▪ Journal of Competitiveness

# Can industry-finance cooperation firm enhance total factor productivity: evidence from listed companies

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**Abstract**

Industry-finance cooperation is a key step for advancing financial reform. It is of profound significance to study the mechanism and policy structure of industry-finance cooperation. Taking China's industry-finance cooperation as a quasi-natural experiment, the difference-in-difference (DID) approach is used to analyze listed enterprises from 2013 to 2020. We find that industry-finance cooperation promotes enterprises' total factor productivity (TFP). To bolster the credibility of empirical results, we conduct a series of robustness checks, such as the parallel trends assumption verification, placebo test, and alternative variable definitions. To control for endogeneity, we further utilize methods such as PSM-DID and instrumental variable estimation. Our findings indicate heterogeneous effects: industry-finance cooperation exerts a stronger impact on TFP for (1) state-owned enterprises, (2) capital-intensive and traditional manufacturing firms, and (3) enterprises located in provincial capitals or central cities. Furthermore, industry-finance cooperation is to improve TFP by reducing the R&D expenditure, improving the investment efficiency, and reducing the internal costs. In light of the foregoing conclusions, the Chinese government should continue advancing and refining the pilot and mechanism of industry-finance collaboration. By adopting a localized policy approach tailored to regional conditions, it can better leverage finance's role in bolstering the real economy.

***Keywords:*** *Industry-finance cooperation, Total factor productivity, innovation, Difference in difference approach*

**JEL Classification**: D8, O16, O25

Article history: Received: November 2024; Accepted: March 2025; Published: June 2025

## 1 INTRODUCTION

During the Third Plenary Session of the 20th Central Committee, the "Decision on Further Comprehensively Deepening Reform and Promoting Chinese-style Modernization" was reviewed and approved. Among the proposals, the call to "deepen financial system reform" has attracted considerable focus. In this context, the financial system reform will be carried out according to the content of the Central Financial Work Conference as a program, to further improve the function of capital markets and improve the support of the direct financing system to the real economy. In 2016, the Ministry of Industry and Information Technology (MIIT), the People's Bank of China

(PBOC), and the China Banking and Insurance Regulatory Commission (CBIRC) jointly issued the Action Plan for Strengthening Information Sharing to Promote Industry-Finance Cooperation The plan seeks to channel financial resources toward the real economy and enhance their allocation efficiency by establishing mechanisms for bank-enterprise communication and data sharing. That same year, authorities initiated the selection process for pilot cities in industry-finance cooperation and published the first list of cities designated as national-level pilots. Since the launch of the National Industry and Finance Cooperation Platform, it has helped enterprises to raise more than 830 billion yuan, warehoused more than 290,000 high-quality enterprises, and settled in more than 2,400 financial institutions. Industry-finance cooperation has emerged as a pivotal mechanism for fostering the real economy and industrial upgrading, facilitating tripartite collaboration among science, technology, and financial sectors.

Extensive literature has examined the economic effects of industry-finance cooperation. Industry-finance integration represents a key form of industry-finance cooperation (Li et al., 1997), with enterprise involvement in financial institutions exemplifying this integration. Some scholars have studied its economic significance from the viewpoint of industry-finance integration. Industry-finance integration can alleviate financing constraints, lower funding costs, and thereby enhancing operational performance of enterprises (Lu et al., 2012; Wan et al., 2015). By mitigating both under-investment and over-investment, industry-finance integration contributes to enhancing enterprises investment efficiency (Wang et al., 2020). In addition, industry-finance integration can also alleviate the constraints of innovation financing, increase the R&D expenditure of enterprises, thereby ultimately promoting the innovation output (Xu & Deng, 2021; Tian et al., 2022), green technology innovation and development performance (Li et al., 2022). Several studies have investigated how industry-finance cooperation pilot programs affect micro-level enterprises. Industry-finance cooperation has been shown to enhance enterprises investment efficiency (Li et al., 2023), lower their financing costs, and stimulate innovation activities (Wang et al., 2024). Furthermore, other research suggests that industry-finance cooperation can enhance green total factor productivity at the urban level. (Qiu et al., 2024).

Utilizing a quasi-natural experiment from pilot cities for industry-finance collaboration, this paper examines how the industry-finance collaboration affects enterprises total factor productivity (TFP). From a theoretical perspective, this paper explores how industry-finance cooperation affects enterprises' TFP through three main channels: lowering R&D expenditures, enhancing investment efficiency, and decreasing internal operational costs. Empirically, this paper empirically examines the impact of industry-finance cooperation on enterprises' TFP, using the data of A-share listed manufacturing firms from 2013 to 2020. This paper further investigates the heterogeneity of industry-finance cooperation's impact on TFP, considering factors such as equity ownership, factor intensity, and the enterprise's location. Furthermore, this paper empirically examines the triple mechanism of industry-finance cooperation in reducing R&D expenditures, enhancing investment efficiency, and lowering internal costs.

The remaining chapters of this article are arranged as follows: Section 2 outlines the

policy background of industry-finance cooperation and provides a theoretical analysis of its impact on enterprises' TFP; Section 3 discusses the empirical methods and data sources; Section 4 presents the empirical findings; Section 5 offers a discussion and research outlook; and Section 6 concludes the paper.

## 2 THEORETICAL BACKGROUND

### 2.1 Policy background

While finance originates from the real economy, its fundamental role is to serve the real economy's development. In order to achieve high-quality development and prevent the financial industry from going from real to virtual, the government has implemented multiple important financial reform measures, among which the pilot city of industrial and financial cooperation (referred to as industry-finance cooperation) is a key part. The establishment of the industry-finance cooperation pilot aims to promote supply-side structural reform, enhance financial sector efficiency and ability in serving the real economy, and promote industrial quality and efficiency improvement, transformation and upgrading. Eventually establish a docking mechanism between industrial information and financial institutions to improve the capabilities of the financial services industry. The MIIT issued the "Notice on Organizing Applications for Industry-Finance Cooperation Pilot Cities" on July 18, 2016, requiring the cities applying for the pilot to prepare the "Implementation Plan for Pilot Cities for Industry-finance cooperation", focusing on major national strategies and key industries, and scientifically planning and guiding the general idea of financial support for industrial development. Meanwhile, provincial-level industry and information technology authorities, finance departments (bureaus), branches of the PBOC, and dispatched offices of the CBIRC should strengthen supervision and guidance, and timely help coordinate and solve difficulties and problems in the pilot. On December 29 of the same year, the (MIIT) released the first batch of national pilot cities for industry-finance cooperation, and 37 cities (districts) were selected. Subsequently, on December 18, 2020 and June 14, 2024, the list of the second and third batch of national industry-finance cooperation pilot cities was released, some of which were disqualified from the industry-finance cooperation pilot. So far, 66 cities (districts) have been in the state of industry-finance cooperation pilot.

