How does leverage affect R&D intensity and how does R&D intensity impact on firm value in South Korea?*

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Abstract.

We examine how leverage affects corporate research and development (R&D) intensity, as well as examine the impact of R&D on firm value in South Korea, a country in which corporate-funded R&D intensity is one of the highest in the world. Among our main results, we find that growth opportunities have a positive effect on R&D intensity, while leverage has a negative effect on R&D intensity. When leverage is at an extremely high level, the relationship between growth opportunities and R&D intensity turns from positive to negative. Using instrumental variables we find that R&D generates an increase in firm value.

Key words: firm value; R&D; leverage, South Korea.

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I Introduction

South Korea (hereafter Korea), as a late industrialised country, is one of the few nations that has successfully transformed from imitator to innovator (Amsden, 1992). Korea has a very high level of investment in R&D. Korea's R&D expenditure-to-GDP ratio in 2012 was 4.36 per cent, which was the second highest in the world after Israel (Korea Ministry of Science, 2013). The Bloomberg Rankings in 2014 placed Korea first in the world in terms of level of innovative activities and third in the world in terms of R&D intensity.[1] Korea's total R&D expenditure in 2012 was 55,450.1 billion won (equivalent to $US49.2 billion), an 11.1 percent increase on a year earlier, indicating that Korea successfully expanded its R&D investment, despite facing difficult economic conditions (Korea Ministry of Science, 2013).

As a result of the high level of investment in innovation, many Korean brands have established global reputations. According to Interbrand's list of the Best Global Brands, Samsung Electronics was ranked as one of the top 10 global brands in 2012 (Kim, 2013). According to Interbrand, other Korean firms ranked in the world's top 100 firms in terms of brand name recognition were Hyundai Motors and Kia Motors. Notably, the Interbrand report found that brand value for all three of these companies went up by more than 15 per cent from the previous year, indicating that the brand value of Korean companies is growing rapidly. In addition, in a survey released by the Nikkei, Japan's leading economic newspaper, Korean companies ranked third overall in terms of global market share for 50 categories of major goods and services in 2012 with Korean companies coming out top in terms of global market share for eight of the major goods and services surveyed (Kim, 2013).

[1] See http://www.bloomberg.com/rank

In contrast to many other countries, Korea's R&D intensity is largely driven by corporations (Korea Ministry of Science, 2013). Corporations spent 43,222.9 billion won in 2012, representing 77.9 per cent of total R&D investment, compared to public research institutions and universities, which spent 6,950.3 billion won (12.5 per cent) and 5,276.9 billion won (9.5 per cent) on R&D, respectively. The corporate sector's share of total R&D expenditure (77.9 per cent) matched, or surpassed, that in the major G7 countries such as the United States (US) (68.3 per cent), Japan (77.0 per cent), and Germany (67.3 per cent) (Kim, 2013).

That the corporate sector's share of total R&D expenditure in an innovative economy such as Korea is so high poses two interesting questions that we address in this study. The first is what is the relationship between leverage and R&D investment and to what extent is the effect of growth opportunities on R&D investment moderated by leverage? The incentive for family business is to leverage to finance growth and build business empires. This is because equity financing dilutes family ownership, which aggravates principal agent problems (Young *et al.*, 2008). Leverage is also important in understanding business group strategies (Khanna and Yafeh, 2007). How does leverage affect R&D intensity? Schmookler (1966) argued that growth opportunities are an important determinant of R&D intensity. Does leverage moderate the effect of growth opportunities on R&D intensity?

The second question we address in this study is do company level R&D activities increase firm value? This is important because decisions on where to invest, including whether to invest in R&D, should ultimately be based on their impact on firm value. Existing studies focus on the impact of R&D on exports (Wakelin, 1998; Aw *et al.*, 2011), economic growth and spill over effects (Brautzsch *et al.*, 2015; Cassiman and Veugelers, 2002; Frantzen, 2000;

Scherer, 1982) or productivity (Griliches, 1979, 1998). Several studies have examined the impact of R&D on firm value in the US (see eg. Jaffe, 1986 and Pakes, 1985). There are, however, few, such studies for Asia (Xu and Zhang, 2004 is an exception).

