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R&D spending among Chinese SMEs: the role of business owners' characteristics

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Abstract

Purpose – Given that organizational decisions are made by individuals and thus shaped by their subjective and objective characteristics, the purpose of this paper is to examine the effect of SME business owners' characteristics on their firms' research and development (R&D) spending in a transition economy.
Design/methodology/approach – The authors first build the arguments that, among small- and medium-sized enterprises (SMEs), business owners' perceived importance of R&D-related activities, their education, related experiences, and social connections, should affect their firms' R&D spending positively. Then the authors use a Chinese nationwide survey of private SMEs to test the arguments. Tobit regression analyses are conducted by taking Stata 12.0 as the statistic tool.
Findings – The authors find that business owners' perceived importance of R&D-related activities is positively associated with their firms' R&D spending. In addition, better-educated owners and owners who have technology-related working experience tend to invest more in R&D activities. Finally, owners who have social connections, especially industrial connections, tend to spend more on R&D activities.
Originality/value – This study improves the understanding of R&D spending determinants among SMEs. Going beyond general environmental determinants, it reveals the important agency role of SME owners, and thus contributes to a better understanding of how decisions leading to SME innovations are influenced by business owners' perceptions and demographic characteristics.

Keywords China, Top management, R&D, Small- to medium-sized enterprises
Paper type Research paper

Introduction

Research and development (R&D) is an important driver of corporate financial performance and a critical source of competitive advantage (Christensen and Bower, 1996; Kor, 2006; McWilliams and Siegel, 2000; Peteraf and Barney, 2003; Schumpeter, 1934). It is a strategic decision in many industries, and for many firms, but particularly sensitive for SMEs. To date, a number of studies have identified many determinants of R&D spending such as industry (e.g. Scherer, 1984; Sujit and Mukherjee, 2005), corporate strategy and structure (e.g. Baysinger and Hoskisson, 1989; Hoskisson and Johnson, 1992; Lopez-Sanchez *et al.*, 2006), financial performance relative to aspiration levels (e.g. Chen and Miller, 2007; Greve, 2003; O'Brien and David, 2014), top management team (TMT) characteristics (Kor, 2006), ownership structure (e.g. Chen and Hsu, 2009; Lee and O'Neil, 2003; Zeng and Lin, 2011), board of directors (e.g. Baysinger *et al.*, 1991; Osma, 2008), and leadership style (e.g. Jung *et al.*, 2003).

Despite this abundant literature, however, prior studies on R&D spending have focussed mainly on large firms which, compared to small firms, have access to more resources and thus are believed to be in a better position to invest in R&D. Comparatively, R&D spending among SMEs has received little attention. R&D spending is an indication

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of a firm's commitment to innovation and it is generally related to innovation. Still the relationship between R&D spending and innovation is tenuous at best (Mansfield, 1968; Tellis *et al.*, 2009), which makes the decision to spend hard and equivocal. This is clearly more so for SMEs whose resources, compared to large firms, are puny. Another damper for SMEs is the general belief that it is more effective to imitate than innovate (Schumpeter, 1942). This probably explains the little interest in studying R&D spending among SMEs. It is generally believed to be generally low. But it has been found that firms differ in their R&D spending even when controlling for industry, firm size and past performance (Kor, 2006). It is thus likely that SMEs' spending patterns are heterogeneous enough to justify our study of their R&D decisions.

One feature of SMEs is that they are less likely than larger firms to have formalized governance and management arrangements. In China the owner is often the general manager as well (Huang, 2009). This suggests that owners make all the strategic decisions for their firms. Even when occasionally the owner does not act as the general manager, s/he still makes or at least shapes strategic decisions, because there is little social trust (Chen, 2001; Yuan and Vinig, 2007). As a result, we can expect the business owner, rather than the hired general manager or so-called chief executive officer (CEO), to play the leading role in the firm's R&D decisions. Little research has been done on such a role. A handful of studies have examined the role of CEOs in R&D spending among large firms (e.g. Barker and Muller, 2002; Mezghanni, 2010), but nothing is known about the role of SMEs' business owners.

To reduce this gap in the literature, we study here owner-related antecedents of R&D spending among SMEs. Drawing on TMT perspective (Hambrick, 1994, 2005; Hambrick and Mason, 1984), we build the argument that for SMEs, the owners' perception of the importance of R&D-related activities and capability acts as an important driver of their firms' R&D spending. We also argue that owners' level of education and technology-related working experience, affect their firms' R&D spending. High levels of education have been related to openness, and a willingness to innovate. Business owners with a higher education have a better understanding of the role of R&D in business success, and would thus feel more confident to invest in risky R&D projects. Past working experience, when relevant, is also related to a practical knowledge about R&D, and of the process by which a firm's R&D activities can be made more effective. Not only education and experience, but also owners' political and industrial connections provide access to information, knowledge, and support from government and industry peers, which could facilitate the decision to undertake R&D activities. In summary, business owners' perception, R&D-related capability, and social connections are all expected to have a positive effect on their firms' R&D spending.

We test these arguments by using a unique set of data, which comes from a nationwide survey of private enterprises. Most of the firms surveyed were by Chinese rules (see Table I) SMEs. In the following section we introduce the theories and develop hypotheses. In the third section we introduce the data and methods used to test our arguments. The results of empirical tests are reported in the fourth section. We end our paper with a discussion of the findings and their significance, and with a few concluding comments.

