"Debt maturity and corporate R&D investment – the empirical study of US listed firms"

| AUTHORS | Hai-Chin Yu ⓘ https://orcid.org/0000-0003-3274-4656
Ⓡ https://publons.com/researcher/2441225/hai-chin-yu/
Thi-Thanh Phan ⓘ https://orcid.org/0000-0001-8107-3217 |

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
51	1	6

Hai-Chin Yu, Professor, Department
of International Business, Chung
Yuan Christian University, Taoyuan
City, Taiwan.

Thi-Thanh Phan, Ph.D., College of
Business, Chung Yuan Christian
University, Taoyuan City, Taiwan.

Hai-Chin Yu (Taiwan), Thi-Thanh Phan (Taiwan)

DEBT MATURITY AND CORPORATE R&D INVESTMENT – THE EMPIRICAL STUDY OF US LISTED FIRMS

Abstract

This study investigates the relationships between debt maturity structure and corporation R&D investment. Using a large sample of US listed firms over the period of 1995 to 2015, it was found that the use of bank debt positively influences R&D investment, whereas the use of public debt exerts a negative impact. However, the Sarbanes-Oxley Act (SOX) mitigates the information asymmetry such that the advantages of private information from banks shrunk. As a result, public debtholders benefit more from the SOX and turn out to be positively influenced by the R&D investment after SOX. Moreover, bank debt impact on R&D spending reduces over the post-SOX. The results also find that the SOX influences the debt maturity on corporate R&D investment only for large corporations, the effects remain unchanged for small businesses.

Keywords	R&D investment, debt maturity, debt structure, Sarbanes-Oxley Act
JEL Classification	G23, G21

INTRODUCTION

Knowledge, technical progress, and human capital exert a substantial impact on firm growth and survival. Consequently, uncovering the determinants of innovation is crucial for managers to foster R&D investment. Corporate R&D decision is part of the investment decisions for allocating the limited financial resources of firms toward different potential projects. External financing has always been a primary source of firm financing, and deciding between borrowing from banks or issuing bonds or equity is challenging. However, highly innovative companies have difficulty in acquiring external funding due to the asymmetric information problem between firms and outside investors (Kamien & Schwartz, 1978). This asymmetric information favors the issue of private debt, as businesses must share their private information with debtholders to reveal that the investment is profitable, to access to finance for innovative projects.

Since most previous studies on financing corporate innovation focus on internal financing or equity channels, very few papers mentioned debt financing. Among corporations with external financing, the amount of debt has exceeded the equity[1]. Given the economic importance of debt in allocating capital to firms, an emerging stream of research explores the relationship between leverage and investment decisions. For example, McConnell and Servaes (1995), Bhagat and

---

1   According to the Loan Pricing Corporation and the Federal Reserve System, the total amount of equity issued was approximately $115 billion, the total amount of corporate bonds issued was roughly $700 billion, and the total amount of bank loans issued was nearly $1,500 billion in 2005 (Chi, Huang, & Xie, 2015).

Welch (1995), Aivazian et al. (2005) and Firth et al. (2008) examine the effect of leverage on firm invest-ment and find that leverage significantly negatively influences corporate investment. However, research exploring the effect of debt maturity structure on R&D investment is rare. Moreover, whether short-term bank borrowings and long-term public debt influence the pace of firm R&D investment remains an unresolved empirical issue.

The motivation of this work involves the facts that R&D spending is a high-risk investment and has the difficulty in financing such investment from outsiders due to asymmetric information (Kamien & Schwartz, 1978; Nofsinger & Wang, 2011). Innovative firms have lower incentive to release information regarding know-how, confidentiality, and competitiveness. Therefore, compa-nies with high-quality projects may avoid issuing public debt given the high costs of information disclosure and potential loss of competitive advantage to competitors (Yosha, 1995). By contrast, bank debt is more advantageous than public debt in terms of keeping information private. Banks used to maintain long-term relationships with borrowing firms and accumulate soft information about the businesses (Diamond, 1991; Chemmanur & Fulghieri, 1994; Lin et al., 2013). Banks can also access inside information on borrowing firms, whereas outside debt holders must rely mostly on publicly available information (Fama, 1985; Boot, 2000). Although public creditors and banks have relative advantages for innovative companies, the tradeoff between them remains a concern for managers. How can an effective monitoring or less information exposure help foster the suc-cess in innovation? How does debt maturity influence a firm's innovation? All these issues deserve further examination.

Aghion et al. (2004) show that firms having R&D innovation input tend to use more debt than those without R&D activities. They also find a non-linear relationship between innovation and debt finance. Recently, some researchers examine the relationship between bank development/deregulation and cor-porate innovation outputs (Gu, Mao, & Tian, 2013; Amore, Schneider, & Žaldokas, 2013; Cornaggia & Wolfe, 2015). However, none of them examine the impacts of debt maturity on corporate innovation. This study fills the gap in the literature by exploring the impact of debt maturity structure on corporate innovation.

Given the limited empirical research on exploring the relationships between debt maturity structure and R&D investment in US firms, this work employs a measure for debt maturity. Short-term bank borrowings and long-term public debt to measure debt are used maturity structure. Biases due to firm heterogeneity and endogeneity present a concern in the analysis. The authors carefully choose the set of control variables and employ two-stage least squares (2SLS) regression to address the endogeneity is-sue. Further, multivariate difference-in-differences analysis is conducted to provide robust tests on the relationships among bank debt, public debt, and R&D investment. The results are quite consistent. The study contributes to the literature on capital structure and corporate innovation, especially on the angle of financing innovation through debt channels.

The findings reveal a positive relationship between the use of bank debt and R&D investment: a higher fraction of bank financing is associated with a greater level of R&D investment. Conversely, public debt use seems to mitigate R&D investment due to a negative relationship between public debt and R&D in-vestment. Moreover, the enactment of the Sarbanes-Oxley Act (SOX) in 2002 mitigates the information asymmetry, such that public debtholders gain more benefits from the SOX than banks in the relation-ship with R&D investment. This paper presents implications for innovative firms making financing decisions.

The remainder of this paper is organized as follows. Section 2 briefly reviews the relevant literature. Section 3 describes the data and methodology, followed by the empirical results in Section 4 and the conclusions in the last Section.

1. LITERATURE REVIEW

Innovation involves the development of novel technological know-how to generate higher quality or lower cost product relative to extant resources (O'Sullivan, 2000). A number of notable scholars are in agreement regarding the value of innovation along with that of R&D investment as the keys to economic development and company growth (Zahra & Covin, 1995; Cohen & Klepper, 1996; Hurley & Hult, 1998; Woodside, 2005). R&D activities have high failure probability and uncertain return and thus are regarded as risky investment; nevertheless, they considerably benefit an enterprise (Bergemann & Hege, 2005).

