



Financing R&D in Chinese private firms: Business associations or political connection?

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ABSTRACT

Using a new and unique dataset of Chinese private firms, this paper explores how private firms access bank loans to finance innovative activities. The results reveal that political connection, rather than membership in a government-controlled business association, largely determines private firms' innovations by providing access to bank loans. Furthermore, the “grease-the-wheels” mechanism of political connection is stronger if the firms are more constrained financially, located in regions with low levels of financial development, or located in regions with relatively under-developed institutional environments. Finally, cash flow, used to measure internal financing, and trade credit, used to measure informal financing, are important alternative financing channels and support firms' R&D investments. Our paper implies that China's government needs to continue fostering a good financing environment and supporting innovation activities.

1. Introduction and background

Research and development (R&D) at China's private firms has served as a major engine of China's innovations (e.g., Allen et al., 2005; Firth et al., 2009; Qiao et al., 2014). In China, private firms contribute 66% of patent applications, 74% of technological innovations, and 82% of new products; however, the domestic R&D expenditure proportion contributed by private firms was only 22.9% in 2014.¹ In such an environment, it is important to note that the innovation activities of private firms are constrained, externally and formally, by banks. The importance of bank loans has undoubtedly exceeded that of other informal financing channels, as bank loans account for almost 80% of Chinese enterprises' financing (Allen et al., 2005). However, while China's private sector contributes more than half of its GDP, it is more financially constrained by external forces (e.g., reliant on bank loans) in terms of innovation than state-owned enterprises (SOEs) and foreign-owned firms (e.g., Hall, 2002; Firth et al., 2009), since they are restricted to just 27% of total bank loans by some regulations in China (Farrell and Lund, 2006). (see Fig. 1)

The aforementioned facts suggest that it may be difficult to finance innovation projects through external sources. However, direct micro evidence that these financial effects are large enough to affect innovation is scarce (Brown and Petersen, 2009; Guariglia and Liu, 2014). Accordingly, this paper aims to shed light on these issues. We will look at three issues in this paper. First, we investigate which financial intermediations finance private firms' innovation investments efficiently. Second, we explore the factors that will help private firms to finance innovative activities. Does joining government-controlled business associations help more than connecting the political relationships, or “greasing the wheels”, directly? Third, we exam whether financial constraints, financial development and the institutional environment affect the “grease-the-wheels” mechanism. By exploring these relationships, we seek to understand the link between financing intermediations and R&D investment in China, despite the private sector's financial constraints and China's underdeveloped financial systems.²

The results reveal that political connection on the part of private firms can help these firms secure bank loans for investments in R&D activities.

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¹ Data source: China Statistical Yearbook & China Statistical Yearbook on Science and Technology. The calculation has been done by authors.

² Our research interest is related to the question raised by Allen et al. (2005) on how China's vibrant private sector can coexist with its weak legal system.

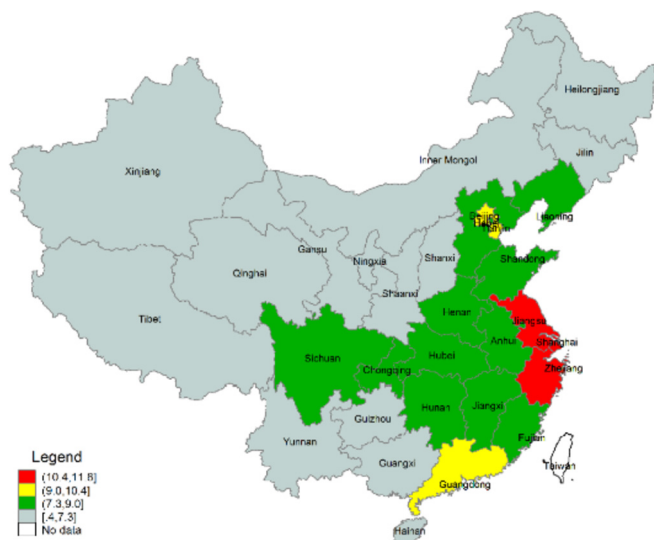


Fig. 1. NERI Index Distribution (Total Index). Note: Data source: NERI Index is from Fan, Gang, and Xiaolu Wang, -NERI Index of Marketization of China's Provinces, 2001, 2004, 2007, 2010, 2011 Report.

Specifically, firms which have fewer financial constraints and are located in regions with better financial development and relatively well-developed marketization as well as institutional environments can benefit from more bank loans via corrupt business practices. Previous studies have concluded that Chinese banks are reasonably efficient in terms of private firms' credit allocations, as they can exercise commercial judgments accurately. Ayyagari et al. (2008) also suggest that, compared with other formal financial channels, the bank financing process in China is still associated with faster firm growth. This paper argues and supports the idea that, in an unmotivated banking system, corruption can serve as the proverbial "grease" for the bureaucratic "wheels" (Pei, 2008; Chen et al., 2013). Therefore, these findings confirm that a grease-the-wheel role for corruption or political connection exists in financing R&D activities via bank loans. Meanwhile, the results also show that the All-China Federation of Industry and Commerce (ACFIC) members cannot improve their firms' R&D investments via bank loans. Since the ACFIC was founded by and is under the control of the Chinese government (Jia, 2014), it is more likely to stand for the interests of the government, perhaps restricting the effectiveness of the association.

The contributions to the literature of this study are threefold. The first contribution is the advancement of the literature in terms of the role and mechanisms of financing in Chinese private firms' R&D activities. This paper uses a new, unique, private dataset and extends previous research on financing R&D investments that has focused primarily on developed countries (Brown and Peterson, 2009; Brown et al., 2009). Second, this paper makes a major contribution to the currently limited literature on the effect of political relationships on private firms' R&D investments. We explore whether the social relationships related to government-controlled business associations and/or political connection have impacts on moderating the relationship between bank loans and R&D activities. We find that government-controlled business associations cannot help firms finance their R&D investment through access to bank loans, while political connection is a direct and efficient way to help private firms finance R&D through bank loans. These findings provide a deeper understanding of how business associations help in combating bureaucratic predation as well as in protecting property rights in developing and transitional economies (Acemoglu et al., 2005; Pyle, 2009; Chavis, 2013; Oglivie, 2014). In addition, these results also indicate that political connection, to some extent, acts as an efficient facilitator between state-owned financing and private firms in developing and transitional countries and supports the grease-the-wheel mechanism in terms

of facilitating the practices of Chinese bank financing (Chen et al., 2013). Third, we extend the relationship between bank loans and the investment in R&D activities under different financial, marketization, and institutional development environments. These types of heterogeneities are studied rarely in the innovation investment field, and we contribute to the existing literature from this perspective. Finally, this paper illustrates that China's government needs to continue fostering a good financing environment and supporting innovation activities, in order keep the sustainable growth of the private sectors in China.

The remainder of this paper is structured as follows. Section 2 provides the institutional background faced by Chinese private firms and the literature on financing and firm performance and develops the research hypotheses. Next, Section 3 presents the data and descriptive statistics. Further, Section 4 explains our baseline specifications and displays the main estimation methodology, followed by our empirical results. Then Section 5 explains the endogeneity problems encountered and tests the robustness of our results. Finally, the conclusions follow.

2. Institutional background and hypothesis development

2.1. Bank loans and R&D investment

The banking sector plays a determining role in innovation. On the one hand, bank loans are an important external financing source for innovation because they can meet the need for innovation investments directly. On the other hand, applying for bank loans may affect which projects go forward because applying has a direct effect on the quality of innovation and investment spending as well as firms' effectiveness in generating innovations. Evidence has shown that developing a banking structure for loans can help finance innovation (Benfratello et al., 2008; Borisova and Brown, 2013). Even during the pre-and post-crisis periods in China, bank loans had a positive impact on R&D investment through their indirect effect on firm performance (Nemlioglu and Mallick, 2017).

However, the uncertainty involved in innovation makes banks reluctant to finance innovation-related activities (e.g., high adjustment costs, as evinced in Hall and Lerner (2010) and Guariglia and Liu (2014), and a high degree of uncertainty, as shown by Tyagi (2006)). Banks are risk-averse, and the risk associated with innovation projects causes banks to impose restrictions on any financial support offered. In addition, market inefficiencies can also make it difficult for firms to finance innovations via bank loans. Banks lack information on the probability of success and the expected return on investments associated with these projects due to information asymmetry.³ Furthermore, innovative firms generally lack collateral assets, and R&D is an intangible asset which is difficult to collateralize. This issue causes firms to be unable to satisfy the requirements for bank loans. Moreover, to avoid competitors' imitations, firms are reluctant to reveal their potential innovation plans fully (Anton and Yao, 2002).

Our paper extends the previous literature by exploring the specific mechanisms by which membership in government-controlled business associations or direct political connection affect the link between bank loans and R&D investments. Specifically, we address the following questions: As a bridge between the government and enterprises, can business associations participate in negotiations with the government to help firms gain access to bank loans with which to invest in R&D? As a facilitator between the government and enterprises, does political connection play a significant role in gaining access to bank loans to finance R&D?

