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The certification effect of government R&D subsidies on innovative entrepreneurial firms' access to bank finance: evidence from China

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Abstract In this paper, we argue that obtaining government R&D subsidies has a certification effect and is used by innovative entrepreneurial firms as a legitimation strategy to access bank finance. We extend the extant literature on the certification effect by combining legitimacy theory with information asymmetry to build our theoretical framework. We test our theoretical model under China's unique institutional setting, in particular, the weak intellectual property rights (IPR) protection. Using 549 listed and 192 unlisted Chinese innovative entrepreneurial firms from 2009 to 2013, we find a positive certification effect on the acquisition of bank loans for all those sample firms. This positive effect is more profound in unlisted firms in our sample than the listed ones. We further find that regional variation of IPR protection has a moderating effect on the effectiveness of the certification. The certification effect is more significant in those regions where IPR protection is weaker.

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1 Introduction

Innovative entrepreneurial firms have been widely recognized as one of the key driving forces of sustained economic growth in both developed and emerging economies, mainly because the capacity of an economy to produce innovative and high-tech goods signifies the potential of its innovation and competitiveness, and therefore of its growth in the long run. However, one of the major obstacles to the proliferation and growth of innovative entrepreneurial firms is financial constraints, i.e., limited access to external finance, which can be attributed to a low probability of financial success of their R&D projects causing their return uncertainty (Carpenter and Petersen 2002), substantial information asymmetries (Guiso 1998), and limited collateral value of their innovative projects (Kamien and Schwartz 1978; Honjo et al. 2014).
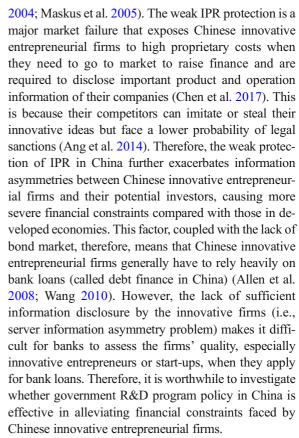
Facing such constraints, governments in both developed and emerging economies have proactively launched various government-funded R&D programs. Studies based on the developed markets such as Meuleman and De Maeseneire (2012) suggest that the SMEs' successful acquisition of such government programs can garner government certification and therefore be helpful for boosting their subsequent access to debt and equity financing. An important purpose of this kind of government award, thus, is to bring in private money through a "certification effect": the acquisition of

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government-funded R&D programs may be taken to certify that firms are of high quality, sending a signal to outside potential capital providers, reducing information asymmetry without increase of proprietary cost, and hence promoting non-governmental investment. This indicates that obtaining such a government certification can send a signal to outside capital providers, therefore reducing information asymmetry without increase of proprietary cost, which is typically high for innovative entrepreneurial small- and medium-sized enterprises (SMEs) when they disclose business information.

China's economic transition has greatly facilitated the development of entrepreneurs and private enterprises (He et al. 2018). In particular, the Chinese government has recently recognized innovation as one of the top priorities in its current economic development plan, i.e., the 13th Five-Year Plan (2016–2020). Innovation has been viewed as the most significant factor driving its long-run economic growth. The Chinese government has made enormous efforts in promoting the development of innovative entrepreneurial firms by introducing various government-subsidized R&D programs (Wang et al. 2013) (see Appendix Table 9 for detailed information). The primary objective of those government funding programs is to show the certification effect, i.e., send a signal to the market about the quality of the innovative entrepreneurial firms so as to reduce the information asymmetry and make them more attractive to private financing sources, in particular helping them to access bank loans rather than needing to pour more public money into them. This is evidenced by the fact that the amount of government funding, such as R&D subsidies, is much lower than that subsequently attracted from private sources, such as bank loans. Taking the Torch Program as an example, in 2012, the total government funding was RMB 1.97 billion (US$ 299.7 million) while subsequent private financing (mainly from banks) reached RMB 57.52 billion (US$ 8.75 billion).

However, China's ongoing economic transition has given rise to unique institutional environment that differs from that of developed countries, affecting entrepreneurial activities (He et al. 2018). Compared with innovative entrepreneurial firms in developed economies, Chinese innovative entrepreneurial firms (most of them are SMEs) suffer from more financial constraints due to the lack of corporate bond market and the weak institutional environment, particularly weak protection of intellectual property rights (IPR) (Wang

2004; Maskus et al. 2005). The weak IPR protection is a major market failure that exposes Chinese innovative entrepreneurial firms to high proprietary costs when they need to go to market to raise finance and are required to disclose important product and operation information of their companies (Chen et al. 2017). This is because their competitors can imitate or steal their innovative ideas but face a lower probability of legal sanctions (Ang et al. 2014). Therefore, the weak protection of IPR in China further exacerbates information asymmetries between Chinese innovative entrepreneurial firms and their potential investors, causing more severe financial constraints compared with those in developed economies. This factor, coupled with the lack of bond market, therefore, means that Chinese innovative entrepreneurial firms generally have to rely heavily on bank loans (called debt finance in China) (Allen et al. 2008; Wang 2010). However, the lack of sufficient information disclosure by the innovative firms (i.e., server information asymmetry problem) makes it difficult for banks to assess the firms' quality, especially innovative entrepreneurs or start-ups, when they apply for bank loans. Therefore, it is worthwhile to investigate whether government R&D program policy in China is effective in alleviating financial constraints faced by Chinese innovative entrepreneurial firms.

To date, although it is generally acknowledged that certificate effect may exist, there has been limited empirical investigation of this important issue in the extant literature in developed markets, and to the best of our knowledge, there has to date been no empirical investigation of it in emerging economies in general, and in China in particular where institutional environment is significantly different. This study aims to fill this void in the literature. What makes our study more interesting is that there is a significant variation of IPR protection at the provincial level in China (Yao and Rao 2009; Hsu et al. 2013; Ang et al. 2014; Fang et al. 2017). Even if under the same IPR law, difference in effective enforcement of IPR protection at the provincial level matters in China. Therefore, China's unique institutional settings provide a good opportunity to test whether the certification effect generated by government R&D subsidies helps innovative entrepreneurial firms to acquire bank finance and whether the regional variation of IPR protection in China affects the effectiveness of the certification.

Our contribution to the literature is twofold. The extant literature on the government certification effect

on innovative firms' access to external finance in the US and Belgium settings (Lerner 1999; Meuleman and De Maeseneire 2012) is from the viewpoint of information asymmetry only. We extend the extant theoretical framework by combining legitimacy theory with information asymmetry to examine the certification effect. We argue that obtaining certification as a legitimation strategy through the acquisition of government R&D subsidies can signal the quality of innovative entrepreneurial firms to the market and therefore has the benefits of information disclosure but at no increase of proprietary cost of disclosure. The certification can alleviate information asymmetry and thus facilitate Chinese innovative entrepreneurial firms' access to bank finance. This is an important incremental contribution of our study.

The second contribution lies in our empirical test of how regional differences in IPR protection as a reflection of China's unique institutional settings affects the government certification effect under our extended theoretical framework. It is these differences that make possible, in a single-country setting, our empirical investigation of how the variation of IPR protection can affect the certification effect. We apply these regional variations of IPR protection to test the effectiveness of the certification effect on innovative entrepreneurial firms' access to bank finance and demonstrate the substitutive effect of certification on IPR protection.