Agency theory indicates that managers are risk averse due to concerns about their undiversified human capital (Fama, 1980). In response to this, later researches explore the means to motivate managers into making risky decisions by using external and internal corporate governance mechanisms. External mechanisms include supervision by the board of directors, shareholders, and lenders.

Diamond (1984) develops a theory of financial intermediation based on minimizing the cost of monitoring information to resolve incentive problems that arise between borrowers and lenders. It is expected that the lenders, particularly banks, can retrieve proprietary information and ensure effectiveness in terms of monitoring because of their roles as insider and delegated monitors.

Modigliani and Miller (1958) are one of the first who investigated the role of debt. They later claim that the firm value increases with debt due to the two advantages of debt. One benefit is from tax shield, that is, interest payments are typically not taxed (Modigliani & Miller, 1963; Atiyet, 2012). The other advantage is that managers can be disciplined through debt. The law usually guarantees a right of information disclosure to debt holders, which serves as another tool for monitoring managers (Jensen, 1986). Consequently, debt disciplines managers, forcing them to disinvest, or to finance new investment, even in firms that have ready access to additional equity (Lambrecht & Myers, 2008) and create maximum value for the firms (Wruck, 1994).

Jensen (1986) describes two agency problems resulting from debt financing, namely, underinvestment and overinvestment. He suggests that firms with substantial free cash flow have a tendency to invest more by accepting projects with low expected returns. In these cases, debts can be used to mitigate the effects of overinvestment because managers would use the excess cash flow to pay out the interest rather than invest in projects with negative net present value. Similarly, Gomariz and Ballesta (2014) examine the effect of debt maturity on investment efficiency for Spanish firms and indicate that short-term debt would improve investment efficiency, reduce both underinvestment and overinvestment problems. A recent study uses the dispersion of debt maturities and constitutes a crucial dimension to capital structure choice (Choi et al., 2018). It also inspires the authors to investigate the relationships between debt maturity structure and corporation R&D investment.

The question of how the use of debt should matter in innovation investments has been examined in prior literature, but results are mixed across various countries. Using US and Japanese firms as sample, Bhagat and Welch (1995) explore the determining factors of corporate R&D and find a significantly negative correlation between the debt ratio of the previous year and the present R&D expenses in US companies, although this ratio is significantly positively correlated for Japanese firms. Singh and Faircloth (2005) confirm a significantly negative relationship between the financial leverage and R&D expenditure. Their findings further indicate that high leverage leads to low R&D expenditure instead of vice versa. Empirical study by Czarnitzki and Kraft (2009) verifies that debt financing itself exerts a negative impact on firms' innovativeness in Germany. Conversely, employing data from manufacturing firms in Italy, Alfonso and Giannangeli (2012) find a positive effect of debt financing on the probability of R&D outsourcing. They argue that the asymmetric information problems plaguing the relationship between a firm and its lenders are particularly important in the financing of R&D.

The mixed regarding the effects of leverage and the gap in examining the influence of debt maturity structure on R&D investment leave room for us to add to the existing literature. In this research,

the focus is on debt financing and investigating whether short-term bank debt or long-term public debt give more incentives for R&D investment. Critics suggest an important role of bank debt through lending, mitigating asymmetric information, and monitoring the financing of firm investments. Fama (1985) and Diamond (1991) indicate that the asymmetric information problem may be reduced because banks specialize in collecting the borrowing firm's private information and maintaining long-term relationships with those firms. Calomiris and Kahn (1991) address that short-term debt serves as a mechanism to supervise the managers. Jiménez and Saurina (2004) indicate that a close bank-borrower relationship increases the willingness of firm to take risk. Given these arguments, the authors of the article hypothesize a positive relationship between bank debt and firm R&D investment. Furthermore, the view of Yosha (1995) is followed who argues that firms with high-quality projects are likely to avoid public debt due to the high information disclosure costs and the potential loss of competitive advantage relative to rivals. It is expected that public debt is negatively related to R&D investment considering that R&D projects entail high-growth options for firms.

2. METHODS

The Compustat Fundamentals Annual database is used to collect the financial statements of US companies during 1995–2015. The R&D investment (*RD_TA*) was measured by R&D expenses divided by total assets. Leverage, debt maturity, firm size, age, cash ratio, return on assets, and growth opportunities are a set of control variables. The related definitions are presented in the next section and in Table 1a. Three restrictions are imposed on the data: First, the financial firms (SIC codes 6000–6999) are excluded due to their different regulatory accounting considerations. Second, firm-year observations with missing explanatory variables are excluded. Third, to alleviate the effect of outliers, all variables at the 1st and 99th percentiles (Aivazian et al., 2005; Cleary, 1999) are excluded. The final data set comprises 166,178 firm-year observations from the sample period. Table 1 presents the descriptive statistics of the variables.

2.1. Measuring the variables

This section provides the definitions of the dependent and independent variables. The detailed variable definitions are also presented in Table 1a of the Appendix.

Research and development investments (*RD_TA*): A firm's R&D expenditure ratio during the fiscal year was measured as innovative investment. *RD_TA* is defined as the ratio of R&D expenditure (Compustat item XRD) to the book value of the total assets (Compustat item AT)[2].

Bank debt (*BANKDEBT_TA*): Bank debt is measured as the total amount of short-term borrowings, including bank advances, bank liabilities, bank overdrafts, current bank loans, notes payable to banks, and other borrowed funds reported as part of short-term borrowings. Bank debt ratio equals bank debt divided by the book value of the total assets (Compustat item AT). Given that banks help mitigate the asymmetric information problem, a positive relationship is expected between bank debt and firm R&D investment.

Public debt (*PUBLICDEBT_TA*): Long-term public debt is measured by the amount of total long-term debt, including long-term borrowings and corporate bonds. Public debt is calculated as the ratio of long-term debt (Compustat item DLTT) divided by the book value of the total assets (Compustat item AT). A negative relationship is expected between public debt and R&D investment.

Firm size (*LNSALE*): A firm's size and age affect innovation; thus, the size reflects a company's present situation and innovation prospects. Firm size is measured using the natural logarithm of total sale (Compustat item *SALE*) (Craig & Dibrell, 2006). Firm innovation is expected to be positively correlated with firm size.

Firm age (*LNAGE*): Firm age was measured by the natural logarithm of one plus the number of years as a publicly listed company. As the start-up phase is usually linked to the commercialization of inventions, younger firms may be viewed as more innovative than established firms. As described

---

2   See the same definition as reported by Aboody and Baruch (2000).

above, established firms might be more reluctant to introduce their innovations.

Return on assets (*ROA*): Profitability is reflected in this variable. Return on assets is defined as the net operating income (Compustat item NI) divided by the book value of the total assets (Compustat item AT). Hitt et al. (1991) find a negative relationship between ROA and patent intensity. By contrast, Fang et al. (2014) report a positive relationship between firm profitability and the level of firm innovation.

