets. During the establishment and investment process, the role of government endorsement as an "investment signal" can effectively reduce the investment uncertainty of social capital (Guerini & Quas, 2016), facilitating innovative enterprises to attract private investment. Simultaneously, the increased supply of state-owned capital can reduce the marginal innovation cost of

enterprises, facilitating private capital's entry into the venture capital market and forming a virtuous cycle.

In addressing structural failures in the venture capital market, the mechanism of the guiding effect of government industrial funds primarily stems from the herding effect (Banerjee, 1992) and the spillover effect (Buzzacchi et al., 2013). Under the policy guidance, GIFs as "patient capital" have played a leading role in "investing early and investing for the long term", encouraging private venture capital to follow and adjust investment strategies, improving the capital's risk–return preference, promoting the aggregation of long-term capital, and enabling local enterprises to place greater emphasis on innovative investment (Lei et al., 2018). At the same time, based on policy objectives, GIFs are more focused on seeking investment projects with positive externalities, effectively enhancing enterprises' willingness to innovate and promoting innovation among local enterprises.

Therefore, we propose the following hypothesis:

Hypothesis 2. *The establishment of government industrial funds can serve as a guiding force for social capital, thereby bridging the gap in equity capital and promoting corporate innovation.*

2.3. Synergistic Effect of Government Funding and Social Capital

The main difference between government industrial funds and other traditional government investment institutions lies in the capital structure and management mechanism of the former. GIFs have adopted a public–private partnership model, entrusted professional management teams, and brought about synergistic effects with social capital. China's government industrial funds typically have a multi-party funding structure, including government funding entities, state-owned enterprises, financial institutions, and private capital. In terms of managing the team, industrial funds select managers through an open process, requiring that the management institutions possess a professional investment team and successful experience in private equity fund management. The managers selected by industrial funds come from diverse backgrounds, including state-owned management institutions as well as private institutions. This model of separation of ownership and management can mitigate government intervention in the professional decision making of funds to a certain extent. By fully leveraging the resource advantages of the government and the experience advantages of private capital, the role of government industrial funds can be better utilized, thereby strengthening the innovation-promoting effect on local enterprises. Therefore, we propose the following hypothesis:

Hypothesis 3. *The establishment of government industrial funds promotes innovation in local enterprises by leveraging the synergistic effect between government funds and social capital.*

3. Data and Methodology

3.1. Research Model and Variable Definitions

The research objective of this paper is to investigate the impact of GIFs on enterprise innovation and whether GIFs play a guiding and synergistic role in bridging the equity gap. We conduct empirical tests based on city-level aggregation and employ the city–time panel data regression method to assess the impact of the establishment of government industrial funds on local enterprise innovation.

The choice of research methods is based on the following considerations: Firstly, this paper aims to examine the policy effects of GIFs exerted predominantly at the macro-level. The establishment of GIFs can bridge the financing gap in equity markets through their guiding effect, optimize the regional innovation ecosystem, and influence the innovation activities and development paths of enterprises. Compared to micro-level measurement

methods, city-level aggregation can more comprehensively capture this macro-effect. Secondly, the impact of the establishment of GIFs is not limited to invested enterprises; their positive externalities may indirectly affect the innovation activities of other enterprises within the region through industrial chain synergy or the industrial cluster effect. Thirdly, considering that we have included a large-scale sample of enterprises (58,147 industrial enterprises) in the construction of our regional sample, the differences at the individual enterprise level will not systematically affect the evaluation of the innovation-promoting role of GIFs. In summary, the measurement method in this paper is consistent with the operating mechanism of GIFs and can more accurately reflect the guiding effect of GIFs on enterprises at the macro-level, thereby better serving the evaluation of GIF policy effects aimed at bridging the equity gap.

We have constructed a two-way fixed effect model (1) to test the impact of GIFs on industrial enterprises' innovation performance:

$$Y_{c,t} = \beta_0 + \beta_1 \times GIF_{c,t} + \sum b_j \times X_{c,t} + \theta_t + \lambda_c + \varepsilon_{c,t} \quad (1)$$

where subscripts c and t respectively denote prefecture-level city and year; $Y_{c,t}$ denotes enterprise innovation, which is evaluated by the total number of new patents applied for and granted by sample enterprises in city c at year t (denoted by Pataply and Patgrant). $GIF_{c,t}$ is the core explanatory variable, measured by the number of government industrial investment funds established by city c in year t . The data on enterprise innovation and the establishment of government industrial funds are matched one-to-one at the city–year level. The regression coefficient of GIF reflects the impact of the establishment of government industrial funds on enterprise innovation, and therefore the coefficient of β_1 and t-statistics are reported for each test to examine the significance level of the variable.

To test Hypothesis 2, we employ a mediation effect model for mechanism testing. A two-step approach is adopted, where the activity level of other venture capital institutions, excluding GIFs, is used as the mechanism variable to test the guiding effect of GIFs. The model is set as follows:

$$VC_{c,t} = \beta_0 + \beta_1 \times GIF_{c,t} + \sum b_j \times X_{c,t} + \theta_t + \lambda_c + \varepsilon_{c,t} \quad (2)$$

where $VC_{c,t}$ denotes the mechanism variable, which is measured by the number of venture capital funds established (VC_num) and the fundraising scale of funds (VC_aum) other than GIFs. Similarly to the method in model (1), $VC_{c,t}$ and $GIF_{c,t}$ in model (2) are matched one-by-one by region and time period. To test the “seeding” hypothesis, we further examine the guiding effect of GIFs on early-stage investment funds, measured through two approaches: fund type and fund investment strategy.

To test Hypothesis 3, we employ a moderated effect model to analyze the synergistic effect between government industrial funds and public funding from social capital, as shown in model (3), where $M_{c,t}$ denotes the mechanism variable. The synergistic effect is measured by the proportion of private capital contributed to government industrial funds. If the interaction term between the explanatory variable and mechanism variable is significantly positive, this may reveal that the mechanism variable plays a positive moderating role between the GIF and the enterprise innovation.

$$Y_{c,t} = \beta_0 + \beta_1 \times GIF_{c,t} + \beta_2 \times M_{c,t} + \beta_3 \times GIF_{c,t} \times M_{c,t} + \sum b_j \times X_{c,t} + \theta_t + \lambda_c + \varepsilon_{c,t} \quad (3)$$

To control for the effect of other factors on innovation at the regional level, we incorporated a series of control variables ($X_{c,t}$), encompassing the city-level GDP (lnctgdp), provincial-level GDP (lnpvgdp), industrial structure upgrade index (Indust_Stru), urban–

rural income ratio (cx), city-level per capita GDP (percagdp), and city-level human capital indicator (cthr). To enhance the robustness of the model, we control for the fixed effects of city and year in the regression analysis, where θ and λ denote time and city-level fixed effects, and ε is the error term. Table 1 presents the definitions of key variables.

Table 1. Variable definition and description.