In the pilot industry-finance cooperation, various localities have explored a variety of innovative cooperation models and solutions based on the characteristics of local industries and financial resource endowments. For example, in cities such as Shenzhen and Suzhou, where the manufacturing industry is developed and the industrial chain is complete, the local government has launched a supply chain finance model, which replaces mortgage guarantees with data credit enhancement; in cities such as Wuhan and Hefei, where technology-based SMEs are concentrated, the government-led risk mitigation mechanism has been launched. In Huzhou, Guangzhou and other cities where green industry transformation is urgent, a green financial service model has been launched. In addition, there are industrial fund cluster linkage models, regional equity

market cultivation models, and cross-border financial coordination models. Although the focus of these industry-finance cooperation models is different, the core logic lies in "adapting to local conditions + policy leverage": leveraging market-oriented resources through government-guided funds and risk-sharing mechanisms, while designing exclusive tools based on local industry pain points.

### 2.2 Theoretical analysis

First, industry-finance cooperation increases the TFP of enterprises by saving R&D costs. The pilot of industry-finance cooperation provides enterprises with a wider range of loan channels, reduces their loan cost, and alleviates financing constraints(Lu et al., 2012; Du & Geng，2024). Corporate R&D activities are a long-term process, which requires a lot of long-term sustained support of funds. Financing constraints limit the innovation output of enterprises to some degree (Hall et al., 2015; Yin et al., 2024). Industry-finance cooperation provides enterprises with a large number of opportunities to obtain external financing resources. Some enterprises may experience uncertainties such as insufficient funds due to lack of financing channels during the R&D process, potentially disrupting or halting R&D activities and leading to failure (Hvolkova et al., 2019; Mane & Love，2020), increasing R&D costs. Therefore, through industry-finance cooperation, in one aspect, enterprises can increase R&D fund supply, provide a stable source of funds, and ensure the continuous and stable development of enterprises' R&D activities. In another aspect, the connection between industrial information and the financial institution group establishes a long-term cooperative relationship between enterprises and the financial institution group, so that enterprises do not have to frequently seek financing sources and focus resources on R&D activities (Liu et al., 2024). In the meantime, with the reduction of financing costs, enterprises can save part of the cost for R&D activities, thereby ensuring the continuity of research projects to some extent. By ensuring the continuity of R&D activities, enterprises' likelihood of successful innovation is enhanced, while reducing R&D costs. This, in turn, boosts actual R&D investment and technological innovation (Pomegbe et al., 2020), ultimately driving improvements in production efficiency (Li et al., 2024). Building on this, Hypothesis 1 is formulated.

*H1: Industry-finance cooperation can save the enterprises' R&D expenditure, and improve TFP by increasing the effective R&D investment.*

Second, industry-finance cooperation improves enterprises' TFP by improving the investment efficiency. By cooperating with the financial institution group, whether the enterprise holds shares in the financial institution group or the financial institution group participates in the enterprise, the enterprise can obtain more financing opportunities (Pan & Tian, 2015). This role can enable enterprises to quickly obtain support when they need funds, avoid underinvestment due to lack of funds, and thus stimulate investment expansion and increase the level of investment (Lin et al., 2009). financial institutions can help enterprises manage and diversify risks and reduce corporate investment risks. Enterprises can diversify and manage capital risks by holding shares in banks and other financial institutions, thereby reducing operational uncertainty or the impact of external shocks and improving asset stability. In addition,

industry-finance cooperation will also reduce the excessive investment of enterprises (Wang et al., 2020). After banks hold shares in enterprises, a bond supervision mechanism will be formed, which will restrain enterprises' unreasonable investment behavior by restricting corporate funds. The equity financing method of industry-finance cooperation reduces the degree of equity concentration to a certain extent, which is beneficial for raising the level of corporate governance (Kim et al., 2010), which in turn can reduce the inefficient investment of enterprises. By avoiding underinvestment, reducing investment risks, and minimizing overinvestment, enterprises can increase their investment efficiency, improve their capital utilization efficiency and financial efficiency (Lee et al., 2021), promote the development of R&D innovation (Kapidani & Luci, 2019; Chen et al., 2023), thereby ultimately improving their TFP. Therefore, Hypothesis 2 is proposed:

*H2: Industry-finance cooperation enhances the TFP of firms by elevating their investment levels.*

Third, industry-finance cooperation increases TFP by reducing internal costs. The level of financing costs is an issue that must be considered in the process of corporate financing. Industry-finance cooperation can provide enterprises with several funding avenues, such as bank loans, equity financing, bond issuance and so on. Diversified financing options allow companies to weigh the pros and cons of various financing methods so as to choose the most suitable financing method, reducing the complexity and cost of capital acquisition. In addition, compared with the traditional loan financing methods between banks and enterprises, enterprises can reach a cooperative relationship with financial institution group through digital technologies like Internet platforms, saving the financing cost of seeking credit funds from banks (Jiang et al., 2017; Estrin et al., 2022; Wang et al., 2023). In terms of transaction costs, the electronic payment and settlement services provided by financial institution group can significantly increase transaction speed, reduce the time for funds to be in transit, and reduce costs due to long settlement times (Chen & Yoon, 2022). For example, enterprises can achieve fast payments and instant settlements through electronic payment systems, reducing the time and cost of traditional paper payments and manual settlements. In terms of information cost, industrial information will be shared among financial institutions through information technology like big data, and enterprises with financing needs will be recommended for financial institutions, which will save the cost of enterprise information search (Liu & Chen, 2022). The application of digital finance and reduction of enterprise costs will enable firms to optimize resource utilization and improve operational efficiency (Lyu et al., 2023; Duan & Zhang, 2024), and ultimately improve the TFP of enterprises. Therefore, Propose Hypothesis 3:

