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Abstract

This study empirically examines the impact of investments in manufacturing firms by industrial-guided funds (IGFs), which have been established in large numbers since 2015 and are considered to play a crucial role in the implementation of China's industrial policy since "China Manufacturing 2025," on the output, including sales, profit margins, fixed asset value, and R&D of these firms. In particular, the following methods were employed during the analysis. First, we compiled a list of over 3,000 funds established until 2018 from the private placement database provided by zero2IPO, combined it with data on manufacturing firms from Orbis provided by Bureau van Dijk, and extracted from them the subsidiaries and sub-subsidiaries of government-sponsored funds. We then identified the timing of the funds' investments in these companies. Then, we performed a difference-in-difference matching analysis using the firms that had received the investment as the treatment group and the remaining firms as the control group. We analyzed total sales, the number of employees, fixed assets, labor productivity, R&D expenditures/total sales, debt ratio, and return on equity. Our analysis revealed that although investments by IGFs increased fixed assets and equity capital significantly, the other variables did not change significantly. And significant change also did not exist in the ratio of R&D expenditures to sales. These results indicate that although the investment by IGFs increased the assets of the target firms, it did not have the expected effect on R&D capacity and productivity improvement.

Keywords: Industrial Policy, Chinese Economy, Government-guided Funds, R & D
JEL classification：L52,　O16, O25

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1. Introduction

In recent years, there has been a growing interest in China's industrial policy. Since the beginning of the 21st century, the Chinese government has promoted industrial policies that encourage competition and innovation rather than the traditional "infant industry protectionism" policy of protecting and fostering specific industries through protective tariffs. In addition, this is because industrial policy research by mainstream economics is becoming increasingly interested in industrial policies that aim to promote competition and innovation through "knowledge spillovers." For example, Aiginger and Rodrik (2020) noted that the demand for industrial structural change in developing countries, the long-term labor market deterioration and financial crisis in developed countries, and significant technological change have prompted economists to reevaluate industrial policy in recent years.[1] Moreover, it is noteworthy that they cite China's presence as a factor in relation to each preceding issue.

In light of this, China's recent industrial policy must be viewed through the lens of a more competition- and innovation-promoting industrial policy based on knowledge spillover as opposed to the traditional infant industry protection geared toward technology catch-up.

According to Naughton's (2021) definition of industrial policy as direct government intervention in an industry to alter its structure, the Chinese government did not have what could be termed an industrial policy until the 21st century. According to him, the announcement of the medium- to long-term science and technology program in 2006, based on the State Council's 2005 "Provisional Provisions for Promoting Industrial Structural Adjustment," was a significant turning point in the implementation of the Chinese government's industrial policy. Specifically, the medium- to long-term science and technology program aimed to improve the overall level of science and technology in China and did not correspond with an industrial policy designed to protect particular industries. However, the promotion of 16 mega projects

[1] A typical example of an industrial policy that emphasizes knowledge spillovers is the innovation promotion policy. Bloom, Reenenen, and Williams (2019), based on a survey of relevant empirical studies, identifies nine policy tools, including R&D subsidies, tax credits for R&D expenditures, and patent boxes (tax incentives for profits arising from patents). For each policy instrument, they summarized the evidence on its effectiveness and the difference between the benefits and costs of the policy.

included therein, such as the core electronics industry, including general-purpose microchips, advanced manufacturing technologies, and next-generation broadband and mobile communications, had affinities with the industrial policy that promotes innovation.

The year 2010 saw the release of the State Council's Decision on Accelerating the Development of Strategic Emerging Industries. Accordingly, in 2013, seven sectors were designated as strategic industries, succeeding the 16 mega projects mentioned previously: energy conservation and environmental protection, next-generation information technology, biotechnology, precision and high-performance manufacturing equipment, new materials, new energy vehicles, and new energy. According to Naughton (2021), this marked a significant shift in the Chinese government's industrial policy, which had previously been aimed at catching up with developed countries, to a "leapfrog-type" or innovation-promoting industrial policy that aimed to take the lead in new industries. Specifically, the Chinese government sought to foster underdeveloped global technologies and industries by providing financial institution loans and easing preferential tax regulations.

Furthermore, the "Resolution on the Comprehensive Evolution of Reforms by the CPC Central Committee" in the fall of 2013, issued by the subsequent Xi Jinping administration, clearly stated the policy of actively developing a mixed ownership economy in which state and private capital own shares, investing more capital in critical areas, such as the seven aforementioned strategic industries, and providing public services (Marukawa 2021).

In 2015, successive industrial policies were announced, including "China Manufacturing 2025," "Internet+," and "mass startups and innovation for all." China Manufacturing 2025 expands the scope of "strategic emerging industries" to include medical devices, aerospace, robotics, marine structures and ships, desert railroads, power equipment, and agricultural machinery. The goal is for China to join the ranks of the world's manufacturing nations by 2025. Moreover, China Manufacturing 2025 aims to increase the domestic production of innovative components and essential raw materials in key industries to 40% by 2020 and 70% by 2013[2].

[2] Furthermore, for each of the policy issues, such as innovation promotion and application of artificial intelligence, a "technology roadmap" was created for each of the seven strategic industries, specifying the percentage of domestically produced products in each of the 11 planned priority industries. The "Technology Road Map," for example, calls for increasing the share of domestically produced integrated

The policy of innovation-promoting industrial guidelines outlined in the "National Innovation Driven Development Strategy Platform" announced by the CPC Central Committee and the State Council in 2016 served as the basis for these policies (Naughton 2021).