Using 549 listed and 192 unlisted Chinese innovative entrepreneurial firms from 2009 to 2013, we find that there is a positive certification effect on the acquisition of bank loans for all those firms. Moreover, this positive certification effect is stronger for those unlisted firms than for the listed ones. We further find that the certification effect is stronger for those sample firms in provinces with weaker IPR protection.

In addition to these two main contributions, our study also extends the extant entrepreneurship research into the Chinese context. For example, Hsu and Ziedonis (2008) and Häussler et al. (2012) examine the effect of patents as quality signals on entrepreneurial ventures' access to external financing. Pan and Yang (2018) examine the geographical characteristics of startup cities and the role of finance in promoting start-ups across Chinese cities. However, our study highlights obtaining certification as a way of acquiring legitimacy can provide valuable signal/information to banks as funding providers for SMEs, particularly Chinese innovative entrepreneurial firms, which adds a good collection to the extant literature of SMEs.

The remainder of the paper is organized as follow. Section 2 builds our theoretical model and constructs hypotheses. Section 3 presents data and the empirical model. Section 4 reports empirical results and results of robustness tests. Section 5 discusses and concludes the study.

2 Theoretical framework and hypothesis development

2.1 The legitimacy of government certification and the alleviation of information asymmetry

Suchman (1995) defines legitimacy in an inclusive, broad-based manner, suggesting that "legitimacy is a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions" (Suchman 1995: p. 574). Specifically, legitimacy is a judgment by resource-holding audiences about the acceptance, desirability, or appropriateness of a firm based on well-constructed norms, values, beliefs, and definitions in a society, which enables the firm to acquire other resources necessary for its survival and growth (Zimmerman and Zeitz 2002; Überbacher 2014).

Legitimacy is vital to both established firms and, in particular, innovative ventures.[1] Compared with established firms that can employ their past performance record to acquire legitimacy and access resources, particularly external finance, innovative ventures often suffer from more legitimacy deficits because of their limited past record, future uncertainty about financial performance (Aldrich and Fiol 1994; Zimmerman and Zeitz 2002) and the coexistence of the intrinsic difficulties of assessment of innovative projects and the lower abilities of banks to screen these projects (Carpenter and Petersen 2002; Ueda 2004). These legitimacy deficits usually result in substantial information asymmetry, causing problems for innovative entrepreneurial firms to prove their credentials.
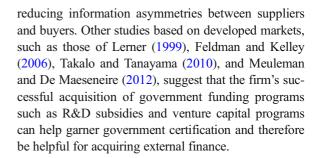
The extant literature has documented sources of legitimacy and strategies of acquiring legitimacy (i.e.,

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[1] Innovative ventures, or new ventures, are referred to as nascent organizational entities in their first years of existence, according to researchers such as Zimmerman and Zeitz (2002) and Überbacher (2014).

legitimation strategies) for innovative ventures. One of the sources of legitimacy, that is, socio-political regulatory legitimacy or regulative legitimacy (Scott 1995), is derived from standards, regulations, and rules generated by powerful institutional organizations such as governments (Hunt and Aldrich 1996; Zimmerman and Zeitz 2002). It suggests that firms can acquire legitimacy by conforming to rules, standards, regulations, and expectations created by governments, industry associations, and professional bodies. By using conformance as a legitimation strategy, innovative ventures can acquire legitimacy by obtaining external certification (Zimmerman and Zeitz 2002). For example, Rao (1994) finds that winning in certification contests offered by authorities in the American auto industry can be regarded as credentials that enable firms to acquire a reputation for competence, showing that reputation as an intangible resource is the result of the process of legitimation.

Sine et al. (2007) refer to certification as "a process in which a central institutional actor with authority or status formally acknowledges that a venture meets a particular standard" (Sine et al. 2007: p. 578). Sine et al. (2007) further argue that certification has a signaling effect to send positive message about the firm's credentials which facilitates it to acquire other resources in various fields. The extant literature further argues that the signaling effect of certification is able to reduce information asymmetries between firms and outside potential resources holders and thus to facilitate firm's access to external finance. This is particularly true for innovative entrepreneurial firms where IPR protection is weak, which puts the firms at high risk of information disclosure due to proprietary cost consideration. For example, Terlaak and King (2006) indicate that certification with the ISO 9000 Quality Management Standard can reduce information asymmetries in supply chains, in which supply chain transactions tend to be distant and international, making it more difficult for buyers as resources holders to observe the qualifications of suppliers. Particularly when supplier attributes are more intangible, i.e., suppliers have more R&D investments, buyers have more difficulty acquiring information about underlying supplier attributes and therefore more difficulty assessing the quality of suppliers, due to suppliers protecting their innovations from expropriation by keeping their innovations secret. Terlaak and King (2006) suggest that ISO 9000 can act as a signal of superior quality of suppliers, thus

reducing information asymmetries between suppliers and buyers. Other studies based on developed markets, such as those of Lerner (1999), Feldman and Kelley (2006), Takalo and Tanayama (2010), and Meuleman and De Maeseneire (2012), suggest that the firm's successful acquisition of government funding programs such as R&D subsidies and venture capital programs can help garner government certification and therefore be helpful for acquiring external finance.

2.2 Hypothesis development

In this study, we combine the legitimacy theory with information asymmetry to argue that government certification's effectiveness can reduce information asymmetry because it has legitimacy and is used as a legitimation strategy to act as a signal of superior quality of innovative entrepreneurial firms, particularly innovative SMEs, and therefore, compensates the information disclosure deficit of innovative SMEs, which enable innovative SMEs' access to bank finance.

We firstly investigate the effect of receiving government R&D subsidies on access to bank finance from the perspective of legitimacy theory and information asymmetry. We focus our study on the certification effect of Chinese government R&D subsidies on innovative entrepreneurial firms' access to bank financing (short-term and long-term bank loans) since Chinese banks have played a leading role in promoting innovations of entrepreneurial firms in China (Wang 2010) compared with equity financing (Allen et al. 2008) (also see the statistics included in the Introduction section). Our core argument is that the signaling effect generated by acquiring certification (R&D subsidies) as a legitimation strategy can reduce the information gap between innovative entrepreneurial firms and banks, and lower banks' search costs when facing a large set of potential innovative firms from which to lend.

Innovative projects often involve new knowledge, and understanding these projects requires technological expertise (Carpenter and Petersen 2002; Ueda 2004). However, banks are often less informed than such innovative entrepreneurial firms or other investors such as venture capitalists (Ueda 2004), creating substantial information asymmetry, and very often they have lower screening abilities for those innovative projects (Hellmann et al. 2008). In addition, banks also tend to undertake traditional financial statement analysis for lending to potential firms, but for innovative (or high-tech)

firms, their primary assets are intangible intellectual property, which does not appear on balance sheet and may yield returns only after many years (Lerner 1999). Thus, there is a high information gap between innovative firms and banks.