*H3: Industry-finance cooperation increases TFP by reducing internal costs.*

# 3 RESEARCH DESIGN

## 3.1 Econometric model construction

Since the pilot cities for industry-finance cooperation are implemented in batches, this paper uses a staggered difference-in-differences (DID) model. Based on the list of the first batch of national pilot cities for industry-finance cooperation, this paper constructs a fixed-effects DID model to empirically test the impact of industry-finance cooperation on the TFP of manufacturing enterprises. Enterprises located in pilot cities that are involved in industry-finance cooperation will constitute the treatment group, while those located in non-pilot cities will serve as the control group. The specific econometrics model is:

$$TFP_{ijt} = \alpha + \beta did_{it} + \gamma X_{it} + u_i + \mu_t + Industry_j + Province + \epsilon_{ijt} \quad (1)$$

$$did_{it} = treat_i * period_t \quad (2)$$

Wherein, $TFP_{ijt}$ denotes the TFP of the enterprise $i$ of industry $j$ in year $t$, and $did_{it}$ is the cross-product term of DID, which is formed by $treat_i$ and $period_t$. $treat_i$ indicates presence of enterprise $i$ within the pilot city area designated for industry-finance cooperation, with a value of 1 if situated in the pilot area and 0 otherwise. $period_t$ indicates whether the pilot policy of industry-finance cooperation was carried out in the year. If the policy has been implemented in that year, it is 1; otherwise, it is 0. $X_{it}$ shows a series of control variables. The model also accounts for fixed effects at the firm, year, industry, and province levels, denoted by $u_i$, $\mu_t$, $Industry_j$ and $Province$. $\epsilon_{ijt}$ indicate random perturbation terms.

### 3.2 Variable selection

*Explained variable*

The main methods for assessing TFP at the enterprise level include the Olley-Pakes (OP), Levinsohn-Petri (LP), fixed effects (FE), and ordinary least squares (OLS) method. The LP method uses intermediate input indicators to estimate TFP. Compared to the OP method, which uses investment amounts, the LP method is not only easier to obtain data, but also avoids information loss caused by non positive investment amounts of some enterprises. Referring to the research of Lu and Lian (2012), Giannetti et al. (2015), Krishnan et al. (2015), we uses the LP method to calculate enterprises' TFP. Additionally, TFP measured by FE method and OLS method are used for robustness checks.

*Explanatory variables*

According to the list of the first batch of national-level industry-finance cooperation pilots announced by the MIIT, this article has sorted out 37 cities and counties for the pilot. In terms of enterprises, the office address reported by the enterprise every year is matched with the area where the policy is piloted. If the enterprise is within the pilot area, it is the treatment group, represented by $treat_i = 1$; other enterprises are the control group, represented by $treat_i = 0$. In terms of year, if the year is a policy pilot year, then $period_t$ is 0, otherwise $period_t$ is 0. 2017 was chosen as the starting date for the policy, since the first batch of pilot cities will be announced on December 29, 2016.

*Control variables*

According to the research conducted by Peng and Tao (2022), the control variables identified in this study encompass the growth rate of total assets (growth), asset-liability ratio (leverage), current assets-liabilities ratio (liquid), Tobin Q value (tobin), net profit to shareholders' equity ratio (roe), the logarithm of net profit (profit), equity concentration (top1), fixed assets ratio (fix), whether the chairperson and general manager are the same person (dual), number of board members (board), the logarithm of company age (age), return on assets (roa).

### 3.3 Data sources

This paper employs unbalanced panel data from publicly listed companies from 2013 to 2020. In terms of data sources, the data of the pilot cities for industry-finance cooperation is collated according to the list published by the MIIT, and the enterprise-level data is primarily derived from the CSMAR database. This study undertakes the preprocessing of original data sources in the following manner: the exclusion of listed companies designated with ST and ST*; the exclusion of listed companies exhibiting a debt-to-asset ratio exceeding 1; the exclusion of listed companies characterized by a lack of variables and office locations; and the exclusion of companies that have been listed in the current year. In addition, considering the change of corporate office address, companies located in the pilot area but moved out or moved into the area are also excluded. Finally, 10,591 company-year observations including 2,001 listed companies were obtained.

Tab. 1 presents descriptive statistics for each variable. The table clearly shows significant variation in TFP across different enterprises.

Tab. 1 – Descriptive statistics. Source: own research

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Variable | Mean | Standard deviation | Min | Max |
| TFP_LP | 8.187 | 0.956 | 3.920 | 11.63 |
| did | 0.223 | 0.416 | 0 | 1 |
| growth | 0.166 | 0.585 | -0.972 | 19.77 |
| leverage | 0.396 | 0.193 | 0.00797 | 0.996 |
| liquid | 2.059 | 3.020 | 0.0177 | 135.6 |
| tobin | 2.296 | 3.008 | 0.699 | 127.0 |
| roe | 0.0276 | 2.276 | -76.76 | 204.7 |
| profit | 18.73 | 1.505 | 10.34 | 24.63 |
| top1 | 33.57 | 13.91 | 3.390 | 89.99 |
| fix | 0.231 | 0.138 | 2.50e-05 | 0.872 |
| dual | 0.314 | 0.464 | 0 | 1 |
| board | 2.110 | 0.192 | 1.386 | 2.890 |
| age | 2.906 | 0.299 | 1.609 | 4.143 |
| roa | 0.0381 | 0.150 | -3.164 | 10.40 |

# 4 EMPIRICAL RESULTS

## 4.1 Baseline regression

The DID approach is used to empirically test how the industry-finance cooperation pilot affects firms' TFP. Columns (1) to (3) in Tab. 2 show the regression outcomes with enterprises' TFP as the explained variable after adding control variables. In the analysis presented, columns (2) and (3) sequentially incorporate the industry and province fixed effect, respectively. It can be found that in the above three cases, the coefficient of did is always significantly positive, indicating that the industry-finance cooperation pilot is conducive to improving the enterprises' TFP.