According to Naughton(2021), the essential component of these innovation-promoting industrial policy frameworks was providing substantial funding for innovation-generating emerging industries, such as 5G networks, data centers, artificial intelligence, Internet of Things, electric vehicles, and city transportation systems. Mainly, industrial guidance funds (IGFs) were crucial to this mobilization.

Conversely, even though China has adopted an innovation-based industrial policy, remnants of the previous industrial policy that protects specific industries still remain. Mainly, it is widely acknowledged that local government industrial policies are protectionist and impede the efficient allocation of resources.

For example, Jiang and Li (2021) provided a four-point summary of Chinese industrial policies' specific characteristics and problems. First, industrial policies were used to protect and maintain the position of large firms. This is because large companies are encouraged to improve their international competitiveness. Second, China's industrial policies are typically implemented through administrative monopolies, specifically intervention in targeted industries and approval of investment actions. Third, the approval of investment, market intervention, and the forced exit of inefficient firms have become the predominant methods of implementing industrial policy. For instance, these instruments were utilized in the steel and coal industries. Lastly, these Chinese industrial policies tend to selectively determine the targets of government intervention, which tends to violate the fundamental principle of fair competition. They further point out that the industrial policies enacted by local governments at various levels favor local companies, often mimicking the protectionism of protectionist industrial provinces[3].

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circuits in the domestic market to 49% by 2020 and 75% by 2030 (Marukawa 2021).

3 Jiang and Li (2021) also outlined the primary implementation strategies for China's industrial policy in the 21st century as follows. First, a list of policies to be implemented is provided, followed by guidance based on these policies, which each company must adhere to. Second, there is forced selection, which involves eliminating or depriving companies with low production capacity of their production capacity (i.e., forcing them into bankruptcy). The third factor is land policy. The government has a monopoly on the first-class land market supply. Thus, it can provide preferential treatment to industries whose development it wishes to encourage by providing land for land production on a preferential basis. The

Given this situation, we empirically examine the impact of investments in manufacturing firms by industrial-guided funds (IGFs) in this paper. This is because IGFs are considered crucial in implementing China's innovation-based industrial policy. In addition, the local governments have established many IGFs that have been responsible for measures to promote local businesses, as discussed below.

The following methods are employed during the analysis. First, we compile a list of IGFs from the private placement database provided by zero2IPO, combine it with data on manufacturing firms from Orbis provided by Bureau van Dijk, and extract the subsidiaries and sub-subsidiaries of government-sponsored funds. Then, we perform a difference-in-difference matching analysis using the firms that had received investment as the treatment group and the remaining firms as the control group for the output, namely sales, profit margins, fixed asset value, and R&D of these firms.

The rest of the paper is structured as follows. Section 2 outlines the development of IGFs, which have played an essential role in China's industrial policy. Section 3 introduces several previous studies that have examined the effects of China's industrial policy, including IGFs' investments in firms. Sections 4 and 5 examine the empirical research to show the impact of industrial-guided funds investments in manufacturing firms. Section 6 discusses the implications of the results for China's industrial policy. The final section, Section 7, summarizes the paper's contents and points out the remaining issues.

2. The Development of IGF and its Performance

2.1. The Development of IGFs

The IGFs played an important role in China's industrial policy in the 21st century and were a source of contention between the United States and China. IGFs are funds collected from government agencies, financial institutions, corporations, private equity funds, public pensions,

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fourth factor is fiscal aid. Not only do these subsidies target specific industries, but they also include subsidies for companies that have conducted research and development, modified technology, and so on. Other forms of financial support include tax incentives, policy loans, and investments made through industrial guidance funds.

and other financing entities to optimize industrial structure by investing in government projects, financing corporations, and facilitating mergers. As government-established and market-oriented policy funds, IGFs have become a crucial policy instrument for directing social capital into the field of venture capital (VC) and VC into early-stage technology-based small and medium-sized enterprises (Xu, Yu, and Gupta 2020).

Since 2002, IGFs have been in the exploratory startup phase. In 2002, China's first IGF: Zhongguancun Venture Capital Guide Fund was established. Moreover, the phase of rapid development is from 2007 to 2008; according to statistics, the size of government-led funds was close to 20 billion yuan (Gong et al. 2019). In October 2008, the State Council issued "Guiding Opinions on the Regulations for the Establishment and Operation of Investment Promotion Funds" (State Council [2008] No. 116), notifying financial and relevant departments responsible for the development of entrepreneurial investment to establish an effective performance evaluation system for IGFs. This marked the beginning of the administrative procedure development process for IGFs (Zero2IPO Research 2020b).[4]

In 2014, the market for IGFs entered a period of complete saturation and experienced an explosive increase, especially in 2015, when China Manufacturing 2025 and Internet+ were proposed. The "Measures for the Interim Administration of Government Investment Funds" were enacted in 2015. This stipulated the fund's establishment, including the establishment of the offering, investment areas and regions, management and withdrawal, profit sharing, performance evaluation, and management and supervision (Figure 1). The "Measures for the Interim Management of Government-funded Industrial Investment Fund" was also enacted in December 2016 to ensure that the fund's investments in various industries are aligned with regional, industrial, and macroeconomic policies and that government funds are utilized efficiently.

[4] In 2011, the central government formulated the Interim Measures for the Management of Venture Capital Funds for Emerging Industry Venture Capital Programs, which stipulated that the central financial participation fund should invest in emerging strategic industries, such as energy conservation and environmental protection, new energy, new materials, and aerospace (Gong et al. 2019).