Growth opportunities (*GROWTH*): The market value of common equity (Compustat item MKVALT) with the book value of debt (Compustat item DTT+DLC), divided by the total book value of assets (Compustat item AT), gives the variable of growth. According to Abdioglu et al. (2013), a positive relationship exists between investment opportunities and R&D expenditure.

Cash ratio (*CASHRATIO*): Cash ratio is measured by the ratio of cash and short-term market securities to total assets (Compustat item AT). The capital expenditure ratio, or *CAPEX_TA*, is measured by the capital expenditure (Compustat item CAPX) to total assets. Cash ratio and capital expenditure is expected to be positively related to R&D investment.

Industry effect: Two-digit SIC dummies are used to control for potential differences in firm innovations because opportunities differ among industries.

Time/Event effects: The variable *SOX2002* controls for the impact of the SOX in 2002 to examine the shock on influencing the impact between debt maturity structure and firm R&D investment, which equals one if the year was after 2002, and zero otherwise. Extant literature verifies that highly innovative companies face difficulties in attracting capital for implementing projects (Bushee, 1998; Graves & Waddock, 1990). Moreover, although a high level of information asymmetry between firms and financiers may cause high costs of monitoring from outside financiers (Abdioglu et al., 2013; Jensen & Meckling, 1976), the SOX was believed to improve financial disclosure and the quality of information (Engel et al., 2007). As such,

a positive relationship expected between public debt and R&D investment over the post-SOX period.

2.2. Methodology

In examining the relationship between the debt maturity structure and firm innovation investment, firm innovative investment (*RD_TA*) is first regressed on the debt structure that includes bank debt and public debt. The authors also control for firm operational characteristics and other industries fixed effects, and time and event factors. The regression is specified as equation (1):

$$RD\_TA_{it} = \alpha_1 + \alpha_2 \cdot BANKDEBT\_TA_{it} +$$
$$+\alpha_3 \cdot PUBLICDEBT\_TA_{it} +$$
$$+\alpha_4 \cdot Controls_{it} + \alpha_5 \cdot Industry\ Effects_{it} +$$
$$+\alpha_6 \cdot Time\ /\ Event\ Effects_{it} + \varepsilon_{it}, \qquad (1)$$

where the subscripts *i* and *t* indicate firm and time, respectively. Variable definitions are as follows: *RD_TA* is the R&D investment in corporate operations. *BANKDEBT_TA* measures the short-term borrowings to the total assets. *PUBLICDEBT_TA* is a proxy for the long-term borrowings and corporate bonds to the total assets. The controls indicate a set of control firm characteristic variables. Specifically, we control for firm size *(LNSALE)*, firm age *(LNAGE)*, profitability *(ROA)*, growth opportunities *(GROWTH)*, cash ratio *(CASHRATIO)*, and capital expenditure ratio *(CAPEX_TA)*. *Industry Effects* and *Time/Event Effects* control for the industry and time effects, respectively. ε is the error term.

A test is conducted to confirm that the firm bank debt (*BANKDEBT_TA*) and public debt (*PUBLICDEBT_TA*) are not exogenous random variables. Instead, they are endogenously affected by firms' financial conditions. Three instrumental variables are thus employed to solve the endogeneity problem. (1) Retained earnings (*RE_TA*) represent the firm's ability to accumulate earnings as measured by the retained earnings (Compustat item RE) divided by the total assets. (2) Firm working capital (*WC_TA*) considers whether a firm has sufficient capital to support its assets, measured by working capital (Compustat item WCAP) divid-

ed by the total assets. An estimated model is first built for *BANKDEBT_TA* and *PUBLICDEBT_TA* using the above instrumental variables and all the control variables in equation (1). The models are shown as equations (2) and (3):

$$BANKDEBT\_TA_{it} = \beta_1 + \beta_2 \cdot RE\_TA_{it} +$$
$$+\beta_3 \cdot WC\_TA_{it} + \beta_4 \cdot Controls_{it} +$$
$$+\beta_5 \cdot Industry\ Effects_{it} + \quad\quad (2)$$
$$+\beta_6 \cdot Time\ /\ Event\ Effects_{it} + \Upsilon_{it},$$

$$PUBLICDEBT\_TA_{it} = \delta_1 + \delta_2 \cdot RE\_TA_{it} +$$
$$+\delta_3 \cdot WC\_TA_{it} + \delta_4 \cdot Controls_{it} +$$
$$+\delta_5 \cdot Industry\ Effects_{it} + \quad\quad (3)$$
$$+\delta_6 \cdot Time\ /\ Event\ Effects_{it} + \Upsilon_{it},$$

where the subscripts i and t indicate firm and time, respectively. Υ is the error term. The error terms in both equations may be correlated. Therefore, adopting a 2SLS regression to address the endogeneity issue and the correlated errors between the equations is reasonable. The Hausman specification test (Hausman, 1978) is employed to confirm the existence of endogeneity. Further, the identification test and excluded-instruments F-test are also conducted to check for soundness and adequate instruments.

Table 2 presents the results of the Hausman tests. The authors first regress *BANKDEBT_TA* and *PUBLICDEBT_TA* on selected instrumental variables and the rest of the exogenous variables in the original regression. Initial regressions of *BANKDEBT_TA* and *PUBLICDEBT_TA* against the exogenous variables resulted in a p-value for instrumental variables that are small enough to suggest that *RE_TA*, and *WC_TA* are the good instruments. Subsequently, the residuals of *BANKDEBT_TA* and *PUBLICDEBT_TA* equations are plugged into the original equation (1). Results show that the residuals from the *BANKDEBT_TA* and *PUBLICDEBT_TA* equations are statistically significant. The F-value is 356.81 with a p-value of 0.000, which indicates that *BANKDEBT_TA* and *PUBLICDEBT_TA* are endogenous in terms of the relationships with R&D investment. Thus, a 2SLS regression is necessary and justified.