Variables	Measurement	Formula
Dependent variable		
Patent applications (Pataply)	The natural logarithm of the total number of patent applications from industrial enterprises in city c . Denote i as the enterprise and t as the year.	$Pataply_{c,t} = \ln(\sum_{i=1}^n Pataply_{i,c,t})$
Authorized patents (Patgrant)	The natural logarithm of the total number of authorized patents of industrial enterprises in city c .	$Patgrant_{c,t} = \ln(\sum_{i=1}^n Patgrant_{i,c,t})$
Independent variable		
Government industrial funds (GIF)	The number of government industrial funds established in city c in year t . Provincial-level data have also been tested for robustness.	
Mechanism variable		
The guiding effect of industrial funds on the local venture capital market ($VC_{c,t}$)	VC_num: The number of venture capital funds established other than GIFs. VC_aum: The fundraising scale of venture capital funds other than GIFs (the amount is aggregated at the city level and taken as the natural logarithm with units of one million yuan).	
Synergistic effect between GIFs and other types of venture capital ($M_{c,t}$)	DS: The proxy variable for the decentralization of governance structure of GIFs. PSocial: The proportion of private capital contributions in industrial funds.	
Control variables		
City-level GDP (lnctgdp)	Logarithm of city GDP.	
Provincial-level GDP (lnpvvgdp)	Logarithm of provincial GDP.	
Industrial structure upgrade index (Indstru)	Referring to An et al. (2025), the industrial structure upgrading index is employed to measure the changes in regional industrial structure.	$Indust_Stru_{c,t} = \sum Ind_j \times j$ ($j = 1, 2, 3$), Ind_j indicate the proportion of the output value of the i -th industry in the total output value of the region
GDP per capita (percagdp)	Logarithm of per capita GDP.	
Urban–rural income ratio (cx)	The per capita disposable income of urban residents in City c divided by the per capita disposable income of rural residents.	
Human capital indicator (cthr)	Number of students enrolled in regular institutions of higher learning in the city $\times 100$ /total population at the end of the year.	

The above table describes variable definitions. Panel data have been implied for this research and variables are computed for each city and year.

3.2. Data and Descriptive Statistics

The enterprise data used in this study include data from 58,147 industrial enterprises that are included in the list of the Industrial Enterprise Database and for which complete patent application data can be found in the China National Intellectual Property Administration, with incomplete data excluded. As this study primarily focuses on macro-analysis, we matched enterprise data with city codes and aggregated individual enterprise data at the city level, resulting in summarized innovation data for industrial enterprises at the 333 cities. Panel data were employed for this study with a time period covering 2014–2024, and 3663 city–year-level datasets were obtained. The enterprise data used in this study were

obtained from the Chinese Research Data Services Platform (CNRDS) and the Innovation of Industrial Enterprise Database (IIED). Data at the city and provincial levels were sourced from the Wind database.

Industrial fund data were manually constructed based on the matching of the Ministry of Industry and Information Technology's industrial fund directory, the Zero2IPO database, and the Global Enterprise Database. Funds with revoked business licenses, incomplete information, and no government funding were excluded from the industrial fund data. Although PPP (public–private partnership) funds are a form of government industrial funds, they are primarily used for infrastructure and municipal engineering construction, which is not closely related to the focus of this study. Furthermore, PPP funds account for a relatively small proportion of the overall industrial funds. Therefore, PPP funds were excluded from the sample of industrial funds in this paper. The research sample of GIFs in this article includes information on 2974 funds which have been set up from 2014 to 2024 in China. Corresponding to the hierarchical structure of enterprise innovation data, the data on the establishment of industrial funds were aggregated at the city level. Compared to the construction method that solely relies on a single commercial database, the construction method for the industrial fund database in this study is relatively more comprehensive.

The fund data established by other venture capital institutions mainly come from the Zero2IPO database, supplemented by data on investments in China. The sample encompasses information on 8155 funds of other types, excluding GIFs, that were registered with the Asset Management Association of China from 2014 to 2024. Similarly, the fund information was aggregated by city and year. Table 2 presents the descriptive statistical information of the main data.

Table 2. Descriptive statistics.

Variable	N	Mean	SD	Min	p50	Max
Pataply	3663	5.4914	2.1327	0	5.6500	10.660
Patgrant	3663	5.3223	2.1120	0	5.4800	10.420
GIF	3663	0.7183	1.9530	0	0	30
VC_num	3663	2.2129	22.507	0	0	586
VC_amu	3663	1.3031	2.7945	0	0	12.210
lnctgdp	3663	7.3986	1.0735	3.5700	7.3700	10.900
lnpvgdp	3663	10.217	0.8949	6.8600	10.290	11.860
Indust_Stru	3663	2.3517	0.1617	1.5703	2.3414	4.3686
cxbi	3663	2.2519	0.4636	1.1669	2.1801	4.6572
percagdp	3663	6.0986	3.5069	0.2150	5.1533	27.273
cthr	3663	1.9687	2.1413	0.02600	1.2949	16.661

The above table reports descriptive statistics of the variables. The variables are defined in Table 1 (Section 3.1).

4. Results and Discussion

4.1. Baseline Regression

We first examined the impact of the establishment of GIFs on the innovation activity of regional industrial enterprises using model (1) to build the foundation for our empirical analysis, with the regression results presented in Table 3. The results in columns (1) and (2) were estimated by regressing the core explanatory variable solely on enterprise innovation, whereas columns (3) and (4) present the results after introducing control variables. The dependent variables are the number of patent applications (Pataply) and the number of patent grants (Patgrant), respectively. The coefficient of the core explanatory variable (GIF) is significantly positive at the 1% level, indicating that the establishment of GIFs can

significantly increase the number of patent applications and grants. We also examined the provincial-level data of GIF and obtained similar results, which are presented in columns (5) and (6). Overall, our baseline regression results support the basic hypothesis that GIFs enhance the innovation of industrial enterprises, in line with Hypothesis 1.

Table 3. Baseline regression of the establishment of GIFs on enterprises innovation.

Variable	(1) Pataply	(2) Patgrant	(3) Pataply	(4) Patgrant	(5) Pataply	(6) Patgrant
GIF	0.0162 *** (3.53)	0.0183 *** (3.68)	0.0138 *** (3.17)	0.0167 *** (3.58)	0.0052 *** (3.85)	0.0035 *** (2.75)
lnctgdp			−0.4508 ** (−2.32)	−0.3636 * (−1.90)	−0.4592 ** (−2.38)	−0.3702 * (−1.94)
lnpvgdp			0.5800 (1.39)	0.2396 (0.60)	0.5563 (1.33)	0.2401 (0.60)
Indust_Stru			0.5800 (1.39)	0.2396 (0.60)	0.5563 (1.33)	0.2401 (0.60)
cxbi			−0.6597 *** (−3.04)	−0.6140 *** (−3.32)	−0.6210 *** (−2.94)	−0.5916 *** (−3.27)
percagdp			0.0191 (0.86)	0.0222 (1.09)	0.0180 (0.83)	0.0198 (0.98)
cthr			0.0213 (0.77)	0.0119 (0.41)	0.0175 (0.64)	0.0090 (0.31)
City FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Obs	3663	3663	3663	3663	3663	3663
adj. R ²	0.3361	0.3333	0.3257	0.3263	0.3281	0.3264

In this table, we have examined the impact of GIF establishment on the enterprise innovation. T-statistics adjusted with robust standard error are written in parentheses; superscripts ***, ** and * denote significance at 1%, 5% and 10% levels, respectively. Year fixed effects—Year F.E. and city fixed effects—City F.E. are included in all regressions.