Accordingly, we raise our **Hypothesis 1**:

³ For example, Aboody and Lev (2000) argue that insider gains come from a specific source of information asymmetry-R&D- and accounting rules on R&D expenditures further contribute to information asymmetry (accounting measurements and reporting rules treat R&D differently from physical assets).

Hypothesis 1. Bank loans play a positive and significant role in R&D investment on the part of Chinese privately-owned firms.

2.2. *The mechanism involved in the links between business associations, bank loans, and innovation*

The impact of the influence of business associations in China and how business associations contribute to bank financing for innovation activities are still unclear. In China, the ACFIC is the most prominent business association and claims to support entrepreneurs. To be specific, the ACFIC is responsible for organizing private entrepreneurs; promoting connections between enterprises and the central, as well as local, governments; lobbying for private enterprises; providing protective networks; and supporting policies that back the private sector (Guo, 2007; Jia, 2014). In addition, engagement with the ACFIC can benefit firms in terms of improving their innovativeness by enabling them to draw on networks for missing resources. (Qiao et al., 2014). It stands to reason that, by joining industry and business associations, firm leaders can expand their external networks and access external resources more effectively in order to improve their firms' innovation performances.

However, we consider the possibility that this typical Chinese business association, the ACFIC, might not be efficient in financing innovation. As the ACFIC was founded by and is under the control of the government rather than self-managed members, the lack of autonomy may lead ACFIC to cater more to the interests of the government. Thus, the effectiveness of the collective actions of the ACFIC may be restricted largely by political influence. Moreover, the leaders of the ACFIC are not, in essence, elected by its members, so there is no incentive for these leaders to work for the public good or to avoid government expropriations from members. In addition, the relatively small⁴ membership in the ACFIC constrains its effectiveness. Even so, the free rider problem may increase as this business association grows, demoting the goal of collective action as a result. From another point of view, entrepreneurs' memberships in industry associations can indeed make up for these disadvantages to some extent. For example, increased exposure to diverse ideas and ample external sources may enable firms to improve their innovation performances (Diez, 2002). Moreover, using these business networks, small- and medium-sized enterprises (SMEs) can find it much easier to establish partnerships with competent partners and obtain the latest and most comprehensive knowledge of technological resources and market changes, thus enhancing their innovation capacities (Rindfleisch and Moorman, 2001).

Hypothesis 2. ACFIC members are unlikely to obtain bank loans to invest in Chinese firms' R&D.

2.3. *The mechanism involved in the links between political connection, bank loans, and innovation*

In China, firms tend to obtain larger loans through corrupt behaviour because political connection can ease a firm's rent seeking and help it to receive more assistance from the government, resulting in a significant reduction in bargaining time and overall costs (Chen et al., 2013; Ho and Mallick, 2015). Some suggest that political connection may help “grease the wheels” of progress through the bargaining process (Méon and Weil, 2010; Vial and Hanoteau, 2010). In this case, political connection may actually serve as the grease that allows a rigid administration perform more fluidly and efficiency (Vial and Hanoteau, 2010). Therefore, political connection may be able to help firms access more bank loans via a “grease-the-wheels” mechanism. In addition, Chen et al. (2013) provide evidence that political connection plays a role in improving lending efficiency and aiding Chinese entrepreneurial firms. As private borrowers

suffer in an environment of insufficient and unreliable legal protections, entrepreneurs can supply more information on their innovation projects and decrease the information asymmetry through corrupt behaviour, building social connections along the way. Thus, the grease-the-wheels mechanism can provide Chinese private firms with access to bank loans with which to support their innovation projects.

Hypothesis 3. Political connection enables firms to obtain bank loans to invest in their R&D acting as a “grease-the-wheels” mechanism.

Firms' innovation performances can be restricted significantly by financial constraints. What is more, financial constraints are closely related to financial development and the institutional environment. Evidence shows that firm's financing costs can be influenced largely by the development of the financial market as well as their relationships with the creditors (Shleifer and Vishny, 1997). Love (2003) and Islam and Mozumdar (2007) show that financial constraints decrease when the financial market improves. Moreover, a great deal of previous literature reports that financial development can promote investments and capital allocations for firms to invest R&D (Marcelin and Mathur, 2014). Mallick et al. (2016) further demonstrate that financial development has a positive effect on countries' technological changes as well as catch-up from a theoretical perspective. Therefore, financial development can alleviate financial constraints on a firm's innovation investments.

In terms of the institutional environment, much of the literature stipulates that the protection of private property and a good legal environment can promote investments and efficient allocation of capital, which can then help firms gain access to external financial support (Acemoglu et al., 2005; Cull and Xu, 2005; Bai et al., 2009). In addition, privatization can provide a critical mass of traded assets that can boost the development of capital markets (Subrahmanyam and Titman, 1999; Boutchkova and Megginson, 2000). Therefore, a well-developed financial market and institutional environment can reduce the degree of asymmetric information for both the lender and borrower as well as the external financing costs and further ease the financial constraints that firms face. Consequently, institutional reforms are capable of generating returns on private firms' R&D investments and innovative activities (Ades and Tella, 1999; Dreher et al., 2007; Boerner and Hainz, 2009).

For regions in which public institutions are not very efficient and under more financial constraints, a business association can improve the institutional environment, while political connection may aid efficient firms in obtaining timely service. Political connection can help reduce external financing costs and allocate external financing efficiently. In addition, Xu and Yano (2017) demonstrate that anti-corruption can help innovation by showing that, where anti-corruption activities are intensive, as in the relatively developed east-coastal regions, corrupt behaviour has been reduced. Therefore, the firms in the developed-regions, political connection may not help them gain bank loans to finance their R&D investment.

With respect to relatively under-developed regions, due to the state's domination of the financial market, the competition for external financing is more severe for privately-owned firms. In order to access sufficient external financing, political connection is readily adopted. Furthermore, firms in under-developed financial markets suffer from problems associated with severely asymmetric information and high transaction costs; hence, it is more likely that political connection will find a place in the bank financing process since corrupted firms are often regarded as less risky and are associated with a lower cost of borrowing (e.g., Petersen and Rajan, 2002; Qi et al., 2010). Thus, political connection is more common in these regions, and firms can use corrupt practices to obtain bank loans with which to invest in innovation projects more efficiently.

Hypothesis 4. ACFIC members are more likely to obtain bank loans to invest in firms' R&D when the firms are less financially constrained, well financial development, and better marketization and institutional environments.

⁴ The ACFIC has 3.97 million members that only represents 20% of all China's private entrepreneurs-which may also constrain its effectiveness.

Table 1
Summary statistics.

Variable	Obs	Mean	Std.Dev.	Min	Max
Firm characteristics					
R&D	13,331	1.754	5.615	0.000	64.516
R&D Dummy	13,661	0.396	0.489	0.000	1.000
Firm Size	13,409	3.834	1.536	0.693	7.601
Firm Age	13,552	1.865	0.704	0.000	3.045
ROS	12,949	15.162	18.730	−38.462	108.077
Tax	13,080	6.153	6.534	0.000	52.038
Fee	8368	1.959	4.368	0.000	47.059
Tanpai Fee	9111	0.629	1.780	0.000	16.667
Corporatized	13,661	0.764	0.425	0.000	1.000
Owner's Share	10,191	0.937	2.191	0.000	20.000
Former SOEs	13,661	0.061	0.240	0.000	1.000
Financing characteristics					
Bank Loan	13,331	15.246	35.834	0.000	360.000
Bank Loan Dummy	13,661	0.483	0.500	0.000	1.000
Cash Flow	13,202	8.696	15.108	−50.000	92.000
Trade Credit	12,813	2.602	7.586	0.000	75.000
Political capital					
ACFIC Member	13,661	0.621	0.485	0.000	1.000
CCP Member	13,661	0.360	0.480	0.000	1.000
PC or PPCC Deputy	13,661	0.617	0.486	0.000	1.000
Former Cadre	13,661	0.188	0.391	0.000	1.000
Entertainment fee	11,116	1.412	2.856	0.000	25.000
Entrepreneurial characteristics					
Female	13,661	0.143	0.350	0.000	1.000
Owner's Age	13,376	3.794	0.181	3.258	4.190
Education Year	13,661	12.935	2.703	6.000	18.000

Data source: The survey of privately owned enterprises that was jointly conducted in 2004, 2006, 2008, 2010 and 2012 by State Administration for Industry and Commerce and the United Front Work Department of the Central Committee of the CPC. See [Appendix 1](#) for precise definitions of all variables.

Hypothesis 5. Political connection is more likely to play a role in helping firms obtain bank loans to invest in their R&D when they are more financially constrained, under financial development, and bad marketization and institutional environments.

3. Data and variables

3.1. Data

Our primary firm-level dataset comes from the Private Enterprise Survey and includes data from the years 2004, 2006, 2008, 2010, and 2012. This nationwide survey has been conducted jointly by the Central Committee of the Communist Party of China, the ACFIC, and the Chinese Academy of Social Sciences every two years since the early 1990s.