3. RESULTS

3.1. Descriptive statistics

Panels A and B of Table 1 report the descriptive statistics of the endogenous and exogenous variables employed in this study. Interestingly, on average, 46% of firms' financing is provided by bank loans and approximately 20% is from public debt. These results confirm the role of debt financing in the US firms as shown in existing literature. The
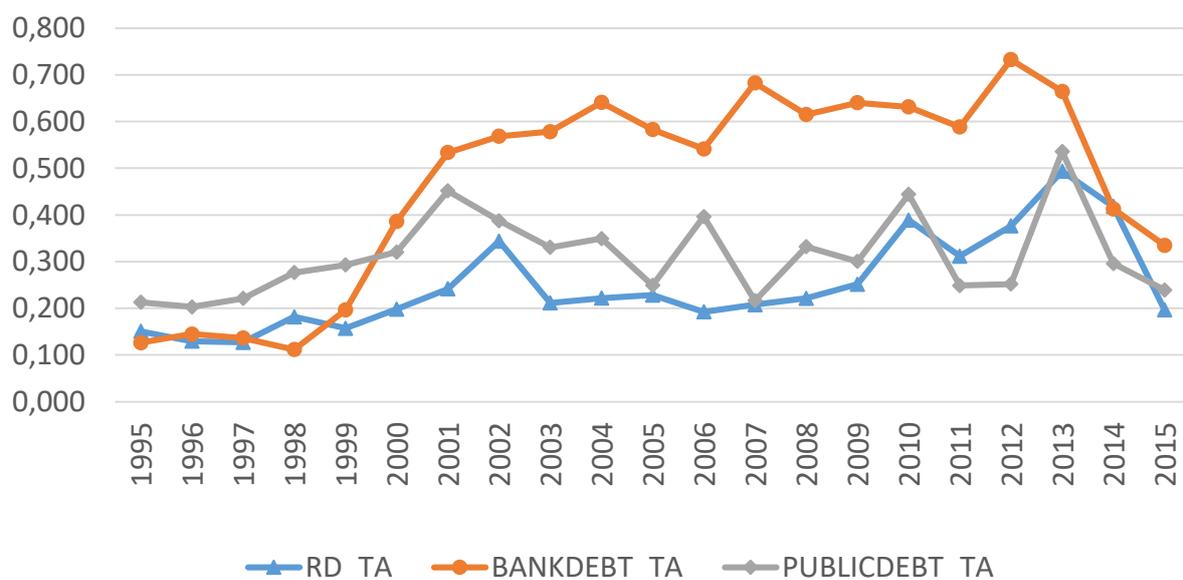

Figure 1. Relationships among R&D investment, bank debt ratio and public debt ratio over time

Table 1. Descriptive statistics of firm characteristics and correlations among the predictors of R&D investment

Characteristics	Obs.	Mean	Median	25th	75th
Panel A: Descriptive statistics of R&D investment and debt maturity structure					
RD_TA	85,625	0.145	0.039	0.002	0.146
BANKDEBT_TA	162,097	0.457	0.021	0.000	0.132
PUBLICDEBT_TA	166,178	0.204	0.108	0.000	0.282
Panel B: Descriptive statistics of firm characteristics					
LNSALE	154,479	4.883	5.019	3.207	6.754
LNAGE	83,833	1.938	2.079	1.386	2.565
CASHRATIO	163,571	0.149	0.067	0.017	0.196
CAPEX_TA	163,342	0.066	0.036	0.014	0.077
ROA	165,477	0.075	0.016	−0.113	0.062
GROWTH	113,423	2.667	1.098	0.672	1.127

RD_TA	Q1 (25%)	Q2 (50%)	Q3 (75%)	Interquartile t-test (Q3–Q1)
Panel C: Interquartile t-test of independent variables on R&D investment				
BANKDEBT_TA	0.145	0.032	0.692	0.840***
PUBLICDEBT_TA	0.274	0.158	0.209	14.708***
LNSALE	5.382	5.312	4.572	38.315***
LNAGE	2.055	2.045	1.862	22.293***
CASH RATIO	0.092	0.160	0.156	−40.552***
CAPEX_TA	0.055	0.046	0.077	−11.183***
ROA	0.195	−0.031	0.095	0.930
GROWTH	2.241	2.269	7.091	1.455***

Panel C: Pearson correlation matrix

Variables	BANK DEBT_TA	PUBLIC DEBT_TA	LNSALE	LNAGE	CASH RATIO	CAPEX_ TA	ROA	GROWTH
BANKDEBT_TA	1.000							
PUBLICDEBT_TA	−0.021	1.000						
LNSALE	−0.044*	0.015*	1.000					
LNAGE	0.012*	0.001*	0.227*	1.000				
CASHRATIO	0.046*	−0.014*	−0.336*	−0.100*	1.000			
CAPEX_TA	0.011*	0.032	−0.022*	−0.145*	−0.042*	1.000		
ROA	−0.054*	0.041*	0.018	0.008	0.019*	0.242*	1.000	
GROWTH	0.059*	−0.026	−0.049*	−0.007	0.011*	−0.001	0.023*	1.000

Note: Panels A, B, and C present the descriptive statistics and Panel D provides the Pearson correlation coefficient for the sample of US public firms from 1995 to 2015. *RD_TA* is the ratio of R&D expenditure to the book value of assets. *BANKDEBT_TA* is the ratio of short-term borrowing to total assets. *PUBLICDEBT_TA* is the ratio of long-term borrowing and corporate bonds to total assets. Firm size (*LNSALE*) is the natural logarithm of the total sales. Firm age *(LNAGE)* is the natural logarithm of one plus the number of years as a publicly listed company. *CASHRATIO* is the ratio of the total cash and cash equivalents to total assets. *CAPEX_TA* is the capital expenditure ratio, which is the capital expenditure divided by the total assets. Profitability *(ROA)* is the ratio of net income to the book value of total assets. *GROWTH* opportunities are measured by the market value of equity plus the book value of debt divided by the total assets. *, and *** represent statistical significance at the 10%, and 1% levels, respectively.

median of *RD_TA* among firms is 3.9 %, although its average is 14.5%, revealing a widely-distributed and right-skewed R&D expenditure among US firms. The time trend of R&D investment, bank debt, and public debt during the sample period are illustrated in Figure 1.

The average *LNSALE* is 4.48, meaning that most firms are adequately large. The average cash ratio is 0.14 and growth opportunities reach 2.66, with a few firms exhibiting negative or extremely high growth rates. Other control variables are displayed in Panel B of Table 1.

Table 2 reports the Hausman test for the endogeneity of *BANKDEBT_TA* and *PUBLICDEBT_TA* in the R&D investment equation where the ratio of R&D expenditure to total assets (*RD_TA*) is a dependent variable (see equation (1)).

BANKDEBT_TA and *PUBLICDEBT_TA* are treated as endogenous variables and instru-

mented by retained earnings (*RE_TA*), and firm working capital (*WC_TA*). See Table 1a for variable definitions. Columns (1) and (2) show the results of the estimated model for *BANKDEBT_TA* and *PUBLICDEBT_TA* using the above instrumental variables and all control variables in equation (1). The residuals of the equations of BANKDEBT_TA and PUBLICDEBT_TA are then plugged into the original regression as the second stage of the Hausman test. Column (3) reports the results where the residuals of *BANKDEBT_TA* and *PUBLICDEBT_TA* are statistically significant. The standard errors of estimated coefficients are clustered by firm and displayed in parentheses.