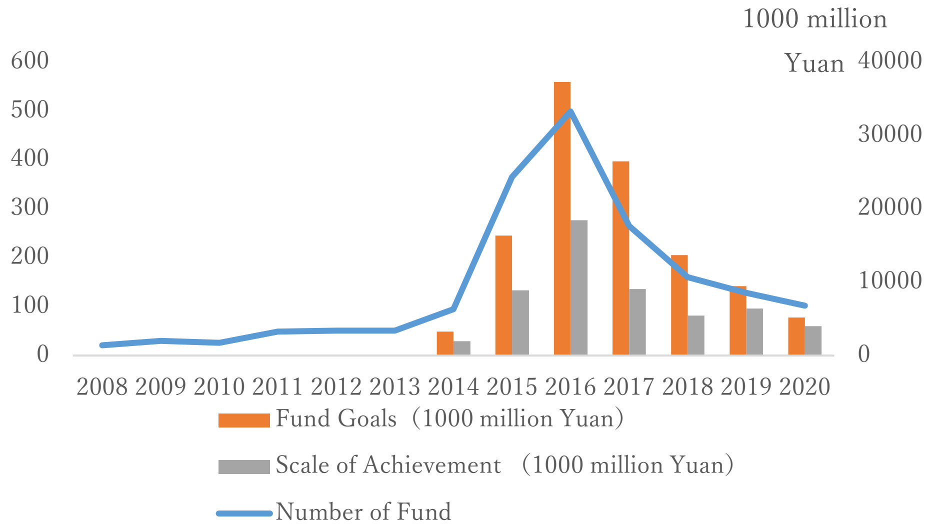

Figure 1. Newly Established Industrial Guidance Funds

Source: Zero2IPO Research 2020a.

As China's economy slowed, regulations tightened, and new local and provincial funds began facing the difficult realities of investing in emerging technologies and companies, this growth slowed in 2018 and 2019 (Luong, Zachary, and Murphy 2021).

According to Zero2IPO Research (2021), by the end of 2020, a total of 1,851 IGFs will have been established, with a target amount of RMB 11.53 trillion, and the total amount invested will reach RMB 5.65 trillion. Considering that fiscal subsidies related to industrial policy in 2018 amounted to approximately 160 billion yuan, this is a substantial amount. Micro-sized funds with a target amount of RMB 1 billion or less accounted for 43.2% (728 grants) of the total. Funds with a target amount between 1 and 10 billion RMB account for 36.8% (621). Most large-scale funds are government funds, and although they represent only 13.8% of the total in terms of number, they account for 82% of the total in terms of the target amount.

These IGFs are classified into three categories according to the type of investment and target (Zero2IPO Research 2020a, Figure 2).[5] The first type of fund is the industrial guidance mother

[5] Xu, Yu, and Gupta (2020) identified the four primary functions of IGFs: (1) to guide social capital and promote the formation of the venture capital aggregation mechanism; (2) to guide the direction of investment and fill the market gap; (3) to optimize the allocation of resources and promote independent innovation; and (4) to train talent and promote the development of local venture capital.

fund, in which the government-sponsored fund either establishes a fund for its participation or acquires a stake in the fund alongside other investment funds, thereby attracting additional investment funds to promote investment in the enterprise. National or provincial funds mainly use this model.[6]

The second type of investment occurs when a government-guided fund invests directly in companies from diverse industries. This model is characterized by the relative ease of operation and management of the funds. In addition, many of these funds that invest directly in enterprises were established by different levels of government to encourage innovation in local enterprises. Consequently, they are more prevalent at the district and county levels than in the mother funds.

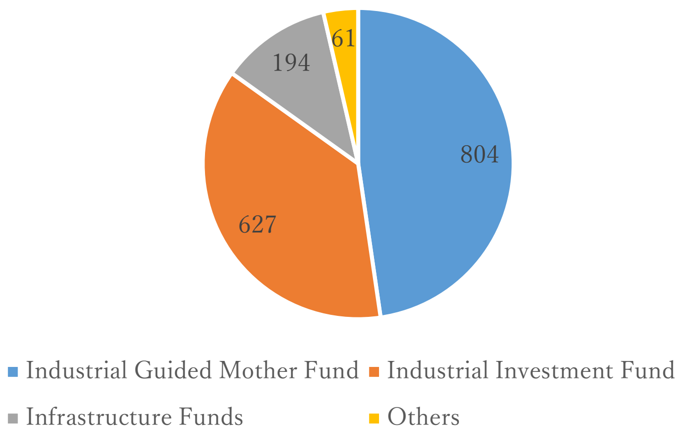

Figure 2. Classification and Composition of Industrial Guidance Funds

Source: Zero2IPO Research 2020a.

The final type of fund is the infrastructure fund, which invests in infrastructure construction projects at the national or local level via the joint investment (private–public partnership, PPP) method between the company and the government. There are instances in which IGFs invest directly in infrastructure construction projects and others in which they invest indirectly through

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6 These mother funds often invest in funds that themselves invest directly in companies. However, in some cases, the funds are second-tier mother funds, that is, small funds that invest in yet another fund. However, only a small number of such funds exist (Zero2IPO Research 2020a).

sub-funds.[7]

Meanwhile, the U.S. government heavily criticized this aggressive investment behavior in strategic industries through the IGFs as a "bad industrial policy" that distorts the market and undermines competition fairness through government intervention. For example, A June 2018 report led by Peter Navarro and titled "How China's Economic Aggression Threatens the Technologies and Intellectual Property of the United States and the World" by the White House Office of Trade and Manufacturing (2018), led by Peter Navarro highlighted one of the IGFs, China Integrated Circuit Industry Fund. According to the report, China's Ministry of Industry and Information Technology issued national guidelines for developing and promoting the integrated circuit industry in June 2014, outlining goals to make the integrated circuit sector self-sufficient in order to meet domestic industrial and security requirements. In other words, they conclude that the Chinese government is acquiring foreign assets at a rapid rate.

