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Public Domain

Seeking Finance, Perceived Financial Constraints and R&D Engagement

Yu Lu

Business School, Beijing Technology and Business University, Beijing, China

Abstract

This study empirically examines the association among R&D engagement, seeking finance and perceived financial constraints in high-tech SMEs. R&D engagement includes the decision of R&D engagement (whether a firm was engaged in R&D) and the degree of R&D engagement (actual R&D expenditure). I take into account both financial constraints and the former process, seeking finance. This paper proposes two sequential hypotheses. Firstly, I postulate that the decision of R&D engagement has a positive relationship with seeking finance in high-tech SMEs. Next, for those high-tech SMEs that applied for fund, I presume that perceived financial constraints are negatively related with the degree of R&D engagement. The empirical results are consistent with my expectations and thus the hypotheses are supported.

Key words: Seeking Finance, Perceived Financial Constraints and R&D Engagement

I. Introduction

High-tech small and medium-sized enterprises (SMEs) play a vital role in economic development (Mile, 2010) and they benefit from R&D (Audrestch 2001). High-tech SMEs need more money to invest in R&D compared to other firms. However, financing difficulty is common among different groups of firms particularly among SMEs. Financing problems impede severely the growth of high-tech SMEs. This study empirically examines the association among R&D engagement, seeking finance and perceived financial constraints in high-tech SMEs. R&D engagement includes the decision of R&D engagement (whether a firm was engaged in R&D) and the degree of R&D engagement (actual R&D expenditure). I take into account both financial constraints and the former process, seeking finance. This paper proposes two sequential hypotheses. Firstly, I postulate that the decision of R&D engagement has a positive relationship with seeking finance in high-tech SMEs. Next, for those high-tech SMEs that applied for fund, I presume that perceived financial constraints are negatively related with the degree of R&D engagement. The empirical results are consistent with my expectations and thus the hypotheses are supported.

II. Literature review and hypotheses development

There is vast literature related to R&D financing and its impact on firm size. Hall (2002) compares R&D "funding gap" of innovative companies in American small and large firms. From the view of financial market, he focuses on R&D underinvestment. The evidence suggests that R&D investment in small firms tends to be less sensitive to venture capital. Venture capital merely alleviates the cost of R&D partly in small companies. Compared to large companies, R&D investment in small firm is low due to its high cost. Specifically, Czarnitzki and Hottenrott (2011) focused on financial constraints and R&D in German manufacturing SMEs between 1992 and 2002. They employed panel data based on firm level to analyse the investment of R&D. They also used a credit rating index as a proxy for the constraints of fund. The results indicate that, for R&D investment, internal financing constraints are decisive. In smaller firms, external finance constraints are more serious because it is difficult for small companies to obtain external finance. However, they fail to find any relationship between firm size and internal financial constraints. With regard to R&D financing in high-tech SMEs firms, Carpenter and Petersen (2002) use the data of American listed high-tech firms from 1981 to 1998 to study the correlation between new equity finance and high-tech investment. They find that it is more difficult for smaller high-tech firms to finance by debt. Capital market imperfection results in great influence of finance on high-tech firms. Further, they find that after firms go public, most companies, especially high-tech SMEs, choose internal finance rather external finance

due to financial constraints. Recently, Xiao (2011) interviewed face-to-face 74 high-tech SMEs in the two Chinese provinces (Guangxi and Guangdong) about financing in Chinese high-tech SMEs. He found that self-finance and informal finance from staff are key sources to obtain fund for Chinese high-tech SMEs in all three stages (start-up stage, early stage and later stage) especially in start and early stages. His results suggest that it is difficult for Chinese high-tech SMEs to obtain finance externally.

However, prior literature focuses only on financial constraints and ignores the prior step. Before financial constraints, the behaviour of financing exists, that is, seeking finance, which is the premise of financial constraints. It is only after SMEs have sought finance that we can know whether there are financial constraints and how serious the constraints are. If the company attempted to obtain additional finance, then R&D engagement would be more. When SMEs secure extra money, they are able to carry out R&D programmes at the best level rather than sub-optimal level (Czarnitzki and Hotternrott 2011). In turn, when a company develops a new innovation, it looks for more external finance (Cosh et al. 2009). R&D engagement may be related to the needs of seeking finance for high-tech SMEs. I examine whether R&D engagement can predict a high-tech SME's attempt to obtain additional finance.

