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Government R&D support and firms' access to external financing: funding effects, certification effects, or both?

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ABSTRACT

We examine the effects of government R&D support on a firm's access to external financing, focusing on the mechanisms through which the impacts are achieved. Based on a panel dataset of Chinese manufacturing firms, we compare firms backed by government R&D subsidies with a control group of firms in their capability to access external financial resources. To address identification issues, we employ a propensity score matching approach to construct the control group and estimate the effects of government R&D subsidies in a difference-in-difference manner. Above all, we find significant ex-post effects of such subsidies on firms' access to external financing after addressing the identification issues. We investigate two mechanisms, namely, direct funding effects and certification effects. In particular, we decompose direct funding effects by identifying the equity effect and the prototyping effect and decompose certification effects by separating quality certification from the certification of the political capital of entrepreneurial firms. We find that both direct funding and certification mechanisms are at play. Specifically, government R&D subsidies have significant and positive effects on innovation outputs but not on the financial returns of firms, supporting the prototyping effects of the direct funding of government subsidies in China. Furthermore, government subsidies for R&D primarily serve as a certificate for political capital rather than the quality of the firms in China. Government-supported firms receive further subsidies afterward. Moreover, the effects of government R&D subsidies are more potent in regions where the local governments are more efficient and impose less intervention in business activities. However, the effects of government subsidies are not sensitive to the magnitude of information problems related to the quality of entrepreneurial firms.

1. Introduction

This study examines the effects of government R&D support on a firm's access to external financing, focusing on the mechanisms through which the impacts are achieved. Governments worldwide have implemented various public policies to subsidize corporate R&D activities. A long-standing rationale for such policies is based on the assumption that government intervention is a solution to market failure of the underinvestment in R&D by for-profit firms. Besides the direct support, one of the major targets of many public R&D programs is to attract banks or other external financiers to participate in corporate R&D investments by leveraging the government seed funding. Such effect is particularly desirable for public support of R&D in small and medium-sized enterprises (SMEs), which typically face severe financial constraints due to profound information problems, the high level of uncertainty, and the lack of collaterals (Hall, 1992; Hao and Jaffe, 1993). A counterargument, however, is that government may fail and public intervention may crowd out private R&D investments (Stiglitz, 1988). Thus, whether and how public R&D programs stimulate corporate R&D and financiers' participation in the private sector are critical empirical questions.

Studies on government R&D subsidies are ample. Most of the existing examinations focus on the effects of government support on the performance of entrepreneurial firms (e.g., Branstetter and Sakakibara, 1998; Klette and Møen, 1998; Ratinho and Henriques, 2010; Doh and Kim, 2014; Guan and Yam, 2015; Radas et al., 2015; Petti et al., 2017; Guo et al., 2016, 2018) or private R&D spending of firms (Audretsch et al., 2002; Görg and Strobl, 2007; Aerts and Schmidt, 2008; Czarnitzki and Lopes-Bento, 2013). Empirical findings on how government support affects firms' access to external financing remain limited. The existing studies mainly find that firms backed by government R&D grants have a

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higher probability of accessing more debts (Meuleman and De Maeseneire, 2012; Wu, 2017; Martí and Quas, 2018; Wei and Zuo, 2018; Li et al., 2019) or equity financing including venture capital investment (Lerner, 2000; Feldman and Kelley, 2006; Howell, 2017; Conti, 2018), or lower cost of capital (Demeulemeester and Hottenrot, 2015).

Several knowledge gaps remain in the existing literature on how public R&D programs stimulate external financiers' engagements. Most importantly, except for a few studies (e.g., Howell, 2017; Demeulemeester and Hottenrot, 2015), the existing literature mainly attributes the role of government subsidies to certification effects without considering alternative mechanisms. One possible mechanism is that government R&D support may help firms improve their financial performance (equity effect) or the technology viability (prototyping effect). Thereby, direct funding may help firms attract external financing (Howell, 2017). However, such funding effects have rarely been estimated. Furthermore, existing studies have focused on government R&D support's certification for firm quality, leaving alternative certification mechanisms under-investigated. Government support may also certify firm-government connections. In economies where political connections play an important role, or in industries where strong government intervention and regulation exist, the certification for political capital may be essential for firms to gain external financing (Li et al., 2008; Guo et al., 2014). However, there is little research on this channel of certification of government R&D support. To our knowledge, the study of Li et al. (2019) is the only investigation that attempts to address alternative certification mechanisms, i.e., the certification of government support for the legitimacy of the award-winning firm. Finally, previous studies are mainly based on data from developed market economies, and we know little about the impact of government R&D subsidies in transitional economies. Institutions such as legal systems and public governance and the development of financial and product markets vary widely across economies (North, 1990; La Porta et al., 1998). These institutional differences may affect firms' financial constraints, innovation paths, and capabilities, impacting government R&D subsidies' effects on firms' access to external financing.

This study attempts to enrich the extant literature by examining the effects of government R&D subsidies on a firm's access to external financing in China. Taking Innovation Fund for Small and Medium Technology-based Firms (Innofund) as an example, we investigate whether public R&D support positively affects a firm's access to external financing in China, where the institutions are significantly different from those in countries examined in the existing studies. More importantly, we explore how such effects work on-site by comparing two relevant mechanisms, i.e., direct funding and certification effects. Furthermore, we break down direct funding effects by identifying the equity effect and the prototyping effect and decompose certification effects by disentangling the certification for quality from the certification for entrepreneurial firms' political capital.

The case of Innofund provides us a perfect opportunity to answer the research questions we raise. First, Innofund is the most extensive public R&D program that supports SMEs' corporate R&D activities in China. The examination of this program is, therefore, sufficiently representative for addressing our questions. Second, Innofund is a nationwide program covering various industries implemented between 1999 and 2014. The heterogeneity of the industries and markets helps us distinguish the mechanisms through which government R&D programs work.

Based on firm-level panel data between 1999 and 2007, we compare Innofund-backed firms and non-Innofund-backed ones regarding their capabilities to attract external financial resources, including short-term and long-term debts and equity investment. In general, we find that government R&D subsidies have significantly positive effects on firms' access to external financing. Everything being equal, the differences in external financing between Innofund-backed and non-Innofund-backed firms are significantly amplified after the infusion of the Innofund. Furthermore, both direct funding and certification mechanisms are at play. Firstly, we find statistical evidence for the prototyping channel but not for the equity channel of the direct funding mechanism. In particular, government R&D subsidies have significantly positive effects on firms' innovation outputs (measured by the count of patents and sales from new products) but not the financial returns of firms (measured by the returns over equity, sales and total assets). Secondly, our findings suggest that government R&D subsidies mainly serve as a certificate for firms' political capital rather than firms' quality in China. Firms obtain further government subsidies after being awarded R&D grants. Moreover, the effects of government R&D subsidies are more potent in regions where the local governments are more efficient and impose less intervention in business activities. Nevertheless, the impact of government subsidies is not sensitive to the severity of the information issues related to identifying firms' quality. Employing a propensity score matching approach (PSM), we construct a rigorous control group and estimate the effects of Innofund using a difference-in-difference (DID) strategy to deal with potential selection biases and other identification concerns.

The remainder of this paper is organized as follows: Section 2 introduces the Innofund program's background. Section 3 reviews the existing literature and discusses how hypotheses are developed. Section 4 describes the sample and the data. Section 5 presents the findings on how government R&D subsidies affect firms' access to external financial resources and addresses the identification concerns. Section 6 investigates mechanisms through which government R&D subsidies work. Finally, Section 7 concludes this study.

2. Government R&D programs in China and the Innofund Program

Innofund is a particular government R&D program established upon the approval of the State Council in May 1999. This program was included in the Law of the People's Republic of China on Scientific and Technological Progress in 2007. As the first policy-guiding funding program, Innofund aims to "facilitate and encourage the innovation activities of small and medium technology-based enterprises (SMTEs) and the transformation of research achievements by ways of financing, trying to bring along and attract outside financing for R&D investment of SMTEs. At the same time, as a non-profit-making government policy, it is oriented towards social welfare induced by the positive effect of innovation."[1]

Various criteria, including the technology, R&D capacity, market potentials, financial health, and the size of firms, are applied for the Innofund selection. First, the projects should comply with the national industrial technology policies, show relatively high potential for economic and social benefits, and possess a strong market competition capacity. Second, the applicant should be an SME with no more than 500 employees in total, among whom no less than 30% should have higher education. Third, the firm's annual R&D investment should be at least 3% of its total sales, and the number of direct R&D employees should be more than 10% of the total number of employees. Fourth, firms with leading products in the market with economies-of-scale production must demonstrate excellent economic performance and have leverage ratios lower than 70%. Priority projects include those with innovative technology or independent intellectual property; projects founded by research personnel or overseas returnees who aim to transfer their scientific achievements; innovation projects jointly initiated by firms, universities, and research institutions; and projects that use new and high technology to revive the stock assets of traditional industries and drive job creation.

Innofund mainly provides three financing forms: appropriation, interest-free bank loan subsidies, and equity investment. Appropriation is the primary funding form contributing to more than 80% of the Innofund support between 1999 and 2011. On average, the Innofund

[1] Source: http://www.innofund.gov.cn/.

grant should not exceed 20% of the investee company's registered capital, and the total amount of subsidy for an individual project is generally between 1 and 2 million RMB. A matching scheme is applied to the Innofund program between the central and local level governments. In principle, local governments must provide at least 50% (25% for provinces located in under-developed western China) of the awarded funds to firms that win the Innofund grant.

On average, the Innofund granting duration is three years. Innofund Administration Committee (IAC) regularly monitors and evaluates the awarded projects' performance after the subsidies' infusion. Moreover, upon completing the contracts, IAC would organize a panel of experts to assess whether the projects have achieved the desired targets. If a firm fails the final evaluation, it will not be qualified to apply for Innofund (or even other government R&D programs) for a period of time.

From 1999 to 2011, the Innofund program provided more than 19.17 billion RMB to 31,537 projects. Among these projects, 27,498, 2,880, and 1159 were backed respectively through appropriation, interest-free bank loan subsidies, and other forms, including equity investment.[2]

3. Government R&D programs and external financing

The relationship between government R&D support and firms' access to external financing can be complex. High-tech SMEs have difficulty obtaining external financing due to profound information problems, high uncertainty, and a lack of collateral and credit history (Diamond, 1991; Holmstrom and Tirole, 1997; David and Hall, 2000). Therefore, one of the main objectives of many public R&D programs is to attract banks and other external financiers to engage in corporate R&D investment by leveraging government seed funding.

Theoretically, government R&D support may only have positive effects on a firm's access to external financing when all the following three conditions are satisfied: a) the firm faces financial frictions and would not make sufficient R&D investment to improve performance if there is no support from the government; b) the size of the government subsidies is large enough for the firm to improve its performance while not too large that the firm's finance friction is completely relaxed, which reduces the firm's incentives to seek further external financial resources; c) government subsidies are used by the awarded firm to improve the quality of the project as promised at the time of application. If a firm is not financially constrained, the marginal return from the government support would be negligible, given that the firm may choose to finance itself regardless of whether it gains public R&D support or not (David et al., 2000). Meanwhile, the relative size of government support matters. If the size of the government subsidies is too small for the firm to improve its performance and credit rating, we should not expect such funding to help the firm access further external financial resources (Görg and Strobl, 2007). Of course, if the size is too large, the awarded firm may not need any additional financial resources. Finally, if government subsidies are abused instead of improving the firm's performance and technology, we would not observe the positive effects of such government support on firms' financing. Therefore, if any of the above-mentioned conditions are not met, we may expect that government support does not significantly affect a firm's access to external financing or even substitutes external financial resources.

In the case of China, SMEs have been suffering from a lack of access to external finance (Gordon and Li, 2003; Allen et al., 2005). Almost all major banks are state-owned in China, which prefer large state-owned enterprises (SOEs) or borrowers related to the government. Although the government has pushed to allocate more funding to SMEs in the past years, such initiatives conflict with the efforts to reduce the state-owned banks' financial risks. The lack of fair competition in the financial market and the lack of tangible assets as collateral make it particularly difficult for high-tech SMEs to get external financing. Guo et al. (2014) discover that bank loan ratios over equity for private enterprises in China were only 0.6% and 0.8% in 2005 and 2009, respectively. As a comparison, the private sector contributed approximately 50% of China's total GDP in 2009. Such disproportionally small bank loans issued to the private sector indicate severe financial frictions private enterprises face. Furthermore, Chinese firms generally have higher proportions of short-term debt in their capital structures than firms in other countries (Li et al., 2008). The lack of access to external financial resources and the overweight of short-run debts further suggest that firms in the private sector face severe liquidity constraints for long-run investment in R&D activities.