With respect to examining the effect of R&D intensity on firm value we use stock returns to measure firm value. The advantage of using stock returns, vis-à-vis using profits or productivity as in Jaffe (1986) and Belenzon and Berkovitz (2010), is that it captures change in the market value of the firm instantly. As such, using stock returns minimises noise in the estimates. Endogeneity is an issue when attempting to establish a causal relationship between R&D intensity and firm value (Harris and Li, 2008; Ito and Lechevalier, 2010). In contrast to existing studies, which largely focus on export outcomes using instruments from inside of the system estimation, we employ two-stage least squares (2SLS) estimation, focusing on firm value after carefully identifying the instruments in the first stage estimation.

II. Hypotheses

We begin with the relationship between debt financing and R&D intensity. We expect debt financing to be inversely related to R&D intensity for several reasons. First, transaction cost theories of the firm propose that whether a project should be financed by debt or equity depends on the degree of asset specificity. Equity funding will be preferable to debt financing where asset specificity is high, such as with R&D investment (Williamson, 1988). Second, debt financing reduces free cash flows, forcing managers to act in the best interests of stockholders (Jensen, 1986). This may limit the ability of mangers to invest in excess in R&D, particularly if this does not generate immediate returns for stockholders (Galende Del Canto & Suarez-Gonzalez, 1999). Third, external sources of capital impose demands for information. Firms may be reluctant to provide such information with respect to their R&D

activities because it may result in the loss of control over its innovative activities. Hence, investment in R&D may be inhibited (Galende Del Canto & Suarez-Gonzalez, 1999). These considerations suggest the following hypothesis that we test in this study:

H1: Leverage has an inverse relationship with R&D intensity.

Schmookler's (1966) demand-pull hypothesis contends that market demand plays an important role in the magnitude of R&D investment. The demand-pull hypothesis posits that growth opportunities "call forth" an innovation (Mowery and Rosenberg, 1979). In other words, growth opportunities for a firm create potential demand for a product and this provides firms with the incentive to invest in R&D to develop, and streamline, those products. The larger the potential growth opportunities, the higher the potential profits from developing the product and, hence, the greater the incentive to invest in R&D. Hence, R&D intensity can be expected to be higher in firms with more growth opportunities. While the demand-pull hypothesis has been criticised (see Mowery and Rosenberg, 1979), it has received empirical support in studies using US data (see eg. Scherer, 1982). Our second hypothesis is that leverage will moderate the relationship between growth opportunities for the firm and R&D intensity. Specifically, if a firm debt finances its growth opportunities the effect of potential growth opportunities on R&D intensity will be attentuated by leveraging.

H2: The positive relationship between growth opportunities and R&D intensity will be moderated by leverage, such that it will be smaller in debt-financed firms.

Investment in R&D represents an activity that can increase the value of a firm's intangible assets. The market value of a firm represents the market valuation of expected future profit streams generated from investment in R&D. These, in turn, are based on an assessment of the market return to the firm's tangible and intangible assets. While not all investments in R&D generate profits (Jensen, 1993), on average, any investment in a firm's intangible assets should be expected to increase the firm's market value (Bosworth & Rogers, 2001). This leads us to our third hypothesis:

H3: There is a positive relationship between R&D intensity and firm value

III. Model

Our strategy consists of first- and second-stage estimation. The first-stage is to identify factors affecting R&D intensity. This entails regressing R&D intensity on growth opportunities, leverage, growth opportunities interacted with leverage and control variables for other determinants of R&D intensity that are commonly employed in the literature. The second-stage is to examine the impact of this estimated R&D intensity on firm value, which is measured by stock returns. R&D intensity in the second-stage estimation is a covariate which is endogenously determined in the first-stage. As such, we need to use 2SLS, which uses the determinants of R&D intensity as instrumental variables.