Moreover, the majority of previous studies examine the amount of R&D rather than whether SMEs decide to engage in R&D or not. Bond et al. (2005) is an exception, he tests the association between R&D and cash flow by using panel data of German and British companies from 1985 to 1994. The results show that, for R&D econometric models, cash flow is informative in Britain. In terms of R&D-performing companies, investment is not sensitive to cash flow in Germany. Cash flow is a predictor of whether UK firms engage in R&D. The findings suggest that financial constraints influence the decision of embarking on R&D or not, but do not affect R&D spending. The companies in Britain perform R&D are self-selected due to less financing constraints. This article develops Bond et al. (2005) by assuming that the decision to undertake R&D is positively related with the behaviour of seeking finance.

This article adopts the perspective of R & D which is different from the focus on R&D investment in earlier works. Further, I classify R&D engagement into the decision of R&D engagement and the degree of R&D engagement. If SMEs do not perform R&D, the suggestion is that they lack capital (Czarnitzki and Hotternrott, 2011). Or if SMEs failed to apply for finance, they may not engage in R&D at all (Bond et al. 2005). By contrast, SMEs may decide to engage in R&D if they obtained funds. I expect that a high-tech SME performed R&D can predict that this firm attempted to seek additional finance. Based on the above analysis, I propose the first hypothesis:

H1: R&D engagement has a positive relationship with seeking finance in high-tech SMEs.

After high-tech SMEs seek funding, they either obtain funding or suffer from financial constraints. On the one hand, if they obtain enough finance, high-tech SMEs may engage in more R&D. On the other hand, due to high risk, high investment and adjustment costs, the uncertainty of results and returns, low collateral value of R&D (Alderson and Betker, 1996), it becomes increasingly expensive for high-tech SMEs to finance both externally and internally (Müller and Zimmermann, 2009; Czarnitzki and Hotternrott 2011). If SMEs fail to finance or face with the binds of financing, then they would pursue less R&D (Chung and Wright, 1998; Czarnitzki and Kraft, 2004).

Many studies have examined the association between R&D and financial constraints from the perspective of liquidity, cash flow, debt, leverage, stock and security respectively. These studies yield mixed results. The empirical results demonstrate that R&D investment has liquidity constraint (Bougheas et al. 2003). However, Hamburg (1966) and Mueller (1967) failed to find the relation. The positive links between R&D and cash flow exist in America, German and British companies (Mulkay et al. 2001). However, Bougheas et al. (2003) argue that there is no relationship between them. Debt and R&D are negatively linked (Chiao, 2002; Czarnitzki and Kraft, 2004). However, Wang and Thornhill (2010) consider that R&D and debt have inverted U-shaped linkage. By testing the choices of R&D financing in 39 American petroleum companies from a comprehensive perspective, they also observe a positive relation between R&D and stock return and provide the evidence that there is a U-shaped relationship between convertible securities financing and R&D.

However, previous research fails to analyse the reason why many SMEs engage less R&D. Czarnitzki and Hotternrott (2011) argue that the main reason is capital. When SMEs face with the restrictions of finance, they may decrease the expenditure in R&D or even abandon R&D, stop setting up facilities and fire R&D employees (Bond et al. 2005). Especially under significant financial constraints, they may not engage in R&D

at all. In contrast, SMEs may invest more in R&D if financial constraints are less. In this paper, I expect perceived difficulties of obtaining financing make SMEs to reduce or even abandon R&D engagement, which means that the higher degree of perceived financial constraints in SMEs, the less the amount of R&D expenditure is. This leads to my second hypothesis:

H2: Perceived financial constraints are negatively related to R&D engagement amongst SMEs that sought finance.

III. Data and variables

3.1 Sample

The sample for this study comes from 2000 firms of UK Business Survey Database in 2004. In order to test my first hypothesis, I used 365 high-tech SMEs. Those high-tech companies are all SMEs. Then I eliminate high-tech SEMs without the behavior of seeking finance in order to examine Hypothesis 2. There were 159 high-tech SMEs that sought finance.

3.2 Variables

3.1 Variables in logistic regression model

The dependent variable is seeking finance. Seeking finance is whether or not high-tech SMEs make attempt to obtain additional finance. It is an indicator variable, which takes the value of one if the objected firm does attempt to obtain additional finance in the last two financial years, otherwise it takes the value of 0.

The independent variable in Hypotheses 1 is the decision of R&D engagement. That is, did your firm engage in R&D in the last financial year? Whether high-tech SMEs engage in R&D is a dummy variable, which is coded as 1 if this firm engaged in R&D in the last financial year, and 0 otherwise.