Meanwhile, the size of the Innofund support is relatively moderate, which is usually less than 1 million RMB. Therefore, the amount of such support may not be large enough to fully relax the financial constraints for R&D-oriented SMEs, given that the average annual sales of private enterprises were 39.2 million RMB in 2005, according to the Seventh Survey on Private Enterprises.[3] However, such an amount may help firms relax the constraints in R&D investment, given that the average R&D investment made by private firms (both R&D-oriented and non-R&D-oriented) was 0.43 million RMB in 2005.

Finally, as discussed in the previous section, the use of Innofund subsidies is under regular government review. Usually, an awarded firm is required to sign a contract with the Innofund office, stating the use of the funds and setting the goals and technological standards it aims to achieve after obtaining the Innofund support. If the pre-set goals are not met, the Innofund office will terminate the support. Moreover, the firm is not eligible for further government subsidy applications for a certain period. With active government oversight and possible penalties, misuse of the fund may be mitigated. According to information provided by the IAC, between 1998 and 2014, 41,588 Innofund-supported projects were evaluated, of which 4605 projects (11.1%) failed to pass the review. These data indicate that the misuse of Innofund is not a widespread problem.

Given the contexts in China mentioned above and the operation of the Innofund support, we expect that the chance of government support substituting the private investment is very slim. Therefore, based on the facts and reasoning under China's context, we posit the following Hypothesis:

Hypothesis 1. Innofund has significantly positive effects on firms' access to external financing.

Government R&D subsidies may help firms gain more external financial resources through several channels. As mentioned earlier, high-tech SMEs have difficulty in attracting external funding because of the information asymmetry issues, a lack of collateral, and high uncertainty associated with these firms. Therefore, if it works, government support should help solve at least one of these problems. This study focuses on two primary mechanisms of government R&D support, i.e., the funding and certification mechanisms.

Intuitively, government R&D support may directly affect firms' fundraising capacity by influencing the R&D efforts and performance of awarded firms. As discussed by Howell (2017), funding effects may work through two potential mechanisms, i.e., the equity and prototyping channels. Regarding the equity channel, the assumption is that government support may help entrepreneurs retain the equity and invest in necessary R&D activities, thus improving the firm's financial position and increasing the collateral to attract external financial resources. As

[2] Innovation Fund Arora et al., 2011 (http://www.innofund.gov.cn/).

[3] The survey was organized by the Chinese Communist Party's central committee department, the United Front Work Department, and two ministry-level central government agencies, that is, the National Association of Industry and Commerce and the State Administration for Industry and Commerce. A stratified random sampling procedure is applied to ensure that the survey is representative of the population of the registered private firms in China. 3837 private firms located in 109 cities were surveyed in 2006. Such data have been used by many studies (e.g., Li et al., 2008; Guo et al., 2014).

for the prototyping channel, it is hypothesized that government support may enable or accelerate proof-of-concept work that the firm cannot finance otherwise. Most R&D activities are accompanied by a high degree of uncertainty and a high failure rate. Without viable evidence, it is hard for external financiers to adequately assess the innovative assets, that they may be hesitant to invest in such projects. As a piece of credible evidence for the technological potentials, prototypes serve as collateral to facilitate firms' access to external financing (Hochberg et al., 2018).

Regardless of which funding channel is referred to, the above arguments assume that government R&D support stimulates a firm's R&D efforts, innovation output and financial performance. However, although most existing studies find government R&D support indeed stimulates corporate R&D investment (e.g., Branstetter and Sakakibara, 1998; Audretsch et al., 2002; Lach, 2002; Görg and Strobl, 2007; Aerts and Schmidt, 2008; Czarnitzki and Lopes- Bento, 2013), the relationship between R&D investment and firm financial or innovative outputs is not always straightforward. Some firms, especially SMEs, may generate innovation outputs and improve their financial performance through informal R&D inputs (Santarelli and Sterlacchini 1990; Rammer et al., 2009; Ortega-Argilés et al., 2009; Petti et al., 2017).

Indeed, empirical findings on the government R&D support, corporate R&D inputs, and firm financial and innovative performance are mixed. Some studies find evidence that government R&D subsidies are associated with increased firm performance and corporate R&D outputs (e.g., Branstetter and Sakakibara, 1998; Aerts and Schmidt, 2008; Hsu et al., 2009; Ratinho and Henriques, 2010; Czarnitzki and Lopes- Bento, 2013; Doh and Kim, 2014; Radas et al., 2015; Guo et al., 2016, 2018; Petti et al., 2017). Meanwhile, some recent studies discover a more complicated picture of government R&D support, showing that the effects of government R&D support are moderated by the size, maturity, technology and innovative capacity of the firm (e.g., Lööf and Heshmati, 2005; Clausen, 2009; Lee, 2011; Petti et al., 2017), external elements including institutions, markets and industry factors (Sternberg, 2014; Guo et al., 2017), or, subsidy size, form and governance of the government R&D programs (Hsu et al., 2009; Barbieri et al., 2012; Guo et al., 2018). Other studies, however, find that public R&D support has done nothing to stimulate firm performance or R&D investment (Klette and Møen, 1998; Guan and Yam, 2015). Moreover, several studies even report a crowding-out effect of government R&D support on firm performance and R&D outputs (David et al., 2000; Wallsten, 2000; Acemoglu et al., 2018).

In the case of China, it is not particularly clear that which funding channel may work because existing studies find heterogeneous results in terms of the relationship between government R&D support, corporate R&D input, and firm financial and innovation performance (Guo et al., 2016, 2018; Guan and Yam, 2015; Boeing, 2016; Boeing et al., 2016; Petti et al., 2017). We, therefore, propose the following Hypothesis:

Hypothesis 2a. If the equity channel serves as a mechanism for government R&D support, we should observe that government grants have significantly positive effects on firm profitability and access to external funding simultaneously.

Hypothesis 2b. If the prototyping channel serves as a mechanism for government R&D support, we should observe that government grants have significantly positive effects on firm technological viability and access to external financing simultaneously.

Government R&D programs may also influence firms' access to external financing through certification mechanisms. The government R&D support serves as a signal conveying relevant information about firms' quality or other potential resources. Usually, certification effects are more significant with more potent information asymmetries (Spence, 1973). We suggest that under China's contexts, the certification mechanisms may work through two channels, i.e., the certification for the quality of firms and the certification for firms' political capital.

First, government R&D support may demonstrate the quality of the projects they support and, in turn, increase a firm's chances of securing external funding. High-tech SMEs usually have a high level of intangible assets and little track record of credit history. Moreover, differing from publicly listed companies, privately-held SMEs are not obligated to disclose information to the public. Such characteristics of high-tech SMEs determine that these firms face severe information problems, increasing their risk and probability of bankruptcy that make them unattractive to external financiers (Cabral and Mata, 2003; Hall, 2008). Direct financial support may not be the only reason for a firm to apply for government R&D subsidies. Instead, entrepreneurial firms seek to maximize such programs' effects, which may help them gain other sources of external financial support. The selection and evaluation of government R&D programs may signal the projects' quality to external financiers, generating certification effects.

Quality certification is well examined and evident in studies on government subsidies under the developed contexts (e.g., Lerner, 2000; Feldman and Kelley, 2006; Meuleman and De Maeseneire, 2012; Demeulemeester and Hottenrot, 2015; Martí and Quas, 2018). Among the few studies on government subsidies on firms' access to external financing in China, most support the certification effects of government R&D subsidies. For instance, Li et al. (2019) find significant certification effects of government R&D subsidies on external financing of innovative firms. However, such effects are moderated by the quality of intellectual property rights institutions across regions. Wu (2017) reaches a similar conclusion and finds that the certification effects are more potent for private firms. Both studies are mainly based on information from listed companies,[4] which are significantly different from privately held companies regarding external financing sources, financial constraints, and information disclosure, among others. Information regarding firms' quality is severe in China because of the weak credit record system and law enforcement. Such problems are even more severe with unlisted R&D-oriented firms. Therefore, if the government R&D programs work through the quality certification effects in China, we should expect to see that the accessibility to external financing of the firms backed by government R&D programs is sensitive to the severity of the information asymmetries associated with firm quality identification. Therefore, we propose the following Hypothesis:

Hypothesis 3a. If the government R&D programs work through the quality certification effects in China, the impact of government R&D subsidies on firms' access to external financing should be significantly more potent for firms associated with a higher level of information issues related to identifying firms' quality.

Second, besides the quality certification, government R&D support may signal a firm's political capital; in turn, such government R&D support may protect the external financiers from the downside risks. The literature on the relationships between political connections and economic variables is extensive. For example, investigating data from 47 countries, Faccio (2006) discovers that the announcement of entering politics by officers or large shareholders of a company is positively associated with the cumulative abnormal return. The degree of the association varies depending upon political power. Similar findings are revealed under different settings, such as in late Victorian Britain (Braggion and Moore, 2011), Italy (Cingano and Pinotti, 2009), the United States (Acemoglu et al., 2010) and Russia (Slinko et al., 2005). Another group identifies the effect of political connections on access to bank loans and government subsidies (Khwaja and Mian, 2005; Johnson and Mitton, 2003).

[4] Although part of the samples of Li et al. (2019) are officially unlisted firms, they are firms registered on the National Equities Exchange and Quotations (NEEQ), which is an over-the-counter (OTC) market through which non-public company stocks were allowed to transfer shares and raise funds for specific purposes. As such, companies need to meet specific financial and information disclosure requirements to be listed on this market. They, therefore, are more similar to those of listed companies than to privately-held companies in many aspects.

In China's context, where the government is heavily engaged in business activities, the relationship between political connections and firms' financial and investment activities has attracted extensive attention from scholars. Some studies find that firms with political connections gain more access to bank loans (Li et al., 2008), equity investment (Francis et al., 2009; Boubakri et al., 2013), or government subsidies (Wu et al., 2012) than other firms do. Meanwhile, studies find that politically connected firms in China are less financially constrained than firms without political connections (Poncet et al., 2010; Guariglia et al., 2011; Cull et al., 2015). Guo et al. (2014) are the first to systematically examine the dynamic relationship between political connections and bank loan access of unlisted firms in China. The authors reveal the dynamic effects of political connections on bank loan access of private enterprises in China. This study shows that political connections benefit firms in the private sector to access bank loans after the nation's regime is changed from anti-capitalistic to pro-capitalistic.

While most existing literature shows positive effects of political connections on a firm's access to financial resources, political connections may not always be visible. In particular, the government-business relationship in China is complicated and subtle. Government R&D programs are designed as a part of the indicative planning system to prioritize selected high-tech sectors for rapid development. Under the regionally decentralized authoritarian regime in China (Xu, 2011), local governors compete to seek political rewards according to the evaluation criteria set by the central government, which has been the economic development and other aspects that the central government is concerned about. In the case of the Innofund program, each year, the Innofund office at the Ministry of Science and Technology announces specific areas of funding as part of the central government's science, technology and industry policy, indicating that the government strategies are to support industries in these areas in the future. As discussed, local governments must provide matching funds and support to firms backed by government R&D programs. The political incentives of the local officers and the commitments from the local governments may motivate the local governments to play the role of guarantors for the awarded firms by providing further support to these firms and promoting these firms to banks and other external financiers. Being awarded by such a government program is a signal for a firm winning the government's favor and recognition. Such recognition may lead to further funding opportunities and indirect government supports such as tax and credit incentives, land acquisition, and loan guarantees, among others (Heilmann and Shih, 2013; Boeing, 2016). Therefore, we suggest that government support may serve as a certificate for a firm's political capital and provide downside protection for external financiers' investment risks, especially for state-owned banks.

However, turning the political connections into political capital may depend on the efficiency of the local government. If the local government is highly corrupted, the political connections may send negative signals to external financiers. In particular, the findings on the relationship between political connections and firm performance are pretty mixed in China. Some studies find that political connections help listed firms to gain resources that enhance performance (Peng and Luo, 2000; Li et al., 2008; Francis et al., 2009), while the others find politically connected firms are less efficient than others (Cull et al., 2015). Indeed, Guo (2010) documents that some foreign venture capitalists state that they try to avoid investing in firms with government support in China because they assume that some local governments are corrupted, and some firms live on government subsidies. If this is the case, the political connections may serve as a political liability rather than political capital.

Based on the above discussion, we suggest that if government R&D subsidies indeed serve as a certificate for political capital, being awarded by the subsidies may enhance a firm's attractiveness for external financiers. Hence, we shall expect to observe: 1) government-supported firms obtain further government support afterward; 2) The accessibility of the awarded firms to external financing should be sensitive to the efficiency of the local governments. Therefore, we propose the following hypotheses:

Hypothesis 3b. If government R&D subsidies serve as a certificate for a firm's political capital, government-supported firms should obtain more support from the government afterward than other firms.

Hypothesis 3c. If government R&D subsidies serve as a certificate for a firm's political capital, government R&D subsidies should have more potent effects on a firm's access to external financing for firms in regions where the local governments are more efficient and more supportive of the market economy.