4.2. Robustness Tests

The baseline regression demonstrates that the setting up of GIFs fosters the innovation of industrial enterprises. We conducted a series of robustness tests to verify the baseline regression results, including a placebo test, a lagged effect test, instrumental variable (IV) regression, and other robustness tests. Overall, our test results demonstrate the validity of the baseline regression.

4.2.1. Placebo Test

To rule out other policy effect and random factors, we conducted a placebo test. The process is as follows: firstly, the treatment effect of the establishment of GIFs is randomly assigned for each city; subsequently, the estimated coefficients are obtained through regression model (1). The kernel density plots of the estimated coefficients of the randomly assigned terms are obtained after the experiment has been repeated 1000 times. The plots are shown in Figures 1 and 2. The results of the placebo test show that the estimated coefficients of the impact of GIFs on enterprise innovation after the random treatment are centrally distributed at 0. Such results indicate that the policy effect of GIFs does not stem from the impact of other virtual pseudo-policy shock effects, supporting the robustness of the benchmark regression.

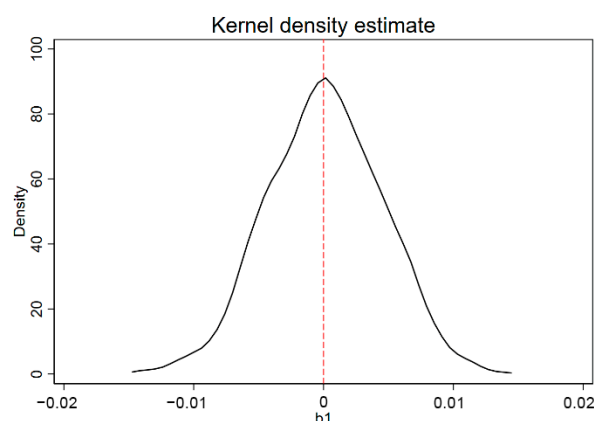


Figure 1. Distribution of coefficient estimates after random treatment (Pataply).

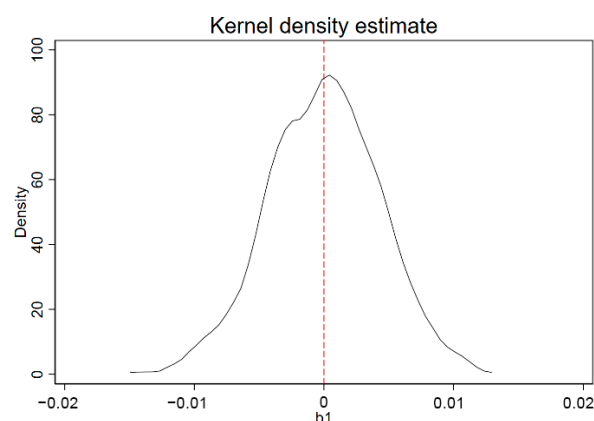


Figure 2. Distribution of coefficient estimates after random treatment (Patgrant).

4.2.2. Test of Lagged Effect

Since the research and development activities of enterprises are a continuous process, the impact of the establishment of GIFs on enterprise innovation may not be reflected in the current period. At the same time, to address the concern with endogeneity, we conducted a lagged one-period test of the benchmark model and constructed a regression model (4).

$$Y_{c,t+1} = \beta_0 + \beta_1 \times GIF_{c,t} + \sum b_j \times X_{c,t} + \theta_t + \lambda_c + \varepsilon_{c,t} \quad (4)$$

As presented in columns (1) and (2) of Table 4, the coefficient of the core explanatory variable (GIF) is significantly positive at the 1% level. The result of lagged period aligns with that of the baseline regression, indicating that the baseline regression results are still valid after the endogeneity and the lagged effect have been considered.

Table 4. Robustness tests of GIF setup on industrial company innovation.

Variable	Lagged Effect		(3) GIF	IV: 2SLS		Consider Spillover Effects	
	(1) Pataply _{t+1}	(2) Patgrant _{t+1}		(4) Pataply	(5) Patgrant	(6) Pataply	(7) Patgrant
GIF	0.0121 *** (3.13)	0.0137 *** (3.11)				0.0092 * (1.86)	0.0137 ** (2.52)
IV			0.0005 *** (5.30)				
Instrumented-GIF				0.1240 * (1.93)	0.1378 ** (2.03)		

Table 4. Cont.

Variable	Lagged Effect		(3) GIF	IV: 2SLS		Consider Spillover Effects	
	(1) Pataply _{t+1}	(2) Patgrant _{t+1}		(4) Pataply	(5) Patgrant	(6) Pataply	(7) Patgrant
Provincial-GIF						0.0057 *** (3.92)	0.0036 ** (2.56)
lnctgdp	−0.3471 * (−1.78)	−0.5039 *** (−2.68)	1.2070 *** (5.68)	−0.3433 *** (−3.89)	−0.3324 *** (−3.09)	−0.2011 (−1.25)	−0.1723 (−1.07)
Indust_Stru	−0.0725 (−0.59)	−0.1901 (−1.23)	−0.2067 (−0.51)	−0.2392 (−1.62)	−0.2667 * (−1.82)	−0.3246 * (−1.75)	−0.2839 * (−1.71)
percagdp	0.0068 (0.28)	0.0132 (0.66)	−0.3224 *** (−9.58)	0.0378 ** (1.98)	0.0477 * (1.91)	−0.0010 (−0.04)	0.0046 (0.19)
cthr	0.0304 (1.04)	0.0003 (0.01)	−0.0368 (−0.60)	0.0313 (1.34)	0.0170 (0.76)	−0.0010 (−0.04)	0.0046 (0.19)
City FE	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES
Obs	3330	3330	3591	3591	3591	3663	3663

In this table, we have reported the robustness test results. T-statistics or Z-statistics adjusted with robust standard error are written in parentheses; superscripts ***, ** and * denote significance at 1%, 5% and 10% levels, respectively. Year fixed effects—Year F.E. and city fixed effects—City F.E. are included in all regressions.

4.2.3. Instrumental Variable Regression

We also employed an instrumental variable (IV) approach to further enhance robustness. Referring to Cai et al. (2024), we used the lagged local government audit intensity as the IV for regression analysis, measured by the number of audits completed by local governments in the previous period. This instrumental variable meets the conditions of correlation and exclusion: the establishment of GIFs is significantly influenced by the effectiveness of local government fiscal expenditure, and for specific enterprises, their R&D decisions are not directly affected by the government audit conducted in the previous year. Data from cities with incomplete government audit information were excluded from the IV regression. Columns (3) to (5) of Table 4 show the 2SLS regression results of the instrumental variable. The first-stage regression results indicate that the instrumental variable (IV) is significantly positively correlated with the explanatory variable (GIF), satisfying the correlation requirement of the instrumental variable. The second-stage regression results show that, after considering the potential endogeneity issues, the regression coefficient of GIF establishment on corporate innovation remains positive, indicating that GIFs can significantly promote regional enterprise innovation, which is fully consistent with the previous results.