In addition to these common reasons in developed economies, the weak enforcement of intellectual property rights protection is a distinctive factor in emerging economies such as China, which further exacerbates such information problems and negatively affects innovative entrepreneurial firms' access to bank finance. Effective IPR protection is vitally important for innovative entrepreneurial firms' success, due to the fact that the competitiveness of those firms is greatly determined by their intellectual properties such as patents, specialized technologies, and processes (Ang et al. 2014). When IPR protection is weak, those firms are exposed to high proprietary cost when disclosing detailed information about their innovative projects. Therefore, innovative entrepreneurial firms suffer from legitimacy deficits as a result.

Since the 1990s, the Chinese government has created government funding, mainly in the form of R&D subsidies, to support the development of its innovative entrepreneurs, particularly in high-tech industry. These initiatives are designed to overcome the market failures of financing innovative entrepreneurial firms by creating the certification effect to attract private money externally. Successful applications serve as a signal that indicates that innovative entrepreneurial firms have garnered certification from the government, proving their acquisition of legitimacy. Such certification works mainly due to both the fact that the government agency may be better motivated than banks to screen projects undertaken by innovative entrepreneurial firms because of the *non-profit-making* nature of government-funded programs (Guo et al. 2016), and the fact that, as a centralized agency, the government could receive a substantial volume of applications for its funding programs and thus have an information advantage over banks (Meuleman and De Maeseneire 2012). This is especially true in the case of innovative SMEs' applications. As a result, in contrast to banks, whose traditional analysis of innovative firms' financial statements is of little use (Lerner 1999, 2002), specialists in the government may have insightful judgment about which innovative firms are more promising by screening their projects. Thus, successful acquisition of government R&D subsidies as a legitimation strategy is able to directly convey information to banks, which is likely to be particularly

valuable in innovative SMEs. It signals outside investors about their credentials, and this is particularly important under the circumstance of weak IPR protection. As a result, information asymmetry will be alleviated at no increase of proprietary cost. We, thus, develop our first hypothesis as follows:

- **Hypothesis 1**: Ceteris paribus, certification by acquiring government R&D subsidies has a positive effect on Chinese innovative entrepreneurial firms' access to bank finance.

We further argue that the degree of the certification as a signal may vary between listed innovative entrepreneurial firms and those unlisted firms due to the fact that listed firms need to conform to strict listing rules, which actually means they have already acquired a certain level of legitimacy, thus reducing the effect of certification as an additional legitimation strategy to obtain debt finance. Therefore, we argue that the certification effect of obtaining government R&D subsidies may be stronger in terms of unlisted innovative entrepreneurial firms' access to debt financing than in those listed firms' access to debt financing. Thus, we develop one sub-hypothesis under our first hypothesis as follows:

- **Hypothesis 1a**: Ceteris paribus, the positive effect of certification on Chinese innovative entrepreneurial firms' access to bank finance is stronger in unlisted ones than in listed ones.

We, then, further examine whether the regional difference in IPR protection (i.e., the degree of IPR protection) matters for the positive certification effect, that is, the moderating effect of IPR protection on the certification effect. One of the salient characteristics within the Chinese institutional environment is the regional difference in IPR protection. Yao and Rao (2009) suggest that, although China's IPR protection has gradually been improved, the regional difference in IPR protection at the provincial level in China is still striking, mainly due to the regional discretionary implementation of IPR, even if under the same IPR law. We use this regional variation of IPR protection to test the moderating role of IPR protection on the certification effect on innovative entrepreneurial firms' access to bank finance.

We argue that innovative entrepreneurial firms in provinces with better IPR protection should be

more willing to disclose their intellectual property information because the chance of infringement is relatively low due to effective legal sanction. More disclosure should be able to mitigate information asymmetry to some extent and, therefore, facilitate the firms' chance of accessing bank finance. Therefore, we expect the moderating effect of IPR protection on the certification effect to be stronger in regions with low-level IPR protection than in regions of high-level protection of IPR. We thus develop our second hypothesis as follows:

• **Hypothesis 2**: Ceteris paribus, the positive effect of certification by acquiring government R&D subsidies on Chinese innovative entrepreneurial firms' access to bank finance is weaker in the regions where IPR protection is stronger.

3 Empirical tests

3.1 Variable design and measurement

We use bank loan (debt) as our dependent variable in the regressions. It includes both short-term debt and long-term debt. We use a discrete measure for this variable that focuses on firm's success in obtaining debt finance. We adopt this measure because it better reflects the certification effect that is under discussion in this study and it is also consistent with the measurement adopted in the literature in this area (De Haan and Hinloopen 2003; Vanacker and Manigart 2010; Meuleman and De Maeseneire 2012; Ang et al. 2014). To measure short-term debt, when the net increase of a firm's short-term debt due within one year exceeds 5% of its total assets, we code this dummy variable 1, otherwise 0. When measuring long-term debt, when the net increase of a firm's long-term debt due within one year exceeds 5% of its total assets we code the dummy 1, otherwise 0. We choose the 5% cutoff point to make sure that we focus on relatively substantial financing events (De Haan and Hinloopen 2003; Vanacker and Manigart 2010; Meuleman and De Maeseneire 2012; Ang et al. 2014).

We also replace this discrete measure by a conventional continuous debt figure as a robustness test in Section 4.5.

The independent variable is the government R&D subsidies. The government R&D subsidies can be measured by the R&D subsidies and coded as 1 if a firm receives R&D subsidies in a given year, otherwise 0. It is lagged by one year relative to the dependent variables following prior studies (De Haan and Hinloopen 2003; Vanacker and Manigart 2010; Meuleman and De Maeseneire 2012; Ang et al. 2014) in order to reduce potential endogeneity problem.

In order to test the moderating role of regional differences of IPR protection in China on the relationship between bank finance and government certification of Chinese innovative entrepreneurial firms, we adopt the measure for IPR protection (IPRS_Y) developed by Yao and Rao in their study of creating a Chinese version of the IPR protection index (Yao and Rao 2009). Yao and Rao's measure is a modified version of the Ginarte-Park index proposed by Ginarte and Park (1997) to measure IPR protection in China. Ginarte and Park (1997) constructed an integrated index quantifying a level of IPR protection according to the five categories of the patent laws: (1) extent of coverage, (2) membership in international patent agreements, (3) provisions for loss of protection, (4) enforcement mechanisms, and (5) duration of protection. However, this index does not consider differences in the different implementations of IPR protection, which is the focus of the IPR protection variation we are studying in this paper. Yao and Rao (2009) developed China's GPI (CGPI) by incorporating the so-called implementation effect[2] in addition to all IPR laws in China to address regional differences in IPR protection at a province-level index in China, which very much fits into the purpose of our study.

Considering some important factors that may influence the relationship between bank loan and R&D subsidies certification, we have included the following control variables in our regressions. All the control variables are lagged by one year relative to the dependent variables in order to reduce the endogeneity problem. Control variables are also winsorized to reduce the impact of outliers.