Theory and hypotheses

The TMT or upper-echelon perspective provides interesting insights into business owners' role in R&D spending among SMEs. In their seminal paper, Hambrick and Mason (1984) argued that organizational decisions are made by individuals and thus

Industry	Revenue	Number of employees	Total assets
Agriculture, forestry, livestock rearing and fishing	< 200 million yuan		
Industry sector (including mining; manufacturing; and electric power, gas, and water production supply)	< 400 million yuan	< 1,000	
Construction	< 800 million yuan		< 800 million yuan
Wholesaling	< 400 million yuan	< 200	
Retailing	< 200 million yuan	< 300	
Transportation	< 300 million yuan	< 1,000	
Accommodation and catering	< 100 million yuan	< 300	
Information transmission	< 1 billion yuan	< 2,000	
Software and information technology service	< 100 million yuan	< 300	
Storage	< 300 million yuan	< 200	
Post	< 300 million yuan	< 1,000	
Real estate	< 2 billion yuan		< 100 million yuan
Property management	< 50 million yuan	< 1,000	
Leasing and business services		< 300	< 1.2 billion yuan
Others (including scientific research, technical services; water conservancy, environment and public facility management; resident services and other services; social work; and culture, sports and entertainment, etc.)		< 300	

Notes: The criteria are based on the "Provisional Rules on Criteria of Small and Medium Sized Enterprises" issued by the Ministry of Industry and Information Technology, the National Bureau of Statistics, the National Development and Reform Commission, and the Ministry of Finance in 2011. For industries with multiple criteria, only one criterion needs to be met

Table I.
The criteria of SMEs in China

shaped by their values, perceptions, and other characteristics. This has stimulated a wealth of studies on both CEOs and top management groups (see Hambrick, 1994, 2005), and has even been extended to board membership (Hillman *et al.*, 2007). The upper-echelon view customarily considers demographical attributes of managers as good proxies for mental processes (Carpenter *et al.*, 2004). It assumes that TMT member attributes (e.g. gender, age, education, tenure, functional background) would lead to different mental processes, and the resulting team heterogeneity can be related to creative strategic decisions (Murray, 1989).

Managers' cognition "systematically affect the processing of issues and the types of organizational actions taken in response to them" (Dutton and Jackson, 1987, p. 76). Many studies have examined the role of managers' characteristics in organizational strategic behavior, either taking top management as a whole or focussing on the CEO alone (e.g. Barker and Muller, 2002; Kor, 2006; Mezghanni, 2010).

In this study, borrowing on the TMT perspective, we build the argument that for SMEs, owners' characteristics shape firms' R&D spending decisions. In many Chinese SMEs, we said, the owner acts as the general manager too (Huang, 2009). Even when that is not the case, most strategic decisions are still made or shaped by the owner. We argued that this is due to the pervasive mistrust of hired manager and the lack of a formal governance structure (Chen, 2001; Yuan and Vinig, 2007). For large publicly

traded firms also, it is not uncommon that the chairman of the board, who is usually the largest owner or his/her representative, shunts the CEO and other executives, to engage in daily management (Di *et al.*, 2005). Numerous studies have shown that it is possible and reasonable to extend the TMT to owners and board of directors (Carpenter *et al.*, 2004; Finkelstein *et al.*, 2009; Rost and Osterloh, 2010), in particular to predict firm's strategic outcomes (Daily *et al.*, 1999; Goodstein *et al.*, 1994; Hillman *et al.*, 2002, 2007; Pugliese *et al.*, 2009).

With this theoretical background, and given the significant role played by the owners in Chinese SMEs, this study uses the TMT insights to investigate the effects of their subjective and objective characteristics on R&D spending. Specifically, we intend to investigate the relationship between R&D spending and managers': capabilities, in particular their level of education and relevant experience, political and industrial connections, and perceptions of the importance of R&D for future well-being.

Owners' perceptions of R&D activities

Among SMEs, the manager-owners' perceived importance or value of R&D should play an important role in affecting their firms' R&D spending. Human activity could be seen as "an ongoing input-output cycle in which subjective interpretations of externally situated information become themselves objectified via behavior" (Porac *et al.*, 1989, p. 398). This can be seen sometimes as fact-based (when the perception is related to experience and knowledge) or value-based (when perception is related to beliefs, norms, or culture) premises in their decision-making process (see Simon, 1997). Thus, a manager's (here the owner's) perception to the importance of R&D activities could be a powerful premise to motivate him/her to invest more resources in those activities.

Perception is a premise related to motivation. Motivation "accounts for the incentives that drive a firm to undertake action" (Smith *et al.*, 2001, p. 320). It is associated with perceived gains and losses, which stem from the firm's belief of "whether it stands to gain advantages from actions or stands to lose if no action is carried out" (Smith *et al.*, 2001, p. 320). Simon (1997), in his study of the "Administrative behavior" and Cyert and March (1963) in their seminal study of the "Behavioral theory of the firm" have argued that expectations and levels of aspirations, all of which are seen as determinants of perceptions, are strong drivers of decision making. When the perceived or expected gains of taking a particular action or equivalently the losses of not taking it are larger, an individual or organization is driven to undertake it (Smith *et al.*, 2001). In the context of R&D spending, if the owner perceives that R&D activities are important for his/her firm, and expects them to determine health and survival, (s)he should be driven to invest more resources in R&D activities. Thus, we propose the following hypothesis:

H1. An owner's perceived importance of R&D activities is positively associated with his/her firm's R&D spending.