This comprehensive survey includes nearly 55 percent of all private enterprises on the mainland, which includes 31 provincial-level divisions.⁵ The questions on this survey cover a firm's history, profitability, management, and financial structure as well as the characteristics of the firm's owners. In addition, one observation in this survey dataset corresponds to one enterprise. More importantly, the survey collects information on the entrepreneur's participation in ACFIC and their political identity (CCP, PC, or PPCC deputyship⁶). Therefore, it is a particular appropriate dataset for examining political influence on Chinese private enterprises. This dataset has been used widely in previous research ([Bai et al., 2006](#); [Li et al., 2008](#); [Dong et al., 2016](#)). Detailed information about this dataset can be found in [Lu et al. \(2010\)](#).

⁵ [Appendices 2 and 3](#) show the distribution of firms by province and by industry, respectively.

⁶ CCP, PC and PPCC are short for Chinese Communist Party, People's Congress, People's Political Consultative Conference, separately.

3.2. Descriptive statistics

[Table 1](#) presents the descriptive statistics for the dataset. We find that approximately 39.6% of the firms have R&D expenditures. Further, the average ROS (profitability) is approximately 15.162, but the fluctuation in the ROS is strong. In addition, 76.4% of firms are corporate systems. The owners' average share is rather high (about 93.7%), and 6.1% of firms have transformed from SOEs. The second set of results concerns financing resources. Approximately 48.3% of the firms have obtained access to bank loans (measured by a bank lending dummy variable), and the mean of bank loans is about 15.246 (measured by the amount of bank borrowing scaled by firm sales). Cash flow (internal financing measured by net profit over firm sales) and trade credit (informal financing measured by account of payable over firm sales) are about 8.696 and 2.602 by mean, respectively. The third set of results contains information on political capital. About 62.1% of the entrepreneurs in our sample are ACFIC members, 36.0% are CCP members, and 61.7% are either a PC deputy or PPCC deputy. Moreover, 18.8% of the entrepreneurs in the dataset are former cadres. The average entertainment fee is 1.412 in our samples. The last set of results focuses on entrepreneurial characteristics. In this set, 14.3% of the entrepreneurs are female, the logarithm of owners' average age is about 3.794, and the average number of years of education is 12.935.

The coefficients of correlation between these variables are reported in [Appendix 4](#). We notice that the correlation coefficients are relatively small, which suggests that the variables in this survey's dataset are not highly correlated, alleviating concerns of a multicollinearity problem.

[Table 2](#) presents variables related to the firms' and entrepreneurs' information regarding ACFIC membership, with political connection and without political connection, respectively. The mean difference between each of the two groups is tested using *t*-tests. The statistics in column 3 show that ACFIC members' firms are more innovative than non-ACFIC members' firms. Moreover, the member firms are older and larger and have easier access to financial support from banks. However, they have less cash flow and trade credit than the non-member firms. The

Table 2

Comparison of firms: ACFIC members versus non-ACFIC members and Political connection versus Non-Political connection.

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	ACFIC Member	Non-ACFIC Member	Mean Diff.	Political connection	Non-Political connection	Mean Diff.
R&D	2.006	1.333	0.673***	1.818	1.265	0.553***
R&D Dummy	0.498	0.230	0.268***	0.416	0.244	0.172***
Bank Loan	18.08	10.50	7.583***	15.96	9.757	6.203***
Bank Loan Dummy	0.580	0.323	0.257***	0.508	0.289	0.218***
Cash Flow	8.209	9.526	-1.318***	8.869	7.354	1.515***
Trade Credit	2.501	2.773	-0.272**	2.624	2.437	0.187
Firm Size	4.354	2.977	1.377***	3.910	3.234	0.675***
Firm Age	2.056	1.554	0.503***	1.877	1.773	0.104***
Former SOEs	0.074	0.040	0.034***	0.062	0.057	0.004
Corporatized	0.765	0.762	0.003	0.769	0.727	0.041***
Education	2.541	2.524	0.017***	2.535	2.531	0.004
Owner's Age	3.818	3.753	0.065***	3.795	3.784	0.012**
Female	0.117	0.185	-0.068***	0.137	0.188	-0.051***
Management Experience	0.306	0.200	0.106***	0.269	0.238	0.031***
Former Cadre	0.205	0.161	0.044***	0.195	0.131	0.065***
CCP Member	0.404	0.287	0.117***	0.366	0.314	0.051***
PC or PPCC Deputy	0.751	0.398	0.353***	0.620	0.595	0.025*
Observations	8479	5182		8104	5557	

Data source: The survey of privately owned enterprises that was jointly conducted in 2004, 2006, 2008, 2010 and 2012 by State Administration for Industry and Commerce and the United Front Work Department of the Central Committee of the CPC. See Appendix 1 for precise definitions of all variables.

entrepreneurs (firm owners) among the member firms are more highly educated, older, less likely to be female, and have more managerial experience. More importantly, they are more likely to have political identities, including identities as former cadres, CCPs, PCs, and PPCC deputies. The statistics in column 6 show further that highly corrupted firms are more innovative, older and larger, have better access to financial support from banks, and have larger cash flows than firms with low political connection. Similarly, the entrepreneurs at the corrupt firms are more highly educated, older, less likely to be female, and have more management experience. They are also more likely to have political identities.

4. Empirical equations and estimation methodology

4.1. Baseline equation

We initially established an R&D investment model as follows:

$$R\&D_{i,t} = \alpha_0 + \alpha_1 Bank\ Loan_{i,t} + \alpha_2 Cash\ Flow_{i,t} + \alpha_3 Trade\ Credit_{i,t} + \alpha_4 X_{i,t} + v_j + v_t + v_r + v_{jt} + \varepsilon_{it}, \quad (1)$$

The investment decision dummy variable and intensity are the most extensively used measurements for R&D investments (e.g., Cohen and Klepper, 1996; Coles et al., 2006), and here $R\&D_{i,t}$ indicates the R&D expenditure scaled by sales of firm i at time t (Qiao et al., 2014); *Bank Loan* scaled by sales measures the Bank Loan information; *Cash Flow* scaled by sales measures the internal finances of a firm⁷; *Trade Credit* is measured using the accounts payable scaled by sales, and we use it to stand for the informal financing sector; $X_{i,t}$ is a vector of a firm's characteristics, including firm attributes (firm size, age, firm corporatized or not, former SOE or not) the entrepreneur's information (education, age,

⁷ If capital markets were frictionless, the distinction between internal and external capital would be irrelevant and all sources of financing would have the same cost. When frictions are introduced into capital markets, internal and external capital cease to be perfect substitutes for each other. Information asymmetries between founders and external investors render the marginal cost of external capital higher than that of internal capital and lead investors to miss some investment opportunities that would be financed in a frictionless world, resulting in under-investment. This phenomenon is particularly severe in young high-tech companies (Carpenter and Petersen, 2002; Hall, 2002).

gender, and management experience), political capital (former cadre, ACFIC, CCP, PC, and PPCC deputy), and political connection information.⁸

The terms v_j , v_t , and v_r represent the industry-specific effect, time-specific effect, and region-specific effect, respectively. The industry-specific business cycle effect is controlled by the term v_{jt} (Guariglia et al., 2011; Chen and Guariglia, 2013). Finally, the term ε_{it} represents the idiosyncratic error. This equation enables us to test how financial resources influence Chinese firms' R&D investments.

An ordinary-least-squares (OLS) method was used to estimate equation (1). The reason why we did not choose a non-linear estimation method, such as a probit model, is that nonlinear estimation requires additional conditions on functional forms as well as an established error distribution. Further, instrumental variable estimation is more flexible in the OLS method. Nevertheless, we also report on the IV-Probit and IV-Tobit regression results in our robustness tests for comparison (Du et al., 2015).

The OLS estimation result of equation (1) is shown in column (1) of Table 3. It reveals that cash flow, bank loans, and trade credit play positive and significant roles in R&D investment. In columns 2–5, we brought in the control variables for firm characteristics (i.e., firm size and firm age), entrepreneurial characteristics (i.e., political and social capital), year dummies, industry dummies, region dummies, and clusters in a step-wise fashion. The results regarding the impact of bank loans on R&D investment remain robust to these controls. Our regression in column 5 shows that the bank loans measuring formal and external financing resources are positively associated with R&D investment, having a marginal effect of 0.01 at 1% significance when other variables in the model are kept, and this finding proves that bank loans are a determining financial resource for R&D investment. This supports our Hypothesis 1.

Next, cash flow as a measure of internal financing has a positive marginal effect of 0.028 on R&D activities at 1% significance for all samples using various estimation methods, indicating strong evidence

⁸ ETCs are a mix that includes "grease" money to obtain better government services, protection money to lower tax rates, managerial excesses, and normal business expenditures to build relational capital with suppliers and clients (Cai et al., 2011). Evidence shows that Chinese credit is allocated in accordance with entertainment and travel costs (ETCs) of private firms, a fudge item in company accounts. For example, Chen et al. (2013) argue that corruption acts as the proverbial grease for the bureaucratic wheels of an otherwise unmotivated banking system.

Table 3
Benchmark regressions.