Leverage (Leverage) is measured as firm's total debt divided by total assets. In general, firms with

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[2] Such "implementation effect" is measured based on the four dimensions: (1) social legalization, (2) the local government's attitude of enforcement, (3) facilities of relative services agency, and (4) the consciousness of social intellectual property protection. Please refer to Yao and Rao (2009) for detailed information on how to measure these four dimensions and how to construct China's GPI after considering such "implementation effect." Based on Yao and Rao (2009), we calculate the provincial-level data of IPR protection for 31 provinces in our sampled period, i.e., from 2009 to 2013.

higher leverage are less likely to attract additional debt financing, as the potential financial risk and liquidation risk are higher (Harris and Raviv 1991). *Firm size (Size)* is measured as the natural logarithm of the firm's total assets. Large firms are more likely to attract external finance since they always have better solvency and more stable cash flow (Hovakimian et al. 2001). *Liquidity (Liquidity)* is measured by dividing the firm's total amount of liquid assets by total assets. Firms with higher liquidity ratios have lower incentives for external finance as they prefer to use internal finance (De Haan and Hinloopen 2003). *Cash flow ratio (CFR)* is measured by dividing the firm's free cash flow (FCFF) by total assets. Similar to liquidity, firms with higher cash flow ratio are less likely to use external finance as they prefer to use internal finance (De Haan and Hinloopen 2003). *Firm's profitability (Profit)* is measured by return on firm's assets, which is calculated by dividing firm's net profit by total assets. The higher the profitability, the more easily the firm would acquire external finance. *Firm's growth (Growth)* is measured by its growth of sales. It is calculated as the sales in current year minus sales in previous year then divided by the sales in previous year. Sales growth is an essential element when external investors decide whether to invest in a firm. Firms with higher sales growth ratio could attract external finance more easily as they are more likely to be recognized by the market. *Intangible assets (Inassets)* denote a firm's innovation and potential, showing the capability of engaging in R&D to generate future growth options. This variable is measured by intangible assets scaled by total assets. *Asset turnover (Turnover)* is measured as the sales scaled by total assets. This variable indicates the firm's ability to use its assets to generate sales. The higher asset turnover ratio may alleviate the firm's need for external financing. However, a higher asset turnover ratio increases a firm's ability to attract external financing. *Audit (Audit)* is coded as 1 if the auditor reports an unqualified opinion or a clean opinion of firms, showing the firms' financial statements are presumed to be free from material misstatements, otherwise it is coded as 0. Firth (1979) suggests that banks are likely to offer better loan contracts (i.e., higher loan amount with lower interest rate) to firms with an unqualified opinion in audit reports.

Table 1 Definition of key variables

Variable name	Description
Short-term debt (STD)	Dummy variable coded as 1 when the net increase of short-term debt (i.e., debt with a maturity of less than or equal to one year) exceeds 5% of total assets, and 0 otherwise
Long-term debt (LTD)	Dummy variable coded as 1 if the net increase of long-term debt exceeds 5% of total assets, and 0 otherwise
Subsidies	Dummy variable coded as 1 if receiving R&D subsidies in a given year
Leverage	Total debt divided by total assets
Size	Natural logarithm of total assets
Liquidity	The total amount of liquid assets divided by total assets
CFR	Free cash flow for the firm (FCFF) divided by total assets
Profit	Return on assets, net profit divided by total assets
Growth	Sales in current year minus sales in previous year, divided by sales in previous year
Audit	Dummy variable coded as 1 if the auditor gives a clean opinion or unqualified opinion report, and 0 otherwise
Inassets	Intangible assets scaled by total assets
Turnover	Sales scaled by total assets
IPRS_Y	Regional intellectual property rights (IPR) protection in China based on Yao and Rao (2009)

Table 1 illustrates the variable construction and their measurements.

3.2 Empirical model

Since we choose to measure bank debt by a dummy variable, we use a fixed effect logit panel model to test our hypotheses. We employ the fixed effect model with the concern about omitted factors that may be correlated with key predictors at the group level. Fixed effect models control for unobserved heterogeneous characteristics when these characteristics are constant over time and correlated with independent variables. We test our hypotheses 1 and 1a using the following model:

$$Financing\ Increase_t = \beta_0 + \beta_1\ Subsidy_{t\text{-}1}$$
$$+ \beta_c Control\ Variables_{t\text{-}1}. \quad (1)$$

Financing Increase includes the increase in short-term debt and long-term debt respectively. We take one lag for both the independent variable and the control variables to control for endogeneity.

We test our hypothesis 2 using the following model:

$$Financing\ Increase_t = \beta_0 + \beta_1\ Subsidy_{t-1}$$
$$+ \beta_2\ IPRS\_Y_{t-1}$$
$$+ \beta_3\ Subsidy_{t-1}{}^*IPRS\_Y_{t-1}$$
$$+ \beta_c\ Control\ Variables_{t-1}.$$
$$(2)$$

The regression model (2) is used to test our second hypothesis. The coefficient of Subsidy*IPRS_Y will explain the moderating role of regional differences in IPR protection on the certification effect tested in Hypothesis 1.

3.3 Data source and sample

To construct our sample, we first identify Chinese innovative entrepreneurial firms according to the seven main tech fields[3] based on China Science & Technology Statistics Yearbook issued by the Ministry of Science and Technology of China. Based on this identification, our initial dataset includes 553 listed innovative entrepreneurial firms from the Main Board (MB), the Small and Medium Enterprise Board (SMEB), and the Growth Enterprise Board (GEB), and 1209 unlisted innovative entrepreneurial firms

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[3] The seven fields include (1) Electronic Information Technology; (2) Biological, Medical Technology; (3) New Materials; (4) Integrated Light, Electronics and Machinery; (5) New Energy and Efficient Energy-saving; (6) Environment Protection; and (7) Other High-tech Fields.

from the New Third Board.[4] After eliminating firms with less than two years' disclosed annual reports and the four firms with special treatment,[5] our final sample covers the period from 2009 to 2013 and has 741 innovative entrepreneurial firms in total, including 549 listed ones and 192 unlisted ones. Our firm-level financial data are collected from the WIND database and our provincial-level data of IPR protection are obtained based on the model of the IPR protection index from Yao and Rao (2009). The firms' R&D subsidy data are manually collected from the firms' annual reports.

4 Empirical results

4.1 Descriptive statistics

Table 2 depicts the descriptive statistics for key variables based on our full sample. In general, on average, 46% of the firms in our sample have access to short-term debt exceeding 5% of total assets, while only 16% of the firms have access to long-term debt exceeding 5% of total assets, suggesting that innovative entrepreneurial firms find it more difficult to access long-term debt financing than short-term debt financing. This may be because banks perceive offering long-term debt to this

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[4] The Chinese government has designed the multi-tier capital market for firms at different stages of growth and of different quality and risk profiles, satisfying their capital-raising needs and different risk appetites of investors. So far, China has developed various capital markets, including the Main Board (MB) market, the Small and Medium Enterprise Board (SMEB) market, and the Growth Enterprise Board (GEB) market, and the New Third Board market.

The MB markets from both Shanghai Stock Exchange (SSE) and Shenzhen Stock Exchange (SZSE) are markets for the issuance and trading of stocks of relatively large and well-established firms.

The SMEB market was established in May 2004 and aims to serve firms in a relatively mature stage of development and with stable profitability. The SME Board is considered a barometer of the Chinese manufacturing sector.

The GEB market was launched in October 2009 and primarily targets innovative firms with profitability. The GEB market reflects innovative efforts in both technology and business models in Chinese high-tech firms. It is open to firms of all sizes that meet the listing criteria.

The New Third Board is an experimental platform that was initiated in 2006, which is intended to facilitate financing for China's unlisted small, promising high-tech firms mainly located in Beijing's Zhongguancun Science Park, allowing them to transfer shares and raise funds for specific purposes.