Indeed, some significant funds with subscription amounts exceeding RMB 50 billion, such as National Advanced Manufacturing Industry Investment Fund, established in 2016 by the central government, the State Development Investment Group Corporation, and eight financial institutions, local government funds, and state-owned enterprises, have a strong character as a state policy fund. The central government has positioned this fund as one of the measures to promote China Manufacturing 2025. Important areas of China Manufacturing 2025, such as industrial robots and new energy vehicles, have been prioritized for substantial investment (Sano 2020). Several other funds, such as the National I.C. Industry Investment Fund and the National Emerging Industry Venture Investment Fund, also play a significant role in industrial policy.

2.2. Do IGFs lead to "Bad Industrial Policy?"

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[7] On the basis of their investment objectives, these funds can be divided into three types. The first "business start-up guidance fund" provides entrepreneurs with funds to launch their businesses. The secone type is the "industrial investment fund," which supports particular local industries. Moreover, the third is the "PPP guidance fund," through which the financial sector invests primarily in infrastructure development in collaboration with financial institutions and others. The Industrial Guiding Fund is the most prevalent as of 2020, comprising 1,134 (61.3%) of the 1,851 IGFs (Zero2IPO Research 2021, 18).

Whether the investments of such investment funds, particularly those established by local governments, constitute a “bad industrial policy” that distorts the market and undermines the fairness of competition through government intervention is a complex issue. Some researchers argued that the investment destinations of such IGFs are not necessarily exclusively concentrated in the priority areas of China Manufacturing 2025 and that the majority of funds are managed in accordance with economic rationality by imposing numerous conditions on the investment performance and investment ratio of the recipient companies, among others. In other words, they emphasized that the promotion of investment by such IGFs differs from conventional industrial policy, which seeks to foster the growth of specific industries.

However, many IGFs have yet to fulfill their role of supporting emerging industries to the extent that was initially expected. Luong, Arnold, and Murphy (2021) state that despite their intention to support early-stage ventures, many IGFs end up investing in mature companies. They specified that in 2018, of the IGF investments, 6.41%, 18.69%, 42.30%, and 31.21% were in the seed, startup, expansion, and mature stages, respectively. Even if foundations wish to invest in early-stage companies, finding high-quality investments is difficult, and there is a growing preference for established companies.[8] In addition, they noted that overcapacity, misappropriation of funds, incompetent management, and excessive government intervention have been prevalent in IGFs to date, resulting in far less fund being raised and managed than was intended.

Furthermore, Gong et al. (2019) identified two issues with IGF corporate investments. First, the return on investment for IGFs is lower than the return on capital for market-based private equity funds. According to private equity, the average return of private equity funds that exited as of March 2018 was 13,705, which was 6.48 times, whereas the average return of government-sponsored IGFs was only 2.01 times. This low return rate directly impacts the fund’s attractiveness and significantly reduces the IGFs’ capacity to raise capital.

[8] Luong, Arnold, and Murphy (2021) also noted that IGFs may reduce the market’s overall efficiency, undermining the original objective of keeping retail investors out of the market in some cases and increasing the pool of funds available to strategic industries.

Second, there is the issue of idle or reinvested funds due to the lack of high-quality projects and the small number of companies eligible for government funding. In recent years, local governments have established numerous government investment funds rapidly. However, due to insufficient coordination during the fund's establishment, multiple industrial investment funds with similar objectives have been established in the same region. Consequently, relatively few good projects satisfy the fund's strategic requirements and the market's revenue goals. According to the report, many funds have been decimated due to their inability to find suitable projects.

However, none of these problem points were derived from a rigorous quantitative analysis. To determine whether the actual performance of IGFs is effective from an industrial policy standpoint an econometric analysis using firm data must be conducted. In the following section, we will discuss previous empirical studies on the effectiveness of China's industrial policies, including the effectiveness of investments made through IGFs.

3. Empirical Studies on China's Industrial Policy and IGFs

3.1 Efficiency of China's Industrial Policy

This section first presents recently published empirical studies on the effects of China's industrial policies. Aghion et al. (2015) found that productivity-raising effects are only significant when industrial policies are designed to promote competition among firms, such as policies that give dispersed subsidies to firms in a sector, "policies that promote competition within a sector," and policies that encourage new and productive firms. Barwick, Kalouptsidi, and Zahur's (2019) study on China's shipbuilding industry also questions the efficacy of sector-specific subsidies. The authors concluded that the subsidies resulted in the inefficient expansion of production capacity and excessive competition, which led to a loss of social calibration. Chen et al. (2021) examined the effect of the 2008 tax reform [9]on industrial

[9] China implemented a tax reform that reduced the marginal corporate income tax rate on R&D investment relative to sales by at least 5% prior to 2008. The 2008 tax reform established three thresholds based on firm size (3%, 4%, and 6%) and decreased the average tax rate as opposed to the marginal tax rate.

innovation and found that firms' reported R&D expenses show a significant increase around a threshold value (= bunching), testing the possibility that firms are relabeling expenses as R&D.