4.2.4. Other Robustness Tests

Considering that the establishment of industrial funds within the same province may have spillover effects on enterprise innovation across different cities within the province, we further incorporated the impact of fund establishment within the same province in our regression analysis. The results are presented in columns (6) and (7) of Table 4. The results indicate that the baseline regression results remain robust after considering the impact of intra-provincial spillover effects. We also conducted a sub-sample test excluding municipalities directly under the central government, and the results were consistent with the benchmark regression. Due to space limitations, the sub-sample results are not presented in detail.

4.3. Heterogeneity

The effect of the GIFs on enterprise innovation may vary depending on the disparities between firms, innovation patters, fund structures, and regions. In this subsection, we

delve deeper into the heterogeneity of the baseline findings by considering the features of enterprise innovation characteristics, fund structure, and regional environment.

4.3.1. Heterogeneity at the Fund Level

Different fund characteristics may have an impact on the guiding mechanism and innovation-promoting effect of GIFs. Therefore, we examined the heterogeneity of different fund characteristics.

(1) Characteristics of fund managers. GIFs employ managers through market-oriented methods. Although GIFs are supported by government funding, some also have private institutions serving as managers, reflecting the governance advantage of separating funders and managers in the fund structure. Due to more flexible incentive mechanisms, private institutions may possess a more professional team of professional managers, thereby better leveraging the guiding effect of GIFs. We grouped the samples by region based on whether private institutions served as managers in locally established funds. Columns (1) and (2) of Table 5 present the regression results at the city level, where private institutions serve as GIF managers, while columns (3) and (4) show the regression results at the city level, where all GIF managers are state-owned institutions. The sub-group regression results indicate that GIFs with private institutions serving as managers have a stronger ability to promote enterprise innovation, with regression coefficients for GIF and enterprise patent applications and patent grants both significantly positive at the 1% level. GIFs managed entirely by state-owned institutions have a weaker promoting effect on innovation in local industrial enterprises, with regression coefficients that are not significant. A possible explanation for the heterogeneous results is that the inclusion of private investment institutions as managers of GIFs may send a more pronounced positive signal to the local venture capital market, thereby better leveraging the synergistic effect between government capital and private capital, and promoting corporate innovation momentum.

Table 5. Heterogeneity at the fund level.

Variable	Fund Management Team				Proportion of Local Funds			
	Include Non-SOE		SOE		Above Average		Below Average	
	(1) Pataply	(2) Patgrant	(3) Pataply	(4) Patgrant	(5) Pataply	(6) Patgrant	(7) Pataply	(8) Patgrant
GIF	0.0137 *** (3.20)	0.0145 *** (3.13)	−0.0057 (−0.16)	0.0342 (1.23)	0.0175 ** (2.48)	0.0198 ** (2.32)	0.0044 (0.77)	0.0059 (1.00)
lnctgdp	−0.8097 *** (−3.72)	−0.5990 *** (−2.98)	−0.1441 (−0.49)	−0.1714 (−0.58)	−0.6388 *** (−2.83)	−0.3768 * (−1.80)	−0.5492 (−1.63)	−0.3825 (−1.12)
lnpvgdp	0.4856 (1.02)	0.0557 (0.12)	0.5752 (0.97)	0.3269 (0.56)	1.0989 ** (2.09)	0.3282 (0.65)	−0.5492 (−1.63)	−0.3825 (−1.12)
Indust_Stru	−0.5617 *** (−4.18)	−0.4981 *** (−3.70)	0.0680 (0.32)	0.0650 (0.37)	−0.4784 *** (−3.26)	−0.3331 * (−1.93)	−0.5628 (−1.46)	−0.5144 (−1.51)
cxbi	−1.2488 *** (−3.91)	−1.1179 *** (−4.21)	−0.2737 (−1.22)	−0.2800 (−1.49)	−0.5325 * (−1.89)	−0.5688 ** (−2.32)	−0.5628 (−1.46)	−0.5144 (−1.51)
percagdp	0.0524 * (1.97)	0.0535 ** (2.43)	−0.0088 (−0.31)	0.0004 (0.01)	0.0306 (1.13)	0.0370 (1.48)	0.0370 (0.74)	0.0066 (0.16)
cthr	−0.0112 (−0.29)	−0.0033 (−0.09)	0.0621 * (1.73)	0.0396 (1.08)	−0.0038 (−0.09)	0.0012 (0.03)	−0.0208 (−0.44)	−0.0608 (−1.42)
City FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Obs	1870	1870	1793	1793	2112	2112	704	704

This table reports the heterogeneity test on fund characteristics. Columns (1) to (4) report the results of sub-sample tests by different fund managers. Columns (5) to (8) report the results of sub-sample tests by different levels of localization characteristics. T-statistics adjusted with robust standard error are written in parentheses; superscripts ***, ** and * denote significance at 1%, 5% and 10% levels, respectively. City fixed effect and year effect are controlled for each sub-sample test.

(2) The localization characteristics of industrial funds. The industrial funds can be divided into national, provincial, municipal, and district/county levels according to the level of investors. In this paper, we further investigated whether the localization operational characteristics of funds have a significant innovation-promoting effect on local enterprises. We grouped the samples according to the proportion of local GIFs, which is calculated by the ratio of municipal and district/county funds to the total number of GIFs in the local area. Columns (5) and (6) of Table 5 present the regression results for cities where the proportion of local funds in government industrial funds established is greater than or equal to the average value, while columns (7) and (8) present the regression results for cities where that proportion is smaller than the average value. Due to differences in the jurisdiction levels of funds established in municipalities directly under the central government compared to other regions, samples from such municipalities were excluded from this part of the test. The regression results by sub-group show that GIFs with a high proportion of local funds have a stronger ability to promote enterprise innovation. The regression coefficients of GIFs on enterprise patent applications and patent grants are both significantly positive at the 5% level. Industrial funds with a lower proportion of local funds have a weaker effect on promoting enterprise innovation, and the regression coefficients are not significant. A possible explanation for this heterogeneous result is that the localization characteristics of funds will lead to a more concentrated investment strategy towards local enterprises, generating an industrial cluster effect that promotes knowledge dissemination, thereby leading to the exertion of a more significant promoting effect on local enterprise innovation. The results of the heterogeneity test support the virtuous cycle effect of the guiding mechanism through which GIFs promote innovation.

4.3.2. Heterogeneity of Enterprises and Innovation

To further explore in which enterprises and types of innovation GIFs can play a greater role, we conducted a heterogeneity analysis at the enterprise and innovation levels. Based on the sub-group test of enterprises with different technological intensity, we found that, for technology-intensive enterprises, the promotion effect of GIFs on enterprise innovation is significant, whereas for those with lower technology intensity, the promotion effect is not significant. The main reason is that high-tech enterprises are more affected by information asymmetry (Martí & Quas, 2018) and are considered by investors to have higher investment risks. Therefore, the importance of GIFs in bridging the equity gap for high-tech companies is more significant. The heterogeneous analysis results based on different types of innovation show that the establishment of GIFs has a significant promoting effect on enterprises' green innovation. In the analysis of the innovative nature, we found that GIFs can support both exploratory innovation and exploitative innovation, and is more conducive in promoting exploitative innovation. This may indicate that the incentive effect of GIF establishment on enterprise innovation is more focused on technological innovation directly related to product production, which is in line with the fund objective of guiding industry upgrading, and the degree of incentive for underlying technological innovation needs to be further strengthened. Detailed results are provided in Appendix A.