Owner R&D-related capability

As the decision maker of R&D activities, owner's R&D-related capability should play a significant role in shaping R&D spending. R&D-related capability helps the decision makers to overcome their worries about the high risk of R&D activities, increases their confidence, and promotes their firms' R&D spending. Comfort with R&D spending comes with familiarity provided by knowledge, both theoretical and practical, of the process and outcomes of R&D. Reasonable proxies for such knowledge are provided by managers' education level and working experience.

Owner's education. When an owner has higher levels of education, (s)he should be more familiar with the nature and outcome of R&D activities. Familiarity increases the possibility for the owner to overcome the fear and threat which come from the risks associated to R&D activities. In addition, better-educated owners tend to have greater cognitive complexity (Hitt and Tyler, 1991; Wally and Baum, 1994), which is associated to a greater ability to absorb new ideas. This could help them resist the appeal of a focus on short-term efficiency and lower R&D investments (Baysinger and Hoskisson, 1989; Deutsch, 2005). This should then increase their willingness to accept innovations (Barker and Muller, 2002). Several studies support this argument (see Damanpour, 1991). For example, Bantel and Jackson (1989) and Thomas *et al.* (1991), among others, find that managerial education is positively associated with organizational innovations.

Business owners' education should be particularly important for SMEs' R&D spending. Given their limited resources and the relatively high risk of R&D activities, SME managers may be reluctant to invest in R&D activities if they are not cognizant and familiar with the innovation process. In these cases, a lack of education, even if general, would lead to a lack of confidence in the usefulness of R&D activities and vice versa. Thus we propose the following hypothesis:

H2a. An owner's education level is positively associated with his/her firm's R&D spending.

Owner's experience. In addition to education, and in a cognitive process which is related, an owner's technology-related working experience should also play a significant role in his/her firm's R&D spending. As a starting point, Dearborn and Simon (1958) argued and demonstrated that managers' experience with the goals, rewards, and methods of a particular functional area affects their related perceptions and decision making. They would perceive and interpret information to reflect their functional training. Similar results are achieved in a study conducted by Tyler and Steensma (1998) who find that executives having engineering and technology as their primary work experience are more likely to rate technological alliances favorably.

More specifically, Finkelstein and Hambrick (1996), Finkelstein *et al.* (2009), and Hambrick and Mason (1984), among others, have argued that decision makers with experience in output functions as R&D/engineering and marketing/sales are more likely to support innovation strategies because output functions emphasize business opportunities and growth related to new products and markets. Barker and Muller (2002) find R&D spending is greater in firms where CEOs have significant career experience in marketing and/or engineering/R&D. Following the same logic, we propose that business owners with technology-related working experience are more likely to support R&D activities:

H2b. An owner's technology-related working experience is positively associated with his/her firm's R&D spending.

Owners' social connections

Given the risky nature of R&D activities, it may be very important for firms especially the SMEs to get support from external stakeholders. Prior studies have found that inter-organizational relations affect firms' innovation (Burt, 1987; Powell *et al.*, 1996). Haynes and Hillman (2010) have studied the effect of what they called board capital depth and breadth (in relation to functional expertise depth and network of relations) on performance and change. Their dependence theory emphasis on managers and

board members' network of relationship, as a determinant of resource acquisition, is somewhat germane to our concerns here. However, there is lack of research on the relationship of managerial social connections with R&D spending decisions. In this study, we build a similar dependence theory-based argument that firm owners' social connections, both political and industrial, enable them to get important resources for R&D activities and thus may enhance their firms' R&D spending.

Political connections. Literature on business-government relations has well documented the importance of political connections or ties for firms (e.g. Bertrand *et al.*, 2004; Faccio, 2006). Political connections, resulting from business owners' formal association to political institutions, or their patterns of interpersonal interactions with public officials, provide firms with access to scarce resources such as bank loans, subsidies, tax breaks (Faccio, 2006; Khwaja and Mian, 2005), and information such as policies and industrial regulations (Hillman *et al.*, 1999), improve their political legitimacy (Suchman, 1995), help them receive exclusive government endorsements and favorable treatment (Peng *et al.*, 2004), and improve their long-term financial performance (e.g. Li and Zhang, 2007; Hillman, 2005).

Literature on firms' R&D activities has also found a significant role played by the government. For instance, government R&D-related subsidies reduce a firm's R&D costs and motivate it to invest more in R&D activities (e.g. Lach, 2002; Lee, 2011). Other forms of government support, such as bank loans, tax preferences, and national economic policies are also critical for firms, especially SMEs, to conduct R&D activities (Hu, 2001). Since political connections help firms to get access to government support and increase business owners' incentives to conduct R&D activities, we expect business owners with political connections to be more likely to invest in R&D activities:

H3a. Firm owners' political connections are positively associated with their firms' R&D spending.

Industrial connections. Similar to political connections, industrial connections effect on their ability to access needed resources (see Haynes and Hillman, 2010) may also affect firms' especially SMEs' R&D spending. Industrial connections, resulting from business owners' personal relationships and membership in industrial institutions (e.g. trade association), provide firms with access to critical external resources and facilitate their R&D activities. As a result, these firms may be willing to invest more money in R&D activities.