4. Data, sample, and variables

The data of this study are collected from two primary sources. First, the information on Innofund-backed firms is obtained from the official Innofund program website (http://www.innofund.gov.cn). Since 1999, the names of Innofund-backed firms have been publicly announced on the website annually. The website provides the name and address of the firm, nature of the project, date when the firm won Innofund, type of support from Innofund, and the performance evaluation result of the project (e.g., whether terminated during the process or completed on time with the proposed goal achieved). Second, firm-level data on financial information and other firm-specific characteristics are derived from the Above Scale Industrial Firms Panel (ASIFP) database. ASIFP consists of all state-owned and non-state-owned industrial firms with annual sales of at least 5 million RMB (US$750,000) from 1998 to 2007.[5] This database provides sophisticated financial and other firm-specific information, including location, industry, age, and ownership structure. This study's first challenge is data matching, given that the names of the firms listed in the two databases may not be entirely consistent. We borrow the data matching strategies used by the NBER Patent Data Project[6] to ensure matching accuracy. As a first step, we standardize the firm names in the two databases. We create a "standard name" for all firms in the two databases by removing the punctuation, space, or other special characters (e.g., !@#$%ˆ&*- = [/]\, etc.) and standardizing the legal entity identifiers (e.g., we convert Limited into Ltd.). We then create a "stem name" for all firms by removing all legal entity identifiers of firm names (e.g., a firm called "Hao Yun Logistics Ltd" is changed to "Hao Yun Logistics").

After standardization of firm names, we match the Innofund Program data with ASIFP data to identify Innofund-backed firms in ASIFP. We employ both computerized and manual matching strategies. Between

[5] ASIFP is available for years between 1998 and 2014. We choose not to use the data after 2007 for four major reasons. First, the data quality for 2008 and 2009 is very poor. The legal person ID of firms, the only information to identify the same firm accurately for the panel data, is not available in the data for 2008. Besides the legal person code, variables such as state-owned capital, which is one of our control variables, are missing in 2008 and 2009. Some important financial information is missing as well, such as sales income. Meanwhile, for 2009, the number of observations dropped significantly (from more than 400K in 2008 to 320K in 2009), such that we suspect it is not the full sample of the above-scale manufacturing firms in China. The second major reason for us not to use 2008 and 2009 data is because of the financial crisis in 2008. Many other external shocks, including the crisis itself and the sequential stimulus packages, happened after 2008 and may lead to noises to our estimations. Third, since 2010, the threshold of including a non-SOE into this database is changed from annual sales of at least 5 million RMB to at least 20 million RMB. Lastly and most importantly, the research questions raised in this study are time independent. The theories regarding the certification and equity effects are the major concerns in this study and neither of them are time variant issues. Given the abovementioned reasons, we choose to use data between 1998 and 2007, which are of good quality by nature, for the examinations of this study.

[6] For more detailed methodology and the codes of patent matching of the NBER Patent Data Project, please refer to https://sites.google.com/site/patentdataproject/Home.

1999 and 2007, the Innofund Program supported 6167 projects (some firms were backed by Innofund more than once), including manufacturing and non-manufacturing firms. We first match the Innofund-backed firms to the ASIFP database through “standard names”, locations (at the city level[7]), and industries of firms to generate a matched file called “full matching”. Subsequently, we match Innofund-backed firms to the ASIFP database by “stem names”, locations (at the city level) and industries of the firm to generate a matched file called “partial matching”. By using “stem names” to conduct the matching, we attempt to capture potentially missed cases by matching “standard names” (we might not be able to exhaust all expressions of the legal entity identifiers and convert them into standard identifiers when we create “standard names”). We then combine the matching results of the two matching approaches and delete the duplicates by using each firm’s identical legal person code by year. After computerized matching, we manually cross-check the matching results to ensure the accuracy of matching results using Google and Baidu search engines. Finally, 2638 firms in the manufacturing sector that won Innofund at least once between 1999 and 2007 are identified for the estimations.[8] We then build the panel data for the identified firms (Brandt et al., 2012). The final sample consists of 18,224 firm-year observations for Innofund-backed firms.

We are interested in the effects of Innofund on a firm’s access to external financing with the focus on debts and equity investment the firm receives. We take the logarithm values of short- (***Debt_short***) and long-term debts (***Debt_long***), and total debts (***Debt_total***) as well as the total equity (***Equity***) as our dependent variables. It is worth noting that the linear regression model estimates the unit change between the independent and dependent variables. The unit change becomes the percentage change after the dependent variable is converted to a logarithmic format. Given that all of our dependent variables related to external financing are transformed into logarithmic form, we interpret our findings in terms of percentage change rather than unit change. Thus, these dependent variables represent growth rates when we interpret the economic meanings of our estimates.

We use a difference-in-differences (DID) approach to examine the causal effect of Innofund on firms’ access to external financing. ***Innofund*** is a dummy variable that equals one if a firm once received Innofund support and zero if otherwise. A significantly positive coefficient on this variable implies that Innofund-backed firms generally have better access to external financing than non-Innofund-backed firms before the inward of the grant. ***After*** is a dummy variable used to divide the entire examination period into two parts: the period before and after the first round of Innofund infusion, and it equals one for the period after a firm gains the subsidies for the first time and equals zero if otherwise.[9] The value of this variable for the firms in the control group is determined by their pairs in the Innofund-backed group. We use this variable to capture the change in the control group before and after the infusion of Innofund support. Finally, an interaction term of ***Innofund*** and ***After*** will be included in DID estimates to examine the changes of differences in external financing between the Innofund-backed and non-Innofund-backed firms before and after the government support, identifying the causal relationship between the Innofund support and firms’ access to external financing.

A series of variables related to firm characteristics and a firm’s financing ability is controlled, and these variables are derived from the ASIFP (1998–2007). ***Firm_Age*** is measured by the logarithm form of the age of a firm in a given year. At the firm-specific level, ***Firm_Age*** is adjusted in a panel data manner to minimize statistical error. ***Firm_Size*** is measured by the logarithm form of the total number of employees of the firm. We suppose that a firm’s financing decision at time t is associated with its leverage level at time t-1. We, therefore, control the leverage of the firm in the previous year. ***L. leve*** is the lag ratio of total liability over the total assets of a firm in the previous year. We further control the ratio of fixed assets over total assets (***Fixasset_R***), the ratio of liquid assets over total assets (***Liquidasset_R***) and return over total assets (***ROA***) of a firm to control the influences of the firm’s financial situation on its external funding. A close relationship with the government may significantly influence a firm’s access to external financial resources, given state-owned financial institutions in China dominate the financial market. Therefore, we control the ratio of state ownership over the total equity (***Stateshare***) to capture the relationship between the firm and the government. The variables used are winsorized at the 1st and 99th percentiles to eliminate outliers.

Table 1 reports the summary statistics. Panel A presents the mean values, standard deviations, minimum and maximum of short and long-term debts, total debts, equity investment, and other variables for the Innofund-backed firms.

5. Findings on the government R&D subsidies and external financing of firms

In the subsequent sections, we discuss the estimation findings on the effects of Innofund on firms’ access to external financial resources in general. We also discuss how we address the identification concerns using the PSM strategy alongside other robustness checks.

5.1. Innfund and firms’ access to external financing: selection biases

The major challenges in examining the effects of government R&D support are the difficulties in avoiding selection biases (David et al., 2000). The selection of government R&D grants is not random. Public R&D programs are more likely to choose stronger projects at the time of the project selection (Irwin and Klenow, 1996; Lerner, 2000; Wallsten, 2000; Zhao and Ziedonis, 2020). If this is the case, companies favored by external financiers may be more likely to receive government R&D support, and, in turn, the increase in external financing following government R&D support may be overestimated in empirical studies. Also, because of this cherry-picking screening mechanism, only those companies that meet the selection criteria will likely apply for these government R&D grants.

In the case of China, as we have discussed, the Innofund program has been the most prominent government initiative to support SMTEs, and the selection of programs is highly competitive. Under China’s regionally decentralized authoritarian rule, local governments compete in all areas concerned by the central government (Xu, 2011). Moreover, the Innofund program has an explicit goal of helping SMTEs attract external financing. Thus, to achieve the goal set by the central government, local governments may have a strong incentive to select projects that are attractive for external financing. As a result, cherry-picking is likely to occur during the project selection process. Indeed, empirical studies find

[7] By Chinese law, firm names cannot be the duplicate in the same city and the same industry. Therefore, as long as we control the firm location at city level and 2-digit industry code, there should not be duplicates in firm names.

[8] The number of Innofund-backed firms for the estimations dropped substantially from 6167 (the number of projects backed between 1999 and 2007) to 2638 for the estimations during the examination period because of several reasons. The ASIFP database only covers manufacturing firms, therefore, we cannot include non-manufacturing firms backed by Innofund, thereby reducing the number of Innofund-backed firms in the sample. Non-state-owned firms with sales of less than RMB 5 million are also not included in the ASIFP. Hence, we might have missed some micro-sized firms backed by Innofund. One of the aims of the study is to estimate the ex-post effects of Innofund. Hence, an Innofund-backed firm that lacks information on the year when it received funding is also excluded. Theoretically speaking, we included all state-owned manufacturing firms supported by Innofund and non-state-owned manufacturing firms with more than 5 million RMB in sales (in the year of application) backed by Innofund for the estimations.

[9] As we have the entire list of firms which obtained Innofund grant between 1998 and 2007, we have made sure that the treated group in our estimates have not received the Innofund grant before the time defined by the variable ‘After’.

Table 1
Summary Statistics for Innofund-backed and non-Innofund-backed firms (Random Sample).

	Panel A: Innofund-backed firms					Panel B: Non-Innofund-backed firms					Panel C: T-stat
Variable	Obs	Mean	Std. Dev	Min	Max	Obs	Mean	Std. Dev	Min	Max	Diff
Debt_short	17,627	9.9	1.39	0	13.33	62,223	8.99	1.46	0	13.33	−0.91***
Debt_long	10,415	7.86	2.35	0	11.38	25,902	6.75	2.4	0	11.38	−1.11***
Debt_total	17,775	10.08	1.39	0.69	13.56	63,117	9.11	1.47	0	13.56	−0.96***
Equity	17,443	9.83	1.41	0	13.14	59,862	8.73	1.51	0	13.14	−1.11***
Subsidy	17,847	1.7	2.84	0	8.39	63,713	0.74	1.95	0	8.39	−0.95***
Firm_Age	17,845	2.15	0.74	0	3.4	63,695	2.15	0.77	0	3.4	−0.005
Stateshare	17,702	0.1	0.27	0	1	62,776	0.12	0.31	0	1	0.02***
Firm_Size	17,847	5.14	1.08	0	8.15	63,713	4.6	1.02	0	8.15	−0.54***
Fixasset_R	17,714	0.25	0.16	0.01	0.85	62,775	0.29	0.19	0.01	0.85	0.04***
Liquidasset_R	17,799	0.56	0.2	0	1.12	63,388	0.58	0.23	0	1.12	0.02***
ROA	17,799	0.056	0.087	−0.184	0.917	63,388	0.049	0.117	−0.294	0.907	0.007***
Leverage	17,799	0.56	0.22	0.01	1.56	63,388	0.6	0.28	0.01	1.56	0.04***

Note: * = $p < 0.1$; ** = $p < 0.05$; *** = $p < 0.01$.

significant selection biases of government R&D programs in China (Guo et al., 2016; Boeing et al., 2016).

Therefore, before we examine the effects of the Innofund program, we first test the selection biases of this program to help us build up a methodological foundation to deal with the selection issues. To test the selection issues, we first build up a randomly selected control group by applying the Innofund selection criteria. The control group is generated in several steps to ensure that the results are not driven by a specific matching method. The non-Innofund-backed firms (i.e., eligible for Innofund but did not apply or win in a given year) are initially identified from the ASIFP. The Innofund selection criteria are officially announced each year. A firm is eligible for Innofund application if it has an industry code that is the same as one of the awarded group's codes, has fewer than 500 employees, and has a leverage ratio lower than 70%. After the firms eligible for Innofund application but not awarded are determined, one-to-five matched pairs are randomly drawn from the eligible sample to formulate the control group of Innofund-backed firms while controlling for location (provincial level). The pseudo Innofund year of the non-Innofund-backed counterpart is the same as the granting year for the matched Innofund-backed firms. Such an approach allows us to conduct detailed comparisons between Innofund- and non-Innofund-backed firms in different dimensions. Finally, 64,474 firm-year observations are obtained for 12,025 eligible firms.[10] However, these firms are eligible but not supported by the Innofund program.

Panel B of Table 1 reports the summary statistics of the randomly-matched non-Innofund-backed firms. Panel C presents the *t*-test results for the comparison between the randomly matched control group and the Innofund-backed firms. It shows that the two groups are significantly different in many aspects. In particular, on average, Innofund-backed firms have better access to debts measured by all means, equity investment and government subsidies than their non-Innofund-backed counterparts in the randomly matched sample. Meanwhile, Innofund-backed firms hire more employees than non-Innofund-backed ones. By contrast, on average, non-Innofund-backed firms have more state ownership, higher fixed and liquid asset ratios, higher leverage ratio and higher return over assets than Innofund-backed firms.