This paper further examines the dynamic effects of industry-finance cooperation. First of all, given that the commencement year of industry-finance cooperation is 2017, 2017 to 2020 years are designated as year dummy variables with a value of 1, while others are all 0. Next, the year and policy dummy variables are cross-multiplied and brought into the model for regression. The statistical significance of the regression coefficient shows a dynamic effect of industry-finance cooperation. Column (4) in Tab. 2 reveals a statistically significant positive dynamic effect from industrial-financial cooperation only in 2020, suggesting a temporal lag in its impact on enterprises' TFP.

Tab. 2 – Benchmark regression. Source: own research

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Variable | TFP_LP | TFP_LP | TFP_LP | TFP_LP |
| did | 0.02480** | 0.02417** | 0.02711** | |
| | (2.2840) | (2.2134) | (2.4958) | |
| did_year17 | | | | 0.02224 |
| | | | | (1.4117) |
| did_year18 | | | | 0.01878 |
| | | | | (1.2198) |
| did_year19 | | | | 0.02240 |
| | | | | (1.4649) |
| did_year20 | | | | 0.04511*** |
| | | | | (2.8933) |
| Constant | 3.3420*** | 3.4610*** | 3.4494*** | 3.3705*** |
| | (14.9658) | (15.4600) | (15.4632) | (15.0182) |
| Control variable | Yes | Yes | Yes | Yes |
| Firm FE | Yes | Yes | Yes | Yes |
| Industry FE | No | Yes | Yes | Yes |
| Provincial FE | No | No | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes |
| *N* | 10519 | 10519 | 10519 | 10519 |
| $R^2$ | 0.9474 | 0.9470 | 0.9480 | 0.9481 |

**Notes:** "***", "**", "*" denote significant at 1%, 5%, and 10% significance levels, respectively. The t statistic is in parentheses. The same is true for the following tables.

### 4.2 Robustness test

*Parallel trend test*

Fig. 1 shows the outcomes of the parallel trend test. The results indicate that in the years leading up to the implementation of the policy, the estimated coefficients revealed an insignificant difference of 0, signifying no substantial disparity in TFP between the treatment and control group enterprises before the policy was introduced. Subsequent to the policy's adoption, the estimated coefficients exhibited a substantial increase. Consequently, the study sample fulfills the parallel trend hypothesis. This confirms the conclusion's robustness.

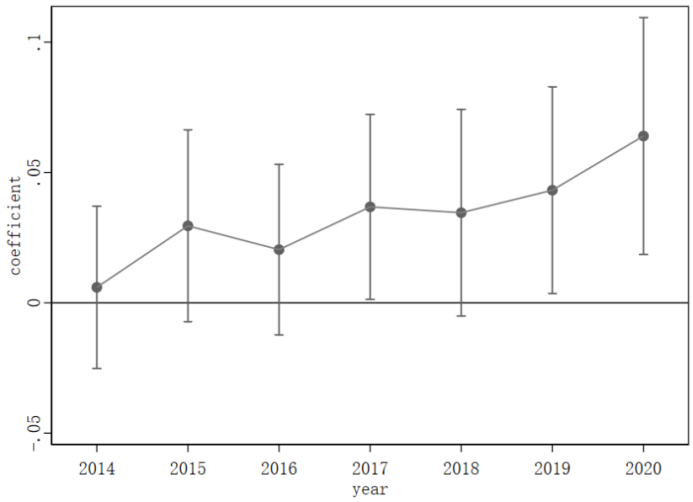


Fig. 1 – Parallel trend test. Source: own research

*Placebo test*

This paper constructs fictitious pilot enterprises and pilot years by randomly generating individual enterprises and pilot years influenced by the pilot of industry-finance cooperation, taking into account the impact of unobservable and omitted variables, as well as the characteristics of urban individuals. The regression model is estimated for the scenario shown in column (4) of Tab. 2 in the baseline regression. Fig. 2 shows the placebo test results after 500 replicated randomized trials. The estimation coefficients of the primary explanatory variable did are clustered around 0 and exhibit a form resembling that of a normal distribution. Consequently, it is deemed that there is no exclusion of additional essential explanatory variables in the model, thereby affirming the conclusion of the baseline regression, which remains robust.

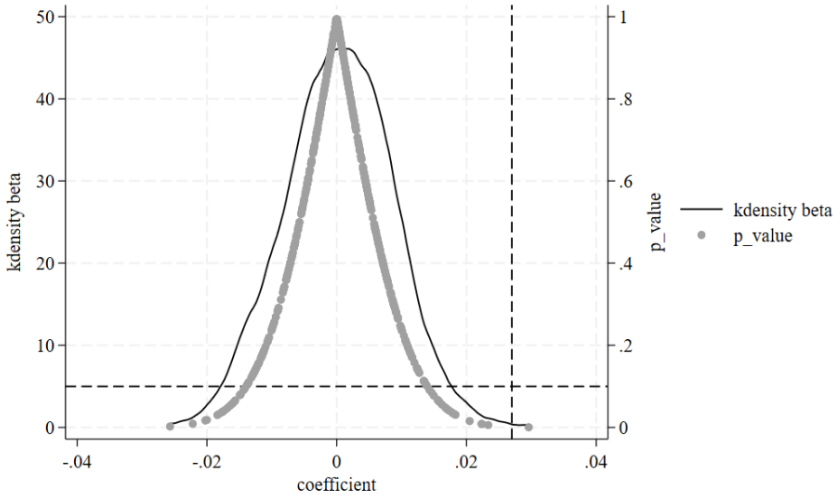


Fig. 2 – Placebo test. Source: own research

*Controlling for endogeneity issues*

Considering that the pilot cities of industry-finance cooperation are not randomly selected, and may be affected by many unobservable or difficult-to-observe factors at the city level, it is challenging to circumvent the issue of missing variables. In this regard, we use the instrumental variable (IV) method to tackle the endogeneity problem. The instrumental variable identifies the interaction between the logarithm of local finance's general budget revenue and the dummy variable indicating the implementation of the pilot policy for industry-finance cooperation. On the one hand, the selection of pilot cities is related to the local financial strength. Only strong financial strength and sufficient financial support can build an industry-finance cooperation platform and provide more help for enterprises to reach cooperation with financial institutions. The stronger the local financial strength, the more likely it is to become industry-finance cooperation pilot object. Thus, it satisfies the criteria of relevancy. On the other hand, the regional level variable local fiscal strength does not directly affect the TFP among local enterprises, so it also meets the requirements of exogenicity.