[5] The "special treatment" tag denotes firms that have suffered losses for two or more consecutive years or which have entered delisting procedures.

Table 2 Descriptive statistics

Variable	Obs	Mean	Std. dev.	Min	Max
STD	2882	0.46	0.5	0.00	1.00
LTD	2016	0.14	0.34	0.00	1.00
Subsidies	3296	0.27	0.44	0.00	1.00
Leverage (%)	2848	25.43	22.11	0.02	99.25
Size	2882	20.02	1.85	14.94	24.24
Liquidity (%)	2882	3.02	5.1	0.01	31.03
CFR (%)	2728	−0.23	0.81	−19.76	1.06
Profit (%)	2876	11.75	11.33	−35.35	53.48
Audit	2848	0.99	0.11	0.00	1.00
Inassets (%)	2528	6.00	8.00	0.00	92.00
Turnover	2873	0.8	0.49	0.00	4.69
Growth (%)	2717	0.44	3.51	−1.00	132.05

This table shows the descriptive statistics of key variables based on the full sampled firms. Definitions of these key variables is shown in Table 1

kind of firms to be a greater risk than issuing short-term debt, due to both the information gap between banks and innovative entrepreneurial firms and the higher uncertainty of those firms' future prospects. Twenty-seven percent of the firms acquire government R&D subsidies in a given year. The average firm size (i.e., the natural logarithm of firm's total assets) is 20.02, which is comparable with the average firm size of all listed firms and all unlisted firms from the New Third Board.[6] The mean value of cash flow ratio (i.e., CFR) is −0.23%. Such a negative percentage may be due to the fact that most of the sampled firms are making large investments that aim to earn high returns in the long run. The mean value of intangible asset ratio (i.e., Inassets) is 6%, while the highest value of intangible asset ratio is 92%. These two figures imply that the weak IPR protection in China may be a disincentive for Chinese innovative entrepreneurial firms disclosing their innovative information as key IPR, and that there is regional variation in IPR protection in China.

Table 3 shows the Pearson correlation coefficients of key variables. It can be seen that government R&D subsidies as the independent variable is significantly positively correlated with the two dependent variables short-term debt (STD) and long-term debt (LTD), indicating that innovative entrepreneurial firms that acquire

R&D subsidies as a certification effect are more likely to attract both short-term and long-term bank finance. This provides some support for Hypothesis 1. In addition, firm size and intangible assets are significantly positively correlated with the two dependent variables, suggesting large firms are more likely to attract debt finance (Hovakimian et al. 2001), and intangible assets as an indicator of R&D capability plays a role in access to debt financing. Liquidity is significantly negatively associated with the two dependent variables, which is in line with the fact that firms with higher liquidity prefer to use internally generated finance and thus have lower incentives for access to external debt financing (De Haan and Hinloopen 2003).

4.2 The effect of certification on access to bank finance

Table 4 shows the main results in response to our Hypothesis 1 and Hypothesis 1a. The first column (with two sub-columns) in Table 4 exhibits the effect of certification by obtaining government R&D subsidies on Chinese innovative entrepreneurial firms' access to short-term and long-term bank finance, respectively. All the coefficients are significantly positive (i.e., 0.678 and 1.055 at 1% level), suggesting that innovative entrepreneurial firms that are granted R&D subsidies are more likely to attract both short-term debt and long-term bank loans, respectively. In addition, when comparing the coefficients of Liquidity, CFR, and Growth between these two sub-columns, we find that, compared with access to long-term bank finance, liquidity, free cash flow, and sales growth (i.e., Growth) all positively affect Chinese innovative entrepreneurial firms' access to short-term bank loans. This finding implies that the banks focus more on firms' profitability when they offer short-term loans to the firms. The findings support Hypothesis 1.

We further test the possible impact of listing on innovative entrepreneurial firms' access to bank loans. The second column (with two sub-columns) displays the certification effect on listed firms' access to short-term and long-term debt finance respectively, and the third column (with two sub-columns) shows those statistics for unlisted firms respectively. It can be seen that the certification effect is stronger for unlisted firms in both short-term (1.691 vs. 0.699) and long-term

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[6] Based on our calculation, the average firm size of all listed firms and all unlisted firms from the New Third Board is 19.77.

Table 3 Correlation matrix

	STD	LTD	Subsidies	Leverage	Size	Liquidity	CFR	Profit	Audit	Inassets	Turnover	Growth
STD	1											
LTD	0.065***	1										
Subsidies	0.051***	0.116***	1									
Leverage	0.037**	0.079***	0.002	1								
Size	0.037**	0.125***	0.372***	−0.036**	1							
Liquidity	−0.202***	−0.087***	−0.042**	−0.033**	0.151***	1						
CFR	−0.01	−0.026	0.01	0.012	−0.017	−0.196***	1					
Profit	−0.012	−0.007	0	−0.005	−0.027	−0.014	−0.004	1				
Audit	−0.012	0.008	0.014	−0.060***	0.040**	0.041**	−0.02	0.062***	1			
Inassets	0.075***	0.094***	−0.022	−0.019	−0.164***	−0.068***	−0.065***	0.014	−0.005	1		
Turnover	0.169***	−0.063***	0.01	0.073***	−0.254***	−0.239***	−0.031*	0.070***	0.027	−0.031*	1	
Growth	0.072***	0.002	−0.004	−0.031*	−0.109***	−0.027	−0.009	0.026	0.004	0.489***	0.02	1

This table shows Pearson correlation results. ***, **, and * indicate statistical significance at the 1, 5, and 10% levels respectively

Table 4 Fixed effect logit panel model: the effect of certification on access to debt financing

	Full sample		Listed firms		Unlisted firms	
	STD	LTD	STD	LTD	STD	LTD
Subsidies	0.678***	1.055***	0.699***	1.071***	1.691***	1.487***
	(2.614)	(2.596)	(2.685)	(2.627)	(1.751)	(2.016)
Leverage	−0.065***	−0.032***	−0.066***	−0.032***	10.744***	7.427***
	(−8.962)	(−3.334)	(−9.032)	(−3.421)	(5.084)	(2.902)
Size	−2.052***	−0.053	−2.046***	−0.062	1.507**	0.002
	(−8.271)	(−0.193)	(−8.531)	(−0.229)	(2.540)	(0.008)
Liquidity	0.076***	−0.164**	0.077***	−0.149**	−59.095***	−8.215
	(3.476)	(−2.352)	(3.456)	(−2.207)	(−3.539)	(−0.435)
CFR	0.262**	0.087	0.271***	0.201	−1.571**	−3.027***
	(2.380)	(0.380)	(2.619)	(0.957)	(−2.320)	(−2.974)
Profit	0.001	0.017	−0.003	0.016	0.000**	0.048**
	(0.185)	(1.570)	(−0.662)	(1.510)	(2.025)	(2.101)
Audit	0.558	0.850	0.574	0.792	0.505	−1.374
	(0.590)	(0.489)	(0.611)	(0.447)	(0.393)	(−1.021)
Inassets	−0.478	0.132	−0.339	2.083	0.956	2.391
	(−0.295)	(0.094)	(−0.211)	(1.042)	(0.468)	(1.225)
Turnover	−0.110	0.470	0.028	0.434	−0.382	−2.082*
	(−0.322)	(0.932)	(0.086)	(0.867)	(−0.567)	(−1.787)
Growth	0.007***	0.001	0.006***	0.002	0.000**	−0.000
	(3.528)	(0.542)	(3.675)	(0.641)	(2.373)	(−0.045)
Constant						−5.270
						(−0.995)
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
LR chi^2	202.02	41.30	205.56	42.90	180.07	46.06
Log likelihood	−704.43	−307.86	−702.66	−307.06	−108.52	−44.60
P	0.00	0.00	0.00	0.00	0.00	0.00
Pseudo R^2						0.34
N	2022	876	2022	876	491	204
Chow test	STD		LTD			
	Listed firms v.s. unlisted firms		Listed firms v.s. unlisted firms			
Chi^2	19.85		23.02			
P	0.019		0.003			