Industrial institutions in China are important platforms for their members to build friendships and share business information. Thus, membership in an industrial institution provides firms with access to critical product information (Heide and John, 1992) and the information about pertinent events or changes in the market (Lusch and Brown, 1996). These market and product information would facilitate firms' R&D activities. In addition, social interactions and communications among members facilitate knowledge transfer and technology acquisition (Rindfleisch and Moorman, 2001; Saxenian, 1996), which further increases a firm's absorptive capacity and new knowledge utilization (Cohen and Levinthal, 1990).

Moreover, some industrial institutions such as the Federation of Industry and Commerce (FIC) in China are government related, with usually retired high-ranked public officials acting as leaders (Hao, 2013). The government often takes advantage of trade associations to facilitate the formulation and implementation of industrial regulations and policies (Jia, 2014). Firms acting as members of a trade association are therefore also in a better position to get access to government-controlled resources.

We believe business partners' and government's support to lead firms to invest more in R&D activities:

H3b. An owner's industrial connections are positively associated with his/her firm's R&D spending.

Data and method

Data collection

To test the arguments proposed in this study, we use a sample drawn from a nationwide survey about private firms in China. Given that the Chinese market is dominated by state-owned enterprises, most of the private firms included in this survey are SMEs. This survey was conducted in early 2008, by a joint force of the United Front Work Department of the Central Committee of the Chinese Communist Party, the All-China Federation of Industry & Commerce, the State Administration for Industry & Commerce of China, and the China Private Economy Association. The purpose of this survey was to gather information and data about private firms' activities in 2007.

To increase the representation of all private firms in China, the research team of scholars from an array of governmental agencies and universities, built up a nationwide random sample of private firms using multistage stratified sampling across all provinces and industries. Investigators used a questionnaire to conduct direct interviews with the majority owner of each selected private firm (Jia, 2014).

In total, more than 4,000 private firms were surveyed, but many questionnaires were not fully completed. By excluding questionnaires with important information missing and a few firms that do not meet the criteria of SMEs, we get a sample of 2,124 private SMEs. Because the respondents who fully completed the questionnaire may be different from those who did not fully complete it, to assess the potential sample selection bias we introduced a dummy coded variable representing whether the respondents completed or not the questionnaire fully (0 = not fully completed, 1 = fully completed). Results revealed that this variable is not significantly related to R&D spending, owners' perception of R&D importance, owners' education and R&D-related experience, and social connections. This suggests no significant sample selection bias exists. It is worthy to note, as mentioned earlier, that the definition of SMEs in China is different for firms located in different industries. In this study, we use a revenue criterion to judge if a firm is a SME or not[1]. Table I describes the detailed criteria for SMEs in China.

Measurement of variables

Variables in this study are measured as follows.

R&D spending. R&D spending, following Greve (2003) and O'Brien and David (2014) and many others, is measured as the total R&D expenditure scaled by total sales. Since this ratio is highly skewed, we winsorized this variable at the upper and lower 1 percent tails of the distribution.

Perceived importance of R&D activities. Business owners' perceived importance of R&D activities or capability (owner perception) is measured by asking business owners if they agreed or not that the failure of some similar private firms around is due to their poor product quality and lack of innovation capability. Owners agreeing with this viewpoint are coded as 1 and 0 otherwise. In the survey, business owners were asked to identify why some private firms around them failed. Investigators have listed a dozen reasons such as lack of operating experience, wrong location decision, illegal and unethical behavior, fierce

competition, too heavy tax burden, and so on. We are assuming that the reason "poor product quality and lack of innovation capability" reflects a particular owner's perceptions on the role of R&D activities in a firm's success.

Owner R&D-related capability. In this study owners' R&D-related capability includes owner education and R&D-related experience. Owner education is divided into six levels: primary school or below, junior middle school, senior middle school, junior college, bachelor degree, and postgraduate degree, which are coded into 1-6, respectively. Owner R&D-related experience (owner experience) is measured by asking an owner whether or not (s)he once was involved in a technical position. Owners with a technical experience are coded as 1 and 0 otherwise. Although technical experience is not necessarily an R&D experience, it is reasonable to use it as a proxy of an owner's R&D experience because technical people (engineers and others) are generally in a better position to know or organize R&D activities.

Owner social connections. In this study, business owners' social connections include both political and business connections. Political connections are defined as the situation where an owner is at the same time a member of People's Congress or a member of People's Political Consultative Conference in 2007 (Gao, 2011; Marquis and Qian, 2014). Business owners with political connections are labeled as 1 and 0 otherwise. Industrial connections are measured in two complementary ways. First, we measured it as a dummy variable (Industrial connections – dummy) with 1 being the code for business owners who act as a member in any of the three industrial institutions in China, including the FIC, the trade associations, and the Chamber of Commerce. Otherwise, it was coded as 0. Second, we measured it as the number of memberships (Industrial connections – number) in the three different industrial institutions. The minimum of this number is 0 and the maximum is 3.