4.3.3. Regional Heterogeneity

Differences in economic conditions, local policies, and business environments across different regions in China may lead to regional variations in the promotional effects of the establishment of GIFs on the innovation of regional industrial enterprises. We have discussed regional heterogeneity, primarily encompassing fiscal transparency, regional financial resources, the degree of marketization, and the investment environment. The regression

results show that, for regions with more fiscal transparency, favorable financing environments, higher levels of marketization and stronger external investment attractions, the promotion effect of industrial funds on enterprise innovation is more significant. This result indicates that a favorable external environment is more conducive to the market-oriented operation mechanism of GIFs, enabling them to fully leverage their role in promoting innovation. Detailed results are provided in Appendix A.

4.4. Mechanism Tests

The results of baseline regression and robustness tests support the basic hypothesis that the establishment of GIFs has a significant positive impact on enterprise innovation, and preliminarily support the guiding and synergistic mechanism of industrial funds. Based on this, we further explored the mechanism by which GIFs promote enterprise innovation. The two possible mechanisms proposed in this study are the guiding effect and the synergistic effects of GIFs on social capital; for each of these mechanisms, we conducted the following tests.

4.4.1. The Guiding Effect Mechanism of GIFs on Other Venture Capital Funds

Firstly, we examined the guiding mechanism of the establishment of government industrial funds on other types of venture capital through model (2). We employed the number of venture capital funds established (VC_num) and the fundraising scale (VC_amu) as mediating mechanism variables. The measurement methods for these variables are detailed in Section 3.1. The results are presented in columns (1) and (2) of Table 6. The mechanism test results indicate that the regression coefficients of GIF with VC_num and VC_amu are significantly positive at the 5% and 1% levels, respectively, suggesting that the establishment of GIFs can promote the establishment of other types of venture capital funds, thereby exerting a guiding effect and promoting corporate innovation.

Table 6. The mediating effect of the guiding mechanism of GIFs.

Variable	(1) VC_num	(2) VC_amu	(3) VC_startup1	(4) VC_startup2	(5) VC_longterm
GIF	5.3577 ** (2.25)	0.1731 *** (4.73)	0.5807 *** (3.39)	0.6367 ** (2.08)	0.6728 ** (2.41)
lnctgdp	−0.0776 (−0.03)	0.3171 (0.73)	−0.8162 (−0.74)	−0.0382 (−0.03)	0.1336 (0.26)
lnpvgdp	11.8013 * (1.70)	−0.7300 (−0.67)	2.2567 (0.99)	−0.8695 (−0.28)	1.3564 (1.44)
Indust_Stru	−1.2028 (−0.63)	0.4385 (0.90)	0.0648 (0.07)	−0.1091 (−0.10)	−0.1401 (−0.41)
cxbi	4.7561 (0.82)	−1.4935 *** (−3.81)	−5.8808 *** (−3.48)	−7.1594 *** (−3.15)	1.4514 (0.97)
percagdp	−2.7748 * (−1.96)	−0.0627 (−1.21)	−0.0625 (−0.36)	−0.0283 (−0.13)	−0.4984 * (−1.91)
cthr	2.2296 * (1.90)	−0.2096 (−1.64)	0.6434 (1.58)	0.5480 (1.06)	0.5292 ** (2.45)
City FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Obs	3663	3663	3663	3663	2997

This table reports mechanism test with the guiding effect as the mechanism variable. T-statistics adjusted with robust standard error are written in parentheses; superscripts ***, ** and * denote significance at 1%, 5% and 10% levels, respectively.

To examine the guiding mechanism that better illustrates the “seeding” effect of GIFs in alleviating early-stage financing gaps, we further tested the guiding effect of government

industrial funds on early-stage investment funds. We measured early-stage funds through two methods: the fund filing type and fund investment strategy. For the first method, based on the private fund filing data from the Asset Management Association of China, we classified the funds with filing types of “venture capital” and “angel investment” as early-stage funds. For the second method, regarding fund investment strategy, we conducted a text search in the description of the fund investment strategy to determine whether it contained the fields “early-stage”, “growth”, “innovation”, or “seed”. If any of these descriptions was present, the fund was considered an early-stage fund. After identifying each venture capital fund established from 2014 to 2024, we counted the number of early-stage fund establishments by city–year and synthesized panel data. We tested the impact of the establishment of government industrial funds on the establishment of early-stage funds using a two-way fixed-effect model. The results are presented in Table 6, with column (3) showing the result of the guiding effect of the early-stage funds measured by fund type (VC_startup1) and column (4) showing the corresponding result measured by fund investment strategy (VC_startup2). The regression results indicate that the establishment of government industrial funds significantly promotes the establishment of early-stage venture capital funds, further validating the guiding effect of GIFs.

Innovation requires long-term capital support, and whether GIFs can guide long-term funds into the venture capital market and leverage the effect of patient capital is also an important aspect of measuring their guiding effect. We thus further tested the guiding effect of GIFs on long-term funds, which are measured by the fund exit ratio (VC_longterm). We identified venture capital funds with investment events among the funds established since 2014 as the analysis sample. If a fund’s exit events accounted for less than 50% of the investment cases, the fund was considered as long-term capital. Similarly, we merged the long-term fund samples into panel data by city–year. To avoid overestimating the proportion of long-term capital due to the small number of exit cases in newly established funds, we excluded funds established in 2023 or later. We examined the guiding effect of the establishment of GIFs on long-term capital through a double fixed-effect model, and the results are presented in column (5) of Table 6. The regression results show that the establishment of GIFs significantly promotes the establishment of long-term venture capital funds, indicating that GIFs have the effect of guiding social capital to “invest early and invest long-term”, promoting enterprise innovation by increasing the supply of long-term capital, which further verifies their guiding effect.

Therefore, the guiding effect of GIFs on other venture capital funds is supported by the mediating effect model, verifying Hypothesis 2.

4.4.2. The Synergistic Effect Mechanism of Government Funds and Social Capital

Hypothesis 3 of this study posits that the synergistic effect of government funding and social capital can better leverage the innovation promotional role of GIFs. To verify the above synergistic effect mechanism, we conducted a test using model (3), the moderation effect model, and the results are presented in Table 7. We measured the synergistic effect in two ways. The first was through the proxy variable for the decentralization of the GIF governance structure (DS), which is calculated by the average proportion of local government funding in the total subscribed capital of local GIFs. We compiled statistics on the subscribed capital composition of all GIFs for which data were available, and calculated the proportion of local government funding in the overall subscribed capital of the fund. If the average proportion of local government funding in the subscribed capital of GIFs was greater than or equal to 66.6%, indicating that the local government has absolute control in most funds (with shareholders holding 2/3 of the voting rights), then DS took a value of 0. Conversely, if the proportion of local government funding was less than 66.6%, indicating

that social investors have a certain degree of influence on the funds, then *DS* took a value of 1. To test the moderating effect of *DS*, we performed an interaction regression between *DS* and *GIF*, with the results presented in columns (1) and (2) of Table 7. As can be seen from these columns, the regression coefficient of the interaction term (*DS* × *GIF*) is significantly positive, indicating that the deep involvement of social capital in the establishment of *GIFs* can positively moderate their innovation-promoting effect.