This table tests the effect of certification on access to debt financing using the empirical specification (1). Definitions of these key variables is shown in Table 1. The results of the first five columns are obtained by conducting fixed effect logit panel model, while the result of the last column by conducting cross-sectional logit model. ***, **, and * indicate statistical significance at the 1, 5, and 10% levels respectively. Robust *t*-statistics in parentheses

(1.487 vs. 1.071) bank loans, and they are all statistically significant. This indicates that the unlisted Chinese firms face more severe information asymmetry and, therefore, certification plays a more important role in their access to bank finance than it does for the listed firms. We further conduct the Chow test shown at the bottom of Table 4

to test the difference between the coefficients of the certification effect on the access to short-term bank loan between the listed and unlisted firms and to long-term bank loan respectively. We find that the differences of the two sets of coefficients are statistically significant (*p* value 0.019 and 0.003). Therefore, Hypothesis 1a is supported.

4.3 Do regional differences in IPR protection affect the certification effect?
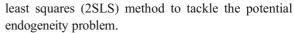
We then test the moderating effect of regional differences in IPR protection in China on the positive relationship between obtaining certification and access to bank finance of Chinese innovative entrepreneurial firms. We introduce an interaction term through multiplying receiving R&D subsidies (i.e., Subsidies) by the term IPRS_Y, which measures regional differences of IPR protection originally proposed by Yao and Rao (2009) (see Table 1 for variable definition).

Both coefficients of the interaction term (IPRS_Y*Subsidies) shown in columns 1 and 2 of Table 5 suggest that there is a statistically significant moderating effect of regional difference in IPR protection on the relation between certification effect on the firms' access to short-term bank loan (− 0.356) and long-term bank loan (− 9.113). The negative coefficients imply that the increase in IPR protection decreases the positive effect of certification on innovative entrepreneurial firms' access to both short-term debt and long-term bank finance.

It can be argued that the level of IPR protection can be associated with the level of marketization (Chen et al. 2014). We thus replace our first measure for IPR protection level with the marketization index of China according to the distinct level of economic development of each province, created by Fan et al. (2010). In terms of this marketization index, three levels of marketization are allocated to each province: "high," "middle," and "low." The faster the economic development of a province, the higher the level of its marketization index (Fan et al. 2010). We denote this measure as IPRS_FG and the test results are presented in columns 3 and 4 of Table 5. The results remain the same and the magnitude is stronger (− 1.563 for short-term loan and − 31.832 for long-term loan). Therefore, we are confident that Hypothesis 2 is supported.

4.4 Endogeneity

Our main empirical tests have offered support for the positive effect of certification by obtaining government R&D subsidies on innovative entrepreneurial firms' access to bank finance. However, it might be the case that obtaining R&D subsidies and access to debt finance are triggered by some unknown factors and interact with each other. This will result in an endogeneity problem that affects our main results. We employ the two-stage

least squares (2SLS) method to tackle the potential endogeneity problem.

We identify an instrumental variable: the number of firms in high-tech zones in the city in which a sampled firm is located in a given year. The instrumental variable must meet two selection criteria: there exists a correlation between the instrumental variable and the independent endogenous variable; and there is no correlation between the instrumental variable and the unobserved variables that may affect the dependent variable. A high-tech zone in China is a special area where central and local governments have a desire to stimulate corporate R&D activities. The total number of innovative entrepreneurial firms in a high-tech zone signals the overall development of corporate R&D capability and the supply of strong innovative firms (Guo et al. 2016). Therefore, the more innovative firms there are in a locality, the higher is the probability that the firms in that area will be granted government-funded R&D subsidies, whereas this instrumental variable should be unrelated with our dependent variable—i.e., firms' access to bank finance.

We use this instrumental variable to conduct 2SLS analysis. We denote the number of firms in local high-tech zones as Firm_No. Panel A of Table 6 displays the regression results in the first stage. The results suggest that the number of firms in the full sample that have access to long-term bank loan and in the two sub-samples (i.e., listed firms and unlisted firms) that have access to both long-term and short-term bank loans are significantly correlated with innovative firm's acquisition of R&D subsidies at the 1 or 5% levels. Such results show that Firm_No is a strong instrumental variable in these samples.

Based on the first stage's results, panel B of Table 6 shows the regression results in the second stage for access to long-term debt within both the full sample and the two sub-samples. The results included in the first two sub-columns in the full sample in panel B are consistent with our main regression results in support of Hypothesis 1.

4.5 Robustness tests

In this section, we conduct two additional tests to further check the robustness of the main regression results. First, we substitute our discrete measure for the dependent variables with a continuous measure and re-run the regressions. The continuous short-term debt variable (i.e., STDC, shown in Table 7) is derived from the net increase of the

Table 5 Fixed effect logit panel model: the moderating role of regional difference in IPR protection

	Full sample		Full sample	
	STD	LTD	STD	LTD
Subsidies	− 0.956	30.231**	− 1.388	18.941**
	(− 1.574)	(2.153)	(− 1.575)	(2.464)
IPRS_Y	− 0.194	9.214**		
	(− 0.742)	(2.130)		
IPRS_Y*Subsidies	− 0.356*	− 9.113**		
	(1.951)	(− 2.125)		
IPRS_FG			− 2.483***	29.491**
			(− 2.790)	(2.286)
IPRS_FG*Subsidies			− 1.563*	− 31.832**
			(1.777)	(− 2.467)
Leverage	− 0.072***	− 0.057***	− 0.096***	− 0.056***
	(− 8.402)	(− 3.459)	(− 7.538)	(− 3.301)
Size	− 1.515***	− 0.676	− 1.258***	− 1.148*
	(− 5.826)	(− 1.376)	(− 4.653)	(− 1.944)
Liquidity	0.058***	− 0.138	0.094***	− 0.091
	(3.182)	(− 1.558)	(2.790)	(− 1.026)
CFR	0.367***	0.134	0.709***	0.198
	(3.472)	(0.566)	(5.046)	(0.797)
Profit	0.004	0.052***	0.001**	0.063***
	(0.567)	(2.648)	(2.421)	(2.983)
Audit	0.727	6.683**	− 0.416	7.277***
	(0.900)	(2.131)	(− 0.481)	(2.613)
Inassets	1.130	2.549	1.377	− 0.605
	(0.856)	(1.014)	(1.465)	(− 0.184)
Turnover	0.116	0.360	0.358	0.221
	(0.322)	(0.354)	(0.863)	(0.178)
Growth	0.000**	− 0.000	0.000	0.003
	(2.052)	(− 0.878)	(1.358)	(0.741)
Year dummy	Yes	Yes	Yes	Yes
LR chi^2	141.53	37.67	149.06	48.47
Log likelihood	− 620.28	− 137.92		− 127.43
P	0	0	0	0
N	1814	429	1216	415

Robust *t*-statistics in parentheses

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

short-term debt, i.e., debt with a maturity of less than or equal to one year, scaled by total assets; and the continuous long-term debt (i.e., LTDC, shown in Table 7) from the net increase of the long-term debt scaled by the firm's total assets. The test results are included in Table 7.