In the first stage we use a fixed effects model to address estimation bias associated with omitted variables. Macroeconomic variables affect all firms (*i*) irrespective of industries. Thus, we consider the following fixed effects model, which includes time effects, θ_t. Time effects, θ_t, are denoted by a series of binary variables. In the results reported below we drop θ_1 to avoid multicollinearity with the constant α. This can be denoted as follows:

$$Y_{it} = \alpha + \beta_1 x_{1,it} + \beta_2 x_{2,it} + \ldots.. + \beta_k x_{k,it} + \theta_t + \varepsilon_{it} \qquad (1)$$

R&D intensity can vary at the industry (*j*) level (Cohen and Klepper, 1992; Pavitt, 1984). Thus, identification based on the average of two industries has little meaning. As such, we consider the following extended model to control for variations due to industries. The identification of coefficients in Equation (2) is based on variation within an industry. This is because the variation across firms is controlled for in the estimation.

$$Y_{ijt} = \alpha + \beta_1 x_{1,it} + \beta_2 x_{2,it} + ... + \beta_k x_{k,it} + \theta_t + \phi_j + \varepsilon_{it} \quad (2)$$

We include industries at the Korea Standard Industry Classification at 2-digit level. This classifies all listed firms into thirteen industries where firms are relatively equally distributed. Equation (2) controls for time-invariant industry-specific fixed effects. However, the remaining concern is time-variant industry-specific fixed effects. An industry can enjoy an upward swing in a given year, which other industries do not. If this occurs, firms in this specific industry may increase R&D intensity more than firms in other industries. In Equation (3) we also include industry-year effects ($\theta \times \phi_{jt}$) to address this issue.

$$Y_{ijt} = \alpha + \beta_1 x_{1,it} + \beta_2 x_{2,it} + ... + \beta_k x_{k,it} + \theta_t + \phi_j + \theta \times \phi_{jt} + \varepsilon_{ijt} \quad (3)$$

Equation (3) includes second-order industry-fixed effects in addition to the primary industry-fixed effects in Equation (2). In estimates reported below, we added a vector of interaction variables between time-effects and the industry variable. All standard errors (p-values) in our estimates are also robust against auto-correlation at the firm level.

Armed with the identified determinants of the R&D intensity from Equations (1)-(3), we use 2SLS to examine the impact of R&D intensity on firm value (R_{ijt}).

$$R_{ijt} = const + \delta_1 \hat{Y}_{ijt} + \sum_{i=2} Others_{it} + \theta_t + \psi_j + \theta \times \psi_{jt} + \xi_{ijt} \quad (4)$$

$\hat{Y}_{ijt}$ in Equation (4) is the estimated variable from Equations (1) - (3). As such, the variable is endogenous and the standard error of the variable estimated by ordinary least squares (OLS) will be biased. To address endogeneity, we use 2SLS using excluded instruments identified by Equations (1) - (3). Standard errors are robust against auto-correlation at the firm level.

IV. Data

Our sample consists of a panel of all firms listed on the Korea Stock Exchange between 2007 and 2012 obtained from three different sources. Data on executive compensation and outside directors are from the reports on the Electronic Disclosure System (DART). All other firm characteristics except stock return are obtained from the KIS-Value database for Korea. Stock return is obtained from the Korea Listed Company Association (KLCA) by averaging monthly compounded share price. We censored all continuous variables at the 1st and 99th percentiles to eliminate extreme values. As a result, we have 3,403 firm-year observations for 606 distinct firms.

Table 1 defines each of the variables and presents the main descriptive statistics for each. Our main variable is R&D intensity. It is calculated by expressing R&D investment as a percentage of firm assets. Its mean (median) value is 0.6 (0.03) with standard deviation of 1.36. The maximum value of R&D intensity is 10.34 percent of total asset value. R&D intensity varies depending on the specific industry. The electronics industry, which includes Samsung Electronics, has the largest R&D intensity in Korea. It is to allow for this feature of the data that we included industry and year-industry effects in our model.