The relevant outcomes from the two-stage regression analysis are presented in Tab. 3. The LM statistic and the F statistic are used to determine whether the null hypothesis regarding insufficient identification and weak instrumental variables can be rejected. If rejected, it is considered that the instrumental variables selected in this paper are reasonable. Column (1) presents the regression outcomes of the first stage of instrumental variables. The explained variables are the industry-finance cooperation pilot, and the explained variables are the instrumental variables. The coefficient is significantly positive, aligning with the theoretical findings. Column (2) presents the regression outcomes from the second step. The coefficient of did is significantly positive, confirming that the industry-finance cooperation pilot enhances the enterprises' TFP. Through the IV method to test and analyze the endogenous problem, the conclusion is consistent with the previous text, thereby strengthening the credibility of the research conclusion.

Tab. 3 - Empirical results of IV method. Source: own research

| Variable | (1) | (2) |
|---|---|---|
| | did | TFP_LP |
| did_iv | 0.05906*** | |
| | (1067.08) | |
| did | | 0.02819*** |
| | | (2.59) |
| Control variable | Yes | Yes |
| Fixed Effect | Yes | Yes |
| *N* | 10519 | 10519 |
| $R^2$ | / | 0.3121 |
| F statistics | 5.8e+05 | / |
| *Kleibergen-Paap rk LM* statistics | / | 1.1e+06 |
| *Cragg-Donald Wald F* statistics | / | 5.8e+05 |
| | / | [16.38] |

**Notes:** The values in square brackets indicate the threshold for the Stock-Yogo weak instrumental variable identification at the 10% level.

*PSM-DID*

Considering that the selection of pilot cities for industry-finance cooperation is not random, the pilot needs to be applied by the local government and approved, and cities with better financial development are more likely to be selected, so there may be a problem of sample selection bias. This study will employ the method of DID estimation following propensity score matching to analyse the effect of industry-finance cooperation on the TFP of companies once again. After controlling the above variables, a Logit model was established for whether the enterprise was selected for the pilot of industry-finance cooperation. Simultaneously, 1:1 nearest neighbor matching was conducted on the variables among the firms, after which the matched data was utilized for regression analysis. Column (1) in Tab. 4 shows the regression outcomes. The outcomes indicate that the did coefficient is significantly positive, aligning with prior results. The coefficient is nearly identical to the baseline regression, indicating that industry-finance collaboration enhances the TFP of firms.

*Other robustness testing methods*

We also used FE model and OLS model to calculate TFP respectively. Columns (2) and (3) in Tab. 4 present the regression outcomes. To alleviate the effects of the absent variables, the imbalanced panel data was converted to balanced panel data, with the regression outcomes presented in column (4). Considering the influence of macro factors, the city's economic level and structure were added as control variables in model (1). The regression outcomes are presented in column (5). The regression outcomes of each column show that the coefficients of the main explanatory variable are always positive, hence reinforcing the robustness of the hypothesis.

Tab. 4 – Robustness test. Source: own research

| Variable | (1) TFP_LP | (2) TFP_FE | (3) TFP_OLS | (4) TFP_LP | (5) TFP_LP |
|---|---|---|---|---|---|
| did | 0.02680** | 0.03174** | 0.02970** | 0.03648*** | 0.02656** |
| | (2.4689) | (2.5616) | (2.4919) | (3.1339) | (2.0981) |
| Constant | 3.3676*** | 4.4751*** | 4.2552*** | 3.3135*** | 3.4054*** |
| | (15.0062) | (17.4687) | (17.2728) | (13.4522) | (10.3064) |
| Control variable | Yes | Yes | Yes | Yes | Yes |
| Fixed Effect | Yes | Yes | Yes | Yes | Yes |
| *N* | 10519 | 10519 | 10519 | 7942 | 9106 |
| $R^2$ | 0.9481 | 0.9603 | 0.9582 | 0.9457 | 0.9550 |

### 4.3 Heterogeneity analysis

*Heterogeneity Based on the Nature of Enterprise Equity*

Enterprises are divided into state-owned and non-state-owned based on their ownership nature, and group regression is performed. Tab. 5 presents the regression outcomes for enterprises with varying ownership structures. The regression outcomes show that the regression coefficient of industry-finance cooperation on state-owned enterprise groups is significant at 0.052, while the impact coefficient on state-owned enterprises is 0.019 and is not significant, indicating that industry-finance cooperation has a stronger impact on improving the state-owned enterprises' TFP. It could be because: First, according to soft budget constraints theory of Kornai (1986), state-owned enterprises have easier access to low-cost, long-term financial resources due to implicit government guarantees. When state-owned enterprises are not well-run, the central or local government often provides them with financial support or policy support to avoid bankruptcy or bankruptcy. This loose budget constraint facilitates easier access to funding for state-owned enterprises (Dai & Cheng, 2015), thereby improving TFP. Second, state-owned enterprises are typically in sectors vital to the national economy and public welfare, enjoying government backing, policy protection, and then have strong relationships with local authorities. These provide a lot of convenience for state-owned enterprises in financing, technical cooperation, market access, etc. In industry-finance cooperation, state-owned enterprises may more easily obtain resources, funds and policy support through political connections, so as to achieve greater improvement in technological innovation and production efficiency.