Based on this randomly selected sample, we examine whether the Innofund-backed firms have better access to external financing than non-Innofund-backed ones at the time of winning the grant. Falsification placebo tests are conducted using 'fake' treatments one year before the award of an Innofund to demonstrate whether there are pre-Innofund selection effects. The specification of the regression model is seen as following:

$$Y_{i,\,t-1} = \beta_0 + \beta_1 pseudoInnofund_{i,\,t} + \beta_2 Z_{i,\,t-1} + \theta_t + e_{i,t} \quad (1)$$

where $Y_{i,\,t-1}$ is firm *i*'s access to different external financing sources one year before the award of an Innofund, including the short-term debts, long-term debts, total debts and total equity, which are all transformed into logarithm format. ***PseudoInnofund$_{i,t}$*** is a dummy variable, and it equals one if the firm *i* received the Innofund award at time *t* and equals zero if otherwise. β_1 is the estimated coefficient capturing the firm's access to external financial resources in relation to the Innofund selection. $Z_{i,\,t-1}$ is a vector of firm-level characteristics we control for, including ***Firm_Age, Firm_Size, L. leve, Fixasset_R, Liquidasset_R, ROA and Stateshare***. We also incorporate controls for year fixed effects (θ_t) in this pooled cross-section analysis.

Table 2 presents the results. It shows that all the debt and equity measures are significantly and positively correlated with ***pseudoInnofund***, implying that the ex-ante selection exists when government provides R&D subsidies. Firms chosen by Innofund generally have better access to external financing than other firms when winning the grant, suggesting cherry-picking of the government R&D support in China, consistent with the findings in the existing literature (Guo et al., 2016; Boeing et al., 2016).

Table 2
Test for Innofund selection (Random Sample).

	(1)	(2)	(3)	(4)
	Debt_short	Debt_long	Debt_total	Equity
Pseudo-Innofund	0.333***	0.436***	0.345***	0.440***
	(0.029)	(0.083)	(0.028)	(0.031)
Firm_Age	−0.075***	−0.093*	−0.070***	−0.079***
	(0.019)	(0.050)	(0.018)	(0.021)
Stateshare	−0.018	0.300***	0.047	−0.054
	(0.046)	(0.110)	(0.043)	(0.052)
Firm_Size	0.840***	0.726***	0.847***	0.814***
	(0.018)	(0.042)	(0.018)	(0.019)
Fixasset_R	−1.661***	−0.963***	−1.655***	−1.463***
	(0.099)	(0.234)	(0.095)	(0.106)
Liquidasset_R	−0.677***	−2.799***	−1.020***	−1.151***
	(0.084)	(0.210)	(0.082)	(0.091)
ROA	−1.364***	−0.726***	−1.410***	0.021
	(0.117)	(0.275)	(0.114)	(0.136)
L.Leve	1.114***	1.031***	1.199***	−2.066***
	(0.078)	(0.142)	(0.078)	(0.139)
_cons	5.396***	5.111***	5.623***	7.248***
	(0.133)	(0.312)	(0.124)	(0.150)
Year FE	Y	Y	Y	Y
N	6949	3143	6999	6726
adj. R-sq	0.453	0.392	0.487	0.443

Note: Values in parentheses are standard errors; * = $p < 0.1$; ** = $p < 0.05$; *** = $p < 0.01$.

[10] In total, there are as many as 290, 107 firms that are eligible for matching.

5.2. Innfund and firms' access to external financing: ex-post effects

Next, we examine the ex-post effects of the Innofund program on firms' access to external financing. As we showed in the previous subsection, the Innofund selection process has a "cherry-picking" tendency, suggesting that winning Innofund support is endogenous. As a result, the chosen firms might have stronger financing ability than others before the government support was infused. Meanwhile, some unobservable factors co-exist with the Innofund backing, such as the management, technology, or market changes that favor the external funding for firms. Therefore, when we examine the ex-post effects of the subsidies, it is critical to control such selection effects to identify the causal relationship between the government R&D support and firms' capability to attract external financing afterward.

To address the abovementioned identification concerns, we employ a matched DID method, which combines the ordinary DID estimations with PSM matching. We first employ the PSM algorithm to construct a control sample. The propensity score is the probability of the treatment assignment, which is conditional on the observed baseline characteristics that enable us to design a nonrandomized study and mitigate the selection issues of a randomized trial (Austin, 2011). In our context, we choose the PSM approach proposed by Rosenbaum and Rubin (1985) because it eliminates a significant proportion of the systematic difference in baseline characteristics between treated and untreated subjects than the stratification on propensity score or the covariate adjustment using such a score does (Austin et al., 2007). One significant limitation of the PSM methodology is its inability to determine the impact of unobservable variables. Missing variables instead of Innofund may contribute to the improved financing capability. For instance, we could not measure the risk of firms' R&D projects or observe the special connection between managers and local financial institutions by existing data. However, these factors may contribute to firms' capability to get externally financed. We employ the DID approach in our panel analysis based on the PSM sample to overcome such concerns. DID is a quasi-experimental approach to study the effect of a treatment by estimating the differences between the treatment and control group of the changes in the outcome variables that occur over time. It thereby captures both the between and within-group differences that help to mitigate concerns with unobservable variables.

We match Innofund-backed firms with non-Innofund-backed ones with multiple dimensions for the year before Innofund awarding. In the context of our study, the propensity score is the predicted probability that a firm will win Innofund support. Following Austin et al. (2007), we choose matching variables related to the treatment and the outcome of the PSM models to improve the balance of the matching process. Innovation capability is the primary consideration in Innofund project selection and is an important signal for the firm to finance its R&D project. Therefore, we include the patent stock of firms, which is a major indicator of firms' innovation capabilities in the matching process. We also control the size (measured by the number of employees), location, and age of firms. Better financial situations enable a firm to accumulate more capital and collateral and send positive signals to external financiers, which may help attract external financing. Therefore, we include the firm's return over total assets (ROA) as one of the controls for the PSM matching. Besides, we also control the output variables in the PSM matching. The total liability, total equity, short-term debts, and long-term debts of a firm are controlled. Meanwhile, we lag all explanatory variables for one period in estimating the logit model to predict the propensity score. We apply the one-to-five nearest-neighbor PSM to identify non-Innofund-backed firms.[11]

The comparison between Innofund-backed firms and matched non-Innofund-backed firms in terms of the matching variables is shown in Table 3.[12] We also conduct balancing tests for some major matching variables to examine the matching quality, as shown in Table A-1. Table A-1 presents the *t*-test results for the balancing tests and the global measures for the matching quality for each year, including LR Chi squares, *P*-values of LR tests, and the Pseudo R-squares for each year. The t-tests shown in Table 3 and balancing tests in the appendix confirm no statistically significant difference between the two groups regarding matching indices except for patent stocks in Table 3.

To further check the matching quality, we rerun the falsification placebo tests based on the matched sample. The results are shown in Table A-2. In general, the placebo tests suggest no significant difference between the treated and control groups constructed by PSM regarding access to external financing one year before the award of an Innofund. Specifically, it shows no statistically significant relationship between the Innofund award and the growth of firms' access to short-run debts, long-run debts or equity investment one year before the award of an Innofund. The only exception is that the growth of the total debts is significantly lower for Innofund-backed firms though the economic meaning is very slim.

Based on this rigorously matched sample, we employ the DID approach to estimate the ex-post effects of the Innofund. The regression specification is as follows:

$$Y_{it+1} = \beta_0 + \beta_1 Innofund_i + \beta_2 After_{it} + \beta_3 Innofund_i{*}After_{it} + \beta_4 Z_{it} + \theta_t + e_{it} \tag{2}$$

where Y_{it+1} is firm *i*'s access to different sources of external financing in year *t+1*, including ***Debt_short, Debt_long, Debt_total and Equity,*** which refer to the short-term debts, long-term debts, total debts and total equity of a firm in logarithm format. $\boldsymbol{Innofund_i}$ is a dummy variable, and it is equal to one if firm *i* received the Innofund award any time in our examination period and equals zero if otherwise. $\boldsymbol{After_{it}}$ is a dummy variable defining the time before and after the Innofund infusion for firm *i* and its counterparts in the control group at time *t*. The interaction term of $\boldsymbol{Innofund_i}$ and $\boldsymbol{After_{it}}$ is included in the DID estimates to identify the ex-post effects of the Innofund infusion. β_3 is the coefficient capturing the differences between the treated and control groups and the within-group differences over time regarding firms' access to external financial resources. Z_{it} is a vector of firm-level characteristics we control for, and it includes *Firm_Age, Firm_Size, L. leve, Fixasset_R, Liquidasset_R, ROA and Stateshare*. We also control time trends in a firm's access to external financial resources (using year fixed effects θ_t).

Table 4 presents the results. Panel A presents the estimation results on the relationship between the growth of external funding, including

Table 3
Comparison for major variables of Innofund-backed firms and PSM sample.

T-test at the Innofund awarded year			
Variable	Innofund	Non-innofund	Diff
Ln_total patent count	0.530	0.445	0.086***
Ln_staff	4.982	4.983	−0.001
Ln_total liability	9.840	9.850	0.010
Ln_Equity	9.635	9.645	−0.010
ROA	0.080	0.077	0.003
Ln_Long term debt	4.162	4.168	−0.006
Ln_age	1.983	1.976	0.007
Ln_short term debt	9.570	9.572	0.002

Note: *** = p < 0.01.

[11] The reasons why we apply the one-to-five nearest-neighbor PSM to identify non-Innofund-backed firms are as follows. First, as explained before, there are as many as 290,107 firms eligible for matching in the sample of potential control group, which makes it possible that we are able to construct a 1-to-m matched control group with m larger than 1. If we use 1-to-1 matching, many qualified firms would be discarded from the control group, which leads to reduced power of explanation (Stuart, 2010). Second, 1-to-m matching with increasing "m" can help to reduce the standard errors of comparisons (Rosenbaum and Rubin, 1985; Rubin and Thomas, 1996).

[12] We use log-transformation of all control variables except ROA to do the balancing test.

Table 4
Government R&D programs and firms' external financing (DID estimations).

Panel A: DID estimator defined with Innofund and After

	(1) Debt_short	(2) Debt_long	(3) Debt_total	(4) Equity
Innofund	0.004	0.077*	−0.002	0.020
	(0.022)	(0.046)	(0.021)	(0.023)
After	0.035***	0.027	0.024***	−0.013
	(0.009)	(0.027)	(0.008)	(0.009)
Innofund*After	0.158***	0.199***	0.175***	0.226***
	(0.017)	(0.049)	(0.016)	(0.017)
Firm_Age	0.138***	−0.002	0.152***	0.127***
	(0.012)	(0.023)	(0.012)	(0.012)
Stateshare	0.029	0.338***	0.051***	0.031
	(0.019)	(0.047)	(0.019)	(0.022)
Firm_Size	0.578***	0.610***	0.574***	0.555***
	(0.011)	(0.018)	(0.011)	(0.010)
Fixasset_R	−0.960***	−0.131*	−0.944***	−0.671***
	(0.034)	(0.078)	(0.032)	(0.034)
Liquidasset_R	−0.303***	−1.956***	−0.459***	−0.877***
	(0.027)	(0.070)	(0.025)	(0.027)
ROA	−1.192***	−1.314***	−1.229***	0.146***
	(0.050)	(0.122)	(0.049)	(0.052)
L.Leve	0.655***	0.958***	0.682***	−0.972***
	(0.029)	(0.062)	(0.030)	(0.032)
_cons	6.848***	5.252***	7.074***	8.035***
	(0.059)	(0.116)	(0.059)	(0.056)
Year FE	Y	Y	Y	Y
N	69,880	38,306	70,542	69,396
adj. R-sq	0.269	0.174	0.294	0.285
N_clust	13,247	10,638	13,287	13,272