Consistent with earlier research, I control the age of the firm (business age) (Cosh et al. 2009), the size of the firm (sum of current full and part time workers) (Bond et al. 2005; Wang and Thornhillb, 2010) and industry style (Cosh et al. 2009; Wang and Thornhillb, 2010).

3.2 Variables in linear regression model

The degree of R&D engagement is the dependent variable in Hypotheses 2. I employ the natural logarithm of the total R&D expenditure to measure R&D engagement.

My independent variable is perceived financial constrain. The percentage of finance obtained is the proxy variable of perceived financial constrain.

Control variables are firm age (business age) (Müller and Zimmermann, 2009; Czarnizki and Hotternrott, 2011; Block, 2012), firm size (Bond et al. 2005; Müller and Zimmermann, 2009; Czarnizki and Hotternrott, 2011; Block, 2012), industry (Bond et al. 2005; Czarnizki and Hotternrott, 2011; Block, 2012), profits (Cosh et al. 2009; Wang and Thornhillb, 2010; Lin et al. 2011), the turnover of latest financial year (Cosh et al. 2009; Lin et al. 2011) and growth (1= become smaller; 2= stay same size; 3=grow moderately; 4=grow substantially) (Xiao and Qu, 2012).

Table 1 Variable descriptions

Variable	Descriptions
Panel A Model 1	
<i>Dependent variables</i>	
Seeking finance	It is an indicator variable, which takes the value of one if the objected firm did attempt to obtain additional finance in the last two financial years, otherwise 0.
<i>Independent variables</i>	
R&D engagement	Whether SMEs engage in R&D is a dummy variable, which is coded as 1 if the firm engaged in R&D in the last financial year, and 0 otherwise.
<i>Control variables</i>	
Firm age	Natural logarithm of business age
Firm size	Natural logarithm of sum of current full and part time workers
Industry	Dummy=1 if this high-tech SME is manufacturing, Dummy=0 if this high-tech SME is business services
Panel B Model 2	
<i>Dependent variables</i>	
R&D engagement	Natural logarithm of the total R&D expenditure

Independent variables	
Perceived financial constrain	Percent obtained/100: the percentage of finance obtained is the proxy variable of perceived financial constrain
Control variables	
Firmage	Natural logarithm of business age
Firm size	Natural logarithm of sum of current full and part time workers
Industry	Dummy=1 if this high-tech SME is manufacturing, Dummy=0 if this high-tech SME is business services
Profit	Natural logarithm of pre-tax profit in the last financial year
Turnover	Natural logarithm of the turnover of latest financial year
Growth	1= become smaller; 2= stay same size; 3=grow moderately; 4=grow substantially

3.3 Methods

In order to test Hypothesis 1, I build a logistic regression model as the dependent variable (seeking finance) is a dummy variable. Then I employ linear regression analysis to examine Hypothesis 2 as the dependent variable (R&D expenditure) is a continuous variable.

IV. Results

4.1 Descriptive statistics

Panel A and B of Table 2 present descriptive statistics of Model 1 and Model 2, respectively. Panel A shows that the mean value of seeking financing is 0.4404 and standard deviation is 0.4971. In average, about 44% sample firms attempted to obtain additional finance in the last two financial years. Panel A also indicates that the mean value and standard deviation of the decision of R&D engagement are 0.61 and 0.489 separately. That is to say, average 61% of sample firms engaged in R&D in the last financial year. From Panel B we can see that mean value of natural logarithm of the total R&D expenditure is 2.2726 and its standard deviation is 0.8549. The average percentage of finance obtained is 0.8721 with the standard deviation of 0.2765. That is, sample companies obtained averagely about 87% finance.

Table 2 Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
Panel A Model1 (365 obs.)				
Seeking financing	0.4404	0.4971	0	1
R&D Engagement	0.61	0.489	0	1
Age	1.1870	0.3549	0	2.27
Size	1.4404	0.5058	0	2.69
Industry	0.53	0.500	0	1
Panel B Model 2 (159 obs.)				
R&D	2.2726	0.8549	0	4.36
Engagement				
Percentobtained	0.8721	0.2765	0	1
Age	1.1370	0.3903	0.3	2.27
Size	1.5066	0.4394	0.48	2.63
Industry	0.50	0.502	0	1
Growth	3.39	0.670	1	4
Profit	2.1385	0.6246	0.3	3.63
Turnover	3.3854	0.5698	2.16	4.81

4.2 Correlation analysis

Table 3 lists correlation analysis results between the variables. As we can see, in Panel A, the person correlation relationship between the decision of R&D engagement and seeking financing is strong ($r=0.149$, $p<0.05$). While the correlation coefficients between other variables are all below 0.4, so muticollinearity might not be a problem. Similarly, as expected, the bivariate correlation between the degree of R&D engagement and percent obtained is 0.104. All other inter-correlation coefficients are below 0.8 in Panel B, suggesting that muticolinaearity is also not an issue (Tabachnich and Fidell, 2001).