Control variables. In this study, we controlled for business owner's gender and age, as well as organizational characteristics including firm size, firm age, financial performance, leverage, competitive strategy, industry-level R&D spending, and industry (e.g. Barker and Muller, 2002; Chen and Hsu, 2009; Lopez-Sanchez *et al.*, 2006). Owner gender and age may affect his/her attitude toward risk and thus further affect R&D spending (Barker and Muller, 2002). Firms with larger size, longer history, better financial performance, or lower debt level would have more financial resources to support R&D projects (e.g. Baysinger and Hoskisson, 1989; Hundley *et al.*, 1996). Strategy is also regarded to affect R&D spending because R&D is one usual way for firms to implement a differentiation strategy (Barney and Hesterley, 2006; Porter, 1980). In addition, firms located in different industries may face different incentives to invest in R&D activities. All these variables are controlled for in this study and measured following previous relevant research practices. Owner gender is a dummy variable with male owners being coded as 1 and 0 otherwise. Owner age is the number of years from birth to the end of 2007. *Firm size* is the natural logarithm of the total number of employees in 2007. Firm age is the years from a firm's foundation to the end of 2007. Financial performance is measured as the "return on assets (ROA)" in 2007. Leverage is measured as the ratio of total debts to total assets at the end of 2007. We winsorized ROA and leverage at the upper and lower 1 percent tails of the distribution because they are highly skewed. In this study, following the lead of Hambrick (1983) and others, we used three variables to measure competitive strategy. Advertising intensity and philanthropic giving intensity are used to capture a firm's differentiation strategy, while asset parsimony is used to capture its cost-orientation strategy (see Miller, 1986). Advertising intensity is measured as a firm's expenditure in advertising scaled by total

sales, while giving intensity is measured as a firm's philanthropic giving scaled by total sales, in 2007. Since these two ratios are highly skewed, we also winsorized them at the upper and lower 1 percent tails of the distribution. Asset parsimony is measured as a firm's total sales scaled by total assets. For a particular firm, industry R&D spending is the average industry R&D intensity, excluding the focal firm. In this study, our sampled firms were located mainly in the following industry groupings: agriculture, mining, manufacturing, construction, transportation, information service, wholesale and retailing, catering, real estate, and others. Thus we introduced nine industry dummies to represent ten industries.

Analysis and results

Characteristics of the sample

Characteristics of the sampled firms and owners are summarized in Table II. In this sample, R&D amount ranged from RMB0 to RMB50 million[2], with a mean of RMB 4,939,000. R&D spending or intensity ranged from 0 to 25 percent, with a mean of 1.28 percent.

A total of 938 (or 44.2 percent) business owners thought that "poor product quality and lack of innovation capability" is the reason of some similar private SMEs' failure around. Most owners had received education of senior middle school or above. Totally, 312 owners (or 14.7 percent) had R&D – or technology-related working experience. In total, 1,012 (or 47.6 percent) owners had political connections, while 1,675 (or 78.9 percent) had industrial connections. The average number of industrial connections is 1.74. Among the respondents, 1,816 (or 85.5 percent) owners were males, with an average age of 44.75.

The largest firm had 6,000 employees while the smallest hired only one. The average firm was 7.50-year-old. ROA ranges from −27.96 to 285.71 percent, while leverage ranges from 0 to 93.18 percent. The average asset parsimony is 4.42. Advertising intensity ranges from 0 to 20 percent, while giving intensity ranges from 0 to 8 percent. Industry R&D spending ranges from 0 to 4.53 percent.

Descriptive statistics

Table III summarizes the means, standard deviations, and Pearson correlations among the variables. From the Pearson correlations we can see that owner perception, owner education, and owner experience are significantly correlated to the dependent variable, R&D spending. But both political connections and industrial connections are not.

We also find significant correlations between most of the independent variables, especially the correlation between the two measures of industrial connections, dummy and number ($r = 0.780$). To check the multicollinearity problem among independent variables, we followed the Coldiag procedure recommended by Belsley *et al.* (1980). Results show that the condition number is 17.44, far below the threshold of 30 (Belsley *et al.*, 1980), suggesting multicollinearity is not serious in this study. However, the high correlation between the two measures of industrial connections suggests that they should not be put into the same model.

Regression analysis and results

In this study, our dependent variable, R&D spending, is a continuous random variable with non-negative values. Besides, there are many corner solutions because a lot of SMEs did not invest in R&D activities. This case fits a Tobit regression model

Characteristics	Max.	Min.	Mean	Number of firms	% of *n*
R&D amount (RMB10,000)	5,000	0	49.39	2,124	100
R&D spending (%)	25	0	1.28	2,124	100
Owner perception					
Yes	1	1	1	938	44.2
No	0	0	0	1,186	55.8
Owner education					
Primary school	1	1	1	20	0.9
Junior middle school	2	2	2	166	7.8
Senior middle school	3	3	3	646	30.4
Junior college	4	4	4	583	27.4
Bachelor	5	5	5	450	21.2
Postgraduate	6	6	6	259	12.2
Owner experience					
Yes	1	1	1	312	14.7
No	0	0	0	1,812	85.3
Political connections					
Have	1	1	1	1,012	47.6
Not have	0	0	0	1,112	52.4
Industrial connections – dummy					
Have	1	1	1	1,675	78.9
Not have	0	0	0	449	21.1
Industrial connections – number	3	0	1.74	2,124	100
Owner gender					
Male	1	1	1	1,816	85.5
Female	0	0	0	308	14.5
Owner age	83	18	44.75	2,124	100
Firm size (number of employees)	6,000	1	173.43	2,124	100
Firm age	27	1	7.50	2,124	100
ROA (%)	285.71	−27.96	18.97	2,124	100
Leverage (%)	93.18	0	21.37	2,124	100
Asset parsimony	200	0	4.42	2,124	100
Advertising intensity (%)	20	0	0.96	2,124	100
Giving intensity (%)	8	0	0.44	2,124	100
Industry R&D spending (%)	4.53	0	0.89	2,124	100
Industry					
Agriculture	–	–	–	143	6.7
Mining	–	–	–	48	2.3
Manufacturing	–	–	–	987	46.5
Construction	–	–	–	122	5.7
Transportation	–	–	–	49	2.3
Information service	–	–	–	108	5.1
Wholesale & retailing	–	–	–	377	17.7
Catering	–	–	–	86	4.0
Real estate	–	–	–	55	2.6
Others	–	–	–	149	7.0