Growth opportunities are proxied by the market price of equity divided by the book value of equity (i.e., the price to book ratio). The mean (median) value is 1.11 (0.78) which means that the average stock price of our sample is slightly overvalued (undervalued) compared to the reference value of unity. However, it is not desirable to compare directly firms with large R&D intensity with firms with long-term fixed assets. This is because firms with large long-term fixed assets tend to exhibit big differences between book and market values. Again, this is another reason why we include industry and year-industry effects in our model. Leverage is defined as total debts divided by total assets. Payment to the board is defined as the average payment to registered board member divided by total assets.

Table 1. Summary statistics

V. Results

Table 2 examines the relationship between leveraging and R&D intensity. In specifications (1) to (6), firm leveraging has a negative sign and is statistically significant, consistent with hypothesis 1. The average of the estimated coefficient of leverage for Models 1-6 is -0.60. That is, a one standard deviation increase in leverage decreases R&D intensity by 0.118, which is 20 percent of average R&D intensity. This indicates that the leverage effect is both statistically and economically significant. To test the second hypothesis, we interacted leverage and growth opportunity (i.e., growth x leverage). The negative sign on the interaction term in specifications 7-9 indicate that the positive effect of growth opportunity on R&D intensity is attenuated by leverage. To illustrate the magnitudes, results in the final specification indicate that a one standard deviation increase in leverage attenuates the positive effect of growth opportunities on R&D intensity by 27 per cent, consistent with H2.

Table 2. Leverage effects on R&D intensity

To examine our second hypothesis further, we split our sample into quartile-basis subsamples based on the leverage variable. We then generate four binary variables indicating each interval of the sub-samples. Leverage25 (leverage2550) refers to a binary variable equal to unity if a firm belongs to the 25 percentile (low quartile) and zero otherwise. In the same way, leverage5075 and leverage75 indicates that a firm belongs to the third and fourth quartile respectively. Then, we generated four interaction terms between these binary variables and growth opportunity. This allows us to examine any potential non-linearities.

The results in column 1 in Table 3 are the same as the results in column 9 in Table 2, in order to facilitate comparison. The results in columns 2-5 in Table 3 indicate that only growth x leverage75 is negative and statistically significant. That is, the estimated coefficients in model 5 imply that a one standard deviation increase in leverage attenuates the positive effect of growth opportunities on R&D intensity by around 20 percent. The signs on the other interaction variables shown in columns 2-4 are positive, but not statistically significant. These findings suggest that at an extreme level of leverage, the relationship between growth opportunities and R&D intensity turns from being positive into negative.

Table 3. Non-linear effects of leverage on R&D intensity

Figure 1 shows the moderated effect of growth opportunity on R&D intensity by leverage. Estimated coefficients from Table 3 (Model 1 and Model 5) are used to calculate the changing marginal effects of growth opportunity on R&D intensity when leverage increases. Firstly, it confirms that the positive effect of growth opportunity on R&D intensity is attenuated when firm's leverage increases both for the average firm (Model 1) and highly leveraged firms (Model 5). Secondly, the magnitude of attenuation of highly leveraged firms is smaller than that of average firms. This implies a version of diminishing marginal returns for leverage, diluting the positive effect of growth opportunities on R&D intensity. This finding is consistent with our calculation of the attenuation effect of leverage above: 20 percent for high quartile sub-groups versus 27 percent for all (average) firms.

Figure 1: Moderating effect of leverage on the growth opportunity/R&D intensity relationship

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Next, we employed 2SLS to examine the impact of R&D intensity on stock returns. The results are reported in Table 4. Excluded instruments are the major explanatory variables to determine R&D intensity in Tables 2-3, which are reported as the first-stage on the lower panel of Table 4. The p-values of the estimated coefficients, R-squared, and F-values illustrates that the instruments are valid. The upper panel of Table 4 reports that the impact of R&D intensity on stock returns is positive and significant, irrespective of model specification (Models 1-4) and different sub-samples (Models 5-8) consistent with hypothesis three.