Table 3 Correlation matrix

Panel A Model 1								
	Seeking financing	R&D	Age	Size	Growth			
Seeking financing	1.000							
R&D	0.149**	1.000						
Age	-0.174**	0.001	1.000					
Size	0.108	0.294**	0.274**	1.000				
Industry	-0.057	-0.009	0.377**	-0.003	1.000			

Panel B Model 2								
	R&D	Percent obtained	Age	Size	Industry	Growth	Profit	Turnover
R&D	1.000							
Percent obtained	0.104	1.000						
Age	-.083	-0.172*	1.000					
Size	0.419**	-0.036	0.295**	1.000				
Industry	-0.172	-0.021	0.405**	0.106	1.000			
Growth	0.025	0.173*	-0.321**	-0.072	-0.370**	1.000		
Profit	0.291*	0.108	0.036	0.393**	-0.005	0.117	1.000	
Turnover	0.245*	-0.032	0.207**	0.723**	0.045	-0.043	0.658**	1.000

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

4.3 Regression analysis

In this research, I build a logistic regression model in order to test Hypothesis 1. Then I employ linear regression analysis to examine Hypothesis 2. Table 4 shows the results of regression analysis.

Table 4 Regression analysis

Panel A Logistic regression analysis						
$Logis(SF) = \beta_0 + \beta_1 Age + \beta_2 Size + \beta_3 Industry + \beta_4 RD + \varepsilon$						
Variable	Beta(SE)			Beta(SE)		
Constant	0.142 (0.512)			-0.039 (0.523)		
Age	-1.048 (0.421)**			-0.994 (0.421)**		
Size	0.725 (0.278)***			0.568 (0.288)**		
Industry	-0.142 (0.274)			-0.169 (0.275)		
R&D				0.559 (0.283)**		
Observation	365			365		
Log likelihood(p-value)	336.619 (p<0.001)			332.685(p<0.001)		
Chi-square	12.584			16.519		
Cox & Snell R Square	0.049			0.063		
Nagelkerke R Square	0.065			0.085		

Panel B Linear regression analysis						
$RD = \beta_0 + \beta_1 Age + \beta_2 Size + \beta_3 Industry + \beta_4 Turnover + \beta_5 Profit + \beta_6 Growth + \beta_7 PO + \varepsilon$						
Variable	Beta	T	Sig T	Beta	T	Sig T
Constant		0.811	0.432		0.201	0.842
Age	-0.081	-0.587	0.561	0.018	0.128	0.899
Size	0.163	0.562	0.578	0.148	0.533	0.598
Industry	-0.288	-2.020	0.052	-0.309	-2.258	0.031

Turnover	0.580	1.781	0.084	0.641	2.046	0.049
Profit	-0.267	-1.627	0.114	-0.320	-2.003	0.054
Growth	-0.206	-1.341	0.189	-0.219	-1.485	0.148
Percent obtained				0.266	1.974	0.057
Observation	159			159		
R	0.690			0.731		
R Square	0.477			0.535		
Adjusted R Square	0.378			0.430		
Std. Error	0.5208			0.4987		
F(p-value)	4.855(p<0.001)			5.095(p<0.001)		

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

4.3.1 Logistic regression analysis

Hypothesis 1 employs logistic regression analysis to test the relation between the decision of R&D engagement and seeking financing. Panel A of Table 4 reports the results of logistic regression analysis. The model is significant with $-2 \log \text{likelihood} = 332.685$ ($p < 0.001$), Cox & Snell R Square = 0.063, Nagelkerke R Square = 0.085. The results show that the decision of R&D engagement and seeking financing are significantly related with each other ($B = 0.559$; $p < 0.05$), which supports Hypothesis 1.