Hausman test for endogeneity:

(1) BANKDEBT_RESHAT = 0
(2) PUBLICDEBT_RESHAT = 0
$F_{(2, 32277)} = 357.88$
Prob > F = 0.000

Table 2. Hausman test for endogeneity

Variables	BANKDEBT_TA	PUBLICDEBT_TA	RD_TA
	(1)	(2)	(3)
BANKDEBT_TA			0.021***
			(0.001)
PUBLICDEBT_TA			−0.012***
			(0.003)
Control variables			
LNSALE	0.012**	−0.014***	−0.037***
	(0.006)	(0.003)	(0.001)
LNAGE	−0.151***	0.011	0.028***
	(0.021)	(0.012)	(0.004)
CASHRATIO	−0.313***	−0.361***	−0.061***
	(0.073)	(0.041)	(0.015)
CAPEX_TA	−9.045***	−0.627***	0.477***
	(0.102)	(0.057)	(0.044)
GROWTH	0.014***	−0.001***	0.001***
	(0.002)	(0.001)	(0.001)
ROA	0.112***	−0.011***	−0.052***
	(0.001)	(0.001)	(0.001)
SOX2002	−0.062**	0.007	0.012**
	(0.029)	(0.016)	(0.006)
BANKDEBT_RESHAT			0.018***
			(0.002)
PUBLICDEBT_RESHAT			−0.469***
			(0.018)

Table 2 (cont.). Hausman test for endogeneity

Variables	BANKDEBT_TA	PUBLICDEBT_TA	RD_TA
	(1)	(2)	(3)
Instrumented variables			
RE_TA	−0.001	0.001***	
	(0.001)	(0.001)	
WC_TA	−0.113***	0.010***	
	(0.001)	(0.001)	
Constant	0.689***	0.311**	0.289***
	(0.233)	(0.129)	(0.059)
Industry effects	Yes	Yes	Yes
Observations	51,363	51,363	32,304
R-squared	0.949	0.480	0.733

Note: *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel C of Table 1 reports the t-test of independent variables among R&D quintiles. Bank debt and public debt have significant differences between low and high R&D quintiles. This relationship was further checked by running regressions. Panel D reports the Pearson correlation coefficients among all independent variables and confirms low levels of correlations among all of them.

3.2. 2SLS results

Table 3 reports the 2SLS regression results of the use of bank debt and public debt on R&D investment. Columns (1) and (2) show the outcomes of the first stage wherein dependent variables involve *BANKDEBT_TA* and *PUBLICDEBT_TA* concurrently. The coefficients of three instrumental variables are statistically significant at the 1% level in both equations. The F value of excluded instruments is very high with a p-value of 0.000, suggesting that the instrumental variables are good predictors. The coefficients of *LNSALE* and *GROWTH* on *BANKDEBT_TA* are positive, suggesting that larger firms and firms with high growth opportunities prefer using more bank loans. Furthermore, the coefficient of SOX2002 is positive and significantly related to *PUBLICDEBT_TA* at the 1% level, implying that the SOX helps improve financial disclosure and information quality and is good for public debt financing.

Table 3 reports the two-stage least squares regression results of firm R&D investment and debt maturity structure, where the ratio of R&D expendi-ture to total assets (*RD_TA*) is a dependent varia-ble (see equation (1)).

BANKDEBT_TA and *PUBLICDEBT_TA* are treat-ed as endogenous variables and instrumented by firm retained earnings (*RE_TA*), and working capital (*WC_TA*). The first-stage results generat-ed the estimated values of *BANKDEBT_TA* and *PUBLICDEBT_TA* as reported in columns (1) and (2). Column (3) reports the second stage of 2SLS estimation results of R&D investment (*RD_TA*) on bank debt and public debt in equation (1). The test of weak instruments examines the null hy-pothesis that the instruments are weak at the 5% level of significance. The test of over-identifying restriction examines the null hypothesis that all instruments are valid. The standard errors of es-timated coefficients are clustered by the firm and displayed in parentheses.

Column (3) of Table 3 reports the second stage of 2SLS results. The coefficient of bank debt on firm R&D investment is positive and significant, im-plying that banks assist in collecting private infor-mation to mitigate information asymmetry and help keep confidentiality and maintain advantag-es. As a result, lower loan spreads or better non-price loan terms may be offered. All these cost advantages motivate higher R&D spending. Bank debt use fosters R&D investment, whereas public debt hinders it. These findings are consistent with the idea of Yosha (1995) indicating that the pub-lic debt has high costs of information disclosure, which are harmful to firm investments.

Table 3. Firm R&D investments and debt maturity structure

Variables	First stage		Second stage
	(1)	(2)	(3)
	BANKDEBT_TA	**PUBLICDEBT_TA**	**RD_TA**
BANKDEBT_TA			0.021***
			(0.001)
PUBLICDEBT_TA			−0.062*
			(0.036)
Control variables			
LNSALE	0.028***	−0.016***	−0.031***
	(0.004)	(0.002)	(0.001)
LNAGE	−0.024**	0.034***	0.024***
	(0.014)	(0.009)	(0.004)
CASHRATIO	0.408***	−0.256***	0.091***
	(0.044)	(0.028)	(0.016)
CAPEX_TA	−0.608***	0.055	0.658***
	(0.138)	(0.089)	(0.041)
GROWTH	0.002***	0.001***	0.002***
	(0.001)	(0.001)	(0.001)
ROA	0.019***	0.002**	−0.050***
	(0.002)	(0.001)	(0.001)
SOX2002	−0.021	0.029**	0.012**
	(0.019)	(0.012)	(0.006)
Instrumental variables			
RE_TA	0.004***	−0.004***	
	(0.000)	(0.001)	
WC_TA	−0.233***	0.023***	
	(0.003)	(0.002)	
Constant	0.131***	0.135***	0.156***
	(0.035)	(0.127)	(0.059)
Industry effects	Yes	Yes	Yes
Observations	32,304	32,304	32,304
R-squared	0.959	0.130	0.723
F-test of excluded instruments	4557.03	82.88	
P-value	0.000	0.000	
Under-identification test			
LM statistic			165.028
P-value			0.000
Weak identification test			
Cragg–Donald F statistic			55.251
Stock–Yogo critical values (5%)			13.43
Sargan statistic (Chi-sq value)			5.920
P-value			0.000

Note: *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Most of the control variables show the expected signs, except for *LNSALE*. As shown, older firms or those with more cash or higher growth opportunities tend to invest more in R&D spending. Moreover, the coefficient of *SOX2002* is positive and statistically significant, revealing that firms invest more in R&D investment after the SOX was implemented in 2002.

3.3. Multivariate difference-in-differences analysis

It is examined whether the enactment of SOX in 2002 affects the relationships between the types of debt financing and R&D investment. After adding the interaction of $SOX2002 \cdot BANKDEBT\_TA$ and $SOX2002 \cdot PUBLICDEBT\_TA$ into

equation (1), bank debt is positively related to firm R&D investment as confirmed in column (1) of Table 4. The coefficient is significant and even higher compared to that in Table 3. Interestingly, the interaction of *SOX*2002 and public debt over the post-SOX period turns out to be significantly positive, but the interaction of *SOX*2002 and bank debt becomes negative. These findings imply that while the SOX regulates businesses to disclose accurate and complete information, the advantages of banks disappear. Instead, public debt benefits more and becomes a good debt financing arrangement after *SOX*.