Government subsidies targeting specific industries and firms with a particular ownership structure, such as the state-owned sector, are more likely to impede fair competition. Cheng et al. (2019) examined the distribution and impact of innovation-promoting subsidies using data from the China Employer and Employee Survey.[10] They found that subsidies are disproportionately allocated to state-owned enterprises and firms with political capital, despite the fact that these firms are not more productive, profitable, or have a larger market share.[11]

Additionally, Wen and Chao (2021) examined the difference-in-difference (DID) and CEM analysis of the impact of CM2025 on firms' R&D investment using panel data on 1,440 Chinese A-share listed firms from 2012 to 2018. They found that government subsidies and bank loans had increased significantly for the CM2025-targeted state-owned firms, but policy had no effect on innovation or TFP.[12]

As we have seen, there is no consensus among experts regarding the effectiveness of China's industrial policies promoting innovation. However, many previous studies have indicated that subsidies and preferential policies targeting firms in specific industrial sectors or with specific ownership structures, such as state-owned sectors, are likely to impede fair competition and undermine social welfare. Existing studies on industrial policy for countries other than China have reached nearly identical conclusions. Next, we present additional empirical studies focusing on IGFs or government VC (GVC), which have significantly mobilized capital for particular industrial project sectors.

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[10] The analysis is based on a survey conducted by CEES in Guangdong and Hubei provinces in 2015 and 2016; according to the report, the 2016 survey included 1,122 companies and 9,103 employees.

[11] The authors noted that this inefficiency is due to the fact that subsidies aimed at the state-owned sector encourage incremental innovation but do not provide incentives for revolutionary innovation.

[12] Moreover, the implementation of economic policy in China, including industrial policy, is inextricably linked to the political climate. For example, Fang et al. (2018) analyzed the impact of two exogenous events on the growth of subsidy productivity: a 2013 anti-corruption campaign conducted by the administration of Xi Jinping and the replacement of government officials in charge of local innovation programs. After the anti-corruption campaign, the weak association between R&D subsidies and innovation has become significantly more positive. This indicates that anti-corruption efforts and mechanisms, such as severing ties between firms and government officials, have improved the efficiency of government R&D subsidy allocation.

3.2. Efficiency of GVCs and IGFs

Unfortunately, only a few studies have explored the performance of GVCs in developing nations, including China. In particular, some studies have evaluated the performance of funds established by local governments. As a few exceptions, Zhang and Mayer (2018) investigated the difference between GVCs and PVCs from a VC life cycle perspective. Using data on VC investments in the Chinese market between 1991 and 2010, their empirical results indicate that GVC-supported portfolio companies had a lower likelihood of going public through initial public offerings (IPOs) and other means than PVC-supported portfolio companies.[13] They also demonstrated that some unobservable factors that may increase the likelihood of being backed by GVCs also increase the likelihood of achieving an IPO. They insist that this finding demonstrates that GVCs have been cherry-picking the best projects that are more likely to go public, as opposed to supporting marginal projects with higher risk.

Zhang (2018) employed logit regression and propensity score matching to investigate the performance of mixed syndication involving both GVC and private VC (PVC) firms in China. Using the data on the investments in startups between 1995 and 2011, they found that startups backed by mixed syndication in their initial financing round are less likely to survive to the next round to obtain refinancing, compared to those backed by syndication solely among PVCs. The findings of these studies point to the same conclusions as those of previous studies on the performance of GVCs in developed countries.

Notable differences exist between IGFs and traditional GVCs, which are established by the government and managed by a government-appointed manager. IGFs are intended to serve as a "guide," to attract private capital and establish joint ventures. This will hopefully compensate for the deficiencies of conventional GVCs, which are not immune to government bias in decision-making, and produce a more market-based flow of funds. In addition, IGFs frequently include mother funds, which invest according to specific criteria in VC and private equity firms.

[13] They demonstrated that when unobservable variables that may influence the likelihood of being supported by GVCs and achieving an IPO are taken into account, companies supported by GVCs have a 26 percentage point lower success rate in achieving an IPO compared to those supported by PVCs.

Nevertheless, only a few quantitative analyses have been conducted on the performance of IGFs, including mother funds, in which the government is not directly involved in their management.

In this context, Gong et al. (2019) designed a comprehensive evaluation index system for IGFs in China. Moreover, Xu, Yu, and Gupta (2020) evaluated the performance of the IGF in Ningbo City, Zhejiang Province. They constructed the performance analysis model of the GVC from four dimensions: the standardization development of the guidance fund, risk control ability, leverage, and support effects under a multi-attribute decision-making analysis framework. These studies aim to develop a methodology for assessing the performance of more desirable IGFs led by local governments. Therefore, it does not directly analyze the effects of corporate investments made by IGFs. As previously stated, our primary challenge is to analyze and evaluate the effects of IGFs as an instrument of industrial policy on corporate investment.

Using data on manufacturing firms and funds, this empirical study examines the impact of the investment in manufacturing firms by IGFs, which are considered to play an essential role in the implementation of China's industrial policy, especially after China Manufacturing 2025 on the performance of these firms.

4. Data and Methodology

4.1. Data on the Effects of IGFs on Firm Performance

This section empirically examines the impact of industrial-guided funds' investments in manufacturing firms. We utilized Bureau van Dijk Orbis and *Simutong* **(清科研究中心私募通)** from the *Qingke* Research Center to examine the impact of investment guidance funds on the performance of manufacturing firms founded between 2001 and 2015. We constructed an unbalanced panel of these firms from 2001 to 2020 using Orbis from 2014 to 2021,[14] and "treated" the firms that were recorded to be subsidiaries or sub-subsidiaries of non-PPP

[14] In order to create the panel data, we used the 2020 data as the master and merged the data for each year, beginning with the most recent of the year, into it (although the 2021 data were merged last). If the numerical values for each variable were entered in the master, they were not overwritten; only if the values were left blank were the values from the database for the year in which the merged data was created entered.

government-sponsored funds, whose list was obtained from *Simutong* as of September 2021.[15] We decided to include sub-subsidiaries in our analysis because IGFs have a high proportion of mother funds, and in many cases, subsidiaries' investments influence the companies' performance.