The results indicate marginal effects of R&D intensity on stock returns range between 7 percent and 16.7 percent. The marginal effects of R&D intensity on stock returns for chaebols (Models 5 and 7) are slightly greater than non-chaebols (Models 6 and 8), albeit statistical significance dropped. In model (2) we controlled for foreign equity ownership, but the sign of the coefficient was somewhat counter-intuitive. As such, we replaced lagged foreign ownership with one-period leading foreign ownership in models 3 and 4 (and 5 and 6). The negative sign in model 3 implies foreign investors reduced their ownership in firms which had a positive stock return in the previous period. This may imply foreign investors in Korea are myopic, rather than pursuing fundamental analysis using a buy and hold strategy. The coefficient on R&D intensity is consistently positive and significant throughout.

Table 4. 2SLS Estimates of the Impact of R&D intensity on stock returns

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VI. Discussion

Our results suggest that the role of leverage to affect R&D intensity can be complex in an economy where firms experienced financial crisis. The results reported in Table 2 are consistent with our first hypothesis and findings for other countries (see eg. Galende Del Canto & Suarez-Gonzalez, 1999; Honore *et al.,* 2015; Singh & Faircloth, 2005, among others). The negative sign on leverage, none the less, may appear to be counter-intuitive in that more borrowings means a relaxation of financial constraint whereby increase in R&D intensity. However, most Korean firms have experienced financial distress because of the financial crisis in 1997. Debt-ridden growth strategy and absence of risk management increased vulnerability of the economy before the onset of the crisis. One of the lessons of the crisis to Korean firms learned is to recognise the importance of risk management and re-evaluation of growth strategy. Considering R&D is a risky investment, Korean firms might want to avoid debt-financing for the R&D for a better risk management. Debt-ridden growth strategy is also no longer valued high. This explains why the leverage variable attenuated the positive effects of growth opportunity on R&D intensity. Results in Table 3 illustrate that high leverage particularly attenuates the positive effects of growth opportunities. In our sample, for highly leveraged firms, the ratio of total borrowings to asset is at least 0.58.

Our third hypothesis was that there is a positive relationship between R&D intensity and firm value, where we use stock returns to measure firm value. The reasoning is that investment in R&D can increase the value of a firm's intangible assets. A firm's market value represents the market valuation of expected future profit streams generated from R&D investment, which depend on an assessment of the market return to the firm's tangible and intangible assets.

Models of stock return including the CAPM (and multifactor models) by traditional financial economists have focused solely on financial factors such as systematic risk. The rationale behind this theory is to identify expected reward for taking (systematic) risk to investors. In contrast, our focus has been on the effect of the firm's strategic decision (ie R&D investment) on firm value (ie market reactions through share prices). For this reason, our third hypothesis is more in line with neoclassical economists' view of economic fundamentals, rather than financial economist's equilibrium pricing risk taking. We find that R&D has a positive effect on R&D intensity, consistent with H3. This result is generally consistent with previous findings for the US (see eg. Cockburn & Griliches, 1988; Griliches, 1981, 1998; Pakes, 1985) and the limited evidence for elsewhere in Asia (Xu & Zhang, 2004).

VII. Conclusion

We first examined how leverage affects corporate R&D) intensity in Korea. We find that growth opportunities have a positive effect on R&D intensity, while leverage has a negative effect on R&D intensity. When leverage is at an extremely high level, the relationship between growth opportunities and R&D intensity turns from positive to negative.

Armed with the determinants of the endogenous nature of R&D intensity in the first-stage estimation, we used 2SLS to examine the impact of R&D intensity on stock returns. The 2SLS results suggest that R&D intensity increases stock returns, which, in turn, imply an increase in firm value. This finding is important given that the stock return captures expected cash flows in the future which, in turn, influences corporate strategic decisions.