Table II.
Characteristics of the sample

Table III.
Pearson correlation matrix

Variables	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 R&D spending	1.28	3.70																
2 Owner perception	0.44	0.50	0.075															
3 Owner education	3.97	1.18	0.138	0.061														
4 Owner experience	0.15	0.35	0.099	0.038	0.107													
5 Political connections	0.48	0.50	0.029	0.101	0.139	−0.023												
6 Industrial connections – dummy	0.79	0.41	0.019	0.073	0.058	−0.020	0.406											
7 Industrial connections – number	1.74	1.15	0.004	0.110	0.105	−0.002	0.421	0.780										
8 Owner gender	0.86	0.35	0.013	0.024	0.011	0.039	0.090	0.085	0.078									
9 Owner age	44.75	8.46	0.025	0.035	−0.206	−0.032	0.135	0.173	0.140	0.102								
10 Firm size	3.96	1.58	0.015	0.132	0.162	0.032	0.448	0.393	0.466	0.157	0.156							
11 Firm age	7.50	4.81	−0.001	0.046	−0.064	−0.007	0.243	0.280	0.265	0.066	0.251	0.249						
12 ROA	18.97	40.55	−0.019	0.017	0.046	0.054	−0.025	0.029	0.020	−0.006	−0.078	0.040	−0.021					
13 Leverage	21.37	25.70	−0.018	0.026	−0.011	−0.058	0.157	0.121	0.160	0.057	0.051	0.281	0.058	−0.108				
14 Asset parsinomy	4.13	6.76	−0.094	0.022	−0.017	0.024	−0.045	−0.026	−0.017	−0.023	−0.034	0.063	−0.029	0.451	−0.072			
15 Advertising intensity	0.96	2.75	0.264	0.028	0.066	0.025	0.010	0.019	0.009	−0.009	−0.070	−0.052	−0.007	−0.028	−0.017	−0.106		
16 Giving intensity	0.44	1.13	0.110	0.005	0.016	0.010	−0.018	−0.023	−0.035	−0.015	−0.032	−0.104	−0.027	0.051	−0.028	−0.120	0.280	
17 Industry R&D spending	0.89	0.91	0.129	0.041	0.120	0.065	−0.020	−0.007	−0.035	0.028	−0.011	0.022	−0.050	0.033	−0.049	0.009	0.031	−0.012

Notes: $n = 2{,}124$. Correlations $\geq |0.045|$ are significant at $p < 0.05$ level

(Tobin, 1958). Thus, we conducted Tobit regression analysis to test our arguments and hypotheses. Table IV reports the regression analyses results.

In Table IV, Model 1 includes only control variables. From Models 2 to 7, we examine one by one the effect of owner perception, owner education, owner experience, political connections, and industrial connections (measured both as a dummy and as a number). Model 8 is the full model including all the control variables and predictors.

H1 predicts that an owner's perceived importance of R&D activities is positively associated with his/her firm's R&D spending. In Model 2, the coefficient of owner perception is significant and positive ($\beta = 1.007$, $p < 0.01$). The results are in line with our prediction. Thus, *H1* is supported.

H2a predicts a positive relationship between owners' education and R&D spending. This is supported in our study. In Model 3, the coefficient of owner education is positive and significant ($\beta = 1.144$, $p < 0.01$), suggesting well-educated owners tend to invest more money in R&D activities.

H2b predicts a positive relationship between owners' technology-related working experience and their firms' R&D spending. In Model 4, the coefficient of owner experience is positive and significant ($\beta = 1.581$, $p < 0.01$). These results are consistent with our prediction. Thus, *H2b* is supported.

H3a predicts a positive relationship between business owners' political connections and R&D spending. This is marginally supported in this study. In Model 5, the coefficient of political connections is positive and marginally significant ($\beta = 0.663$, $p < 0.1$), suggesting political connections do enhance R&D spending.

H3b predicts a positive relationship between business owners' industrial connections and R&D spending. When we measure industrial connections as a dummy variable, the results in Model 6 shows that the coefficient of industrial connections – dummy is positive and significant ($\beta = 1.166$, $p < 0.05$). When industrial connections are measured as the total number of memberships in industrial institutions, this coefficient (industrial connections – number) is still positive and significant ($\beta = 0.330$, $p < 0.05$). Both are in line with our prediction. Thus, *H3b* is also supported.

Discussion and conclusion

R&D spending is a clear signal of a firm's commitment to innovation. It has been shown to be a good predictor of firms' innovation in larger firms (Kor, 2006), and of competitive success (Dalziel *et al.*, 2011). We have argued that this is even more important for SMEs, which are severely constrained in their ability to devote resources to anything but basic operations. But there is little research to document SMEs' innovative efforts. In this study, building on the upper-echelon literature (Hambrick, 1994, 2005), we have used a large sample of Chinese SMEs to test whether SME owners' personal attributes have an effect on R&D spending.