Tab. 5 – Heterogeneity analysis (I). Source: own research

| Variable | (1) state-owned TFP_LP | (2) non-state-owned TFP_LP | (3) technology TFP_LP | (4) capital TFP_LP | (5) labor TFP_LP |
|---|---|---|---|---|---|
| did | 0.05216** | 0.01869 | -0.02235 | 0.05731*** | 0.03565* |
| | (2.4516) | (1.5439) | (-1.1897) | (3.5664) | (1.9219) |
| Constant | 4.5813*** | 3.1020*** | 3.1080*** | 3.9224*** | 3.7517*** |
| | (7.9438) | (13.0218) | (8.1367) | (11.9202) | (9.1772) |

| | | | | | |
|---|---|---|---|---|---|
| Control variable | Yes | Yes | Yes | Yes | Yes |
| Fixed FE | Yes | Yes | Yes | Yes | Yes |
| *N* | 2944 | 7565 | 3754 | 4455 | 3399 |
| $R^2$ | 0.9517 | 0.9431 | 0.9382 | 0.9548 | 0.9494 |

*Heterogeneity Based on Factor Density*

Referring to the research of Xiao & Yang (2021), and drawing on the practice of measuring R&D investment by Yu et al. (2024), enterprises exhibiting a ratio of R&D investment to operational income that above the average are categorized as technology-intensive, enterprises exhibiting a ratio of fixed assets above the average are categorized as capital-intensive, whereas those that are neither technology-intensive nor capital-intensive are classified as labor-intensive. Grouped regression is performed according to the factor intensity of enterprises. Columns (1), (2), and (3) of **Chyba! Nenašiel sa žiaden zdroj odkazov.** illustrate the regression outcomes for different factor-intensive firms. Regression outcomes show that the regression coefficients of capital-intensive and labor-intensive enterprise groups are significantly positive, and the values are better than the whole sample, indicating that industry-finance cooperation has a positive impact on the TFP of capital-intensive and labor-intensive enterprises. However, its influence on the TFP of technology-intensive firms is not statistically significant. This might trace back to the fact that capital-intensive enterprises typically rely more on external financing to support their production and expansion, such as the construction of equipment and facilities, which often necessitate substantial financial resources. The production process of labor-intensive firms depends on a substantial workforce. Technology-intensive enterprises rely on long-term high-risk research and development (Lin & Chen, 2005; Xu et al., 2020), which usually requires large and long-term capital investment (Li, 2011). The returns from these investments are often long-term and uncertain. Therefore, while the financial support provided by industry-finance cooperation can be converted into capital and labor in the short term, it is more challenging to convert into R&D results, so it cannot have a significant impact on technology-intensive enterprises.

*Heterogeneity Based on the Industry*

According to the definition of high-end manufacturing in "Made in China 2025", the top two enterprises with industry codes 34-41 and 43 are classified as high-end manufacturing, while the remaining manufacturing enterprises are classified as traditional manufacturing. Column (1) and (2) of Tab. 6 present the regression outcomes for various firms within the manufacturing sector. The regression analysis show that while industry-finance cooperation does not have a significant effect on high-end manufacturing enterprises, its impact is more pronounced for traditional manufacturing enterprises. The reason for this may be that high-end manufacturing focuses more on R&D investment, while traditional manufacturing focuses on production and operation. High-end R&D and manufacturing not only demand substantial capital support, but also takes a long time to return investment, so the impact of industry-finance

cooperation on high-end manufacturing is not significant. For traditional manufacturing enterprises that receive industry-finance cooperation support, financial support is more likely to exert a substantial influence on their production and operational activities.

Tab. 6 - Heterogeneity analysis (II). Source: own research

| | (1) high-end manufacturing | (2) traditional manufacturing | (3) central cities | (4) peripheral cities |
|---|---|---|---|---|
| Variable | TFP_LP | TFP_LP | TFP_LP | TFP_LP |
| did | 0.007065 | 0.02719* | 0.04568*** | -0.003136 |
| | (0.4968) | (1.6891) | (2.6286) | (-0.1927) |
| Constant | 3.0642*** | 4.0423*** | 3.6922*** | 3.3271*** |
| | (10.5306) | (12.0434) | (10.6327) | (11.4874) |
| Control variable | Yes | Yes | Yes | Yes |
| Fixed FE | Yes | Yes | Yes | Yes |
| *N* | 5133 | 5362 | 4491 | 6005 |
| $R^2$ | 0.9578 | 0.9438 | 0.9509 | 0.9512 |

*Heterogeneity Based on the Cities*

The sample is categorized into municipalities, central cities and prefecture-level cities according to the location of the enterprises. Columns (3) and (4) of Tab. 6 show the regression outcomes for firms in different city groupings. The regression analysis indicates that the regression coefficient of enterprises located in municipalities or central cities is significantly positive, suggesting that industry-finance collaboration positively influences their TFP. However, there is no significant relationship between industry-finance cooperation and TFP of peripheral city samples. The reasons for this difference may be: First, in terms of institutional environment, peripheral cities lack legal and property rights protection. The low level of legalization in peripheral cities and the lack of confidence in the disposition of collateral and the pursuit of creditor's rights in financial institutions may lead to industry-finance cooperation staying at the formal level and failing to substantially improve corporate governance (Acemoglu et al., 2010). Secondly, according to the decentralization of knowledge, peripheral cities lag behind central cities in information infrastructure building, and there is a digital divide problem. Due to the average level of economic development and low level of digitalization in peripheral cities, it is hard for financial institutions to make a precise evaluation of corporate risks, resulting in industry-finance cooperation staying in the traditional collateral model, and it is difficult to implement innovative financial instruments. Therefore, compared with enterprises in municipalities and central cities, peripheral enterprises are less affected by industry-finance cooperation.