We extracted from Orbis more than 166,000 manufacturing firms founded between 2001 and 2020, and found that over 11,600 of them are subsidiaries or sub-subsidiaries of IGFs. However, many of them lacked essential financial data, and of the 75,505 firms in the panel, only 386 are treated. The summary statistics for the year 2019 are shown in Table 1. It appears that treated firms are larger, more productive, and less profitable than control firms. Moreover, differences in firm age, R&D intensity, and financial leverage are ambiguous, and state-owned firms have a larger share.

Table 1. Summary Statistics (2019)

Variable	Control			Treated			Standardized
	N	Mean	SD	N	Mean	SD	mean diff
Age	75,119	11.9	4.23	386	11.4	4.21	-0.11
State ownership (binary)	75,119	0.014	0.117	386	0.080	0.272	0.32
Sales (log)	9,789	-0.030	3.14	110	2.648	1.55	1.08
Fixed assets (log)	4,249	-0.025	2.17	82	1.284	2.08	0.62
Employment (log)	9,634	-0.020	2.14	106	1.847	1.46	1.02
Labor productivity (log)	9,623	-0.009	1.55	106	0.825	0.89	0.66
R&D to sales ratio	626	0.000	0.13	24	-0.006	0.10	-0.05
Profit to sales ratio	8,286	0.034	18.8	81	-3.449	16.1	-0.20
Pre-tax return on equity	8,257	0.131	52.1	81	-13.365	24.0	-0.33
Debt to equity ratio	9,678	0.015	20.6	108	-1.338	6.4	-0.09

Labor productivity is sales per employee. Varables except age and state ownership are centerd at their means.

4.2. Identification Strategy

As discussed in the preceding section, there are a number of skeptical arguments and empirical studies regarding whether IGFs aid emerging industries. Moreover, the return on investment and success rate of IPOs by IGFs are lower than those of private equity funds.

[15] We took the subsequent actions: 1. conduct a *Simutong* search for IGFs. 2. List their subsidiaries and sub-subsidiaries using Orbis (We used vintage 2020 for funds established until 2018 and vintage 2021 for funds established in 2019). 3. Utilize *Simutong* to determine when each subsidiary or sub-subsidiary was dealt with (received investment).

The following working hypotheses will be tested during our analysis.

H1: Investments from IGFs increase the "scale" of treated firms in terms of their flows and stocks.

H2: Investments from IGFs do not necessarily boost the firms' productivity.

Previous research has demonstrated that IGFs and government investment funds cannot locate high-quality investments and instead invest in already successful companies with highly potential IPOs. If this is true, then investments by IGFs may lead to an expansion in the scale of the companies in which they invest, but not necessarily to an improvement in quality, that is, a rise in productivity that fosters innovation. When examining the effect of investment, we must distinguish between scale expansion and quality improvement.

An additional essential objective of our investigation is determining whether IGF investments foster innovation in emerging industries. However, with the dataset we employ, obtaining information on patents acquired by firms is laborious. Therefore, we use R&D expenditures as a percentage of sales to determine whether firms are innovation-promoting or not.

H3: Investments from IGFs increase the ratio of R&D spending to sales for treated firms.

To test these hypotheses, we use a DID-matching approach to identify the effects of the funds. Let Y_{it} be a variable of interest, one of the variables other than age and state ownership in Table 1, of firm *i* at year *t*, and denote by $Y_{it}^{(1)}$ and $Y_{it}^{(0)}$ respectively potential outcomes if the firm received fund investment and did not. We take the in-sample average *F* year effect on the funded firms as our estimand:

$$SATT_F = \frac{1}{\sum_i D_{i,\tau+F}} \sum_i D_{i,\tau+F} \mathrm{E}\left(Y_{i,\tau+F}^{(1)} - Y_{i,\tau+F}^{(0)} \mid \mu_{i,}, \lambda_{\tau+F}, \mathbf{X}_{i,\tau-1}\right)$$

where $D_{i,\tau+F}$ is a binary variable with a value of 1 if firm i received fund investment at year τ, and 0 otherwise; μ_i and $\lambda_{\tau+F}$ are respectively unobservable firm-specific and time effects, and $\mathbf{X}_{i,\tau-1}$ is a vector of pre-treatment covariates.

We assume for $t = \tau - 1, \tau + F$

$$\mathrm{E}\left(Y_{it}^{(0)} | \mu_i, \mathbf{X}_{i,\tau-1}, t, D_{it}\right) = \mathrm{E}\left(Y_{it}^{(0)} | \mu_i, \mathbf{X}_{i,\tau-1}, t\right)$$
$$= \mu_i + \lambda_t + \mathbf{X}'_{i,\tau-1}\beta,$$
$$\mathrm{E}\left(Y_{it}^{(1)} | \mu_i, \mathbf{X}_{i,\tau-1}, t\right) = \mathrm{E}\left(Y_{it}^{(0)} | \mu_i, \mathbf{X}_{i,\tau-1}, t\right) + \delta.$$