Panel B: DID estimator defined with Innofund, After and Innoamt

	(1) Debt_short	(2) Debt_long	(3) Debt_total	(4) Equity
Innofund	0.004	0.062	−0.000	0.021
	(0.022)	(0.046)	(0.021)	(0.022)
After	0.035***	0.021	0.025***	−0.011
	(0.009)	(0.027)	(0.008)	(0.009)
Innofund*After*Innoamt	0.002***	0.003***	0.002***	0.003***
	(0.000)	(0.001)	(0.000)	(0.000)
Firm_Age	0.138***	−0.003	0.152***	0.127***
	(0.012)	(0.023)	(0.012)	(0.012)
Stateshare	0.029	0.339***	0.051***	0.031
	(0.019)	(0.047)	(0.019)	(0.022)
Firm_Size	0.578***	0.609***	0.574***	0.555***
	(0.011)	(0.018)	(0.011)	(0.010)
Fixasset_R	−0.961***	−0.131*	−0.945***	−0.672***
	(0.034)	(0.078)	(0.032)	(0.034)
Liquidasset_R	−0.303***	−1.956***	−0.460***	−0.878***
	(0.027)	(0.070)	(0.025)	(0.027)
ROA	−1.191***	−1.312***	−1.228***	0.146***
	(0.050)	(0.122)	(0.049)	(0.052)
L.Leve	0.655***	0.959***	0.682***	−0.972***
	(0.029)	(0.062)	(0.030)	(0.032)
_cons	6.849***	5.262***	7.075***	8.037***
	(0.060)	(0.116)	(0.060)	(0.056)
Year FE	Y	Y	Y	Y
N	69,880	38,306	70,542	69,396
adj. R-sq	0.269	0.174	0.284	0.285
N_clust	13,247	10,638	13,287	13,272

Note: Values in parentheses are standard errors; * = p < 0.1; ** = p < 0.05; *** = p < 0.01.
Note: Values in parentheses are standard errors; * = p < 0.1; ** = p < 0.05; *** = p < 0.01.

short-term debts, long-term debts, total debts, and total equity, and the interaction term defining the DID estimator. We find no statistically significant relationship between ***Innofund*** and firms' access to external financing, except for the long-term debts. Such results are consistent with our PSM tests that there are no systematically significant differences between firms backed by the Innofund and those in the control group in terms of the access to external financing before the infusion of Innofund. However, we observe that firms' access to external financing, measured by all means, are significantly and positively correlated with the interaction term, suggesting that the Innofund support helps firms access more external financial resources after controlling both the between and within-group differences based on our matched sample. For example, the growth of short and long-term debt financing of Innofund-backed firms is significantly higher by 15.8% and 19.9%, respectively, than non-Innofund-backed firms after Innofund infusion. Similarly, the growth of total equity of Innofund-backed firms is significantly higher by 22.6% than that of non-Innofund-backed firms after Innofund injection.

Zhao and Ziedonis (2020) find that the amount of subsidy received affects the subsidy's effect. To specify the qualitative and quantitative impacts of Innofund, we look at the effects of the grant size (i.e., ***Innoamt***) on firms' access to external financing. The regression specification is as follows:

$$Y_{it+1} = \beta_0 + \beta_1 Innofund_i + \beta_2 After_{it} + \beta_3 Innofund_i{*}After_{it}{*}Innoamt_i + \beta_4 Z_{it} + \theta_t + e_{it} \quad (3)$$

where all the major variables stay the same as those of equation (2), we introduce $\boldsymbol{Innoamt_i}$ into the interaction term.

Panel B reports the relationship between the growth of external funding and the DID estimators. The results are similar to those shown in Panel A. It shows that the growth of a firm's external financing is significantly and positively correlated to the interaction term of $\boldsymbol{Innofund_i}$, $\boldsymbol{After_{it}}$ and $\boldsymbol{Innoamt_i}$, implying quantitative effects of the government subsidies on firms' access to external financing. After being granted by Innofund, an increase of 10,000 RMB Innofund grant may lead to a 0.2% increase in short-term debts, a 0.3% increase in long-term debts. In addition, a rise of 10,000 RMB is expected to induce a 0.3% increase in the difference in equity between Innofund-backed and non-Innofund-backed firms after the grant's infusion.

Finally, the firm size and age are positively associated with the growth of debts (except for long-term debts and firm age) and equity, implying that bigger firms and more mature firms are more attractive to debt issuers and equity investors. Meanwhile, state ownership is significantly and positively correlated with long-term and total debts but insignificantly associated with equity growth, implying that firms with higher state ownership may have more access to bank loans, especially long-term bank loans but are not more attractive for equity investors than other firms. Interestingly, the previous year's leverage ratio is significantly and positively associated with the growth of debts and significantly and negatively related to the growth of total equity. Such results are understandable because the average leverage ratio of firms in our sample is not high (55%), and the track records with lenders and the repeated games may help firms with debts to have a better chance to borrow from banks. Meanwhile, according to the pecking order of external financing (Myers and Majluf, 1984), debts are cheaper than equity as long as the firm is financially healthy. So, firms with a high chance to borrow debts from external financiers may choose not to seek equity investment. Additionally, ROA is significantly and negatively associated with the measurements for debt growth but significantly and positively correlated to the equity investment growth. Finally, the liquid and fixed assets are significantly and negatively associated with the growth of external financing measured by all means.

To ensure the robustness of the examinations, we also build up the PSM sample by selecting different numbers of nearest neighbors (e.g., one-to-one, one-to-three, one-to-four and one-to-five)[13] in the matching.

[13] We do not choose a larger than five nearest neighbor matching because the more relaxed the matching criteria we employ the less quality of the matching will be. In such a case, we will not be able to secure that the controlled group is sufficiently similar to the treated group at the time of treatment.

The matching quality stays. The results based on the one-to-one matching sample are presented in Table A-3, showing that the results shown in Table 4 stay robust (the results of other matching quality tests for the robustness checks are provided by request).

To sum, the results shown in Table 4 suggest that after controlling the between and within-group differences, Innofund-backed firms experience significantly higher growth in terms of external financial resources, including bank loans, both short-term and long-term ones, and equity investment. Using the matched DID approach, we have controlled both the observable and unobservable variables that help us to establish the causal relationship between the Innofund support and firms' external financing. Such results support Hypothesis 1, which predicts that government R&D programs facilitate firms to obtain more external financing in China.

6. The mechanisms: funding effects or certification effects

We have demonstrated the causal relationship between the Innofund award and a firm's ability to access external financing, employing DID method. This section explores the mechanisms through which the government R&D programs affect a firm's access to external financing.

6.1. Funding mechanisms

We first examine funding effects. As discussed, funding effects may work through two channels, i.e., the equity and prototyping channels. If the equity channel is valid, firms should improve their financial performance after the financial constraints are relaxed with government support. As a result, it may be easier for firms to access external funding from banks or equity investors with such performance improvements. To examine such a Hypothesis, we look at the relationship between the Innofund grant and firms' performance. We use three measurements to capture the financial performance of the firm, i.e., the return over total assets (***ROA***), the return over total equity (***ROE***), and the return over total sales (***ROS***). It is worth noting that this test of mechanisms is an indirect test. We test whether the Innofund increases firms' return; if it does, we infer that the magnified external financing an Innofund-backed firm wins after the infusion of the Innofund is caused by the performance improvements of the firm, confirming the equity channel of the funding mechanism.

To estimate the prototyping channel, we use a few measures to capture the viability of the technology. First, we use the variable ***Ln_NP*** to capture the market growth of the new products, which is the sales value from new products that a firm generates in a given year in a natural logarithm format. Second, we look at patents a firm develops in a given year. ***Patent_F*** is the total number of newly granted patents of the firm in a given year. ***Patent_Ivt*** is the total number of newly granted invention patents of the firm in a given year. Patent data are obtained from the State Intellectual Property Office patent database. We apply a similar matching strategy of Guo et al. (2016) to match the patent data with our sampled firms. Again, we use the matched DID approach in the estimations. The regression model is as follows:

$$Y_{it+1} = \beta_0 + \beta_1 Innofund_i + \beta_2 After_{it} + \beta_3 Innofund_i{*}After_{it} + \beta_4 Z_{it} + \theta_t + e_{it} \tag{4}$$

where Y_{it+1} is firm i's financial performance or the viability of the technology in year $t+1$, including ***ROA, ROE, ROS, Ln_NP, Patent_F*** and ***Patent_Ivt. $Innofund_i$***, ***$After_{it}$***, and θ_t are defined the same as they are in Equation (2). Z_{it} is a vector of firm-level characteristics, which includes ***Firm_Age, Firm_Size, L. leve, Fixasset_R, Liquidasset_R*** and ***Stateshare***.

Table 5 reports the results. As shown in Models (1) to (3), we do not observe any statistical relationship between the interaction term and firms' financial performance measured by ***ROE*** or ***ROS***. Moreover, we even observe a significant and negative relationship between the interaction term and ***ROA*** that is understandable given the positive debt growth of the firm after winning the Innofund. In general, the results shown in Models (1) to (3) suggest that government support does not seem to help firms improve financial performance in China. Therefore, these findings do not support the equity channel for funding effects.

Models (4) to (6) present the relationship between the Innofund support and the firm's technology viability measured by the sales from new products and patenting activities. It shows a significant and positive relationship between the interaction term and the prototyping measurements. Model (4) shows that the change in the growth rate of sales from new products for Innofund-backed firms after winning the grant is 61.4% higher than that of non-Innofund-backed firms. Model (5) shows that the increase in the number of newly granted patents of all types for Innofund-backed firms after winning the grant is 0.52 higher than that of non-Innofund-backed firms. Similarly, model (6) shows that the increase in the number of newly granted invention patents for Innofund-backed firms after the grant appropriation is 0.17 higher than non-Innofund-backed firms. We further conduct estimates in which we introduce the amount of the grant received by firms into the interaction term. The results are similar to those of Table 5 (results are provided by request).

To sum, the results shown in Table 5 imply that government subsidies do not seem to help firms improve financial performance, but it indeed helps firms improve their technological viability. Combining the results shown in Tables 4 and 5, we suggest that Hypothesis 2b is supported while hypothesis 2a is rejected. The funding effects of government support mainly work through the prototyping channel. Such results are consistent with those of Howell's study (2017) based on the US data.

6.2. Certification mechanisms

Next, we examine the certification mechanism. Hypothesis 3a predicts that if government R&D programs work through the quality certification channel, the more severe the information asymmetries associated with firm quality identification, the more likely we observe a significant positive effect of government R&D subsidies on firms' access to external financing. As evident by Aboody and Lev (2000) and other empirical studies (e.g., Gompers, 1995), R&D is a significant contributor to information issues and insider gains.

To examine our Hypothesis, we need to measure information asymmetries associated with a firm. In this study, we use both firm-level and industry-level measures for the information asymmetries, i.e., a firm's age and the R&D intensity at the industry level. It is hard to find proper measures for information issues, especially for privately-held firms. Different from listed firms, privately-held firms do not have to disclose information to the public. Meanwhile, we could not observe bid-ask spreads, share return volatility or share trading volume of the firm, which are usually used for measuring asymmetric information in the literature. Firm age is widely used to proxy information asymmetries for privately held firms (Gompers, 1995; Maskara and Mullineaux, 2011). The rationale is that as a company grows, it accumulates more tangible assets, track records of performance, products, marketing, service and hiring events, all of which bring more information to the outside world about the operation of the business. Moreover, accessing some of the mentioned information does not rely on whether the firm has applied for a bank loan or not before. We therefore take firm age as one of the measurements for information asymmetries in our study. However, we do realize the limitation of this proxy and therefore employ the industry-level R&D intensity as an additional measure to capture the severity of firms' information issues related to firm quality identification. Industries with a higher level of R&D intensity may be subject to more significant information asymmetries, increasing the difficulties for external financiers to identify firms' quality in such industries (Gompers, 1995). The regression model we estimate is the follows:

Table 5
Government R&D support and the performance of firms: Examinations on funding mechanisms.

	(1)	(2)	(3)	(4)	(5)	(6)
	ROA	ROE	ROS	Ln_NP	Patent_F	Patent_Ivt
Innofund	0.000	0.002	0.021***	1.578***	−0.065	0.021
	(0.002)	(0.006)	(0.002)	(0.087)	(0.058)	(0.043)
After	−0.002*	−0.018***	−0.009***	−0.172***	−0.279***	−0.077
	(0.001)	(0.004)	(0.001)	(0.039)	(0.070)	(0.065)
Innofund*After	−0.006***	−0.011	−0.001	0.614***	0.522***	0.173***
	(0.002)	(0.007)	(0.003)	(0.095)	(0.096)	(0.059)
Firm_Age	−0.015***	−0.036***	−0.018***	0.291***	−0.082**	−0.006
	(0.001)	(0.004)	(0.001)	(0.036)	(0.036)	(0.031)
Stateshare	−0.014***	−0.073***	−0.048***	0.173**	−0.113***	−0.036
	(0.002)	(0.008)	(0.004)	(0.082)	(0.043)	(0.030)
Firm_Size	0.003***	0.006**	0.014***	0.772***	0.372***	0.117**
	(0.001)	(0.003)	(0.001)	(0.028)	(0.055)	(0.045)
Fixasset_R	0.006	0.007	−0.072***	−0.791***	−0.662***	−0.320**
	(0.004)	(0.014)	(0.005)	(0.104)	(0.155)	(0.140)
Liquidasset_R	0.008***	0.058***	−0.006	−0.083	0.046	−0.066
	(0.003)	(0.012)	(0.004)	(0.089)	(0.102)	(0.081)
L.leve	−0.032***	−0.012	−0.043***	−0.186**	−0.192**	−0.021
	(0.003)	(0.011)	(0.003)	(0.072)	(0.086)	(0.061)
_cons	0.108***	0.215***	0.056***	−2.391***	−0.376	−0.028
	(0.005)	(0.017)	(0.007)	(0.169)	(0.328)	(0.295)
Year FE	Y	Y	Y	Y	Y	Y
N	70,590	70,538	70,463	62,546	70,590	70,590
adj. R-sq	0.009	0.004	0.01	0.025	0.03	0.018
N_clust	13,288	13,286	13,283	13,264	13,288	13,288

Note: Values in parentheses are standard errors; * = p < 0.1; ** = p < 0.05; *** = p < 0.01.

$$Y_{it+1} = \beta_0 + \beta_1 Innofund_i + \beta_2 After_{it} + \beta_3 Innofund_i{*}After_{it} + \beta_4 Innofund_i{*}After_{it}{*}C_{it} + \beta_5 Z_{it} + \theta_t + e_{it} \quad (5)$$

where Y_{it+1} is firm *i*'s access to different external financing sources in year *t+1* as defined in Equation (2), i.e., the short-term debts, long-term debts, total debts and total equity of a firm in logarithm format. $\boldsymbol{Innofund_i}$, $\boldsymbol{After_{it}}$, Z_{it}, and θ_t are defined the same as they are in Equation (2) as well. C_{it} is used to measure the degree of information asymmetries relevant to firm quality identification, and it could be either firm age or industry-level R&D intensity. To test our Hypothesis 3a, we add the interaction terms of the measurements for information issues associated with firm quality (C_{it}), the Innofund award ($\boldsymbol{Innofund_i}$), and $\boldsymbol{After_{it}}$ into our regression model. β_4 captures how information issues moderate the effect of Innofund subsidies on firms' access to external financing.