VARIABLES	(1)	(2)	(3)	(4)	(5)
	R&D	R&D	R&D	R&D	R&D
Cash Flow	0.025*** (0.005)	0.027*** (0.005)	0.028*** (0.005)	0.028*** (0.005)	0.028*** (0.005)
Bank Loan	0.011*** (0.002)	0.011*** (0.002)	0.010*** (0.002)	0.010*** (0.002)	0.010*** (0.002)
Trade Credit	0.019** (0.010)	0.020** (0.010)	0.022** (0.010)	0.022** (0.010)	0.022** (0.010)
Firm Size		0.163*** (0.040)	0.141*** (0.040)	0.120*** (0.043)	0.113** (0.044)
Firm Age		-0.073 (0.085)	-0.064 (0.090)	-0.094 (0.089)	-0.094 (0.089)
Former SOEs		-0.352* (0.182)	-0.457** (0.188)	-0.462** (0.190)	-0.456** (0.190)
Corporatized		0.071 (0.123)	0.033 (0.123)	0.068 (0.124)	0.066 (0.124)
Education			0.308 (0.218)	0.302 (0.219)	0.302 (0.219)
Owner's Age			-0.151 (0.303)	-0.107 (0.304)	-0.100 (0.304)
Female			-0.108 (0.145)	-0.111 (0.145)	-0.106 (0.145)
Management Experience			0.117 (0.119)	0.125 (0.120)	0.124 (0.120)
Former Cadre			0.759*** (0.154)	0.748*** (0.155)	0.738*** (0.156)
ACFIC Member				0.435*** (0.131)	0.426*** (0.130)
CCP Member				-0.101 (0.114)	-0.102 (0.114)
PC or PPCC Deputy				-0.340*** (0.113)	-0.333*** (0.112)
Political connection					0.272*** (0.032)
Constant	2.566*** (0.276)	2.007*** (0.332)	1.695 (1.300)	1.630 (1.311)	1.391 (1.308)
Observations	11,196	11,196	11,196	11,196	11,196
R-squared	0.038	0.041	0.044	0.045	0.046
Year Dummies	YES	YES	YES	YES	YES
Industry Dummies	YES	YES	YES	YES	YES
Region Dummies	YES	YES	YES	YES	YES
Region Cluster	YES	YES	YES	YES	YES

Data source: The survey of privately owned enterprises that was jointly conducted in 2004, 2006, 2008, 2010 and 2012 by State Administration for Industry and Commerce and the United Front Work Department of the Central Committee of the CPC. See Appendix 1 for precise definitions of all variables.

that internal financing is a key determinant in financing R&D investments. This further supports the idea that Chinese firms' innovation activities are constrained by the availability of internal financial support (Guariglia and Liu, 2014), and, further, that Chinese firms' productivity and fixed investments are constrained by cash flow (Chen and Guariglia, 2013). Further, trade credit as used as an informal financing tool has a marginal effect of 0.022, indicating that informal financing is an important financing source for R&D investment. This extends the findings that trade credit promotes Chinese firms' growth and investments (Wu et al., 2014; Lin and Chou, 2015; Ge and Qiu, 2007). In addition, an entrepreneur's former political background has a positive effect on the firm's innovation activities. In particular, after all control variables are introduced, we find that ACFIC membership and political connection also have positive and statistically significant impacts on R&D investment with coefficients of 0.426 and 0.272, respectively, at 1% significance level. This background can secure firms more supportive regulatory conditions (Agrawal and Knoeber, 2001) and improved access to financial support, including bank loans (Claessens et al., 2010), which ultimately improves their performance (Li et al., 2008). Under these circumstances, an entrepreneur's former cadre experience might help a firm to gain more external financing to conduct R&D activities (Lin et al.,

2011).

4.2. Political connection and ACFIC membership

To examine the potential effects on R&D investments of bank loans associated with ACFIC membership or political connection, we included the interaction terms *Political connection* × *Bank Loan* and *ACFIC* × *Bank Loan* in our model, as shown in equations (2) and (3) below.

$$R\&D_{i,t} = \alpha_0 + \alpha_1 Bank\ Loan_{i,t} + \alpha_2 Corruption \times Bank\ Loan_{i,t} + \alpha_3 Cash\ Flow_{i,t} + \alpha_4 Trade\ Credit_{i,t} + \alpha_5 X_{i,t} + v_j + v_t + v_r + v_{jt} + \varepsilon_{it} \tag{2}$$

$$R\&D_{i,t} = \alpha_0 + \alpha_1 Bank\ Loan_{i,t} + \alpha_2 ACFIC \times Bank\ Loan_{i,t} + \alpha_3 Cash\ Flow_{i,t} + \alpha_4 Trade\ Credit_{i,t} + \alpha_5 X_{i,t} + v_j + v_t + v_r + v_{jt} + \varepsilon_{it} \tag{3}$$

The results of equations (2) and (3) are presented in columns 1–2 of Table 4. Column 1 shows that the coefficient of the interaction term *Political connection* × *Bank Loan*, 0.009, is positive and statistically significant, but bank loans turn out to be insignificant compared to the baseline results shown in Table 3. Therefore, the results show that corrupt behaviour can help firms access bank loans to finance their R&D activities. Our results indicate that political connection has a “grease-the-wheel” effect and helps firms access external financing to invest in R&D. Since column 2 shows that the interaction term *ACFIC* × *Bank Loan* is not significant for R&D investments, business association power cannot help R&D investments through accessing bank loans. These findings support hypotheses 2 and 3.

4.3. Financial constraints

To better understand how financial constraints moderate the link between R&D investment and *Political connection* × *Bank Loan* and *ACFIC* × *Bank Loan*, we explored the interplay under different financial constraint levels. To measure financial constraints, we adopted two methods of evaluation.

First, we measured financial constraints using the entrepreneur's answer to an item on the questionnaire regarding the reason why the amount of their bank loan decreased compared with previous bank loan. If the entrepreneur's answer was either “mortgage restriction” or “credit limit for a non-state firm”, we considered the firm to be externally financially constrained. Second, we followed the methodology of Hadlock and Pierce (2010), who update Kaplan and Zingales (1997) text and introduce the size-age (SA) index. The SA index avoids having the same information built into both the dependent and independent variables. Furthermore, it is relatively easy to calculate and can better avoid an endogeneity bias in the financial factors. The index is calculated as follows:

$$SA_{it} = 0.737^* Size_{it} + 0.043^* Size_{it}^2 - 0.040^* Age_{it} \tag{4}$$

We separated firms according to their financial constraint level as measured by the SA index by considering firms with a SA index above (below) the sample median to be less (more) likely to be financially constrained.

The regression results under different constraint levels and measurements are reported separately in columns 3–10 of Table 4. Columns 3–6 use the entrepreneur's answer to measure financial constraints, and the results measured financial constraints by SA index are reported in columns 7–10. These results show that *Political connection* × *Bank Loan* is not positive and is statistically insignificant when firms are less financially constrained (columns 3 and 7), while *Political connection* × *Bank Loan* is positive and statistically significant when firms are more financially constrained with coefficients of 0.009 and 0.011 by different

Table 4
Regressions with financial constraints.

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Full Samples		Un-FC	FC	Un-FC	FC	Un-FC	FC	Un-FC	FC
	R&D		R&D		R&D		R&D		R&D	
Bank Loan	0.002 (0.003)	0.009** (0.005)	0.009 (0.009)	0.001 (0.003)	0.016 (0.011)	0.008* (0.005)	0.008 (0.007)	−0.001 (0.003)	0.018 (0.011)	0.006* (0.003)
Political connection × Bank Loan	0.009** (0.004)		0.005 (0.010)	0.009* (0.005)			0.005 (0.008)	0.011** (0.005)		
ACFIC × Bank Loan		0.001 (0.005)			−0.003 (0.012)	0.001 (0.006)			−0.006 (0.012)	0.003 (0.004)
Cash Flow	0.028*** (0.005)	0.028*** (0.005)	0.015** (0.007)	0.034*** (0.007)	0.023*** (0.007)	0.034*** (0.006)	0.013*** (0.005)	0.055*** (0.011)	0.014*** (0.004)	0.056*** (0.012)
Trade Credit	0.022** (0.010)	0.022** (0.010)	0.023 (0.016)	0.024** (0.010)	0.013 (0.009)	0.026*** (0.010)	0.022 (0.016)	0.025* (0.013)	0.015 (0.012)	0.019** (0.009)
ACFIC Member	0.430*** (0.130)	0.412*** (0.130)	0.413** (0.194)	0.345** (0.168)	0.416 (0.281)	0.170 (0.172)	0.156 (0.217)	0.485*** (0.158)	0.124 (0.171)	0.481*** (0.168)
Political connection	0.174 (0.138)	0.273** (0.132)	0.251 (0.226)	0.086 (0.186)	0.028 (0.293)	0.101 (0.167)	0.118 (0.263)	0.263 (0.161)	−0.166 (0.188)	0.355* (0.198)
Control Variables	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	11,196	11,196	6201	5659	6201	5659	5794	5786	5794	5786
R-squared	0.046	0.046	0.030	0.062	0.078	0.044	0.061	0.032	0.095	0.064
Year Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Province Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Region Cluster	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Data source: The survey of privately owned enterprises that was jointly conducted in 2004, 2006, 2008, 2010 and 2012 by State Administration for Industry and Commerce and the United Front Work Department of the Central Committee of the CPC. See [Appendix 1](#) for precise definitions of all variables.