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Table 1: Summary statistics

Variable	Mean	Sd	p50	p25	p75	min	max	N	Definition
R&D intensity	0.60	1.36	0.03	0	0.53	0	10.34	3403	R& D expenditure as a percentage of assets
Growth opportunity	1.11	1.05	0.78	0.5	1.29	0.14	7.25	3403	The price to book ratio =market price of equity divided by book value of equity
Leverage	0.44	0.2	0.45	0.29	0.58	0.04	0.94	3403	Debt divided by assets
Firm size	26.66	1.53	26.4	25.59	27.48	22.91	32.52	3403	Natural logarithm of assets
Board payment	1.01	1.23	0.61	0.28	1.26	0	16.06	3403	Payment to registered board members divided by assets in million.
CSH	0.43	0.16	0.43	0.31	0.53	0.06	0.89	3403	Controlling shareholder equity ownership
Operating cash flow	0.05	0.09	0.04	0	0.09	-0.31	0.53	3403	Cash flows from operations divided by assets
Foreign ownership	0.1	0.14	0.04	0.01	0.14	0	0.73	3403	Foreigner equity ownership
Audit committee	0.3	0.46	0	0	1	0	1	3403	A binary variable equal to 1 if a firm has an audit committee; zero otherwise
Outside director	0.38	0.16	0.33	0.25	0.5	0	1	3403	Outside directors divided by board members
Stock return	0.18	0.58	0.09	-0.14	0.40	-0.93	3.7	3403	Continuously compounded return based on average of monthly data

Table 2: Leverage effects on R&D intensity

	1	2	3	4	5	6	7	8	9
Growth opportunity	0.218***	0.228***	0.205***	0.204***	0.235***	0.205***	0.646***	0.634***	0.644***
	[0.002]	[0.002]	[0.004]	[0.004]	[0.001]	[0.004]	[0.004]	[0.006]	[0.004]
Leverage	-0.692***	-0.710***	-0.496**	-0.492**	-0.716***	-0.498**	0.514	0.172	0.506
	[0.004]	[0.004]	[0.049]	[0.050]	[0.004]	[0.048]	[0.134]	[0.619]	[0.141]
Growth x Leverage							-0.881***	-0.794**	-0.876***
							[0.009]	[0.023]	[0.009]
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry effects	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
Time effects	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Industry-time effects	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
_cons	1.025***	1.070***	0.563**	0.545**	1.250***	0.513**	0.013	0.780***	-0.0265
	[0.000]	[0.000]	[0.011]	[0.016]	[0.000]	[0.026]	[0.964]	[0.007]	[0.925]
$R^2\_adjusted$	0.0458	0.0463	0.118	0.118	0.0527	0.117	0.133	0.0656	0.132
N	2701	2701	2701	2701	2701	2701	2701	2701	2701

Notes: Figures in parenthesis are p-values. ***(**) (*) denotes significance at 1(5)(10) per cent. CSH refers to controlling shareholders.

Table 3: Non-linear effects of leverage on R&D intensity

	1	2	3	4	5
Growth opportunity	0.644***	0.143**	0.190***	0.142**	0.310***
	[0.004]	[0.021]	[0.006]	[0.049]	[0.003]
CSH	-0.482	-0.504	-0.544*	-0.564*	-0.512*
	[0.124]	[0.111]	[0.081]	[0.072]	[0.100]
Leverage	0.506				
	[0.141]				
Growth x Leverage	-0.87***				
	[0.009]				
leverage25		-0.195			
		[0.289]			
Growth x Leverage25		0.314			
		[0.119]			
Leverage2550			0.0495		
			[0.726]		
Growth X Leverage 2550			0.00697		
			[0.962]		
Leverage5075				-0.122	
				[0.357]	
Growth X Leverage 5075				0.155	
				[0.238]	
Leverage75					0.125
					[0.279]
Growth X Leverage75					-0.316***
					[0.002]
Industry effects	Yes	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes	Yes
Industry-time effects	Yes	Yes	Yes	Yes	Yes
_cons	-0.0265	0.292	0.283	0.347	0.221
	[0.925]	[0.126]	[0.146]	[0.076]	[0.281]
$R^2\_adjusted$	0.132	0.122	0.113	0.116	0.131
N	2701	2701	2701	2701	2701

Notes: as per Table 2.