Table 6 reports the results for the estimations of the quality channel of certification mechanisms. Panel A reports the regression results in which firm age is used as a measure for information issues. It shows that both ***Firm_Age*** and the interaction term of ***Innofund*** and ***After*** are positively associated with a firm's access to external financing measured by all means except for the long-term debts, consistent with the findings shown in other examinations. Such results suggest that the causal relationships between Innofund support and firms' access to external financing stay as robust. Meanwhile, the more mature a firm is, the more attractive a firm is to external financiers. However, the interaction terms of ***Innofund, After*** and ***Firm_Age***, have no statistically significant relationship with any measurement for firms' access to external financing, indicating that the Innofund effect does not depend on firm age.

Panel B presents the results in which industry-level R&D intensity measures information issues relevant to firm quality. It shows that the R&D intensity of the industry is significantly and positively associated with all measures for external funding of a firm except for the long-term debts. Such results may imply that with the government policies to stimulate high-tech industries, firms in high-tech industries have better access to external funding than firms in other industries. However, we do not observe a statistically significant relationship between the interaction terms of ***Innofund, After*** and ***R&D intensity*** and a firm's growth in debts measured by all means. Meanwhile, we observe a significantly negative relationship between the interaction term of ***Innofund, After*** and ***R&D intensity*** and a firm's growth in equity investment. The results are consistent with those shown in Table 6 if we replace the dummy variable of the Innofund grant with the total amount of funding received by the firms in the interaction terms (results are provided by request).[14]

The results shown in Table 6 suggest that Innofund's effects on firms' access to external financing are not sensitive to information issues, which may help external financiers to identify the firm quality. Therefore, we find no evidence for government support's quality certification effects as predicted in Hypothesis 3a.

Finally, we examine the political capital channel of certification effects. Hypothesis 3b predicts that if the government R&D support serves as a certificate for political capital, government-supported firms may be more likely to gain further public subsidies than other firms. Meanwhile, government R&D subsidies should have more potent effects for firms in regions where the local governments are more efficient and are more supportive of a market economy.

To examine the assumptions mentioned above, we first examine the growth of government subsidies (***Subsidy***) after the Innofund infusion. Table 7 reports the results in which DID approach is applied. Model (1) shows that the interaction terms of ***Innofund*** and ***After*** are significantly and positively associated with the growth of the subsidies that the firm gains from the government. Specifically, the growth of government subsidies increases by 52% after the firm wins the Innofund grant compared to those of non-Innofund-backed firms. In Model (2), we introduce ***Innoamt*** in the interaction term to estimate the ex-post effects of the value of the Innofund award. An increase of 10,000 RMB is associated with a 0.7% increase in subsidy afterward. These estimations suggest that firms gain further support from the government after being

[14] Exploring the reasons why the interaction term Innofund, After, R&D intensity has a negative effect on Innofunds firms' growth of equity investment is beyond the capacity of this study because to answer this question, we need to have much more data on firm R&D activities and the returns of investing in R&D activities. A potential explanation is that private equity investors such as venture capitalists target at investment returns and normally choose to invest in technologies which can be commercialized soon because of the life span limit of the private equity funds (Guo and Jiang, 2013).

Table 6
Government R&D support, information issues with firm quality and firms' external financing: Examinations on the quality channel of certification mechanisms.

Panel A: Information issues measured by firm age

	(1)	(2)	(3)	(4)
	Debt_short	Debt_long	Debt_total	Equity
Innofund	0.006	0.076	−0.003	0.019
	(0.022)	(0.047)	(0.022)	(0.022)
After	0.035***	0.027	0.023***	−0.013
	(0.009)	(0.027)	(0.008)	(0.009)
Innofund*After	0.111*	0.210	0.198***	0.248***
	(0.057)	(0.147)	(0.050)	(0.053)
Firm_Age	0.138***	−0.002	0.152***	0.127***
	(0.012)	(0.024)	(0.012)	(0.012)
Innofund*After*Firm_Age	0.019	−0.004	−0.009	−0.009
	(0.022)	(0.056)	(0.020)	(0.022)
Stateshare	0.029	0.338***	0.051***	0.031
	(0.019)	(0.047)	(0.019)	(0.022)
Firm_Size	0.578***	0.610***	0.574***	0.555***
	(0.011)	(0.018)	(0.011)	(0.010)
Fixasset_R	−0.960***	−0.131*	−0.944***	−0.671***
	(0.034)	(0.078)	(0.032)	(0.034)
Liquidasset_R	−0.302***	−1.957***	−0.460***	−0.877***
	(0.027)	(0.070)	(0.025)	(0.027)
ROA	−1.192***	−1.314***	−1.229***	0.145***
	(0.050)	(0.122)	(0.049)	(0.052)
L.Leve	0.655***	0.959***	0.682***	−0.972***
	(0.029)	(0.062)	(0.030)	(0.032)
_cons	6.848***	5.251***	7.074***	8.034***
Year-Fixed Effect	Y	Y	Y	Y
N	69,880	38,306	70,542	69,396
adj. R-sq	0.231	0.175	0.251	0.26
N_clust	13,247	10,638	13,287	13,272

Panel B: Information issues measured by industry-level R&D intensity

	(1)	(2)	(3)	(4)
	Debt_short	Debt_long	Debt_total	Equity
Innofund	0.001	0.089*	−0.006	0.018
	(0.022)	(0.047)	(0.022)	(0.023)
After	0.037***	0.010	0.024***	−0.009
	(0.009)	(0.028)	(0.008)	(0.009)
Innofund*After	0.187***	0.127	0.181***	0.258***
	(0.029)	(0.081)	(0.027)	(0.027)
R&D Intensity	0.031***	0.002	0.032***	0.058***
	(0.011)	(0.026)	(0.010)	(0.011)
Innofund*After*R&D Intensity	−0.020	0.049	−0.001	−0.026*
	(0.015)	(0.042)	(0.013)	(0.014)
Firm_Age	0.135***	−0.002	0.147***	0.122***
	(0.012)	(0.024)	(0.012)	(0.012)
Stateshare	0.022	0.348***	0.042**	0.026
	(0.019)	(0.048)	(0.020)	(0.023)
Firm_Size	0.582***	0.610***	0.576***	0.558***
	(0.011)	(0.018)	(0.011)	(0.010)
Fixasset_R	−0.940***	−0.123	−0.920***	−0.659***
	(0.034)	(0.079)	(0.033)	(0.034)
Liquidasset_R	−0.289***	−1.974***	−0.445***	−0.873***
	(0.027)	(0.072)	(0.026)	(0.028)
ROA	−1.210***	−1.295***	−1.239***	0.137***
	(0.051)	(0.124)	(0.050)	(0.052)
L.Leve	0.646***	0.954***	0.671***	−0.946***
	(0.030)	(0.064)	(0.030)	(0.032)
_cons	6.787***	5.255***	7.026***	7.938***
Year-Fixed Effect	Y	Y	Y	Y
N	67,063	36,841	67,701	66,587
adj. R-sq	0.226	0.173	0.246	0.256
N_clust	13,130	10,557	13,171	13,153

Note: Values in parentheses are standard errors; * = $p < 0.1$; ** = $p < 0.05$; *** = $p < 0.01$.
Note: Values in parentheses are standard errors; * = $p < 0.1$; ** = $p < 0.05$; *** = $p < 0.01$.

Table 7
Government R&D support and further support from the government to firms: estimations on the political capital channel of certification effects.

	(1)	(2)
	Subsidy	Subsidy
Innofund	0.525***	0.540***
	(0.049)	(0.049)
After	−0.025	−0.018
	(0.025)	(0.025)
Innofund*After	0.520***	
	(0.059)	
Innofund*After*Innoamt		0.007***
		(0.001)
Firm_Age	0.047**	0.046**
	(0.021)	(0.021)
Stateshare	0.088*	0.088*
	(0.048)	(0.048)
Firm_Size	0.379***	0.378***
	(0.016)	(0.016)
Fixasset_R	−0.624***	−0.626***
	(0.066)	(0.066)
Liquidasset_R	−0.139**	−0.140**
	(0.056)	(0.056)
ROA	0.567***	0.568***
	(0.090)	(0.090)
L.Leve	−0.102**	−0.102**
	(0.045)	(0.045)
_cons	−0.601***	−0.594***
Year-Fixed Effect	Y	Y
N	70,590	70,590
adj. R-sq	0.027	0.027
N_clust	13,288	13,288

Note: Values in parentheses are standard errors; * = $p < 0.1$; ** = $p < 0.05$; *** = $p < 0.01$.

supported by the government R&D programs. The results in Table 7 support Hypothesis 3b.

Next, we investigate how government efficiency moderates the effects of government R&D programs. China is vast and heterogeneous in many aspects of institutions across regions. Such heterogeneity provides us an excellent opportunity to examine the guarantor effects of government R&D programs. The indicators of government efficiency are extracted from the marketization index constructed by Fan et al. (2009). The marketization index reports the development of the market economy and the local governments' efficiency in all the provinces in China from various aspects between 1999 and 2007 based on annual questionnaire surveys with business executives. The higher value of the indices are, the more market-oriented the province is.

This study focuses on two aspects of government efficiency, i.e., the relaxation of intervention to business activities by local governments (***Mkt_Index1***) and the reduction of tax and levy burdens to businesses by the local governments (***Mkt_Index2***) in a province. ***Mkt_Index1*** is a dummy variable equal to one if a province ranks in the top 10 (top 30%) of all provinces in reducing intervention to business activities in a given year and equal to zero if otherwise. ***Mkt_Index2*** is a dummy variable equal to one if a province ranks in the top 10 (top 30%) of all provinces in reducing tax and levy burdens in a given year and equal to zero if otherwise. We choose the top 10 as a threshold for the cutoff to identify a more efficient government because the marketization indexes are screwed with high levels of disparity across provinces. The results stay robust if we move the cutoff to any level above the top 30% (e.g., 25%, 20%, 15% etc.). We include these variables and the interaction terms between such variables, ***Innofund*** and ***After,*** into the estimations to examine the political capital channel of the certification effects.

Table 8 reports the results. Panel A presents the estimations in which government efficiency is measured by ***Mkt_Index1***. It shows that the coefficients of the interaction terms of ***Innofund*** and ***After*** are positive and significant across all the estimates, implying that the ex-post effects of Innofund on external financing stay robust. At the same time, we observe that ***Market_Index1*** is significantly and negatively associated with firms' external financing measured by all means except for the long-term debts. Such results suggest that in regions where the Chinese government intervenes less in business activities, banks tend to be more independent and less influenced by government industry policies. That is, we can expect more market failures in financing private R&D activities of SMEs because these activities are associated with more risk and uncertainty (given that all firms in our sample, including the treatment and control groups, are high-tech start-ups). In contrast, those less market-oriented regions may have government pressure on banks to support some high-tech firms encouraged by industrial policy. However, the coefficients of the interaction term of ***Innofund***, ***After*** and ***Mkt_Index1*** are significantly positive across all the estimates except for the long-term debts. Such results suggest that although in regions where the governments intervene less in business activities, it is harder for high-tech entrepreneurial firms to access external financing in general, the gap between Innofund-backed firms and other firms in access to external financial resources are more significant after firms gain the Innofund support. Moreover, such amplified effects of Innofund are further magnified in regions with more efficient governments. The results are consistent with the analysis of Guo and Zhang (2020), which suggests that local governments and efficient markets to some extent may work together to bring out positive effects of government R&D support at an industry level.