Table 5
Regressions with institutional environment.

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Total Indicator				Financial Development			
	Well	Under	Well	Under	Well	Under	Well	Under
	R&D				R&D			
Bank Loan	0.008 (0.007)	0.001 (0.004)	0.006* (0.003)	0.020 (0.013)	0.003 (0.006)	0.001 (0.002)	0.007** (0.003)	0.013 (0.008)
Political connection × Bank Loan	0.006 (0.008)	0.009* (0.005)			0.009 (0.011)	0.008** (0.003)		
ACFIC × Bank Loan			−0.009 (0.012)	0.005 (0.004)			−0.001 (0.009)	0.002 (0.004)
Cash Flow	0.027*** (0.008)	0.028*** (0.006)	0.026* (0.010)	0.029*** (0.004)	0.026** (0.008)	0.028*** (0.009)	0.025** (0.008)	0.027*** (0.004)
Trade Credit	0.021 (0.020)	0.019** (0.009)	0.020 (0.012)	0.019** (0.008)	0.030 (0.015)	0.014* (0.008)	0.027 (0.014)	0.017** (0.009)
ACFIC Member	0.667** (0.265)	0.199 (0.142)	0.771 (0.743)	0.128 (0.150)	0.500 (0.311)	0.303* (0.173)	0.398 (0.351)	0.275* (0.152)
Political connection	0.292 (0.225)	0.132 (0.186)	0.355 (0.393)	0.236 (0.180)	0.378** (0.135)	0.066 (0.145)	0.454* (0.188)	0.117 (0.190)
Control Variables	YES	YES	YES	YES	YES	YES	YES	YES
Observations	4050	4562	4050	4562	5458	5738	5458	6047
R-squared	0.066	0.058	0.066	0.058	0.051	0.031	0.062	0.027
Year Dummies	YES	YES	YES	YES	YES	YES	YES	YES
Industry Dummies	YES	YES	YES	YES	YES	YES	YES	YES
Region Dummies	YES	YES	YES	YES	YES	YES	YES	YES
Region Cluster	YES	YES	YES	YES	YES	YES	YES	YES

Data source: The survey of privately owned enterprises that was jointly conducted in 2004, 2006, 2008 and 2010 by State Administration for Industry and Commerce and the United Front Work Department of the Central Committee of the CPC.

measurements of financial constraints (columns 4 and 8). These findings indicate that when firms are more financially constrained, political connection can reduce asymmetric information for both lender and receiver, and the grease-the-wheels effect of political connection also reduces external financing costs (i.e., reduces the barriers from officials, saves bargaining time, and gains external financing efficiently). Thus, political connection helps firms access external financing to invest in their R&D. Moreover, in this case, when the external financing cost is high, we find that the coefficient of cash flow is greater than in the less-financially constrained group. When firms are less financially

constrained, columns 3 and 7 show that bank loans do not play a significant role in R&D investment. Thus, political connection cannot help firms utilize bank loan financing for their R&D investments.

Columns 5 and 9 reveal that when firms are facing less financial constraints, *Bank Loan* and *ACFIC × Bank Loan* are insignificant, and columns 6 and 10 show that when firms are facing financial constraints, bank loans positively and significantly contribute to R&D investment with the marginal effects of 0.008 and 0.006 by different measurements of financial constraints, but the interaction term *ACFIC × Bank Loan* is insignificant. This result indicates that a bank loan is an efficient

Table 6
2SLS regressions.

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Second Stage		First Stage			
	R&D	R&D	Political connection	Political connection × Bank Loan	ACFIC Member	ACFIC × Bank Loan
Bank Loan	−0.009 (0.011)	0.008** (0.003)	0.002*** (0.001)	0.095*** (0.018)	−0.001* (0.000)	0.166*** (0.011)
Political connection × Bank Loan	0.022* (0.012)					
ACFIC × Bank Loan		0.004 (0.004)				
Cash Flow	0.026*** (0.004)	0.026*** (0.004)	0.001*** (0.000)	0.034*** (0.007)	0.000 (0.000)	−0.044*** (0.009)
Trade Credit	0.023*** (0.007)	0.021*** (0.007)	−0.000 (0.000)	−0.070*** (0.013)	−0.000 (0.000)	−0.037* (0.018)
ACFIC Member	0.388*** (0.127)	−0.015 (0.349)				
Political connection	0.622 (0.387)	0.854** (0.379)				
Province-Industry ACFIC Intensity			−0.045*** (0.015)	−0.299 (0.515)	0.783*** (0.018)	−3.218*** (0.718)
Province-Industry Political connection Intensity			1.040*** (0.021)	−0.392 (0.740)	−0.001 (0.025)	0.636 (1.001)
ACFIC Intensity × Bank Political connection Intensity × Bank					−0.009*** (0.000)	0.867*** (0.015)
Control Variables	YES	YES			YES	YES
Observations	11,196	11,196	11196	11196	11196	11196
R-squared	0.051	0.051				
Shea Partial R-squared			0.1847	0.1667	0.1467	0.2321
Cragg-Donald F-Statistic	705.73	624.638				
Sargan Test	0.145	0.157				
Year Dummies	YES	YES	YES	YES	YES	YES
Industry Dummies	YES	YES	YES	YES	YES	YES
Region Dummies	YES	YES	YES	YES	YES	YES

Data source: The survey of privately owned enterprises that was jointly conducted in 2004, 2006, 2008, 2010 and 2012 by State Administration for Industry and Commerce and the United Front Work Department of the Central Committee of the CPC. See [Appendix 1](#) for precise definitions of all variables.

financing resource for financially-constrained firms' R&D investments, while ACFIC membership cannot improve firms' access to external financing for R&D investments.

Regarding the internal and informal financing resources, we find that cash flow plays a positive and significant role in R&D investment. The coefficients of financially-constrained groups are greater than those for the less financially constrained groups. Because innovation investment cash flow sensitivity is an efficient proxy for measuring the financial constraints for innovation activities⁹ (Brown et al., 2009; Brown and Petersen, 2009), this result indicates that internal financing is still an important and efficient financing resource for firms' R&D investments (Guariglia and Liu, 2014). Moreover, trade credit plays a positive and significant role in financing R&D only in the financially-constrained group. This finding tells us that trade credit can be used as an alternative for financing resources in investments in R&D activities (Zhang, 2017).

4.4. Financial development, marketization, and institutional environment

We used bank branch intensity to measure the financial development level, as a branch's presence can reflect local financial availability (Mallick and HO, 2008; Fafchamps and Schündeln, 2013). Regions with

⁹ Fazzari et al. (1988) demonstrate that if a firm is financially constrained and its cash flow drops, it will have to cut back its investment, as it is unable to access more expensive external financing. Subsequent studies have supported this argument (Bond and Van Reenen, 2007; Hubbard, 1998). Many studies use this framework to identify the sensitivity of R&D expenditure to cash flow across countries (Himmelberg and Petersen, 1994; Cincera, 2002; Boughgas et al., 2003).

higher bank branch intensity are recognized as regions with high financial development. Additionally, the National Economic Research Institute index of Marketization (NERI index)¹⁰ was employed to capture the institutional environment. The NERI index consists of five aspects of the institutional environment in China's provinces, municipalities, and autonomous regions. These aspects are: (1) the relationship between the government and the market, (2) the development of a non-state economy, (3) the degree of development of a product market, (4) the degree of development of a factor market, and (5) the development of market intermediary organizations and a legal system environment. There are two sub-items in each aspect that help to better characterize these five dimensions.¹¹ We utilized the total index to measure the institutional environment in our analysis. Therefore, all of the samples were classified into two groups according to their institutional and financial development level, measured using the NERI index and bank intensity, and we considered firms with a score above (below) the sample median to be less (more) likely to be financially constrained.

Table 5 reveals the heterogeneous effects on the relationship between *Political connection × Bank Loan*, *ACFIC × Bank Loan* and R&D

¹⁰ The NERI index was first constructed and published by Fan and Wang of the National Economic Research Institute of China in 2001 and was then updated frequently, although not regularly, by Fan et al. (2001, 2004, 2007, 2010, 2011). To the best of our knowledge, the NERI index is the only index that provides a systematic annual measurement of the institutional environment for each province of mainland China.