Second, a firm's financial situation is an important factor, especially for innovative entrepreneurial firms, to acquire bank finance. We re-run our regressions by adding one more control variable, the degree of financial health measured by Altman's *Z*-score, to control for this effect. The results are shown in Table 8.

As can be seen from Tables 7 and 8, the results of additional tests are generally consistent with those of our main regressions shown in Table 5,

Table 6 The 2SLS regression: the effect of certification on access to debt financing

	Full sample		Listed firms		Unlisted firms	
	STD	LTD	STD	LTD	STD	LTD
Panel A IV first stage						
Firm_No	0.000	0.000***	0.000***	0.000***	0.000**	0.000***
	(0.056)	(2.709)	(4.112)	(2.618)	(2.242)	(2.600)
Wald chi^2	5115	203.3	155.68	157.21	90.41	98.64
Log likelihood	−3316.73	−1434.73	−2735.21	−1754.64	−475.49	−146.98
P	0.000	0.000	0.000	0.000	0.000	0.000
Obs	2587	1364	2164	1804	423	184
Panel B IV second stage						
Subsidies	1.219***	1.541***	1.321***	1.346*	0.595	2.171***
	(70.137)	(3.032)	(2.957)	(1.676)	(0.449)	(5.391)
Leverage	0.001*	0.010***	0.001**	0.007***	2.194**	3.989***
	(1.838)	(3.807)	(2.207)	(3.198)	(2.495)	(4.147)
Size	−0.163***	0.003	−0.023	−0.003	0.065	0.002
	(−9.401)	(0.055)	(−0.776)	(−0.046)	(0.374)	(0.019)
Liquidity	−0.019***	−0.063***	−0.037***	−0.077***	−8.893**	−1.736
	(−2.640)	(−3.124)	(−5.945)	(−3.171)	(−2.379)	(−0.230)
CFR	0.040	−0.095	0.011	−0.085	−0.362	−0.789
	(1.236)	(−1.240)	(0.245)	(−1.055)	(−1.560)	(−1.166)
Profit	−0.000	0.004	−0.000	0.000*	0.008	0.029
	(−1.405)	(1.199)	(−0.988)	(1.929)	(1.392)	(1.487)
Audit	−0.531**	−0.255	0.609	0.059	−0.315	−1.469***
	(−2.234)	(−0.464)	(1.502)	(0.128)	(−0.477)	(−2.783)
Inassets	0.168	0.923*	−0.005	1.207**	0.799	0.714
	(0.887)	(1.768)	(−0.011)	(2.490)	(1.481)	(0.881)
Turnover	0.144	−0.319	0.289***	−0.316	0.212	−0.743
	(1.632)	(−1.423)	(4.400)	(−1.635)	(1.453)	(−1.055)
Growth	0.000	−0.000	0.001*	−0.000	0.000**	−0.000
	(0.778)	(−0.317)	(1.823)	(−0.445)	(2.501)	(−0.980)
Constant	2.336***	−1.619	−1.340**	−1.722	−1.941	−2.091
	(4.371)	(−1.192)	(−2.070)	(−1.451)	(−0.645)	(−0.780)
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Wald chi^2	5115	203.3	155.68	157.21	90.41	98.64
Log likelihood	−3316.73	−1434.73	−2735.21	−1754.64	−475.49	−146.98
P	0.000	0.000	0.000	0.000	0.000	0.000
Obs	2587	1364	2164	1804	423	184

Robust *t*-statistics in parentheses

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

thus further substantiating Hypotheses 1 and 1a. We use the same instrumental variable identified earlier to run 2SLS robustness tests. The results are highly similar. We further test the moderating role of IPR protection level for these two robustness tests and the results are in support of Hypothesis 2. To save space, we do not present the 2SLS tests and the moderating role tests for the

Table 7 Robustness test I for certification effect by using continuous dependent variables

	Full sample		Listed firms		Unlisted firms	
	STDC	LTDC	STDC	LTDC	STDC	LTDC
Subsidies	0.010**	0.019**	0.010**	0.020**	− 0.006	0.220***
	(2.159)	(2.011)	(2.172)	(2.060)	(− 0.509)	(3.498)
Leverage	0.007***	0.000	0.007***	0.001***	0.891***	0.332**
	(70.852)	(1.118)	(71.433)	(4.664)	(41.429)	(2.149)
Size	− 0.003	0.019**	− 0.002	0.022***	− 0.008	− 0.008
	(− 1.061)	(2.197)	(− 0.731)	(2.631)	(− 1.086)	(− 0.177)
Liquidity	− 0.001**	− 0.000	− 0.001**	0.000	− 0.058	1.107*
	(− 2.272)	(− 0.335)	(− 2.412)	(0.181)	(− 1.584)	(1.899)
CFR	0.010***	0.007*	0.009***	0.004	0.032***	0.012
	(6.007)	(1.718)	(5.811)	(0.976)	(4.122)	(0.281)
Profit	− 0.000	− 0.000***	0.000	− 0.000***	− 0.000**	0.001
	(− 1.587)	(− 3.463)	(0.595)	(− 3.207)	(− 2.438)	(0.641)
Audit	0.010	0.076**	0.008	0.085***	− 0.004	0.018
	(0.894)	(2.445)	(0.688)	(2.847)	(− 0.024)	(0.230)
Inassets	0.017	0.024	0.010	0.003	0.021	− 0.146
	(0.691)	(0.489)	(0.389)	(0.070)	(0.667)	(− 0.822)
Turnover	0.034***	− 0.008	0.029***	− 0.017	0.006	− 0.086
	(6.592)	(− 0.616)	(6.241)	(− 1.215)	(1.624)	(− 1.335)
Growth	0.000	− 0.000	0.000	− 0.000	0.000	0.000
	(0.472)	(− 0.955)	(0.335)	(− 1.347)	(0.312)	(0.595)
Constant	0.094	12.829**	0.077	11.951*	1.692	− 0.064
	(1.539)	(2.010)	(1.302)	(1.888)	(0.380)	(− 0.077)
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
F	766.67	3.51	765.64	5.45	168.18	2.18
P	0.000	0.000	0.000	0.000	0.000	0.016
R^2	0.825	0.032	0.825	0.049	0.85	0.289
N	3001	1697	3001	1697	618	163

STDC denotes continuous short-term debt, and LTDC denotes continuous long-term debt. Robust *t*-statistics in parentheses

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

two robustness checks in this paper, but they are available upon request.