Table 7. The moderation effect of the synergistic mechanism of *GIFs*.

Variable	(1) Pataply	(2) Patgrant	(3) Pataply	(4) Patgrant
<i>DS</i> × <i>GIF</i>	0.0038 ** (2.04)	0.0030 * (1.72)		
<i>PSocial</i> × <i>GIF</i>			0.0104 *** (2.94)	0.0079 ** (2.40)
<i>GIF</i>	0.0041 ** (2.08)	0.0038 * (1.86)	0.0030 * (1.78)	0.0032 * (1.96)
<i>DS</i>	−0.0522 (−1.36)	−0.0383 (−1.14)		
<i>PSocial</i>			0.0094 (0.19)	−0.0023 (−0.06)
<i>lnctgdp</i>	−0.3346 * (−1.77)	−0.2611 (−1.46)	−0.3331 * (−1.75)	−0.2593 (−1.44)
<i>Indust_Stru</i>	−0.4009 * (−1.88)	−0.3990 ** (−2.16)	−0.4020 * (−1.88)	−0.4015 ** (−2.18)
<i>percagdp</i>	0.0006 (0.02)	−0.0009 (−0.04)	0.0011 (0.04)	−0.0005 (−0.02)
<i>cthr</i>	−0.0131 (−0.47)	−0.0058 (−0.19)	−0.0150 (−0.54)	−0.0073 (−0.23)
City FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Obs	3144	3144	3144	3144

This table reports the mechanism test with synergistic effect as the mechanism variable. T-statistics has are in parentheses; superscripts ***, ** and * denote significance at 1%, 5% and 10% levels, respectively.

We further examined the synergistic effect between government funding and social capital using the proportion of private capital contributions (*PSocial*) in *GIFs*, which is calculated by counting the proportion of funds with private capital contributions among the *GIFs* established in each province in the current year. We treated *PSocial* as a mechanism variable and performed an interaction regression with the core explanatory variable *GIF*. The results are presented in columns (3) and (4) of Table 7 and show that the regression coefficient of the interaction term (*PSocial* × *GIF*) is positive at the 1% and 5% significance levels, indicating that the participation of private capital in *GIFs* positively moderates their innovation-promoting effect.

The above results demonstrate that the mechanism of synergistic effect has a positive moderating role between *GIFs* and enterprise innovation. The participation of private capital in *GIFs* is conducive to making *GIFs* more market-oriented and professional in terms of investment operations. Moreover, the joint funding of private capital and government investment can create effective checks and balances within the fund governance structure, promoting more efficient operation of *GIFs* and better leveraging their role in promoting innovation. Therefore, the above results validate Hypothesis 3.

5. Conclusions

In this work, we systematically investigated the effect and mechanism of the establishment of government industrial funds on Chinese enterprise innovation through an empirical study comprising panel data of China industrial enterprises covering the recent period of 2014 to 2024. The results of the empirical research support the hypothesis proposed in this paper that the establishment of GIFs can play a positive role in promoting local enterprise innovation. Our findings indicate that China's GIFs are effectively designed in bridging the equity gap, which hinders innovation, and that the establishment of GIFs is productive in alleviating the structural imbalance of the equity investment market. These results remain valid after a series of robustness tests.

Moreover, the results of the sub-group regression demonstrate that the innovation-driven effect of GIFs is more significant for regions with higher fiscal transparency and marketization, as well as favorable regional financial resources and investment environments. In addition, GIFs play a more pronounced role in bridging the equity financing gap of high-tech companies. The heterogeneity analysis results of different types of innovations indicate that the establishment of GIFs has a positive effect on green, exploratory, and applied innovation. Comparatively speaking, the incentive effect of GIFs on enterprise innovation is more focused on technological innovation directly related to product production, while the degree of incentive for basic technological innovation needs to be further strengthened. Our research results also indicate that GIFs can better exert their innovation-promoting effect when private institutions serve as fund managers and the degree of localization of the fund is higher, which are novel findings in the Chinese context.

The mechanism test results reveal the effective channels through which industrial funds promote enterprise innovation by exerting guiding and synergistic effects with social capital. GIFs effectively play the role of "seeding" funds and "patient capital", guiding social capital to gather towards long-term and early-stage investment funds, improving the structural supply shortage in the local venture capital market and alleviating the financing gap for enterprise innovation. The focus on early-stage and long-term capital is an innovative perspective of this paper. We also verify the synergy mechanism by examining the degree of social capital participation, linking the funds' internal governance mechanisms on their innovation-promoting effect. Our results indicated that the participation of private capital in GIFs is conducive to making GIFs more market-oriented and professional in terms of investment operations, and the joint funding structure can create effective checks and balances within the fund governance structure, thus better leveraging their role in promoting innovation. The impact of the internal governance mechanisms of GIFs on their innovation-promoting effect is a unique contribution of this paper.

Our research findings hold practical significance for emerging market countries in terms of how to better establish government investment fund mechanisms and leverage such funds' innovation-driven effect. Firstly, in the structural design of GIFs, social capital should be encouraged to actively participate and assume key governance roles to better leverage the synergistic effect between professional private venture capital institutions and government venture. GIFs should hire professional teams with extensive investment experience and fund operation capabilities as fund managers, fully leveraging the institutional advantages of specialization and marketization of industrial funds, so that GIFs can operate more effectively and fulfill the function of promoting innovation. Second, GIFs should have clear positioning towards cultivating innovation and adopt the investment strategy of investing in early-stage and long-term projects, thereby driving social capital to gather towards the "patient capital" needed for innovation. This will better address the structural supply shortage in the venture capital market and cultivate an investment orientation that emphasizes long-term value, thereby promoting corporate innovation. Third, GIFs

should further focus on local industrial resources and comparative advantages, carrying out investment tailored to local conditions and focusing on leverage innovation-driven effects by forming industrial chain synergies and industrial cluster effects through localized investments. Establishing a transparent, efficient, and open regional market environment is also beneficial for GIFs to exert their guiding effect.

Due to its length, this paper has limited its focus on enterprise innovation measured by patents, a prevailing measurement for innovation; this could be extended to an investigation into innovation quality and its economic consequences on productivity and profitability. In addition, as this article focuses on policy effects at the macro-level, research on the role of government industrial funds at the individual enterprise level remains to be enriched as part of further research endeavors.

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Abbreviations

The following abbreviations are used in this manuscript:

GIF Government Industrial Fund

Appendix A

1. Test of Regional Heterogeneity

This section presents detailed analysis results of regional heterogeneity, encompassing fiscal transparency, regional financial resources, the degree of marketization, and the investment environment so to trace the cross-sectional differences.