¹¹ Each of these sub-indices been assigned a score, ranging from 0 to 10, calculated based on the statistics obtained from government authorities and surveys of the authors. Excluding Hong Kong, Macau, and Taiwan, China has 31 provinces, municipalities, and autonomous regions.

investment. First, for firms located in a relatively under-developed institutional and financial environment, *Political connection* × *Bank Loan* is positive and statistically significant for R&D investment, and the joint effect of bank loans and political connection on R&D are 0.009 and 0.008 (columns 2 and 6). For firms in a well-developed institutional and financial environment, *Political connection* × *Bank Loan* is insignificant in terms of their R&D investments, bank loans are not significantly associated with R&D (columns 1 and 5). Second, *ACFIC* × *Bank Loan* is insignificant for firms' R&D investment in both under- and relatively well-developed institutional and financial environments (columns 3–4 and 7–8). However, *Bank Loan* is positive and statistically significant for firms' R&D investment in regions with relatively well-developed institutional and financial environments (0.006 in column 3 and 0.007 in column 7). Third, cash flow also plays a positive and significant role in R&D expenditures in all the regions, but trade credit significantly contributes to the R&D investment in under-developed regions.

5. Endogeneity problems and robustness tests

5.1. Instrumental variable estimation

It is likely that the potential correlation between the residual and our regressors (e.g., entrepreneur's social ability) may lead to biased estimated results. Additionally, political connection, ACFIC membership, and bank loan applications for R&D investment made by firms can be endogenous. Moreover, political connection has a grease-the-wheels effect, and bribery amounts may influence access to bank loans, which may

affect firms' further performances, such as R&D investments. This, in turn, may yet determine their choices in terms of bribery (Chen et al., 2013). This mechanism may also be at work in the relationship between firms' performances (e.g., securing a bank loan and investment in R&D) and their owners' decisions to become an ACFIC members.

To figure out these endogeneity issues, an instrumental variable estimation approach is adopted. We chose the proxies for the proportion of ETCs and the proportion of ACFIC members in each province-industry cell, denoted by Political connection Intensity and ACFIC Intensity, respectively, as our instrumental variables. The reason for these choices is that the province-industry level's Political connection Intensity and ACFIC Intensity are orthogonal to the unobserved firm characteristics (denoted by ω_{it}) (Chen et al., 2013). Specifically, we also adopted *Political connection Intensity* × *Bank Loan* and *ACFIC Intensity* × *Bank Loan* as our instrument variables for *Political connection* × *Bank Loan* and *ACFIC* × *Bank Loan*.

The regression results from the 2SLS (Two-stage least squares) model are presented in Table 6. Columns 3–6 present the first-stage results for four outcome variables, respectively. Province-industry Political connection Intensity (*Political connection Intensity* × *Bank Loan*) and ACFIC Intensity (*ACFIC Intensity* × *Bank Loan*) have high explanatory power in terms of the firm-level Political connection (*Political connection* × *Bank Loan*) and ACFIC membership (*ACFIC* × *Bank Loan*) at a 1% significance level. Columns 1–2 present the second-stage results, and these results show the causal mechanisms of political connection and business association on bank financing of R&D activities. The coefficient estimates for *Political connection* × *Bank Loan* are statistically significant

Table 7
Treatment model regressions.

VARIABLES	(1) (2)		(3) (4)		(5) (6)	
	PSM Model		Heckman Treatment Model		Heckman Treatment Model	
	R&D	R&D	R&D	Political connection	R&D	ACFIC Member
Bank Loan	0.001 (0.010)	0.026* (0.015)	0.003 (0.005)	0.004 (0.003)	0.010*** (0.003)	0.002 (0.001)
Political connection × Bank Loan	0.040** (0.019)		0.008* (0.005)			
ACFIC × Bank Loan		-0.017 (0.015)			0.001 (0.003)	
Cash Flow	0.058** (0.021)	0.027** (0.011)	0.027*** (0.004)	0.008*** (0.001)	0.027*** (0.004)	0.001 (0.001)
Trade Credit	0.037 (0.051)	-0.001 (0.009)	0.022*** (0.007)	-0.003 (0.002)	0.022*** (0.007)	-0.004** (0.002)
ACFIC Member	0.625 (0.399)	0.807* (0.455)	0.397*** (0.126)		0.489 (0.343)	
Political connection	-0.005 (0.327)	0.225 (0.346)	0.306 (0.357)		0.303* (0.162)	
Province-Industry ACFIC Intensity				-0.234*** (0.087)		2.561*** (0.079)
Province-Industry Political connection Intensity				4.716*** (0.143)		-0.115 (0.111)
ACFIC Intensity × Bank						0.001 (0.002)
Political connection Intensity × Bank				-0.004 (0.004)		
Control Variables	YES	YES	YES	YES	YES	YES
Observations	1139	2010	11,196	11,196	11,196	11,196
R-squared	0.153	0.070				
rho			-0.012		-0.013	
Year Dummies	YES	YES	YES	YES	YES	YES
Industry Dummies	YES	YES	YES	YES	YES	YES
Region Dummies	YES	YES	YES	YES	YES	YES
Region Cluster	YES	YES	YES	YES	YES	YES
Panel B: first state of PSM	Political connection	ACFIC Member				
Treatment	1.810	1.960				
Control	1.264	1.578				
Difference	0.546**	0.375*				
T-stat	2.62	1.96				

Data source: The survey of privately owned enterprises that was jointly conducted in 2004, 2006, 2008, 2010 and 2012 by State Administration for Industry and Commerce and the United Front Work Department of the Central Committee of the CPC.

Table 8
Tobit and probit model regressions.

VARIABLES	(1)	(2)	(3)	(4)	(5)	
	Tobit	IV-Tobit		IV-Probit		
	R&D	R&D		R&D Dummy		
Bank Loan	0.001*** (0.000)	−0.003 (0.002)		0.003** (0.001)	−0.002 (0.002)	0.002** (0.001)
Political connection × Bank Loan		0.004** (0.002)			0.003** (0.001)	
ACFIC × Bank Loan				0.001 (0.001)		−0.002 (0.001)
Cash Flow	0.003*** (0.000)	0.004*** (0.001)		0.014*** (0.002)	0.005*** (0.001)	0.004*** (0.001)
Trade Credit	0.002*** (0.001)	0.110*** (0.007)		0.063*** (0.018)	0.003*** (0.000)	0.004** (0.002)
ACFIC Member	0.107*** (0.012)	0.006*** (0.001)		0.010*** (0.003)	0.340*** (0.038)	0.522*** (0.099)
Political connection	0.065*** (0.015)	0.071** (0.035)		0.535*** (0.156)	0.280*** (0.091)	0.304*** (0.046)
Control Variables	YES	YES		YES	YES	YES
Observations	11,196	11,196		11,196	11,196	11,196
Wald Test of Exogeneity		0.028		0.014	0.000	0.050
Year Dummies		YES		YES	YES	YES
Industry Dummies		YES		YES	YES	YES
Region Dummies		YES		YES	YES	YES

Data source: The survey of privately owned enterprises that was jointly conducted in 2004, 2006, 2008, 2010 and 2012 by State Administration for Industry and Commerce and the United Front Work Department of the Central Committee of the CPC. This table presents the results from regressions using the Tobit, IV-Probit and IV-Tobit models. Two period lags of financial variables and interactions are used as instrument variables. The numbers in the rows of Wald test testing indicate whether these variables in these regressions is endogenous or not. Robust standard errors are in parentheses. ***, **, and * represent the statistical significance at the 1%, 5%, and 10% percent levels, respectively.

Table 9
Regressions with firm size and profitability.

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Large	Small	Large	Small	ROS ^{Low}	ROS ^{High}	ROS ^{Low}	ROS ^{High}
	R&D	R&D	R&D	R&D	R&D	R&D	R&D	R&D
Bank Loan	−0.000 (0.003)	0.006*** (0.001)	0.006 (0.005)	0.018* (0.009)	0.006 (0.006)	−0.004 (0.004)	0.006 (0.005)	0.014** (0.006)
Political connection × Bank Loan	0.010 (0.006)	0.006* (0.004)			0.002 (0.006)	0.016*** (0.005)		
ACFIC × Bank Loan			0.004 (0.006)	−0.007 (0.010)			0.001 (0.006)	−0.004 (0.008)
Cash Flow	0.015** (0.006)	0.054*** (0.008)	0.014*** (0.005)	0.055*** (0.011)	−0.052** (0.021)	0.028*** (0.006)	−0.052** (0.021)	0.021*** (0.006)
Trade Credit	0.019 (0.016)	0.023* (0.012)	0.018 (0.013)	0.021 (0.016)	−0.004 (0.006)	0.045** (0.019)	−0.005 (0.006)	0.050*** (0.019)
ACFIC Member	0.562** (0.222)	0.166 (0.180)	0.497*** (0.164)	0.231 (0.222)	0.168 (0.139)	0.732*** (0.217)	0.152 (0.147)	0.696*** (0.214)
Political connection	0.312*** (0.064)	0.005 (0.117)	0.374** (0.156)	0.169 (0.244)	−0.023 (0.214)	0.515*** (0.170)	−0.002 (0.208)	0.780*** (0.166)
Control Variables	YES	YES	YES	YES	YES	YES	YES	YES
Observations	5418	5778	5418	5778	5558	5638	5558	5638
R-squared	0.056	0.048	0.066	0.060	0.052	0.058	0.052	0.037
Year Dummies	YES	YES	YES	YES	YES	YES	YES	YES
Industry Dummies	YES	YES	YES	YES	YES	YES	YES	YES
Province Dummies	YES	YES	YES	YES	YES	YES	YES	YES
Region Cluster	YES	YES	YES	YES	YES	YES	YES	YES

Data source: The survey of privately owned enterprises that was jointly conducted in 2004, 2006, 2008, 2010 and 2012 by State Administration for Industry and Commerce and the United Front Work Department of the Central Committee of the CPC. See Appendix 1 for precise definitions of all variables.

at 0.002 (column 1), and the coefficient estimates for *ACFIC × Bank Loan* are statistically insignificant, but the coefficient for a bank loan is still positive and significant (column 2). These estimations results are consistent with the findings in columns 1–2 in Table 4. Our findings further confirm that political connection plays a significant role in greasing bank loans to finance R&D activities.