### 4.4 Mechanism analysis

*Mechanism Analysis Based on R&D Expenditure*

Industry-finance cooperation can provide enterprises with more financing channels and financial support, thus effectively ensuring that enterprises can carry out R&D activities

smoothly and enhance their R&D capabilities (Wang et al., 2024; Xu & Deng, 2021). In turn, it can foster technical innovation and advancement, augment production efficiency and firm competitiveness, and ultimately raise TFP. This paper explores the mechanism through which industry-finance cooperation affects TFP by focusing on R&D expenditures. Specifically, R&D expenses are characterized by the ratio of the logarithm of R&D investment amount to the number of patents plus one. Column (1) of Tab. 7 shows the regression outcomes with R&D expenditures as the dependent variable. The regression coefficient of did is significantly negative, suggesting that industry-finance collaboration can decrease firms' R&D expenditures, hence confirming hypothesis 1.

Tab. 7 – Mechanism analysis. Source: own research

| Variable | (1)<br>Research | (2)<br>Invest | (3)<br>Cost |
|---|---|---|---|
| did | -0.3816*<br>(-1.9413) | -0.01804***<br>(-6.0127) | -0.03345***<br>(-2.6330) |
| did*ROA | | 0.5251***<br>(12.4162) | |
| Constant | -5.5307<br>(-1.3432) | -0.5098***<br>(-9.2065) | 0.1288<br>(0.4901) |
| Control variable | Yes | Yes | Yes |
| Fixed Effect | Yes | Yes | Yes |
| $N$ | 10215 | 10026 | 10518 |
| $R^2$ | 0.6968 | 0.9051 | 0.8614 |

*Mechanism Analysis Based on Investment Efficiency*

Industry-finance cooperation alleviates the funding limitations faced by firms to some degree. Through industry-finance cooperation, enterprises can obtain lower-cost funds, reduce financing costs, and improve the investment efficiency of enterprises (Fazzari & Athey, 1987; Li et al., 2023). Building on the work of Qian et al. (2018), this paper uses the "investment-investment opportunity" model to investigate the mechanism by which industry-finance cooperation affects the TFP of enterprises through investment efficiency. The model is expressed as follows:

$$Invest_{ijt} = \gamma_0 + \gamma_1 did_{it} * ROA_{it} + \gamma_2 did_{it} + \gamma_3 treat_i * ROA_{it} + \gamma_4 period_t * ROA_{it} + X_{ijt} + Industry_j + Province + u_i + \mu_t + \epsilon_{ijt} \quad (3)$$

Among them, $Invest_{ijt}$ is enterprise's investment efficiency; $ROA_{it}$ is the return on assets, and other variables are described in model (1). At this time, the coefficient $\gamma_1$ of $did_{it} * ROA_{it}$ shows the impact of industry-finance cooperation on the enterprise investment efficiency. Column (2) of Tab. 7 shows the regression outcomes. When investment efficiency is used as the explained variable, the coefficient of $did_{it} * ROA_{it}$ is significantly positive. It shows that the industry-finance cooperation pilot program demonstrably enhances the investment efficiency of firms, hence validating hypothesis 2.

*Mechanism Analysis Based on Internal Cost*

Industry-finance cooperation can alleviate information gap between banks and firms, hence decreasing capital costs for both parties (Armstrong et al., 2011; Lambert et al., 2012). Therefore, enterprises can save costs and invest in production, improve operational efficiency, and ultimately enhance their TFP. This research utilizes the logarithm of the management fee to represent the internal costs of the firm, aiming to examine how industry-finance cooperation influences the TFP of the enterprise by diminishing internal costs. Column (3) of Tab. 7 shows the regression outcomes. When internal cost is used as the explained variable, the coefficient of did is significantly negative, suggesting that industry-finance cooperation can diminish the management fees of firms, so corroborating hypothesis 3.

# 5 DISCUSSION

## 5.1 Theoretical Significance

This study makes the following three important theoretical contributions. First, based on the perspective of financial services for the real economy, this paper analyzes the influence of industry-finance cooperation on the TFP of manufacturing enterprises. The current literature mostly considers the effects of industry-finance cooperation, that is, the company's shareholding in financial institution group or financial institution group's shareholding in enterprises, on the performance of enterprises (Fan et al., 2022; Tang & Fang, 2022). In contrast, relatively few studies examine this issue from the perspective of industry-finance cooperation. This research rigorously analyzes the impact and underlying mechanisms of industry-finance cooperation on firm efficiency via TFP, which is helpful to further clarify the economic effects of industry-finance cooperation.

Second, in terms of industrial and financial policy, it broadens the influencing factors of TFP of enterprises, and also provides empirical evidence for whether industrial policy can promote financial service entities. Extensive literatures have been examined the factors influencing enterprises' TFP (Cheng et al., 2023; Ge et al., 2024), but no literatures have been studied from the standpoint of industry-finance cooperation. This study utilizes the national industry-finance cooperation pilot as a quasi-natural experiment to investigate the effect of industry-finance collaboration on firms' TFP at a micro level. The conclusion of this paper expands the driving factors of enterprises' TFP and offers a valuable reference for further research on the relationship between industry-finance cooperation and firm-level TFP.

Third, by examining R&D expenditure, investment efficiency, and internal cost, this study analyzes the mechanism through which industry-finance cooperation influences enterprise's TFP, thereby deepening the understanding of the underlying drivers of total factor productivity at the firm level. Most relevant studies on the mechanisms influencing enterprise's TFP have primarily focused on the perspective of financial constraints (Tang, 2025; Lu, 2025) and innovation output (Wu & Wang, 2022). This article thoroughly examines the process of industry-finance cooperation affecting

enterprises' TFP from three aspects: enterprise R&D expenditure, investment efficiency and internal cost, which can provide reference significance for targeted improvement of economic efficiency and high-quality development.