Panel B presents the estimations in which government efficiency is measured by ***Mkt_Index2***. The results are similar to what we observe from Panel A. However, the main difference between Panel A and B is that we observe a statistically significant and positive relationship between ***Mkt_Index2*** and firms' external financing, implying that reducing tax and levy burden in a region may help entrepreneurial firms to gain more debts and equity in general. Furthermore, we observe that the interaction terms of ***Innofund***, ***After*** and ***Mkt_Index2*** are significantly and positively correlated to firms' access to external financing measured by all means except for the long-term debts.[15] The results shown in Table 8 suggest that government efficiency positively moderates the ex-post effects of Innofund on firms' access to external financing, supporting the political capital channel of the certification effects proposed in hypotheses 3c.

It is worth noting that in all our DID estimations analyzing the different channels through which Innofund affects firm external financing, we observe significant and positive effects of the DID estimator (the interaction term of Innofund and After) on the growth of short-term debt, total debt and total equity of a firm. However, we do not observe a significant relationship between the DID estimator and long-term debt growth. There are several potential explanations. First, high-tech SMEs are associated with high uncertainty and risks. Therefore, issuing short-term debts to or making equity investments in such firms is less risky than issuing long-term debts for external financiers. Second, it is also possible that these high-tech SMEs prefer short-term loans to long-term ones because the capital cost is lower for the former compared to the latter.

To summarize, by comparing the two mechanisms through which the Innofund affects a firm's access to external financing, we find both the funding and certification effects of the government R&D support in China. The funding mechanism mainly works through the prototyping channel, while the certification mechanism works through the political capital signaling channel.

[15] Such results are consistent with those shown in Table 8 if we replace the dummy variable of the Innofund grant with the total amount of funding received by the firms in the interaction terms (results are provided by request).

7. Conclusion

Examinations on such government initiatives are ample given the significance of such issues to academia and policy-making. However, the results are mixed, and we still lack insights into how such government support works. This study examines how government R&D support affects a firm's access to external financing based on a large panel dataset from China. We confirm that firms backed by government support attract more long-term and short-term debts and equity investment in general. Moreover, we discover that such effects mainly work through the prototyping and political capital certification channels. However, we do not find evidence for the quality certification or equity funding channels.

This study contributes to the existing literature in several ways. First, this study enriches the literature on government R&D support to for-profit enterprises. It not only provides evidence to the debate on whether government R&D support may crowd out private investment (Stiglitz, 1988; Wallsten, 2000; Acemoglu et al., 2018) or stimulate private investment in high-tech SMEs (Audretsch et al., 2002; Lach, 2002; Görg and Strobl, 2007; Aerts and Schmidt, 2008; Czarnitzki and Lopes Bento, 2013; Lerner, 2000; Howell, 2017) but also adds insights in the different mechanisms through which such programs work. Consistent with most of the existing studies, we confirm the positive effects of government R&D support on private investment in high-tech SMEs in China's context. However, unlike many existing studies (e.g., Lerner, 2000; Feldman and Kelley, 2006; Meuleman and De Maeseneire, 2012; Demeulemeester and Hottenrot, 2015; Wu, 2017; Martí and Quas, 2018), this study finds no evidence for firm quality certification mechanism of government R&D support. Instead, we identify an alternative type of information asymmetry between entrepreneurial firms and external financiers, namely, the information on firms' political capital, which hinders firms from obtaining external financing in developing countries such as China. In addition, we confirm the prototyping channel of the funding effects provided by the government R&D programs, consistent with the findings of Howell (2017). Such results imply that the effects of government R&D subsidies and the mechanisms through which such effects are achieved may be heterogeneous, depending on institutions, markets, industries and firm characteristics (David et al., 2000; Hsu et al., 2009; Lee, 2011; Sternberg, 2014; Guo et al., 2017; Petti et al., 2017).

Second, this study contributes to the literature on corporate finance and entrepreneurship. Financial constraints and the underinvestment in R&D activities of for-profit enterprises are major concerns in the literature of corporate finance (Hall, 1992, 2008; Hao and Jaffe, 1993; Whited and Wu, 2006). However, there is little empirical evidence of how financial constraints impede SMEs' innovation activities. This study adds some insights into the financial constraints of high-tech SMEs and the primary reasons why they are unattractive to external financiers. The findings that government R&D supports mainly influence firms' access to external financing through the technology prototyping channel in China are consistent with the discoveries in the US (Howell, 2017). It suggests that technological uncertainty, rather than short-term financial performance, is the primary concern of external financiers investing in high-tech SMEs; in addition, this is where government R&D supports may come into play. Furthermore, this study extends the literature on R&D investment under the context of public resource allocation. Our findings suggest that the ex-ante project selection of hierarchical government agents hardly certify firm quality for external financiers. Therefore, this study shed some light on studies on organizational structure and investment decisions (e.g., Dewatripont and Maskin, 1995; Rajan and Wulf, 2006; Arora et al., 2011; Aghion et al., 2013).

Third, this study also contributes to the literature on political connection and resource (mis)allocation. The effects of political connections on business activities are well documented, especially in developing economies (e.g., Poncet et al., 2010; Guariglia et al., 2011; Cull et al., 2015). Meanwhile, studies have argued that resource

Table 8
Government efficiency and the effects of government R&D programs: estimations on the political capital channel of certification mechanisms.

Panel A: Government efficiency measured by the relaxation of government intervention to business activities

	(1)	(2)	(3)	(4)
	Debt_short	Debt_long	Debt_total	Equity
Innofund	0.008	0.071	0.002	0.023
	(0.022)	(0.046)	(0.021)	(0.022)
After	0.035***	0.029	0.024***	−0.012
	(0.009)	(0.027)	(0.008)	(0.009)
Innofund*After	0.110***	0.140**	0.123***	0.181***
	(0.022)	(0.068)	(0.021)	(0.024)
Mkt_Index1	−0.122***	0.156***	−0.103***	−0.088***
	(0.010)	(0.033)	(0.010)	(0.011)
Innofund*After*Mkt_Index1	0.065***	0.082	0.072***	0.062***
	(0.021)	(0.068)	(0.020)	(0.023)
Firm_Age	0.135***	0.002	0.149***	0.124***
	(0.012)	(0.023)	(0.011)	(0.012)
Stateshare	0.033*	0.324***	0.055***	0.034
	(0.019)	(0.047)	(0.019)	(0.022)
Firm_Size	0.579***	0.611***	0.574***	0.556***
	(0.011)	(0.018)	(0.011)	(0.010)
Fixasset_R	−0.958***	−0.141*	−0.942***	−0.669***
	(0.033)	(0.078)	(0.032)	(0.034)
Liquidasset_R	−0.309***	−1.933***	−0.464***	−0.882***
	(0.027)	(0.071)	(0.025)	(0.027)
ROA	−1.184***	−1.337***	−1.222***	0.152***
	(0.050)	(0.122)	(0.049)	(0.052)
L.leve	0.656***	0.959***	0.682***	−0.976***
	(0.029)	(0.062)	(0.030)	(0.032)
_cons	6.942***	5.108***	7.153***	8.104***
	(0.060)	(0.119)	(0.060)	(0.057)
Year FE	Y	Y	Y	Y
N	69,880	38,306	70,542	69,396
adj. R-sq	0.231	0.175	0.252	0.261
N_clust	13,247	10,638	13,287	13,272

Panel B: Government efficiency measured by the reduction of tax and levy burdens by the local governments

	(1)	(2)	(3)	(4)
	Debt_short	Debt_long	Debt_total	Equity
Innofund	0.005	0.076	−0.000	0.021
	(0.022)	(0.046)	(0.021)	(0.023)
After	0.035***	0.026	0.024***	−0.012
	(0.009)	(0.027)	(0.008)	(0.009)
Innofund*After	0.115***	0.248***	0.145***	0.187***
	(0.023)	(0.067)	(0.021)	(0.022)
Mkt_Index2	0.019**	0.074***	0.028***	0.023***
	(0.008)	(0.026)	(0.008)	(0.008)
Innofund*After*Mkt_Index2	0.057***	−0.067	0.040**	0.051**
	(0.021)	(0.064)	(0.019)	(0.020)
Firm_Age	0.139***	−0.002	0.152***	0.127***
	(0.012)	(0.023)	(0.012)	(0.012)
Stateshare	0.030	0.341***	0.053***	0.032
	(0.019)	(0.047)	(0.019)	(0.022)
Firm_Size	0.579***	0.610***	0.574***	0.555***
	(0.011)	(0.018)	(0.011)	(0.010)
Fixasset_R	−0.961***	−0.135*	−0.946***	−0.672***
	(0.034)	(0.078)	(0.032)	(0.034)
Liquidasset_R	−0.301***	−1.956***	−0.458***	−0.876***
	(0.027)	(0.070)	(0.025)	(0.027)
ROA	−1.196***	−1.316***	−1.233***	0.141***
	(0.050)	(0.122)	(0.049)	(0.052)
L.leve	0.656***	0.959***	0.682***	−0.972***
	(0.029)	(0.062)	(0.030)	(0.032)
_cons	6.833***	5.201***	7.051***	8.016***
	(0.060)	(0.117)	(0.060)	(0.057)
Year FE	Y	Y	Y	Y
N	69,880	38,306	70,542	69,396
adj. R-sq	0.231	0.175	0.252	0.261
N_clust	13,247	10,638	13,287	13,272

Note: Values in parentheses are standard errors; * = $p < 0.1$; ** = $p < 0.05$; *** = $p < 0.01$.
Note: Values in parentheses are standard errors; * = $p < 0.1$; ** = $p < 0.05$; *** = $p < 0.01$.

reallocation from low-productivity firms to high-productivity firms is an essential source for sustainable growth (Restuccia and Rogerson, 2008; Asker et al., 2014). Our study links the two lines of literature under the context of R&D financing of SMEs, enriching the existing examinations that are mainly based on listed companies.

The findings of this study have significant policy-making implications. China has identified innovation as the driver of a new growth model and has emphasized the importance of supporting innovation in SMEs in recent years. Various policies, including tax incentives and subsidies for high-tech companies, grants for basic and applied research, and support for venture capital, have been designed to promote innovation. However, whether these policies are effective, or under what conditions they are effective or ineffective, requires rigorous empirical research. These studies have significant implications for allocating public financial resources and R&D incentives for firms and, ultimately, national innovation capacity. The findings from this study provide several suggestions for policy-making. Above all, high-tech SMEs in China face severe financial constraints that cannot be solved solely by the market. Our examination suggests that government involvement in corporate R&D may help firms relax the financial constraints and gain further resources from the market, suggesting that even in a country like China, where the government has already been heavily engaged in business activities, government R&D support to high-tech SMEs is essential. However, our findings indicate that government R&D support is not a practical solution to all the problems associated with underinvestment in corporate R&D activities: only under certain circumstances can some problems be solved. In particular, we suggest that the ex-ante selection may not be as effective as expected.

Government R&D support is effective in helping firms obtain external financing if such support can help firms validate their innovative ideas. Therefore, a practical approach would be to provide support to SMEs with early-stage R&D projects so that they can prototype their innovative ideas as quickly as possible. Such support might include providing small subsidies, laboratory space and facilities, and reducing patent approval and copyright registration time and cost. However, we do recognize that the ex-ante selection may not be as effective as expected, and potential adverse selection problems may exist (Shane, 2009). So, we suggest that government R&D policies that combine both small subsidies and tax credits to high-tech SMEs may be an effective way to provide a compatible incentive to those technology-oriented entrepreneurial firms and avoid adverse selection problems, as demonstrated in the literature (Bloom et al., 2002; Czarnitzki et al., 2011; Freitas et al., 2017). Furthermore, the findings on the different effects of government R&D support across regions suggest that it is hard to provide generalized innovation policies at the national level given the vast size of the Chinese economy and the significant disparity in economic development and institutional environments across regions. Therefore, decentralizing local governments to plan public R&D funding programs according to their characteristics would be more effective than a centralized design. Finally, policymakers should be alerted by the findings on the political capital certification of government R&D programs. It is well documented that political connections and related resource misallocation would impede long-run economic growth. Given that the government R&D initiatives aim to stimulate national innovation capacity and sustainable economic growth, if resource misallocation is not reduced in this segment, the ultimate objectives may eventually be hard to achieve.

This study also has implications for business practice. The analysis in this study provides systematic information for entrepreneurs, banks, and equity investors regarding how they may benefit from government support in China. More importantly, high-tech firms should realize that the significant challenges to seeking external financial resources in China are technological and political uncertainty. Finally, business players may have to adjust their business decisions in different regions, according to the policy changes of the government R&D programs.