That is, fund investment is as good as randomly assigned conditional on firm-specific effect μ_i and pre-treatment covariates $\mathbf{X}_{i,\tau-1}$, and its causal effect δ is additive and constant, which implies $SATT_F = \delta$. We can then have

$$\mathrm{E}\left(Y_{it} | \mu_i, \mathbf{X}_{i,\tau-1}, t, D_{it}\right) = \mu_i + \lambda_t + \mathbf{X}'_{i,\tau-1}\beta + \delta D_{it},$$

which yields

$$\begin{aligned} &\mathrm{E}\left(Y_{i,\tau+F} | \mu_i, \mathbf{X}_{i,\tau-1}, \tau + F, D_{i\tau}\right) - \mathrm{E}\left(Y_{i,\tau-1} | \mu_i, \mathbf{X}_{i,\tau-1}, \tau - 1\right) \\ &= \lambda_{\tau+F} - \lambda_{\tau-1} + \delta D_{i,\tau+F} \\ &= \lambda_\tau^* + \delta D_{i,\tau+F}, \end{aligned} \tag{1}$$

implying that we can regress the difference $Y_{i,\tau+F} - Y_{i,\tau-1}$ on treatment status $D_{i,\tau+F}$ and year dummies to estimate the average F year effect δ.

We select the control group through a combination of propensity score and exact matching. Then, we estimate the propensity score using the linear and quadratic terms of continuous covariates and dummy variables for the values of discrete covariates and require exact matches for discrete variables. We use sales, fixed assets, employment, and pretax return on equity as continuous covariates, and debt-to-equity ratio at year $\tau - 1$, and use as discrete variables firm age at year $\tau - 1$, state ownership, NACE rev. 2 three-digit industry, and the treatment year τ.

5. Results

Before and after matching, covariate balances are compared in Table 2. Removing observations with unavailable values drastically reduced the number of firms treated. Several control observations were also eliminated. The table indicates that observations without NA values pertain to larger firms on average, but it shares with Table 1 the tendency that treated firms are larger. As shown in the table, firms that received government-guided fund investment are, on average, larger, and after matching, all standard mean differences become less than 0.1.

Table 2. Covariate Balance

	Before matching			After matching		
	Mean		Standardized	Mean		Standardized
	Control	Treated	mean diff	Control	Treated	mean diff
Age	9.1	9.9	0.18	9.8	9.8	0
State ownership	0.03	0.04	0.04	0.02	0.02	0
Industry	233.0	250.1	0.32	251.7	251.7	0
Year	2015.8	2017.0	0.63	2017.0	2017.0	0
Sales	1.19	2.06	0.55	1.98	2.06	0.06
Fixed assets	0.50	1.84	0.67	1.74	1.81	0.03
Employment	0.59	1.23	0.39	1.13	1.23	0.06
Pre-tax return on equity	-0.22	9.01	0.16	5.66	9.22	0.06
Debt to equity ratio	-2.05	-5.27	-0.13	-5.49	-5.27	0.01
Sales squared	4.63	5.93	0.19	5.83	5.96	0.02
Fixed assets squared	5.18	6.54	0.17	6.53	6.40	-0.02
Employment squared	4.15	3.27	-0.17	2.76	3.24	0.09
Pre-tax return on equity squared	4268.6	2137.8	-0.08	1155.7	2185.1	0.04
Debt to equity ratio squared	1281.0	45.1	-0.01	41.4	45.4	0.00
N	110,778	129		126	126	

Sales, fixed assets, employment are in logs. They and the ROE and debt equity ratios are centerd at the annual means.

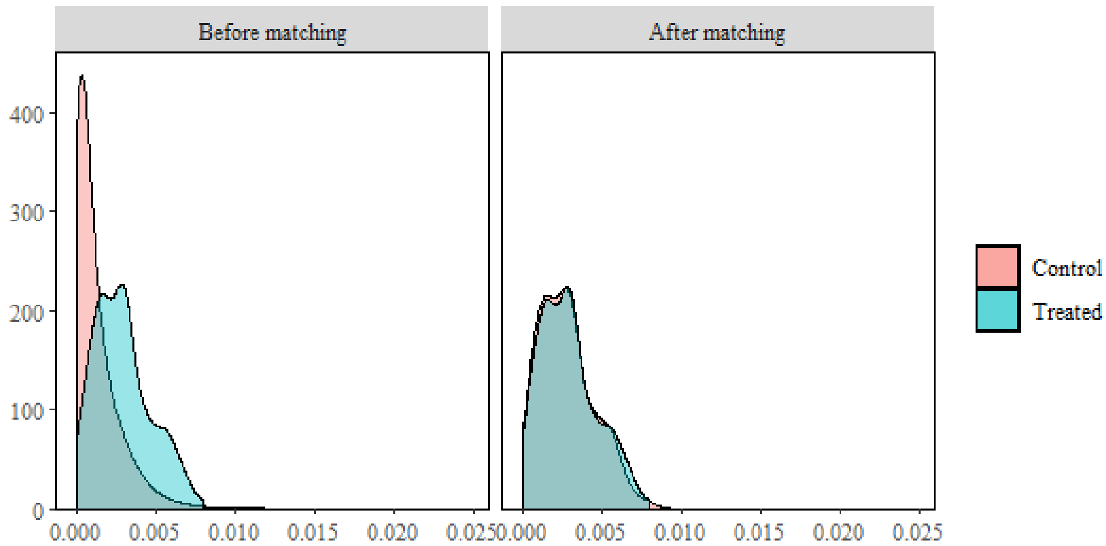

Figure 3. Distributional Balance of Propensity Score

Figure 3 depicts kernel density plots for the propensity score estimated via logit regression. After matching, two groups appear to be well-balanced and substantially overlap.