### 5.2 Practical Significance

This paper's findings have the following practical contributions. First, optimize the precision and differentiated design of industry-finance cooperation policies. According to the findings, the role of industry-finance cooperation in promoting the TFP of non-state-owned enterprises, technology-intensive industries, traditional manufacturing industries and high-energy urban enterprises is more significant. This necessitates that policymakers focus on the precise adaptation and differentiated allocation of policy tools when deepening industry-finance cooperation. First, to address the strong financing challenges faced by non-state-owned enterprises, the coverage of innovative financing tools should be further expanded, including supply chain finance and intellectual property mortgage loans. Simultaneously, policy guarantees and risk compensation mechanisms can mitigate lending risks for financial institutions, ensuring non-state-owned enterprises receive reliable and long-term funding. Second, for technology-intensive and traditional manufacturing enterprises, it is necessary to strengthen the linkage between industry-finance cooperation and industrial technology upgrading. For example, through the establishment of special project industrial investment funds to support enterprises upgrading R&D equipment or undergoing digital transformation. Simultaneously, financial institutions can be guided to develop targeted instruments such as "technological transformation loans" and "green transformation loans" to lower the financing barriers for technological advancement. Finally, optimizing the regional coordination mechanism of the pilot policy is essential. It is important to leverage the financial resource concentration advantages of central cities and enhance their spillover effects on neighboring areas by establishing cross-regional financial service platforms and facilitating financial data sharing. This approach aims to prevent the overconcentration of policy benefits in high-energy cities and mitigate regional development disparities.

Second, strengthen the transmission mechanism of industry-finance cooperation to enterprise innovation and operational efficiency. Empirical analysis reveals that industry-finance cooperation drives TFP improvement through three paths: reducing R&D expenditures, improving investment efficiency, and optimizing internal management. Based on this, future policies need to focus on opening up the "last mile" in converting financial support into core capabilities of enterprises. In terms of R&D support, we should promote the financial institution group and the science and technology sector to jointly establish a "R&D risk sharing pool", and implement a "front-end interest discount + back-end revenue sharing" hybrid financing model for enterprises' innovation projects to ease the short-term cash flow pressure of R&D investment. Meanwhile, improve the intangible asset evaluation system of technology-based enterprises, accelerate the construction of the intellectual property trading market, and enhance the financialization and liquidity of R&D results. In order to enhance investment efficiency, a comprehensive investment and financing service system

should be built to support businesses throughout their entire lifecycle: providing angel investment and venture capital linkage support for start-up enterprises, introducing an "investment-loan linkage" mechanism for growth-stage enterprises, and encouraging mature enterprises to optimize their capital structure through M&A loans and asset securitization. In addition, a dynamic monitoring system for enterprise operating costs can be built on the industrial Internet platform, and the financial institution group can be guided to develop "smart credit" products based on real-time data to help enterprises accurately identify cost compression space and achieve closed-loop management of cost reduction and efficiency.

Third, build a multi-level ecological and dynamic evaluation mechanism for industry-finance coordination. The research revealed that the impact of the policy is significantly regulated by the attributes of enterprises and urban endowments, which requires the construction of an ecological service system coordinated by the government, financial institutions and enterprises. First, a "policy-market" two-wheel-driven industry-finance cooperation mechanism should be established: the government should improve the fiscal incentives, tax incentives and other incentives in pilot cities, and the market should encourage banks, securities and insurance institutions to form industry-finance service alliances to meet diversified needs through a combination of "equity and debt" and "insurance + futures". Secondly, it is necessary to strengthen classified guidance and dynamic evaluation, establish a quantitative index system for the improvement of TFP of enterprises, regularly monitor changes in key indicators such as R&D investment intensity, capital turnover rate, and management fee rate, and conduct multi-dimensional post-evaluation of policy implementation effects. For example, for technology-intensive enterprises, focus on the assessment of patent conversion rate, and for traditional manufacturing industries, pay attention to the increase in unit energy output value. Finally, we should promote the deep integration of industry-finance cooperation with regional development strategies, and explore cross-administrative demonstration zones for industry-finance cooperation in urban clusters such as the Yangtze River Delta. By establishing mechanisms such as cross-regional transfer of credit resources and overall management of risk reserves, we can achieve spatial matching between financial resources and industrial layout, and eventually form a positive cycle of "financial empowerment - industrial upgrading - urban development".

### 5.3 Limitations and Future Research Direction

Although the results and mechanisms of industry-finance cooperation affecting the TFP of enterprises have been deeply analyzed from a theoretical level, and industry-finance cooperation enterprises have been used as samples to conduct empirical tests on the above theories at the micro level. However, because there are various forms of industry-finance cooperation, such as traditional financing services, industrial internet services, and Internet finance. Due to data limitations, it is impossible to understand the focus and cooperation mode of different cities in the form of industry-finance cooperation, so it is difficult to investigate how various cooperation models affect firms' TFP. Therefore, future studies could delve deeper into how different models of industry-finance cooperation influence the firm’s TFP.

## 6 CONCLUSIONS

This paper uses a quasi-natural experiment in China's pilot cities for industry-finance cooperation. The data covers A-share listed manufacturing companies from 2013 to 2020. It theoretically analyzes the influence and mechanism of industry-finance cooperation on enterprises' TFP and empirically assesses the impact results. The empirical findings indicate that the pilot program for industry-finance collaboration substantially enhances the TFP of firms, verifying the hypothesis of the theoretical analysis part. The paper further performs robustness checks, including placebo tests, PSM-DID, substitution variable measure method and alternative sample selections, and finally verify that the above conclusions are robust. Furthermore, this paper conducts heterogeneity analysis based on enterprise ownership form, factor intensity, intra-industry differences, and city-level differences. The results of the heterogeneity analysis show that industry-finance cooperation has a more obvious impact on the TFP of non-state-owned enterprises, technology-intensive, traditional manufacturing enterprises and enterprises located in municipalities or central cities. According to the mechanism of theoretical analysis, this paper also analyzes that industry-finance cooperation ultimately affects the TFP of enterprises by reducing R&D expenditure, improving investment efficiency and reducing internal cost.

**Funding:** This research was funded by the National Natural Science Foundation of China (Grant No. 72473058, 72163008, 71973055); the National Social Science Fund of China (Grant No. 22XJY040, 21BTJ062); the Ministry of Education Humanities and Social Sciences Youth Project (Grant No. 22YJC790188); and the Jiangxi Province Key Research Base of Philosophy and Social Science Project (Grant No. 23SKJD18).

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