These results are interpreted as indicative of less information asymmetry between firms and creditors over the post-SOX period. Pre-SOX, public creditors did not prefer to finance firms with high information asymmetry as they were at a disadvantage relative to the banks that could access inside information on borrowing firms (Fama, 1985). Due to the increase of information transparency post-SOX, public creditors have become willing to provide more funds to innovative firms without too much concern about the disadvantages of the information.

Table 4 reports the DID estimation results of firm R&D investment on debt maturity structure, where the ratio of R&D expenditure to total assets (RD_TA) is a dependent variable (see equation (1)).

The effect of the enactment of SOX in 2002 is examined on the relationship between debt maturity structure and R&D investment by adding the interaction terms of $SOX\,2002 \cdot BANKDEBT\_TA$ and $SOX\,2002 \cdot PUBLICDEBT\_TA$ into equation (1). Column (1) reports the results of the second-stage 2SLS estimation. The effect of the enactment the SOX is further re-examined by adding the interaction terms into equation (1). The results are presented in column (2). *ACCELERATED_FILER* is a dummy variable which equals one if it is an accelerated filer to comply to the SOX (firm with market value of equity larger than $75 million), and zero otherwise. *SOX2002* is a dummy variable which equals one if the year is after the SOX in 2002, and zero otherwise (see Table 1a for the variable definitions). The standard errors of estimated coefficients are clustered by firm and displayed in parentheses.

To confirm the robustness of the findings, the impact of the enactment of the *SOX* in 2002 is re-examined to avoid the confounding effects in the results. Accordingly, the DID robustness test is employed. It was first necessary to identify a control group that is not affected by *SOX*2002. Although the implementation of *SOX*2002 was mandatory, the Securities and Exchange Commission allowed small (market values of equity under $75 million) firms to have more time to comply with the Act (Abdioglu et al., 2013). Hence, for the control group, any change is not expected between R&D investment and debt structure after the enactment of the SOX. The treatment group is an accelerated filer which includes companies with market value of equity higher than $75 million. A dummy variable (*ACCELERATED_FILER*) is created which equals one if a firm is classified as an accelerated filer, and zero otherwise.

Column (2) of Table 4 reports the DID estimation results. *SOX2002* and *ACCELERATED_FILER* are interacted with *BANKDEBT_TA* and *PUBLICDEBT_TA*, resulting in the following interacted terms, *SOX2002 ·ACCELERATED_FILER · ·BANKDEBT_TA* and *SOX2002 ·ACCELERATED_FILER ·PUBLICDEBT_TA*.

It is expected that the relationships among R&D investment, bank debt, and public debt are more pronounced for the treatment group over the post-SOX period. The positive and significant coefficient of *SOX2002 ·ACCELERATED_FILER · ·BANKDEBT_TA* addresses the marginal effect of *SOX2002* on the BANKDEBT-RD relation for accelerated filers. Similar results are also found with PUBLICDEBT-RD relation for accelerated filers. The outcomes support the argument that the enactment of the SOX mitigates the information asymmetry.

Table 5 reports the DID estimation summary for a time comparison before and after the enactment of the SOX between the accelerated filer and non-accelerated filer groups. For the control group, results support the authors expectation that the signs of bank debt and public debt remain unchanged after the SOX enactment. For the treatment group, the DID results are higher for public debt compared to bank debt in the accelerated filer. Therefore, public creditors obtain more benefit from the enactment of the SOX than the

Table 4. Multivariate difference-in-differences analysis and robustness checks

Variables	(1) RD_TA	(2) RD_TA
BANKDEBT_TA	0.208**	0.205***
	(0.088)	(0.075)
PUBLICDEBT_TA	–1.12***	–2.01***
	(12.06)	(9.341)
Interaction terms		
SOX 2002 · BANKDEBT	–0.162**	–0.163**
	(0.077)	(0.066)
SOX 2002 · PUBLICDEBT	1.09***	0.143***
	(12.05)	(9.323)
ACCELERATED _ FILER · BANKDEBT _ TA		0.876**
		(1.203)
ACCELERATED _ FILER · PUBLICDEBT _ TA		1.32***
		(8.093)
SOX 2002 · ACCELERATED _ FILER · BANKDEBT _ TA		0.757**
		(1.562)
SOX 2002 · ACCELERATED _ FILER · PUBLICDEBT _ TA		0.512***
		(7.747)
Control variables		
LNSALE	–0.034	–0.111***
	(0.022)	(0.033)
LNAGE	0.302**	0.117*
	(0.127)	(0.064)
CASHRATIO	2.353**	1.446***
	(0.977)	(0.549)
CAPEX_TA	2.648***	2.146***
	(1.025)	(0.750)
GROWTH	–0.002	–0.001
	(0.002)	(0.001)
ROA	–0.022	–0.017
	(0.019)	(0.017)
SOX2002	0.415**	0.175***
	(1.718)	(0.732)
Constant	4.349**	3.244**
	(1.887)	(1.305)
Industry effects	Yes	Yes
Observations	32,304	32,304
R-squared	0.560	0.480

Note: *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

banks. The DID tests further indicate that following the SOX enactment, the effect of public debt on R&D investment for firms in the accelerated filer increased relatively more than for those in a non-accelerated filer group. Therefore, public debt is significantly negatively related to R&D investment, and this relation is significantly affected by the enactment of the SOX. On the contrary, bank debt has a consistently positive impact on R&D investment, and the magnitudes are robust over the DID model specifications and controls.

Table 5. Difference-in-differences estimation summary

Variables		RD_TA		
		PRE-*SOX2002*	POST-*SOX2002*	DIFFERENCE
BANKDEBT_TA	Accelerated filer	1.081	1.675	0.594***
	Non-accelerated filer	0.205	0.042	−0.163***
	Difference	0.876	1.633	0.757***
PUBLICDEBT_TA	Accelerated filer	−0.69	−0.035	0.655***
	Non-accelerated filer	−2.01	−1.867	0.143***
	Difference	1.32	1.832	0.512***

Note: *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

CONCLUSION

Using a 2SLS approach and multivariate difference-in-differences analysis for a large sample of US firms, several interesting results are obtained.

A positive relationship exists between R&D investment and bank debt use, but an inverse impact on R&D investment occurs in the presence of public debt. One possible explanation is that although the R&D projects prefer information confidentiality, innovative firms avoid public debt use to reduce high information disclosure cost. Instead, bank debt becomes the better choice due to private information advantages. Moreover, firms with high R&D investment could easily borrow funds from banks with lower spreads or better nonprice loan terms. Bank lending also fosters R&D investment. These findings are robust after conducting the DID tests.

The SOX regulates businesses to disclose accurate and complete information, but the advantages from banks are reduced. Instead, the post-SOX is good for public debt financing. In addition, although the enactment of the SOX significantly mitigates the asymmetric information, such effect is for large firms only, the asymmetry remains unchanged for small corporations.