(1) Fiscal transparency. We first explored the impact of regional fiscal transparency. In an environment with high fiscal transparency, the market's trust in government industrial funds increases, which may be conducive to the exertion of the innovation-promotion effect. Drawing on previous research (X. Li et al., 2026), we have selected the fiscal transparency index from the "China Fiscal Transparency Report" as the measurement indicator. To align the heterogeneous classification indicators with the research interval of this paper, we took the average value of the fiscal transparency index from 2014 to 2024 and divided the samples into two groups based on the median of the average fiscal transparency across provinces. We then conducted a regression analysis on model (1) for each sub-group; the results are reported in Panel A of Table A1. The regression results show that, in regions with high fiscal transparency, the promotion effect of GIFs on enterprise innovation is significant. However, in regions with relatively low fiscal transparency, the promotion effect of GIFs on enterprise innovation is not significant.

Table A1. Heterogeneity tests of GIF setup on industrial company innovation at the regional level.

Variable	Panel A: Fiscal Transparency				Panel B: Financing Environments			
	Above Median		Below Median		Above Average		Below Average	
	(1) Pataply	(2) Patgrant	(3) Pataply	(4) Patgrant	(5) Pataply	(6) Patgrant	(7) Pataply	(8) Patgrant
GIF	0.0083 ** (2.10)	0.0157 *** (3.77)	0.0102 (1.12)	0.0138 (1.09)	0.0113 ** (2.44)	0.0148 *** (3.29)	0.0160 (1.28)	0.0172 (1.34)
lnctgdp	−0.0957 (−0.40)	0.2003 (1.05)	−0.4617 ** (−2.11)	−0.535 ** (−2.33)	0.1070 (0.37)	0.3016 (1.11)	−0.609 *** (−2.86)	−0.5703 ** (−2.72)
lnpvgdp	−0.8530 (−1.30)	−2.4384 *** (−4.58)	1.7653 *** (3.21)	1.6493 *** (2.95)	−0.7913 * (−1.67)	−1.4407 *** (−3.34)	1.0626 * (1.96)	0.8493 (1.61)
Indust_Stru	−0.3777 ** (−2.12)	−0.3292 * (−1.85)	0.0845 (0.42)	0.0473 (0.29)	−0.3732 (−1.54)	−0.1933 (−0.77)	−0.1955 (−1.10)	−0.2378 (−1.32)
cxbi	−0.8457 *** (−2.62)	−0.8569 *** (−3.40)	−0.1542 (−0.75)	−0.1126 (−0.58)	−0.6270 * (−1.83)	−0.5455 * (−1.79)	−0.4606 * (−1.66)	−0.4413 * (−1.85)
cthr	−0.0031 (−0.09)	0.0057 (0.16)	0.0629 * (1.78)	0.0354 (0.91)	−0.0473 * (−1.80)	−0.0323 (−1.26)	0.0658 * (1.84)	0.0423 (1.07)
City FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Obs	1947	1947	1716	1716	1595	1595	2068	2068

Variable	Panel C: Marketability				Panel D: Attractiveness of External Investment			
	Above Median		Below Median		Above Median		Below Median	
	(1) Pataply	(2) Patgrant	(3) Pataply	(4) Patgrant	(5) Pataply	(6) Patgrant	(7) Pataply	(8) Patgrant
GIF	0.0121 *** (2.85)	0.0141 *** (3.18)	0.0020 (0.17)	0.0118 (0.86)	0.0111 *** (2.76)	0.0129 *** (3.20)	0.0040 (0.26)	0.0138 (0.80)
lnctgdp	−0.1978 (−0.96)	0.0574 (0.30)	−0.4121 * (−1.76)	−0.4487 * (−1.94)	−0.1222 (−0.49)	0.1037 (0.46)	−0.4918 ** (−2.12)	−0.5075 ** (−2.21)
lnpvgdp	−0.3666 (−0.70)	−0.9831 ** (−2.00)	0.9130 (1.63)	0.7450 (1.34)	−0.8288 (−1.65)	−1.3682 *** (−3.25)	1.0204 * (1.79)	0.8470 (1.50)
Indust_Stru	−0.1871 (−0.96)	0.0519 (0.25)	−0.0569 (−0.30)	−0.1586 (−0.88)	−0.2654 (−1.20)	−0.1200 (−0.53)	−0.0953 (−0.52)	−0.1567 (−0.85)
cxbi	−0.8178 ** (−2.12)	−0.7479 ** (−2.16)	−0.0738 (−0.35)	−0.0972 (−0.52)	−0.6190 ** (−2.10)	−0.5570 ** (−2.16)	−0.1055 (−0.41)	−0.1170 (−0.53)
cthr	0.0240 (0.71)	0.0195 (0.59)	0.0513 (1.00)	0.0385 (0.71)	−0.0398 (−1.40)	−0.0338 (−1.26)	0.0709 * (1.91)	0.0561 (1.43)
City FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Obs	1826	1826	1837	1837	1958	1958	1705	1705

This table reports heterogeneity tests on regional characteristics. Panel A reports the results of sub-sample tests grouped according to the provincial fiscal transparency. Panel B reports the results of sub-sample tests grouped according to the average of the interest spread of local government bonds. Panel C reports the results of sub-sample tests by dividing the entire sample into two groups by the median of the marketization process indicators. Panel D reports the results of sub-sample tests by dividing the entire sample into two groups by the median of the attractiveness to foreign investment index. T-statistics adjusted with robust standard error are written in parentheses; superscripts ***, ** and * denote significance at 1%, 5% and 10% levels, respectively. City fixed effect and year effect are controlled for each sub-sample test.

(2) Financing environments. We further tested the heterogeneity of regional financial resources and financing environments. The coupon rate of local government bond issuance reflects the financing cost of the local government. The lower the financing cost, the richer the local financial resources and the better the financing environment. Therefore, we used the average spread of local government bonds issued in the primary market as a proxy for regional financial resources and the financing environment, and divided the sample into two sub-groups by province. Provinces with spreads lower than the national average are classified as regions with stronger regional financial resources and better financing environments than the average. Panel B of Table A1 presents the regression results for each sub-group. The results show that, for regions with abundant financial resources and good financing environments, the regression coefficient is significantly positive, indicating

a significant promoting effect of GIFs on corporate innovation. For regions with relatively weaker regional financial resources, the promoting effect of GIFs on corporate innovation is not significant.

(3) Regional marketization level. The degree of the regional marketization may affect the investment guidance effect of industrial funds. Therefore, we studied the heterogeneous impact of regional marketization differences on the innovation-promotion effect of industrial funds. The degree of the regional marketization is measured by the marketization process score, with higher scores indicating higher levels of regional marketization. The indicators of the marketization process are sourced from the China Marketization Index and the WIND database. To enhance robustness, this paper employed two indicators to comprehensively rank the level of regional marketization, namely, the overall marketization process score and the financial marketization process score. Based on the median of the indicators, we grouped the samples for regression analysis, and the results are reported in Panel C of Table A1. The regression results indicate that, in regions with faster marketization processes and higher levels of financial marketization, the promotion effect of industrial funds on enterprise innovation is significant. However, in regions with slower marketization processes and lower levels of financial marketization, the promotion effect of industrial funds on enterprise innovation is not significant.