5 Conclusion and implications

Extant literature of examining certification effect on obtaining external finance has focused only on developed capital markets under effective institutional environment. Efficient capital market and effective institutions are important safeguards particularly for innovative entrepreneurial firms whose core asset is largely intangible and more sensitive to proprietary cost when they disclose their business and product information. However, these two important conditions are often lacking in emerging markets that normally suffer from weak institutional environment.

The weak institutional environment in emerging economies exposes innovative entrepreneurial firms to high proprietary costs and makes them being less willing to disclose their business information, resulting in server information asymmetry. Therefore, in the emerging market setting, information asymmetry is an important concern which needs to be addressed in establishing the theoretical framework of financing innovative entrepreneurial firms (most of them are SMEs). China is a

Table 8 Robustness test II by considering an additional control variable Z-score

	Full sample		Listed firms		Unlisted firms	
	STD	LTD	STD	LTD	STD	LTD
Subsidies	0.676***	1.077***	0.695***	1.071***	1.783*	1.417*
	(2.604)	(2.619)	(2.667)	(2.627)	(1.815)	(1.898)
Leverage	− 0.065***	− 0.026**	− 0.066***	− 0.032***	9.829***	8.133***
	(− 8.963)	(− 2.324)	(− 9.041)	(− 3.149)	(4.628)	(2.761)
Size	− 2.054***	− 0.252	− 2.050***	− 0.062	1.692***	0.016
	(− 8.269)	(− 0.901)	(− 8.536)	(− 0.230)	(2.812)	(0.055)
Liquidity	0.074***	− 0.188**	0.072***	− 0.150**	− 48.722***	− 10.654
	(2.901)	(− 2.542)	(2.798)	(− 2.128)	(− 3.033)	(− 0.520)
CFR	0.265**	0.174	0.278***	0.202	− 1.373**	− 3.223***
	(2.376)	(0.724)	(2.647)	(0.959)	(− 2.019)	(− 2.881)
Profit	0.001	0.014	− 0.003	0.016	0.000**	0.044*
	(0.182)	(1.286)	(− 0.664)	(1.511)	(2.097)	(1.922)
Audit	0.557	0.573	0.573	0.789	0.534	− 1.213
	(0.590)	(0.320)	(0.609)	(0.445)	(0.420)	(− 0.881)
Inassets	− 0.471	0.450	− 0.326	2.093	0.418	2.595
	(− 0.290)	(0.309)	(− 0.203)	(1.044)	(0.204)	(1.296)
Turnover	− 0.111	0.386	0.024	0.434	1.051	− 2.567*
	(− 0.324)	(0.780)	(0.075)	(0.868)	(1.131)	(− 1.665)
Growth	0.007***	0.003	0.006***	0.002	0.000**	− 0.000
	(3.528)	(1.393)	(3.683)	(0.633)	(2.533)	(− 0.038)
Z-score	0.001	0.052	0.002	0.002	− 1.031**	0.504
	(0.172)	(1.412)	(0.406)	(0.065)	(− 2.172)	(0.509)
Constant						− 6.262
						(− 1.100)
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
LR chi^2	202.05	45.29	205.72	42.91	184.75	46.31
Log likelihood	− 704.412	− 305.857	− 702.579	− 307.056	− 106.179	− 44.47
P	0.000	0.000	0.000	0.000	0.000	0.000
Pseudo R^2						0.342
N	2022	876	2022	876	491	204

Robust t-statistics in parentheses

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

typical example of this kind of market failures. By combining the legitimacy theory with information asymmetry theory, our study improves the explaining power of certification effect on obtaining external finance for SMEs, particularly for innovative entrepreneurial SMEs, in the emerging economies' setting. Compared with those firms in developed economies, small- and medium-sized innovative firms in emerging countries typically suffer from more financial constraints due to the lack of efficient capital market. They need more external finance to be able to survive and grow. The weak institution further exacerbates information asymmetries between innovative entrepreneurial firms and their potential investors, causing more severe financial constraints. It is this need that prompts the significance of legitimacy of certification effect, such as government R&D subsidies, in emerging economies.

The empirical part of our study demonstrates that obtaining such a government certification can send a signal to outside capital providers, therefore reducing

information asymmetry by compensating the need for more information disclosure that could expose innovative entrepreneurial firms to high proprietary cost. We find a positive certification effect on the acquisition of bank loans for both listed and unlisted innovative entrepreneurial firms in China. This positive effect is more profound in unlisted innovative entrepreneurs than those listed ones. The findings provide empirical evidence that certification effect is more significant for entrepreneurial SMEs in emerging markets depending on the degree of information asymmetry. We further find that the certification effect is more significant in those regions where IPR protection is weaker. This finding shows that institutional effect is an important factor affecting the effectiveness of certification effect reflecting the high proprietary cost resulted from the market failure and how obtaining certification could reduce such cost in the emerging market. Therefore, our study provides a unique test bed for the applicability of certification effect in the emerging market.

Our findings also have important practical implications. The Chinese government has been playing a more pivotal role in promoting the development of innovative entrepreneurial firms, particularly small- and medium-sized innovative firms, during its 13th Five-Year Plan (2016–2020) period. Innovation has been highlighted as one of the top priorities by the Chinese government. Our findings send the message to Chinese innovative firms, particularly to innovative entrepreneurs, that obtaining government funding programs, such as R&D subsidies, can be used as a major legitimation strategy to secure more funding from private sector. This strategy is particular important for those innovative firms in less developed areas in China and unlisted usually relatively smaller innovative firms or start-ups. To extend this strategic/policy implication to emerging economies, official funding that has such a subsidiary nature should be adopted to attract private source of finance from capital markets for innovative start-ups.

To banks, our findings suggest that banks should recognize the importance of government R&D subsidies because acquisition of these government funds proves the credential of the firms and their quality. Banks should include the acquisition of this type of government funds in their loan assessment process and credit rating system not only for the purpose of improving credit control but also for mitigating to some extent the common problem of lack of expertise in the assessment of innovative projects and the lower abilities of banks to screen these projects (Carpenter and Petersen 2002; Ueda 2004) that many emerging markets face.

Appendix

Table 9 China's major S&T programs

S&T program	Year	Aims
The Key Technologies R&D Program	1982	To promote technical upgrading and restructuring of industries and to tackle major technical issues that can advance sustainable social development.
The National High-Tech R&D Program (The 863 Program)	1986	To develop innovation capacity in Chinese innovative industry, particularly in those industries of strategic importance.
The Spark Program	1986	To develop and promote S&T in rural areas for revitalizing the rural economy.
The Torch Program	1988	To establish high-tech industrial development zones, promote the development of innovative (high-tech) products, and improve management systems and operation mechanisms suitable for high-tech industrial development.
The National Basic Research Program (The 973 Program)	1997	To initiate and implement strategic basic research projects in several key industries, including agriculture, energy, information, resources and environment, population and health, and new materials.
The National S&T Infrastructure Program	2001	To develop and strengthen the S&T capacity of national S&T research bases, such as state key laboratories, national engineering technology research centers, R&D infrastructure, and key international S&T cooperative projects.

Table 9 (continued)

S&T program	Year	Aims
Environment Building for S&T Industries	2001	To strengthen policy for S&T environment, enhance technical services and exchanges, stimulate development of S&T SME enterprises, develop S&T intermediaries, and create a sound environment for the commercialization of S&T findings.

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