Finally, it is shown that old firms, firms with more cash, or those with higher growth opportunities invest significantly higher spending on R&D. Overall, the findings shed more light on the effect of debt maturity structure on substantial innovative investment. More importantly, it helps explain the role of corporate debt and bank loans in financing and monitoring corporate R&D investment for long-term economic growth in the US.

REFERENCES

1. Abdioglu, N., Khurshed, A., & Stathopoulos, K. (2013). Firm innovation and institutional investment: the role of the Sarbanes-Oxley Act. *The European Journal of Finance, 21*(1), 71-92. http://doi.org/10.1080/1351847X.2013.769890

2. Aboody, D., & Baruch, L. (2000). Information asymmetry, R&D, and insider gains. *Journal of Finance, 55*(6), 2747-2766. http://doi.org/10.1111/0022-1082.00305

3. Aghion, P., Bond, S., Klemm, A., & Marinescu, I. (2004). Technology and Financial Structure: Are Innovative Firms Different? *Journal of the European Economic Association, 2*(2-3), 277-288. https://doi.org/10.1162/154247604323067989

4. Aivazian, V. A., Ge, Y., & Qiu, J. (2005). The impact of leverage on firm investment: Canadian evidence. *Journal of Corporate Finance, 11*(1-2), 277-291. https://doi.org/10.1016/s0929-1199(03)00062-2

5. Alfonso, E., & Giannangeli, S. (2012). Outsourcing innovation and the role of bank debt for SMEs. *UniCredit Best Paper Award, (May),* 1-19. Retrieved from https://ru.scribd.com/document/192719774/D-Alfonso-Giannangeli

6. Amore, M. D., Schneider, C., & Žaldokas, A. (2013). Credit supply and corporate innovation. *Journal of Financial Economics, 109*(3), 835-855. https://doi.org/10.1016/j.jfineco.2013.04.006

7. Atiyet, B. A. (2012). The Pecking Order Theory and the Static Trade Off Theory: Comparison of the Alternative Explanatory Power in French Firms. *Journal of Business Studies Quaterly, 4*(1), 1-14. Retrieved from https://pdfs.semanticscholar.org/8e2f/fe9e9d9d3aa04f42a0f466fc096c0bb35efe.pdf?_ga=2.50769386.296474506.154-0301679-2122963630.1540301679

8. Bergemann, D., & Hege, U. (2005). The Financing of Innovation: Learning and Stopping. *Rand Journal of Economics, 36*(4), 719-752. Retrieved from https://cpb-us-w2.wpmucdn.com/campuspress.yale.edu/dist/3/352/files/2011/01/Paper13_p1176.pdf

9. Bhagat, S., & Welch, I. (1995). Corporate research & development investments international comparisons. *Journal of Accounting and Economics, 19*(2-3), 443-470. https://doi.org/10.1016/0165-4101(94)00391-h

10. Boot, A. W. A. (2000). Relationship Banking: What Do We Know? *Journal of Financial Intermediation, 9,* 7-25. http://doi.org/10.1006/jfin.2000.0282

11. Bushee, B. J. (1998). The Influence of Institutional Investors on Myopic R&D Investment Behavior. *The Accounting Review, 73*(3), 305-333. Retrieved from https://www.jstor.org/stable/248542

12. Calomiris, C. & Kahn, C. (1991). The Role of Demandable Debt in Structuring Optimal Banking Arrangements. *American Economic Review, 81*(3), 497-513. Retrieved from https://pdfs.semanticscholar.org/952a/989840fd02d17857cde9ab3179b85b02d044.pdf

13. Chang, S., Li, Y., & Gao, F. (2016). The impact of delaying an investment decision on R&D projects in real option game. *Chaos, Solitons and Fractals, 87,* 182-189. http://doi.org/10.1016/j.chaos.2016.03.035

14. Chemmanur, T., & Fulghieri, P. (1994). Reputation, renegotiation, and the choice between bank loans and publicly traded debt. *Review of Financial Studies, 7*(3), 475-506. http://doi.org/10.1093/rfs/7.3.475

15. Chi, W., Huang, H., & Xie, H. (2015). A quantile regression analysis on corporate governance and the cost of bank loans: A research note. *Review of Accounting and Finance, 14*(1), 2-19. http://doi.org/10.1108/RAF-12-2012-0126

16. Choi, J., Hackbarth, D., & Zechner, J. (2018). Corporate debt maturity profiles. *Journal of Financial Economics, 130*(2), 1-19. http://doi.org/10.1016/j.jfineco.2018.07.009

17. Cleary, S. (1999). The relationship between firm investment and financial status. *The Journal of Finance, 54*(2), 673-692. https://doi.org/10.1111/0022-1082.00121

18. Cohen, W. M., & Klepper, S. (1996). Firm Size and the Nature of Innovation within Industries: The Case of Process and Product R&D. *The Review of Economics and Statistics, 78*(2), 232-243. http://doi.org/10.2307/2109925

19. Cornaggia, J., Mao, Y., Tian, X., & Wolfe, B. (2015). Does banking competition affect innovation? *Journal of Financial Economics, 115*(1), 189-209. https://doi.org/10.1016/j.jfineco.2014.09.001

20. Craig, J., & Dibrell, C. (2006). The natural environment, innovation, and firm performance: A comparative study. *Family Business Review, 19*(4), 275-288. https://doi.org/10.1111/j.1741-6248.2006.00075.x

21. Czarnitzki, D., & Kraft, K. (2009). Capital control, debt financing and innovative activity. *Journal of Economic Behavior and Organization, 71*(2), 372-383. https://doi.org/10.1016/j.jebo.2009.03.017

22. Diamond, D. (1984). Financial intermediation and delegated monitoring. *Review of Economic Studies, 51*(3), 393-414. http://doi.org/10.2307/2297430

23. Diamond, D. (1991). Monitoring and Reputation: The Choice between Bank Loans and Directly Placed Debt. *Journal of Political Economy, 99*(4), 689-721. http://doi.org/10.1086/261775

24. Engel, E., Hayes, R. M., & Wang, X. (2007). The Sarbanes-Oxley Act and firms' going-private decisions. *Journal of Accounting and Economics, 44*(1-2), 116-145. https://doi.org/10.1016/j.jacceco.2006.07.002

25. Fama, E. F. (1980). Agency Problems and the Theory of the Firm. *Journal of Political Economy, 88*(2), 288-307. https://doi.org/10.1086/260866

26. Fama, E. F. (1985). What's different about banks? *Journal of Monetary Economics, 15*(1), 29-39. https://doi.org/10.1016/0304-3932(85)90051-0

27. Fang, V. W., Tian, X., & Tice, S. (2014). Does stock liquidity enhance or impede firm innovation? *Journal of Finance, 69*(5), 2085-2125. https://doi.org/10.1111/jofi.12187