Our findings generally confirm that there is a clear relationship between on the one hand, owners' perceptions of the value of R&D, their education, and technology-related experience, and on the other hand R&D spending. Further, industrial and political connections, an important part of their social capital, are also related to R&D spending. In their work Hillman *et al.* (2007) and Haynes and Hillman (2010), have shown that, for boards of directors, capital depth (mostly related to the relevant functional experience) and capital breadth (mostly related to social connections) are important determinants of firm outcomes. Our findings, although using different proxy measures, suggest that a similar conclusion can apply to SMEs. Owners' attributes and relations have a bearing on an important firm outcome, its innovative efforts.

Table IV.
Tobit regression results

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Constant	−8.947**	−9.218**	−14.545**	−9.194**	−8.791**	−9.386**	−9.097**	−15.071**
	(1.278)	(1.282)	(1.470)	(1.277)	(1.282)	(1.301)	(1.286)	(1.502)
Owner gender	−0.034	−0.037	−0.006	−0.084	−0.050	−0.042	−0.033	−0.061
	(0.478)	(0.477)	(0.471)	(0.475)	(0.478)	(0.479)	(0.479)	(470)
Owner age	0.016	0.015	0.050*	0.019	0.014	0.013	0.015	0.047*
	(0.019)	(0.019)	(0.020)	(0.019)	(0.019)	(0.019)	(0.019)	(0.020)
Firm size	0.709**	0.685**	0.469**	0.698**	0.625**	0.622**	0.613**	0.356**
	(0.120)	(0.120)	(0.121)	(0.119)	(0.127)	(0.125)	(0.128)	(0.131)
Firm age	0.036	0.034	0.052	0.038	0.027	0.022	0.025	0.036
	(0.033)	(0.033)	(0.033)	(0.033)	(0.034)	(0.034)	(0.034)	(0.034)
ROA	0.007	0.007	0.005	0.006	0.007***	0.007	0.007	0.005
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Leverage	−0.005	−0.005	−0.002	−0.004	−0.005	−0.005	−0.005	−0.002
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Asset parsimony	−0.064**	−0.066**	−0.056*	−0.065**	−0.062**	−0.063**	−0.062**	−0.058*
	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)
Advertising intensity	0.590**	0.583**	0.573**	0.583**	0.587**	0.588**	0.589**	0.560**
	(0.054)	(0.054)	(0.053)	(0.054)	(0.054)	(0.054)	(0.054)	(0.053)
Giving intensity	0.287***	0.275***	0.272***	0.278***	0.283***	0.290*	0.290*	0.257***
	(0.147)	(0.147)	(0.144)	(0.146)	(0.147)	(0.147)	(0.147)	(0.145)
Industry R&D spending	1.689**	1.642**	1.607**	1.631**	1.672**	1.727**	1.719**	1.550**
	(0.499)	(0.497)	(0.490)	(0.497)	(0.499)	(0.501)	(0.500)	(0.490)
Owner perception		1.007**						0.846**
		(0.311)						(0.307)
Owner education			1.144**					1.084**
			(0.139)					(0.139)
Owner experience				1.581**				1.330**
				(0.416)				(0.412)
Political connections					0.663***			0.183
					(0.348)			(0.354)

(*continued*)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Industrial connections – dummy						1.166*		1.177***
						(0.475)		(0.646)
Industrial connections – number							0.330*	−0.040
							(0.160)	(0.217)
σ	5.860	5.845	5.746	5.826	5.859	5.864	5.865	5.714
	(0.145)	(0.144)	(0.141)	(0.144)	(0.145)	(0.145)	(0.145)	(0.141)
Number of obs.	2,124	2,124	2,124	2,124	2,124	2,124	2,124	2,124
Left-censored obs.	1,197	1,197	1,197	1,197	1,197	1,197	1,197	1,197
Log likelihood	−3,465.106	−3,459.874	−3,430.716	−3,457.992	−3,463.294	−3,462.040	−3,462.968	−3,418.451
LR χ^2	500.68**	511.14**	569.46**	514.91**	504.30**	506.81**	504.96**	593.99**
Pseudo R^2	0.0674	0.0688	0.0766	0.0693	0.0679	0.0682	0.0680	0.0799

Notes: Figures in parentheses are the values of standard errors. Industry dummies are included in each model. ***$p < 0.1$; **$p < 0.01$; *$p < 0.05$ (two-tailed)

Table IV.

More specifically, our empirical evidence from a nationwide survey of private SMEs across China shows that business owners' characteristics, whether objective such as education, and experience, or subjective (perceptions about R&D), play an important role in their firms' R&D decisions. In particular, an owner's perceived importance of product quality and innovation capability motivates his/her firm to invest more money in R&D activities. Well-educated owners and owners with technology-related working experience are more likely to invest more money in R&D activities. In addition to these, owners' social network, including both political and industrial connections, enhances R&D activities. Among the control variables, firm size, advertising intensity, and industry peers' R&D spending act as important determinants of R&D spending.

These findings are important to understand the innovative behavior of SMEs. These firms constitute the bulk of most countries business community. They are generally seen as contributing little to R&D, especially when compared to large firms. Their innovations are, however, crucial, because they could contribute to industry disruptive technologies (Chang and Chen, 2006; Gilbert, 2003). In actual fact, all large firms have been SMEs. Thus, the potential for significant innovation from SMEs is considerable. SMEs' innovation is driven by contextual and environmental factors, which have been documented by a rich contingency theory research. But contingency theory is mostly deterministic, and does not reveal the dynamic character of innovative efforts. Our study suggests that owners are the critical agents. Their background and relations determine SMEs' innovative efforts and ultimately innovation and competitive success (Dalziel *et al.*, 2011).