Table 3 displays the effects estimation results. We estimated the average one- and two-year effects, $SATT_1$ and $SATT_2$, of the funds on sales, fixed assets, employment, labor productivity, R&D-to-sales ratio, profit-to-sales ratio, pretax return in equity, and debt-to-equity ratio of investees using the data obtained after matching. As shown in Equation (1), differences in these variables were regressed on treatment status and year dummies.

Table 3. Estimation Results

	Sales	Fixed assets	Employment	Labor productivity	R&D to sales	Profit to sales	Pre-tax ROE	Debt to equity
$SATT_1$	0.132	0.473^{**}	0.191^{*}	-0.061	0.023	-2.138	-2.213	-0.984
	(0.089)	(0.102)	(0.094)	(0.120)	(0.017)	(2.859)	(8.169)	(0.680)
N	158	151	150	150	68	151	151	156
R^2	0.476	0.406	0.745	0.328	0.197	0.100	0.060	0.235
$SATT_2$	0.085	0.582^{**}	0.255^{+}	-0.177	0.014	-2.351	-12.947^{+}	-0.483
	(0.161)	(0.162)	(0.132)	(0.150)	(0.023)	(3.974)	(6.175)	(0.852)
N	89	82	82	82	32	78	80	88
R^2	0.228	0.643	0.622	0.255	0.37	0.106	0.238	0.391

Regression results of Equation (1). Year dummies are omitted. Robust standard errors in parenthesis. +, *, and ** denote significance at $p < 0.1$, $p < 0.05$, and $p < 0.01$, respectively.

The table indicates that the effects on fixed assets and employment are typically significant. On average, firms that received investment increased their fixed assets by approximately 50 percentage points and their employment by 20 percentage points. However, the effects on sales, labor productivity, R&D, and debt-to-equity ratio are not significant, and profit-to-sales and equity may have decreased. Hence, we believe that H1 is supported because funded firms could expand their business more than average. However, scale expansion did not necessarily increase the productivity of treated firms, as measured by labor productivity, profit-to-sales ratio, at least within two years.And significant change also did not exist in the ratio of R&D expenditures to sales. Therefore, we believe that H2 is also supported, but H3 is not supported.

6. Discussion

Our analysis in the previous section suggests that IGFs may not have necessarily contributed to the original purpose for which they were established, i.e., to increase productivity and promote innovation among start-ups.

Despite this, IGFs have been considered important in China's industrial policy due to the Chinese government's commitment to maximize the use of market mechanisms to improve the efficiency of allocating capital and other production factors. Numerous IGFs, for instance, have been established to invest in PPP infrastructure construction projects at the national or local level. In recent years, PPPs have been actively implemented to use market mechanisms to prevent local governments from blindly constructing infrastructure and expanding their economies by allowing private capital to participate in infrastructure construction.

However, the role of the IGFs has been questioned recently. For example, on July 30, 2022, the CPC Central Commission for Discipline Inspection and the State Inspection Commission announced on their respective websites that Ding Wenwu, the head of the China Integrated Circuit Industry Fund, a sovereign wealth fund targeting the semiconductor industry, is being investigated for alleged violations of the law.

Prior to this, it was reported on July 15 that Lu Jun, the former president of Huaxin Investment Management, which was the Grand Fund's management company and had been contracted to effectively manage the fund, had been detained and was being questioned by the authorities. The fact that the top management of a "state fund" for promoting China's semiconductor industry was successively questioned by the authorities on corruption charges sparked a great deal of rumor and controversy.

The leading Chinese business magazine *Caixin Zhoukan* (财新周刊) pointed out that many of the fund's members were seconded from the State Development Bank, the fund's largest shareholder, and were not necessarily familiar with the state of the semiconductor industry, and that the incentive mechanism to ensure efficient investment was not fully operational.16

[16] "Cover Story: Graft Scandal Casts Long Shadow Over China's Chipmaking Ambitions," in *Caixin Global*, Aug 08, 2022, https://www.caixinglobal.com/2022-08-08/cover-story-graft-scandal-casts-long-shadow-over-chinas-chipmaking-ambitions-101923281.html (accessed in Nov 13,2022).

The scandals involving officials of the China Integrated Circuit Industry Fund indicate that there were fundamental flaws in the management of IGFs, which ought to be effectively governed by the market. This may prompt a reevaluation of China's industrial policy direction, which it has actively promoted and taken pride in achieving in recent years. In this sense, the results of this paper's analysis are highly suggestive when considering the future direction of China's industrial policy.

7. Conclusion

Our analysis revealed that although investments by IGFs increased fixed assets and equity capital significantly, the other variables did not change significantly. And there was no significant change in the ratio of R&D expenditures to sales. These results of our study revealed that, indicating that although the investment by IGFs increased the target firms' assets, it did not have the expected effect on R&D capacity, and productivity improvement is questionable.

There are, of course, several drawbacks in this study, but they are primarily attributable to the large amount of missing data. First, the number of treated firms was restricted, and covariates for estimating propensity scores could only be utilized one year before the investment. Furthermore, we could only examine effects up to two years after the fund's investment, making it impossible to determine the investment's longer-term effects. In the future, we will conduct an empirical analysis with a more comprehensive data set to address these issues. From a corporate finance perspective, the impact of IGF investment on the listing and IPO of investee firms must also be analyzed, a topic for future research. In addition, it will be necessary to consider in greater detail why and how IGFs have not invested efficiently in the past. In the future, these points can be improved upon to provide a more comprehensive understanding of the subject.

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