(4) Investment environment. Attracting high-quality external investment helps to achieve knowledge and technology spillovers, bringing richer capital elements and advanced management experience to regional industrial development. Regions that are attractive to external investment also represent a good business environment, which is conducive to the innovation-driven effect of industrial funds. Referring to previous research (Sun & Shang, 2025), this paper uses the attractiveness to external investment index to measure the regional investment environment. The calculation method of the attractiveness to external investment index is the number of external legal entities' investments obtained by local enterprises in the current year. The data are sourced from the Index of Regional Innovation and Entrepreneurship in China compiled by the Peking University Enterprise Big Data Research Center. We used the average of the indicators for each province from 2014 to 2020 for ranking, and grouped them according to the median. The regression results are reported in Panel D of Table A1. The results show that, for regions with strong ability to attract external investment, the promotion effect of industrial funds on enterprise innovation is significant. For regions with weaker ability to attract external investment, the promotion effect of industrial funds on enterprise innovation is not significant.

2. Test of enterprises and innovation heterogeneity

This section presents the detailed heterogeneity analysis at the enterprise and innovation levels.

(1) Technology intensity. Based on the average R&D expenditure intensity of China's A-share listed companies across various industries in 2024, we categorize the industries in which enterprises operate into technology-intensive and non-technology-intensive industries. Industries with R&D investment exceeding the 1/2 quartile are classified as high-technology-intensive industries, while those with R&D investment below the 1/4 quartile are classified as low-technology-intensive industries. We then reclassified the sample enterprises according to their industry technology intensity. For the enterprises classified as technology-intensive sectors in the sample, we aggregated them at the city level and performed the regression analysis again. Regions with significant missing industry classifications were excluded from the sample, and the results are reported in columns (1) and (2) of Panel A in Table A2. Similarly, we also aggregated the enterprises classified as non-technology-intensive sectors at the city level and performed the regression analysis again. The results are reported in columns (3) and (4) of Panel A in Table A2. The regression

results show that, for technology-intensive enterprises, the promotion effect of GIFs on enterprise innovation is significant. However, for enterprises with lower technology intensity, the promotion effect of GIFs on enterprise innovation is not significant. The research findings of this paper are consistent with previous research conclusions in the European context (Alperovych et al., 2020). The main reason is that high-tech enterprises are more affected by information asymmetry (Martí & Quas, 2018) and are considered by investors to have higher investment risks. Therefore, the importance of GIFs in bridging the equity gap for high-tech companies is more significant, and our empirical result in China context supports this theory.

Table A2. Heterogeneity of enterprises and innovation.

Panel A: Enterprise Heterogeneity					
Variable	High Technology Intensity		Low Technology Intensity		
	(1) Pataply	(2) Patgrant	(3) Pataply	(4) Patgrant	
GIF	0.0105 ** (2.58)	0.0108 ** (2.41)	0.0086 (1.15)	0.0089 (1.42)	
lnctgdp	−0.3834 ** (−2.06)	−0.3005 (−1.61)	−0.5033 ** (−2.09)	−0.3324 * (−1.65)	
lnpvgdp	−0.4077 (−0.92)	−0.4076 (−1.00)	0.4003 (0.64)	−0.1809 (−0.33)	
Indust_Stru	−0.2197 (−1.60)	−0.0832 (−0.57)	−0.2651 ** (−2.01)	−0.2497 (−1.53)	
cxbi	−0.5622 ** (−2.57)	−0.6309 *** (−3.32)	−0.5811 ** (−2.26)	−0.4430 ** (−2.03)	
percagdp	0.0421 ** (2.03)	0.0418 ** (2.20)	−0.0242 (−0.88)	−0.0301 (−1.34)	
cthr	0.0195 (0.50)	0.0276 (0.79)	−0.0056 (−0.15)	−0.0265 (−0.70)	
City FE	YES	YES	YES	YES	
Year FE	YES	YES	YES	YES	
Obs	3245	3245	3245	3245	

Panel B: Innovation Heterogeneity						
Variable	Green Innovation		Exploratory		Exploitative	
	(1) Pataply	(2) Patgrant	(3) Pataply	(4) Patgrant	(5) Pataply	(6) Patgrant
GIF	0.0119 ** (2.26)	0.0150 *** (3.25)	0.0149 ** (2.28)	0.0106 * (1.89)	0.0202 *** (4.27)	0.0196 *** (3.99)
lnctgdp	−0.2273 (−1.05)	−0.1250 (−0.68)	−0.3148 (−1.43)	−0.1082 (−0.58)	−0.6392 *** (−3.34)	−0.3754 ** (−2.08)
lnpvgdp	−0.2273 (−1.05)	−0.1250 (−0.68)	0.6510 (1.17)	0.4303 (1.05)	0.5101 (1.29)	0.2607 (0.75)
Indust_Stru	−0.3793 *** (−2.70)	−0.1474 (−1.00)	−0.4962 *** (−2.95)	−0.1597 (−0.74)	−0.0840 (−0.53)	−0.2136 (−1.33)
cxbi	−0.6625 *** (−3.07)	−0.3908 ** (−2.31)	−0.4036 * (−1.67)	0.1132 (0.75)	−0.7795 *** (−3.31)	−0.7050 *** (−3.36)
percagdp	0.0302 (1.32)	0.0291 (1.48)	0.0411 (1.53)	0.0287 (1.62)	0.0127 (0.57)	0.0087 (0.41)
cthr	0.0263 (0.85)	−0.0163 (−0.55)	0.0339 (1.03)	0.0325 (1.19)	−0.0102 (−0.29)	−0.0117 (−0.38)
City FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Obs	3663	3663	3487	3366	3501	3509

This table reports heterogeneity test results on enterprises and innovation discrepancies. Panel A reports the regression results of classifying enterprises according to the technology intensity of their industries. Panel B reports the regression results classified according to different patent characteristics. T-statistics adjusted with robust standard error are written in parentheses; superscripts ***, ** and * denote significance at 1%, 5% and 10% levels, respectively. City fixed effect and year fixed effect are controlled for each sub-sample test.

(2) Green innovation. We also investigated whether the establishment of GIFs can promote green innovation in industrial enterprises. Green innovation in industrial enterprises is measured at the firm level based on the definition of green patents provided in the “Classification System for Green Technology Patents” issued by the China National Intellectual Property Administration in August 2023. The enterprises’ green patent data are sourced from the China National Research Data Service Platform (CNRDS). Following the previous methods, we merged the firm-year data at the city-year level, obtained the natural logarithm of the number of patents, and reran the regression. The results are presented in columns (1) and (2) of Panel B in Table A2. The regression results indicate that the establishment of GIFs has a significant promoting effect on enterprises’ green innovation.

(3) Exploratory innovation or exploitative innovation. Based on previous research (Liu et al., 2026), this paper further distinguishes corporate innovation into exploratory innovation and exploitative innovation. The natural logarithm of the number of invention patent applications is used to proxy exploratory innovation, while the natural logarithm of the number of utility model patents is used to proxy exploitative innovation. Regression analysis was conducted again, and cities with missing data on invention patents and utility model patents were excluded from the data. The results are presented in columns (3) to (6) of Panel B in Table A2. The results show that the establishment of industrial funds promotes both types of innovation. In terms of significance and regression coefficients, the promotion effect of industrial fund establishment on exploitative innovation is more significant. This may indicate that the incentive effect of GIF establishment on enterprise innovation is more focused on technological innovation directly related to product production, and the degree of incentive for underlying technological innovation needs to be further strengthened.

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