Theoretical implications

This study contributes to the R&D literature in many ways. First, it focusses on the role of decision-maker's characteristics in firms' R&D spending among SMEs. We have seen earlier that although R&D activities have been intensively investigated, very few studies have looked at decision-makers' characteristics (Barker and Muller, 2002; Mezghanni, 2010). In addition, most studies have targeted mainly large firms; little attention has been paid to SMEs (Ortega-Argiles *et al.*, 2009). This study is unique in highlighting individual-level drivers of R&D spending among SMEs.

Second, when looking at the role of decision-makers' characteristics in R&D spending, the extant literature is mostly concerned about the effects of CEOs' demographic characteristics (Barker and Muller, 2002; Mezghanni, 2010); little attention is given to the role of owners. This may not be a problem when looking at large professionally managed firms. In SMEs, it is the owners rather than hired CEOs who have the authority to make the R&D decisions. So this research puts the limelight where it is needed and comes up with significant and important relationships. Furthermore, our study adds another conceptual layer, going beyond the effect of decision-makers' objective characteristics, to consider the importance of owners' perceptions. In so doing, we have provided a rare evidence that decision-makers' subjective characteristics – their perceived importance of R&D- or technology-related activities – also plays an important role in affecting their firms' R&D spending.

Third, this study also provides evidence for the significant role played by decision-makers' social connections in their firms' R&D spending. Literature on managerial social connections has investigated their effect on corporate social behavior (Gao, 2011), innovation (Gao *et al.*, 2008; Shu *et al.*, 2012), and financial performance (e.g. Li and Zhang, 2007; Sheng *et al.*, 2011). However, the effect of managerial social connections on R&D spending has seldom been discussed. This study extends this stream of investigation and

finds that business owners' social connections have a positive effect on R&D spending. Because in China, political ties are seen as critical for business success, we have considered the effects of both political connections and business-related ones. Although focussed on SMEs, this work is in line with such contributions as Wincent *et al.*'s (2010) emphasis on network board of capital on SME innovation, and Haynes and Hillman's (2010) consideration of board of directors' capital breadth, the nature and extent of their network of relationships on firm outcomes. It is also consistent with the large literature on the importance of social capital in entrepreneurial firms (Brush *et al.*, 2002). But it goes further providing a hint at what kind of owners' relationships, and thus social capital, is likely to lead to firm-level innovation.

Finally, an incidental finding in this study also documents the role of competitive strategy in SMEs' R&D decisions. We found that asset parsimony has a negative effect, at least marginally, while advertising and giving intensities have a positive effect, on R&D spending. Because asset parsimony reflects a firm's cost-oriented strategy while advertising and giving intensities reflect jointly a differentiation strategy (Hambrick, 1983; Miller, 1986), this study suggests that smaller firms adopting a differentiation strategy are more likely to invest in R&D activities than firms oriented toward cost. We could argue therefore that smaller firms emphasizing differentiation are likely to emphasize long-term buildup of capabilities. An interesting research could reveal whether firms now dominating their industries have been of the differentiation type mentioned here.

Practical implications

This study also has significant practical implications. First, it provides firms with knowledge about the drivers of R&D spending. Such knowledge is very important for a particular firm to predict its competitors' R&D behavior. In general, both the subjective and objective characteristics of business owners are associated with R&D spending. Although an owner's subjective characteristics are unobservable and thus less meaningful for the competitors, his/her objective characteristics such as education, working experience, and social connections are observable and could help the competitors to predict his/her firm's R&D investment. Better-educated owners and owners having technology-related working experience and social connections tend to invest more in R&D activities. This also could be in family firms when choosing the CEO who would build innovative capabilities.

In addition, organizational characteristics such as firm size and advertising intensity could also be used to predict a firm's R&D spending. Larger firms and firms with more expenditure on advertising and philanthropic giving, tend to invest more in R&D activities. Finally, industry norms also play a significant role in affecting a particular firm's R&D decisions. Industry-level R&D spending acts as a strong motivator of the firm's R&D spending.

Limitations and directions for future studies

The first limitation of this study comes from the data. Cross-sectional data are good to test associations rather than causal relationships. Although decision-makers' characteristics are usually permanent and do not change in the short run, it is better to collect time-series data to test causal relationships. In addition, this study focusses only on SMEs in China. China has its own criteria in defining SMEs, and such criteria are different from other countries', which prevents us from drawing broader

conclusions, and generalize our findings to other countries, especially developed ones. Given that SMEs' R&D activities are relatively overlooked in business research, future studies could identify other determinants of R&D spending, and similarities-differences with large firms.

Notes

1. This criterion is different from many western countries where the number of employees is the usual criterion to judge a firm is a SME or not. In China, due to the large population and the relatively low labor cost, many firms adopt labor-intensive technologies and approaches in production. This makes "the number of employees" not good enough to define a SME. It also makes comparison between Chinese SMEs and that of western countries meaningless.
2. RMB (or yuan) is the Chinese currency. The foreign currency rate between US dollar and RMB was about one USD equals to 7.1 RMB in 2007. This rate at present is about one USD equals to 6.2 RMB.

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