In addition to the endogeneity problems mentioned in this section,

selection biases may also exist in our analysis. Specifically, political connection decisions and the establishment of ACFIC communities are choices made by individual firms. To further cope with selection biases, we attempted to use a Propensity Score Matching (PSM) model and Heckman treatment model to solve this problem. There are subtle differences between the two models. The PSM model addresses selection bias based on observable parameters, such as those already controlled for

in our model, while the Heckman treatment model uses additional exogenous variables to address selection bias due to unobserved factors.

5.2. PSM model

In each specification, only the “treatment” was included as an independent variable. We then regressed the samples paired by the PSM method. PSM estimation requires two steps. In the first step, the propensity score for each firm was calculated via a probit model. We then matched Political connection and non-Political connection firms, ACFIC membership and non-ACFIC membership according to the obtained propensity scores, and then used the paired samples to estimate our results. Columns 1 and 2 in Table 7 show the regression results for equations (2) and (3), where the treatment variables are political connection and ACFIC membership, respectively. We found that *Political connection* \times *Bank Loan* plays a positive and statistically significant role in R&D investment, and the coefficient is greater (0.040) than that of the baseline results, indicating political connection is a significant factor that combines bank loans and firms' R&D (column 1). However, *ACFIC Intensity* \times *Bank Loan* is statistically insignificant for R&D investment. The *Bank Loan* variable still plays a positive and significant role in R&D investment. This suggests that ACFIC membership cannot affect the source of the external financing for R&D investment behaviour (column 2). These results confirm the estimation results in Table 7 further.

5.3. Heckman self-selection model

Table 7 presents the Heckman self-selection model results. Columns 4 and 6 are the first-stage results. We found that Province-Industry Political connection and ACFIC Intensity have high explanatory power for firm-level Political connection and ACFIC membership (coefficients of 4.716 and 2.561 at the 1% significance level). Columns 3 and 5 present the second-stage results. Column 3 shows that *Political connection* \times *Bank Loan* is statistically significant for R&D investment with a coefficient of 0.008, and column 5 reveals that *ACFIC Intensity* \times *Bank Loan* is statistically insignificant for R&D investment, but that bank loans still play a positive and significant role in R&D investment. These results are consistent with the previous findings presented in Table 4. *Political connection* \times *Bank Loan* is statistically significant for innovation investment, but *ACFIC* \times *Bank Loan* is statistically insignificant for innovation investment.

5.4. Robustness tests

To build more credibility for our main findings, we conducted several robustness tests, including adopting alternative estimation methods (Tobit, IV-Probit, and IV-Tobit models).

Following Lin et al. (2011), we used Tobit and probit models to explore the determinants of a firm's R&D investment.¹² The benchmark results of equation (1), regressed by a Tobit model, are reported in columns 1–5 of Table 8. Our results show that cash flow, Bank Loan, and trade credit play positive and significant roles in R&D investment at the 1% significance level (column 1). In columns 2–5, to further consider the endogeneity problems mentioned in Section 5.1, columns 2 and 3 report the regressions obtained using the IV-Tobit model, and our findings are consistent with the regressions shown in columns 1–2 of Table 4.

Additionally, we utilized the bank loan dummy variable as our dependent variable and adopted the IV-Probit model to conduct the regression. Columns 4–5 demonstrate that our results still stand when using the IV-Probit model.

¹² The estimation methods are not presented because the models are well known and widely used in the literature.

5.5. Firm size and firm profitability

Following Almeida et al. (2004), we split the firms into groups based on their size to test the robustness of a firm's financial constraint results.¹³

The regression results under different firm size levels are reported separately in columns 1–4 of Table 9. These results show that *Political connection* \times *Bank Loan* is not positive and is statistically insignificant when firms are large (column 1), while *Political connection* \times *Bank Loan* is positive and statistically significant when firms are small, with a coefficient of 0.006 (column 2). Column 3 reveals that when firms are large, a *Bank Loan* and *ACFIC* \times *Bank Loan* are insignificant, and column 4 shows that when firms are small, a *Bank Loan* positively and significantly contributes to R&D investment, but the interaction term *ACFIC* \times *Bank Loan* is insignificant. These results are consistent with the results reported in Table 4.

Here, we asked further whether rent seeking can induce a firm to either become corrupt or join a government-controlled business association in order to gain access to bank loans with which to invest in R&D (Pei, 2008; Fan et al., 2009). We explored whether firms with high profitability prefer to absorb the cost of political connection, and if political connection led to more uncoordinated rent seeking to these firms. We divided firms into two groups based on ROS, i.e., firms with an ROS above the median value were categorized as “high ROS” and all other firms were categorized as “low ROS”.

The regression results under different firm profitability levels are reported separately in columns 5–8 of Table 9. These results show that *Political connection* \times *Bank Loan* is statistically insignificant for firms with low profitability (column 5), while *Political connection* \times *Bank Loan* is positively statistically significant for firms with high profitability with a coefficient of 0.016 at the 1% significant level (column 6). This indicates that high-profitability firms prefer to absorb the political connection cost to gain access to bank loans for R&D investments. Columns 7 and 8 show that *ACFIC* \times *Bank Loan* is insignificant for high- and low-profitability firms, indicating that ACFIC membership does not have an impact on the relationship between R&D and bank loans.

6. Conclusion

This study examines the effects of external financing combined with either political connection or ACFIC membership on R&D investment. Using a new and unique dataset of Chinese private enterprise surveys from 2004, 2006, 2008, 2010, and 2012, we find that bank loans are positively and significantly related to R&D investment. Our results illustrate further that political connection has an impact on the relationship between R&D investment and bank loans. Specifically, firms with more financial constraints, which are located in regions with underdeveloped financial markets and institutional environments can benefit more from political connection in terms of receiving bank loans and investing in their R&D activities. The results also support that political connection and other unconventional governmental actions still play a major role in allocating scarce economic resources in the Chinese economic system (Pei, 2008).

Moreover, we find that ACFIC members cannot improve their firm's R&D investments through access to bank loans. Since the ACFIC was founded by the Chinese government (Jia, 2014), it is more likely to protect the government's interests, thus its effectiveness in terms of advancing its members priorities may be less than ideal. Finally, we also find that cash flow is also of high importance in firms' R&D investments due to its role in alleviating financial constraints or because it proxies for omitted or mismeasured investment opportunities (Guariglia and Liu,

¹³ Carpenter and Guariglia (2008) demonstrate that information asymmetry adversely affects small firms compared to large firms studying investment-cash flow sensitivity. Thus, we use firm size as a proxy for external finance access.

2014; Chen and Guariglia, 2013). Trade credit is another crucial alternative channel for firms' R&D investments, which confirms the view that the main motive for China's private sector in using trade credit is financing rather than other informal financing intermediations (Ge and Qiu, 2007).

The results of this study lead to the clear policy message that China's government needs to continue fostering a good financing environment and supporting innovation activities. Government and financial institutions help firms overcome innovation investment barriers through decreasing the information asymmetries of innovation investment for the private sector in China. Additionally, the financial environment should be efficiently regulated, and business association's bargain powers should play a more important role in benefiting privately-owned firms in terms of accessing financing resource. The long-term innovation contribution

by the private sector will drive sustainable growth in China.