28. Firth, M., Lin, C., & Wong, S. M. L. (2008). Leverage and investment under a state-owned bank lending environment: Evidence from China. *Journal of Corporate Finance, 14*(5), 642-653. http://doi.org/10.1016/j.jcorpfin.2008.08.002

29. Foss, N., & Stea, D. (2014). Putting a realistic theory of mind into agency theory: Implications for reward design and management in principal-agent relations. *European Management Review, 11*(1), 101-116. http://doi.org/10.1111/emre.12026

30. Gomariz, M. F. C., & Ballesta, J. P. S. (2014). Financial reporting quality, debt maturity and investment efficiency. *Journal of Banking and Finance, 40,* 494-506. http://doi.org/10.1016/j.jbankfin.2013.07.013

31. Graves, S. B., & Waddock, S. A. (1990). Institutional Ownership and Control: Implications for Long-Term Corporate Strategy. *Academy of Management, 4*(1), 75-83. Retrieved from http://www.jstor.org/stable/4164935

32. Gu, Y., Mao, C. X., & Tian, X. (2013). Bank Interventions and Firm Innovation: Evidence from Debt Covenant Violations. https://doi.org/10.2139/ssrn.2329007

33. Hausman, J. A. (1978). Specification Test in Econometrics. *Econometrica, 46*(6), 1251-1271. Retrieved from http://www.jstor.org/stable/1913827

34. Hitt, M. A., Ireland, R. D., Harrison, J. S., & Hoskisson, R. E. (1991). Effects of Acquisitions on R&D Inputs and Outputs. *Academy of Management Journal, 34*(3), 693-706. https://doi.org/10.5465/256412

35. Hurley, R. F., & Hult, G. T. M. (1998). Innovation, Market Orientation, and Organizational Learning: An Integration and Empirical Examination. *Journal of Marketing, 62*(3), 42-54. http://doi.org/10.2307/1251742

36. Jensen, M. C., & Jensen, B. M. C. (1986). Agency costs of free cash flow, corporate finance, and takeovers. *American Economic Review, 76*(2), 323-329. http://doi.org/10.2139/ssrn.99580

37. Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics, 3*(4), 305-360. http://doi.org/10.1016/0304-405X(76)90026-X

38. Jiménez, G., & Saurina, J. (2004). Collateral, type of lender and relationship banking as determinants of credit risk. *Journal of Banking and Finance, 28*(9), 2191-2212. http://doi.org/10.1016/j.jbankfin.2003.09.002

39. Kamien, M. I., & Schwartz, N. L. (1978). Self-Financing of an R&D Project. *American Economic Review, 68*(3), 252. Retrieved from https://www.jstor.org/stable/1805258

40. Lambrecht, B. M., & Myers, S. C. (2008). Debt and managerial rents in a real-options model of the firm. *Journal of Financial Economics, 89*(2), 209-23. http://doi.org/10.1016/j.jfineco.2007.07.007

41. Lin, C., Ma, Y., Malatesta, P., & Xuan, Y. (2013). Corporate ownership structure and the choice between bank debt and public debt. *Journal of Financial Economics, 109*(2), 517-534. https://doi.org/10.1016/j.jfineco.2013.03.006

42. McConnell, J. J., & Servaes, H. (1995). Equity ownership and the two faces of debt. *Journal of Financial Economics, 39*(1), 131-157. https://doi.org/10.1016/0304-405X(95)00824-X

43. Modigliani, F., & Miller, M. H. (1958). The Cost of Capital, Corporation Finance and the Theory of Investment. *American Economic Review, 48*(3), 261-297. Retrieved from http://lib.cufe.edu.cn/upload_files/other/3_20140507105115_01.pdf

44. Modigliani, F., & Miller, M. H. (1963). Corporate Income Taxes and the Cost of Capital: A Correction. *The American Economic Review, 53*(3), 433-443. Retrieved from https://www.jstor.org/stable/1809167

45. Naciri, A. (2009). *Internal and External Aspects of Corporate Governance.* London: Routledge. http://doi.org/10.4324/9780203865293

46. Nofsinger, J. R., & Wang, W. (2011). Determinants of start-up firm external financing worldwide. *Journal of Banking and Finance, 35*(9), 2282-2294. http://doi.org/10.1016/j.jbankfin.2011.01.024

47. O'Sullivan, M. (2000). The innovative enterprise and corporate governance. *Cambridge Journal of Economics, 24*, 393-416. Retrieved from https://www.jstor.org/stable/23600462

48. Woodside, A. G. (2005). Firm orientations, innovativeness, and business performance: Advancing a system dynamics view following a comment on Hult, Hurley, and Knight's 2004 study. *Industrial Marketing Management, 34*(3), 275-279. http://doi.org/10.1016/j.indmarman.2004.10.001

49. Wruck, K. H. (1994). Financial policy, internal control, and performance Sealed Air Corporation's leveraged special dividend. *Journal of Financial Economics, 36*(2), 157-192. http://doi.org/10.1016/0304-405X(94)90023-X

50. Yosha, O. (1995). Information Disclosure Costs and the Choice of Financing Source. *Journal of Financial Intermediation, 4*(1), 3-20. http://doi.org/10.1006/jfin.1995.1001

51. Zahra, S. A., & Covin, J. G. (1995). Contextual influences on the corporate entrepreneurship-performance relationship: A longitudinal analysis. *Journal of Business Venturing, 10*(1), 43-58. http://doi.org/10.1016/0883-9026(94)00004-E

APPENDIX

Table 1a. Definition of variables

Variable name	Variable label	Definition
Measures of R&D investment		
R&D investment	*RD_TA*	Ratio of R&D expenditure to the total assets
Measures of debt maturity structure		
Bank debt	*BANKDEBT_TA*	Ratio of the amount of borrowing from banks to the total assets
Public debt	*PUBLICDEBT_TA*	Ratio of corporate bonds and commercial paper to the total assets
Firm characteristics variables		
Firm size	*LNSALE*	Logarithm of the total sale
Firm age	*LNAGE*	Logarithm of one plus the number of years as a publicly listed company
Cash ratio	*CASHRATIO*	Total cash divided by the total assets
Capital expenditure	*CAPEX_TA*	Capital expenditure divided by the total assets
Firm performance	*ROA*	Net income divided by the total assets
Growth opportunity	*GROWTH*	Market value of equity plus the book value of debt divided by the total assets
Firm leverage	*LEVERAGE*	Book value of the firm's debt divided by the total assets
Working capital	*WC_TA*	Working capital divided by the total assets
Retained earnings	*RE_TA*	Retained earnings divided by the total assets
Industry dummies	*INDUSTRY_D*	Industry dummies, classified by SIC codes
SOX event	*SOX2002*	SOX2002 = 1 if the year is after the Sarbanes-Oxley Act in 2002, and 0 otherwise
Accelerated filers	*ACCELERATED_FILER*	ACCELERATED_FILER = 1 if the firm is an accelerated filer to comply with the SOX (firm with a market value of equity higher than $75 million), and 0 otherwise