4.3.2 Linear regression analysis

In order to examine Hypothesis 2, I construct a linear regression model. Referring to Panel A, Table 4, the adjusted R square of the model is 43% and F is 5.059 with p value less than 0.001. As hypothesized, the coefficient of percent obtained and R&D engagement is in the predicted direction ($\text{Beta} = 0.266$) and statistically significant ($p < 0.1$). R&D spending demonstrates a positive and significant correlation with the percentage of obtained finance. That is, perceived financial constraints are negatively related with R&D engagement amongst high-tech SMEs that sought finance, supporting Hypothesis 2.

Overall, the results of cross-sectional analyses are consistent with Hypothesis 1 and Hypothesis 2. R&D decision has a positive relation with seeking finance in high-tech SMEs. Amongst high-tech SMEs that sought finance, perceived financial constraints are negatively linked with R&D expenditure.

V. Discussion

In summary, empirical results support two sequential hypotheses. This study offers the evidence that, for high-tech SMEs, R&D engagement can predict the behavior of seeking finance (Hypothesis 1). Furthermore, more serious financial constraints lead to less R&D engagement (Hypothesis 2). The results of my first hypothesis extends early work (Hall, 2002; Carpenter and Petersen 2002; Bony et al. 2005; Czarnitzki and Hottenrott 2011; Xiao 2011) by confirming that R&D engagement can predict that a high-tech SME attempted to obtain additional finance. The second findings indicate that if high-tech SMEs could successfully obtain more funds, they would invest more in R&D, which supports the conclusions of Chiao (2002), Bougheas et al. (2003) and Czarnitzki and Kraft (2004). Taken as a whole, my findings are consistent with the theory that the key to fast development of R&D in high-tech SMEs is to address access to finance (Berger and Udell, 2002; Czarnitzki, 2006).

High-tech firms seem to be more concerned with financing constraints (Carpenter and Petersen 2002). When a company plans to develop a new innovation, it looks for more finance (Cosh et al. 2009). The decision of R&D leads to the behavior of seeking finance in high-tech SEMs. Furthermore, after high-tech SMEs have seek funding and face the binds of financing, then they will pursue less R&D (Chung and Wright, 1998; Czarnitzki and Kraft, 2004). Moreover, the more serious financial constraints SMEs perceive, the less the R&D expenditure would be (Bond et al. 2005). In short, I build a comprehensive linkage between R&D and finance in high-tech SMEs. That is, not only the decision of R&D engagement expectsthe behavior of seeking finance, but also perceived financial constraints result in low degree of R&D engagement.

The practical implication of this research is that I identify and confirm the importance of R&D financing in high-tech SMEs. That is, high-tech SMEs need more funds to develop their R&D and financing obstacles restrict seriously R&D investment. Policy-makers should formulate related policies to support R&D financing in high-tech SMEs (Czarnitzki and Hottenrott 2011). In addition, it is necessary for government to relax financial control and encourage financial innovation in order to alleviate financial constraints of high-

tech SMEs. Also importantly, managers of high-tech SMEs need to take advantage of various sources and ways to seek more funds and reduce financial constraints in order to invest more in R&D. Managers also need to be more practically oriented by moving beyond perception of constraints in seeking finance by actually seeking finance. It is only by actually seeking finance that SMEs managers will fully appreciate the real constraints involved in seeking finance and thereby learn the best way going forward.

VI. Conclusions

The purpose of this paper has been to investigate the interrelationship between R&D engagement, seeking finance and perceived financial constraints in high-tech SMEs. I find that whether high-tech SMEs engaged in R&D is significantly associated with whether they had previously attempted to obtain additional finance. I also find that R&D spending and the percentage of obtained finance are significantly linked amongst high-tech SMEs that sought finance. The findings show that R&D engagement in high-tech SMEs has close linkage with finance including seeking finance and perceived financial constraints. My findings confirm that it is vital for high-tech firms to overcome finance problems in order to develop R&D.

One limitation of this paper is the sample. It gathers cross-sectional data from the results of survey. The survey data may be subjective and the usage of cross-sectional data may fail to consider the annual changes. In addition, some missing data may also have an impact on the reliability of results. Future studies could take advantage of other data such as panel data and case study data to explore related research questions (Block, 2012). Another potential limitation seems to be that my analysis is restricted to high-tech SMEs in the UK. Future research might further examine the hypotheses by using data from different industries and countries. Comparative research that analyzes the similarities or differences in various settings would be of interest. In spite of these limitations, this study makes important original and explicatory findings on R & D engagement and seeking finance, perception of financial constraints and the reality of that perception in high-tech SMEs.

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