Table 4: 2SLS Estimates of the Impact of R&D intensity on stock returns

	Unrestricted sample				Chaebol	Non-chaebol	Chaebol	Non-chaebol
	1	2	3	4	5	6	7	8
R&D intensity	0.0712*	0.135***	0.114**	0.167***	0.166**	0.143***	0.167**	0.146***
	[0.062]	[0.002]	[0.016]	[0.002]	[0.034]	[0.009]	[0.033]	[0.006]
CSH	0.149**	0.163**	0.0656	0.0727	0.132	0.0686	0.131	0.0595
	[0.040]	[0.030]	[0.417]	[0.393]	[0.404]	[0.470]	[0.408]	[0.528]
Foreign ownership		-0.298***					0.0701	-0.879***
		[0.001]					[0.801]	[0.001]
foreign_lead			-0.186*	-0.139	-0.108	-0.145	-0.171	0.677**
			[0.052]	[0.173]	[0.636]	[0.204]	[0.616]	[0.012]
Operating cash flow				-0.0314	-0.0968	-0.0087	-0.105	-0.0179
				[0.818]	[0.683]	[0.995]	[0.661]	[0.907]
Audit committee				-0.100***	-0.0535	-0.103***	-0.0556	-0.104***
				[0.002]	[0.320]	[0.006]	[0.309]	[0.006]
Outside director				0.0157	0.0111	-0.0058	0.0129	-0.011
				[0.840]	[0.936]	[0.946]	[0.926]	[0.898]
Industry effects								
Time effects								
Industry-time effects	-0.184**	-0.168**	0.365***	-0.147*	0.415**	-0.145	0.415**	-0.119
_cons	[0.013]	[0.029]	[0.000]	[0.089]	[0.034]	[0.125]	[0.034]	[0.205]
R^2 _ adjusted	0.09	0.03	0.09	0.01	0.27	0.03	0.26	0.03
N	2701	2701	2110	2110	360	1750	360	1750
First-stage estimation								
Growth opportunity	0.202***	0.198***	0.192***	0.189***	0.203***	0.207***	0.202***	0.216***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.001]	[0.000]
Firm size	0.178***	0.171***	0.190***	0.172***	0.191***	0.214***	0.189***	0.205***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.008]	[0.000]	[0.009]	[0.000]
ln(board payment)	0.168***	0.167***	0.172***	0.171***	0.012	0.226***	0.012	0.227***
	[0.000]	[0.001]	[0.000]	[0.000]	[0.846]	[0.000]	[0.859]	[0.000]
Leverage	-0.428***	-0.404***	-0.476***	-0.492***	-1.21***	-0.373**	-1.212***	-0.367**
	[0.002]	[0.005]	[0.004]	[0.003]	[0.000]	[0.05]	[0.000]	[0.045]
CSH			-0.450**	-0.437**	-0.184	-0.444**	-0.181	-0.414**
			[0.013]	[0.017]	[0.648]	[0.034]	[0.656]	[0.047]
Foreign ownership							-0.241	2.011***
							[0.717]	[0.001]
foreign_lead			-0.049	-0.031	0.052	-0.037	0.261	-1.905***
			[0.841]	[0.901]	[0.925]	[0.895]	[0.744]	[0.002]
Operating cash flow				-0.119	0.549	-0.256	0.570	-0.226
				[0.709]	[0.321]	[0.486]	[0.306]	[0.537]
Audit committee				0.162**	0.211	0.148*	0.219*	0.155*
				[0.032]	[0.112]	[0.092]	[0.100]	[0.076]
Outside director				-0.249	-0.364	-0.142	-0.367	-0.127

				[0.160]	[0.276]	[0.481]	[0.273]	[0.528]
Industry effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
_cons	-1.821***	-0.169***	-2.159***	-1.501**	-4.97***	-1.862**	-4.93***	-1.682**
	[0.000]	[0.001]	[0.000]	[0.024]	[0.001]	[0.029]	[0.001]	[0.049]
R^2 _ *adjusted*	0.132	0.132	0.132	0.133	0.426	0.129	0.379	0.138
F-value(p-value)	17.53(0.00)	16.87(0.00)	14.34(0.00)	12.97(0.00)	9.51(0.00)	9.46(0.00)	9.13(0.00)	9.58(0.00)

Notes: as per Table 3

Figure 1: Moderating effect of leverage on the growth opportunity/R&D intensity relationship