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Appendix

Appendix Table 1
Variable definitions

Variable	Definition
Firm characteristics	
R&D	The ratio of R&D expenditure to firm sales $\times 100$
R&D Dummy	A dummy variable that takes a value of 1 if the firm has R&D expenditure
Firm Size	The natural logarithm of the number of employees
Firm Age	The natural logarithm of the number of years since the open year
ROS	The ratio of profit to firm sales $\times 100$
Tax	The ratio of tax paid to firm sales $\times 100$
Fee	The ratio of fees paid to firm sales $\times 100$
Tanpai Fee	The ratio of Tanpai fees paid to firm sales $\times 100$
Corporatized	A dummy variable that takes a value of 1 if the firm is registered as a corporation
Owner's Share	The percentage of equity held by the entrepreneur in total sales
Former SOEs	A dummy variable that takes a value of 1 if the firm was privatized from a former SOE
Financing characteristics	
Bank Loan	The ratio of Bank Loans to firm sales $\times 100$
Bank Loan Dummy	A dummy variable that takes a value of 1 if the firm gains access to bank loans
Cash Flow	The ratio of net profit to firm sales $\times 100$
Trade Credit	The ratio of account of payable to firm sales $\times 100$
Political capital	
ACFIC Member	A dummy variable that takes a value of 1 if the entrepreneur is an ACFIC member
CCP Member	A dummy variable that takes a value of 1 if the entrepreneur is a member of the Communist Party of China
PC or PPCC Deputy	A dummy variable that takes a value of 1 if the entrepreneur has membership in the People's Congress or People's Political Consultative Conference
Political connection	A dummy variable that takes a value of 1 if firm's entertainment cost is over the medium
Entrepreneurial characteristics	
Female	A dummy variable that takes a value of 1 if the entrepreneur is a female
Owner's Age	The natural logarithm of the number of years since the entrepreneur's born year
Education Year	The natural logarithm of the number of entrepreneur's education years
Management Experience	A dummy variable that takes a value of 1 if the entrepreneur previously worked as a manager of a firm
Former Cadre	A dummy variable that takes a value of 1 if the entrepreneur previously worked as a government cadre

Appendix Table 2
Distribution of Firms by Provinces

Year	2004		2006		2008		2010		2012	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Beijing	61	2.9	119	4.5	121	3.7	98	3.7	121	4.0
Tianjin	46	2.2	35	1.3	76	2.3	50	1.9	68	2.2
Hebei	31	1.5	112	4.3	135	4.1	84	3.2	89	2.9
Shanxi	24	1.2	26	1.0	53	1.6	48	1.8	52	1.7
Inner Mongolia	74	3.6	28	1.1	71	2.2	44	1.7	50	1.6
Liaoning	67	3.2	135	5.1	130	4.0	114	4.4	159	5.2
Jilin	52	2.5	17	0.7	68	2.1	87	3.3	122	4.0
Heilongjiang	22	1.1	67	2.6	104	3.2	73	2.8	109	3.6
Shanghai	148	7.1	266	10.1	277	8.5	175	6.7	164	5.4
Jiangsu	209	10.0	395	15.0	379	11.6	234	8.9	418	13.7
Zhejiang	139	6.7	268	10.2	202	6.2	210	8.0	219	7.2
Anhui	84	4.0	23	0.9	83	2.5	79	3.0	116	3.8
Fujian	52	2.5	34	1.3	33	1.0	51	2.0	98	3.2
Jiangxi	59	2.8	115	4.4	68	2.1	44	1.7	28	0.9

(continued on next column)

Appendix Table 2 (continued)

Year	2004		2006		2008		2010		2012	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Shandong	186	8.9	118	4.5	234	7.1	148	5.7	199	6.5
Henan	49	2.4	57	2.2	121	3.7	47	1.8	52	1.7
Hubei	120	5.8	145	5.5	153	4.7	167	6.4	132	4.3
Hunan	18	0.9	109	4.1	63	1.9	67	2.6	30	1.0
Guangdong	143	6.9	210	8.0	221	6.7	177	6.8	200	6.6
Guangxi	46	2.2	24	0.9	61	1.9	58	2.2	54	1.8
Hainan	64	3.1	10	0.4	21	0.6	66	2.5	69	2.3
Chongqing	56	2.7	39	1.5	153	4.7	110	4.2	93	3.1
Sichuan	65	3.1	87	3.3	117	3.6	82	3.1	93	3.1
Guizhou	37	1.8	10	0.4	59	1.8	66	2.5	52	1.7
Yunnan	32	1.5	19	0.7	35	1.1	34	1.3	39	1.3
Shannxi	71	3.4	38	1.4	64	2.0	65	2.5	74	2.4
Gansu	61	2.9	67	2.6	43	1.3	46	1.8	47	1.5
Ningxia	7	0.3	9	0.3	44	1.3	25	1.0	22	0.7
Qianghai	39	1.9	10	0.4	31	1.0	36	1.4	31	1.0
Xinjiang	16	0.8	35	1.3	54	1.7	23	0.9	47	1.5
Tibet	7	0.3	3	0.1	6	0.2	9	0.3	2	0.1
Total	2085	100	2630	100	3280	100	2617	100	3049	100

Data source: The survey of privately owned enterprises that was jointly conducted in 2004, 2006, 2008, 2010 and 2012 by State Administration for Industry and Commerce and the United Front Work Department of the Central Committee of the CPC.

Appendix Table 3

Distribution of Firms by Industries

Year	2004		2006		2008		2010		2012	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Agriculture, forestry, animal, husbandry and fishery	142	7.1	151	6.2	199	7.1	222	8.7	203	6.7
Mining	35	1.8	43	1.8	58	2.1	74	2.9	54	1.8
Manufacturing	758	37.9	1133	46.5	1266	45.1	1054	41.2	1133	37.4
Production and supply of electricity, heat, gas and water	27	1.4	31	1.3	28	1.0	29	1.1	28	0.9
Construction	134	6.7	132	5.4	155	5.5	168	6.6	199	6.6
Transport, storage and post	42	2.1	55	2.3	65	2.3	80	3.1	101	3.3
Information technology, information transmission and software			90	3.7	151	5.4	129	5.0	116	3.8
Wholesale and retail trades			479	19.7	511	18.2	458	17.9	541	17.9
Hotels and catering services	426	21.3	107	4.4	119	4.2	90	3.5	119	3.9
Financial intermediation	1	0.1	2	0.1	12	0.4	12	0.5	20	0.7
Real estate	55	2.8	54	2.2	72	2.6	82	3.2	107	3.5
Leasing and business services			20	0.8	28	1.0	27	1.1	97	3.2
Scientific research and technical services management	38	1.9	39	1.6	36	1.3	17	0.7	22	0.7
Management of public facilities			7	0.3	6	0.2	8	0.3	7	0.2
Services to households	127	6.4	51	2.1	61	2.2	57	2.2	34	1.1
Education	14	0.7	3	0.1	2	0.1	12	0.5	9	0.3
Health			18	0.7	13	0.5	15	0.6	7	0.2
Culture and sports	31	1.6	19	0.8	24	0.9	24	0.9	33	1.1
Public management			2	0.1	1	0.0	2	0.1	196	6.5
Other	169	8.5								
Total	1999	100	2436	100	2807	100	2560	100	3026	100

Data source: The survey of privately owned enterprises that was jointly conducted in 2004, 2006, 2008, 2010 and 2012 by State Administration for Industry and Commerce and the United Front Work Department of the Central Committee of the CPC.

Appendix Table 4
Coefficients of Correlation between Owner's Identities

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
R&D	1.000																	
R&D Dummy	0.387***	1.000																
Cash Flow	0.055***	-0.024	1.000															
Bank Loan	0.081***	0.072***	0.052***	1.000														
Trade Credit	0.033**	0.031	-0.025	0.078***	1.000													
Firm Size	0.071***	0.396***	-0.109***	0.131***	0.003	1.000												
Firm Age	0.022	0.183***	-0.020	0.073***	-0.028	0.325***	1.000											
Former SOEs	-0.012	0.049***	-0.046**	0.017	-0.002	0.116***	0.003	1.000										
Corporatized	0.004	0.064***	-0.124***	0.044***	0.005	0.145***	0.007	0.056**	1.000									
Education	0.019	-0.003	0.013	0.017	0.011	0.050***	0.011	0.031*	0.047***	1.000								
Owner's Age	0.015	0.093***	-0.064**	0.039**	-0.004	0.197***	0.020	0.094***	0.020	-0.047***	1.000							
Female	-0.023	-0.100***	0.035***	-0.036**	-0.026	-0.154***	-0.077***	-0.040***	0.011	-0.093***	-0.166***	1.000						
Management	0.019	0.074***	-0.039***	0.042***	-0.001	0.138***	0.056***	0.139***	0.016	0.046***	0.020	-0.083***	1.000					
Experience														1.000				
Former Cadre	0.055***	0.061***	-0.023	0.022	0.007	0.067***	-0.029	0.067***	0.030*	0.054***	0.080***	-0.039***	0.003	1.000				
ACFIC Member	0.058***	0.266***	-0.042***	0.102***	-0.017	0.435***	0.347***	0.070***	0.003	0.034**	0.175***	-0.095***	0.117***	0.054***	1.000			
CCP Member	0.020	0.119***	-0.046**	0.031*	0.016	0.200**	0.085**	0.152***	0.070***	0.053***	0.228***	-0.116***	0.145***	0.178***	0.118***	1.000		
PC or PCCC Deputy	0.002	0.168***	-0.024	0.080***	-0.042**	0.294***	0.255**	0.036***	0.046***	-0.007	0.134**	-0.057***	0.104***	-0.008	0.353***	0.103***	1.000	
Political connection	0.032**	0.112***	0.032**	0.055***	0.008	0.139***	0.047***	0.006	0.031*	0.006	0.020	-0.046***	0.022	0.052***	0.087***	0.034**	0.016	1.000

Data source: The survey of privately owned enterprises that was jointly conducted in 2004, 2006, 2008, 2010 and 2012 by State Administration for Industry and Commerce and the United Front Work Department of the Central Committee of the CPC. See Appendix 1 for precise definitions of all variables.

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