We recognize limitations with this study. First, the data we use in this study is not the most updated. However, as discussed earlier, the theoretical nature of the research questions addressed in this study are time-and-context-independent. Therefore, we suggest that such limitations should not have significant impacts on our findings. Second, some of the measurements used in this study, particularly proxies for information asymmetries, may not be the most adequate. However, considering the data availability of privately held firms, we use similar proxies in existing studies to ensure our findings are comparable to existing work. Third, we recognize that although the PSM and DID approach helps us address identification concerns, this strategy allows us to control only unobserved time-invariant individual effects while it may not well control some unobserved time-variant factors.

Several questions arising from our discoveries require further research. How do firms adjust the resource allocation after winning the government R&D support? Are there other mechanisms (e.g., property rights institutions, intellectual property rights protection, market competition and input markets) influence the effects of government R&D support? Why are particular mechanisms more prevalent than others under certain conditions? These future research directions promise to contribute to the literature on public finance and innovation, knowledge of public and private governance and the interaction between the two.

Appendix 1

Appendix A-1
Balancing tests for variables of interest after PSM

	Variable	Sample	Treated	Controls	Difference	T-stat
1999	***Debt_short***	Unmatched	9.7899	8.4827	1.3072	11.95***
		Matched	9.7899	9.7820	0.0079	0.07
	Debt_long	Unmatched	5.6474	3.1173	2.5302	11.3***
		Matched	5.6474	5.5678	0.0796	0.28
	Debt_total	Unmatched	10.1876	8.7446	1.4430	15.5***
		Matched	10.1876	10.1587	0.0289	0.34
	Equity	Unmatched	9.8795	8.1840	1.6955	18.12***
		Matched	9.8795	9.8916	−0.0121	−0.13
	LR Chi-sq	***349.33****	***Pseudo R-sq***	***0.0992***		
2000	***Debt_short***	Unmatched	9.8362	8.5469	1.2893	10.36***
		Matched	9.8362	9.8634	−0.0272	−0.25
	Debt_long	Unmatched	5.2871	2.6972	2.5899	10.38***
		Matched	5.2871	5.4094	−0.1223	−0.37
	Debt_total	Unmatched	10.1169	8.7830	1.3340	12.67***
		Matched	10.1169	10.1753	−0.0583	−0.61

(continued on next page)

Appendix A-1 (*continued*)

	Variable	Sample	Treated	Controls	Difference	T-stat
	Equity	Unmatched	9.6912	8.2789	1.4122	13.57***
		Matched	9.6912	9.7643	−0.0731	−0.7
	LR Chi-sq	***279.21****	***Pseudo R-sq***	***0.1034***		
2001	***Debt_short***	Unmatched	9.6421	8.4847	1.1574	8.9***
		Matched	9.6421	9.6615	−0.0194	−0.15
	Debt_long	Unmatched	4.8261	2.5779	2.2482	8.75***
		Matched	4.8261	4.8511	−0.0250	−0.07
	Debt_total	Unmatched	9.9410	8.7369	1.2041	11.12***
		Matched	9.9410	9.9738	−0.0328	−0.3
	Equity	Unmatched	9.8163	8.2922	1.5241	13.95***
		Matched	9.8163	9.8686	−0.0523	−0.53
	LR Chi-sq	***220.55****	***Pseudo R-sq***	***0.0852***		
2002	***Debt_short***	Unmatched	9.5198	8.5123	1.0074	7.46***
		Matched	9.5198	9.5305	−0.0108	−0.07
	Debt_long	Unmatched	3.9736	2.2069	1.7667	6.98***
		Matched	3.9736	3.7131	0.2606	0.76
	Debt_total	Unmatched	9.8427	8.7399	1.1027	9.67***
		Matched	9.8427	9.7984	0.0443	0.39
	Equity	Unmatched	9.7323	8.3584	1.3739	12.36***
		Matched	9.7323	9.7964	−0.0641	−0.65
	LR Chi-sq	***209.16****	***Pseudo R-sq***	***0.0836***		
2003	***Debt_short***	Unmatched	9.7740	8.6344	1.1397	9.7***
		Matched	9.7740	9.7343	0.0398	0.3
	Debt_long	Unmatched	5.7429	4.2590	1.4839	10.72***
		Matched	5.7429	5.7835	−0.0406	−0.19
	Debt_total	Unmatched	10.0714	8.8160	1.2554	12.09***
		Matched	10.0714	10.0789	−0.0075	−0.07
	Equity	Unmatched	9.7925	8.4419	1.3505	12.94***
		Matched	9.7925	9.7847	0.0078	0.07
	LR Chi-sq	***303.42****	***Pseudo R-sq***	***0.1032***		
2004	***Debt_short***	Unmatched	9.6289	8.5486	1.0802	11.21***
		Matched	9.6289	9.6689	−0.0400	−0.39
	Debt_long	Unmatched	3.7400	1.6763	2.0636	11.92***
		Matched	3.7400	3.9901	−0.2501	−0.97
	Debt_total	Unmatched	9.8347	8.7231	1.1116	13.15***
		Matched	9.8347	9.8931	−0.0584	−0.64
	Equity	Unmatched	9.7496	8.3674	1.3822	16.62***
		Matched	9.7496	9.7480	0.0016	0.02
	LR Chi-sq	428.12***	Pseudo R-sq	0.0935		
2005	***Debt_short***	Unmatched	9.5768	8.6036	0.9732	12.07***
		Matched	9.5768	9.6443	−0.0675	−0.8
	Debt_long	Unmatched	4.0085	1.6440	2.3645	15.93***
		Matched	4.0085	4.2938	−0.2853	−1.32
	Debt_total	Unmatched	9.8403	8.7780	1.0622	15.15***
		Matched	9.8403	9.9324	−0.0922	−1.31
	Equity	Unmatched	9.6892	8.4631	1.2261	16.98***
		Matched	9.6892	9.8242	−0.1350	−1.85
	LR Chi-sq	***755.78****	***Pseudo R-sq***	***0.1240***		
2006	***Debt_short***	Unmatched	9.3546	8.5677	0.7869	7.02***
		Matched	9.3546	9.5324	−0.1778	−1.84**
	Debt_long	Unmatched	2.9495	1.5134	1.4361	8.35***
		Matched	2.9495	3.1107	−0.1611	−0.69
	Debt_total	Unmatched	9.5832	8.8074	0.7758	8.41***
		Matched	9.5832	9.7532	−0.1700	−2.33
	Equity	Unmatched	9.3075	8.5667	0.7408	8.36***
		Matched	9.3075	9.3970	−0.0895	−1.22
	LR Chi-sq	***384.64****	***Pseudo R-sq***	***0.0870***		
2007	***Debt_short***	Unmatched	9.2228	8.6283	0.5945	5.62***
		Matched	9.2228	9.2843	−0.0615	−0.64
	Debt_long	Unmatched	2.7213	1.4580	1.2634	7.84***
		Matched	2.7213	2.9221	−0.2008	−0.91
	Debt_total	Unmatched	9.4271	8.8816	0.5455	6.47***
		Matched	9.4271	9.5091	−0.0820	−0.98
	Equity	Unmatched	9.2771	8.6359	0.6412	7.79***
		Matched	9.2771	9.3388	−0.0617	−0.7
	LR Chi-sq	***476.75****	***Pseudo R-sq***	***0.0939***		

Note: * = $p < 0.1$; ** = $p < 0.05$; *** = $p < 0.01$.

Appendix A-2
Placebo test for Innofund selection (PSM Sample)

	(1) Debt_short	(2) Debt_long	(3) Debt_total	(4) Equity
Pseudo-Innofund	−0.030	0.037	−0.044*	−0.016
	(0.027)	(0.076)	(0.026)	(0.028)
Firm_Age	−0.101***	−0.071	−0.089***	−0.061***
	(0.019)	(0.045)	(0.018)	(0.019)
Stateshare	0.088*	0.485***	0.189***	0.085*
	(0.046)	(0.101)	(0.043)	(0.045)
Firm_Size	0.842***	0.770***	0.848***	0.804***
	(0.019)	(0.040)	(0.018)	(0.018)
Fixasset_R	−1.702***	−0.562***	−1.626***	−1.318***
	(0.092)	(0.207)	(0.087)	(0.088)
Liquidasset_R	−0.583***	−2.768***	−0.968***	−1.251***
	(0.084)	(0.196)	(0.079)	(0.081)
ROA	−1.812***	−1.449***	−1.778***	−0.182
	(0.136)	(0.359)	(0.121)	(0.139)
L.Leve	0.972***	1.181***	1.110***	−2.030***
	(0.083)	(0.167)	(0.081)	(0.135)
_cons	5.953***	5.199***	6.089***	7.830***
	(0.136)	(0.291)	(0.130)	(0.139)
Year FE	Y	Y	Y	Y
N	7745	4187	7810	7716
adj. R-sq	0.425	0.341	0.458	0.410

Note: Values in parentheses are standard errors; * = $p < 0.1$; ** = $p < 0.05$; *** = $p < 0.01$.

Appendix A-3
Government R&D programs and firms' external financing (DID estimations based on 1-to-1 matched sample)

Panel A: DID estimator defined with Innofund and After

	(1) Debt_short	(2) Debt_long	(3) Debt_total	(4) Equity
Innofund	0.370***	0.337***	0.377***	0.510***
	(0.030)	(0.065)	(0.030)	(0.032)
After	−0.008	0.110*	0.004	−0.009
	(0.018)	(0.062)	(0.017)	(0.020)
Innofund*After	0.154***	0.139*	0.158***	0.186***
	(0.023)	(0.073)	(0.022)	(0.024)
Firm_Age	0.134***	0.077**	0.164***	0.114***
	(0.017)	(0.036)	(0.017)	(0.020)
Stateshare	0.067**	0.287***	0.097***	−0.027
	(0.032)	(0.074)	(0.030)	(0.035)
Firm_Size	0.642***	0.734***	0.636***	0.635***
	(0.016)	(0.027)	(0.016)	(0.015)
Fixasset_R	−0.937***	−0.405***	−0.951***	−0.706***
	(0.055)	(0.133)	(0.051)	(0.058)
Liquidasset_R	−0.312***	−2.095***	−0.517***	−0.866***
	(0.045)	(0.114)	(0.041)	(0.046)
ROA	−1.222***	−1.191***	−1.180***	0.355***
	(0.078)	(0.216)	(0.075)	(0.089)
L.Leve	0.607***	0.849***	0.648***	−1.013***
	(0.029)	(0.062)	(0.030)	(0.032)
_cons	6.253***	4.279***	6.443***	7.227***
	(0.092)	(0.187)	(0.091)	(0.089)
Year FE	Y	Y	Y	Y
N	26,601	14,752	26,808	26,045
N_clust	4964	3955	4972	4918

Panel B: DID estimator defined with Innofund, After and Innoamt

	(1) Debt_short	(2) Debt_long	(3) Debt_total	(4) Equity
Innofund	0.371***	0.314***	0.380***	0.509***
	(0.029)	(0.063)	(0.030)	(0.032)
After	−0.004	0.082	0.008	−0.008
	(0.018)	(0.059)	(0.017)	(0.019)
Innofund*After*Innoamt	0.002***	0.003***	0.002***	0.003***
	(0.000)	(0.001)	(0.000)	(0.000)
Firm_Age	0.134***	0.075**	0.164***	0.113***
	(0.017)	(0.036)	(0.017)	(0.020)
Stateshare	0.067**	0.288***	0.097***	−0.027

(*continued on next page*)

Appendix A-3 (*continued*)

Panel B: DID estimator defined with Innofund, After and Innoamt

	(1)	(2)	(3)	(4)
	Debt_short	Debt_long	Debt_total	Equity
	(0.032)	(0.074)	(0.030)	(0.035)
Firm_Size	0.642***	0.732***	0.636***	0.635***
	(0.016)	(0.027)	(0.016)	(0.015)
Fixasset_R	−0.938***	−0.404***	−0.953***	−0.707***
	(0.055)	(0.133)	(0.051)	(0.058)
Liquidasset_R	−0.313***	−2.095***	−0.518***	−0.867***
	(0.045)	(0.114)	(0.041)	(0.046)
ROA	−1.220***	−1.184***	−1.179***	0.357***
	(0.078)	(0.216)	(0.075)	(0.089)
L.Leve	0.607***	0.852***	0.648***	−1.014***
	(0.040)	(0.090)	(0.039)	(0.048)
_cons	6.256***	4.309***	6.444***	7.233***
	(0.092)	(0.188)	(0.091)	(0.090)
Year FE	Y	Y	Y	Y
N	26,601	14,752	26,808	26,045
N_clust	4964	3955	4972	4918

Note: Values in parentheses are standard errors; * = p < 0.1; ** = p < 0.05; *** = p < 0.01.
Note: Values in parentheses are standard errors; * = p < 0.1; ** = p < 0.05; *** = p < 0.01.

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