DEVELOPING A NEW RISK MANAGEMENT-HUMAN GOVERNANCE (RMHG) FRAMEWORK ON FIRM EFFICIENCY

IRENE TING WEI KIONG
MOHD RIDZUAN BIN DARUN
LEE CHIA KUANG
KWEH QIAN LONG

RESEARCH VOTE NO:
RDU1703126

Faculty of Industrial Management
Universiti Malaysia Pahang

2019

Due to some unavoidable constraints and research limitation, the project team has changed the direction and research title to How do ownership concentration and family control affect R&D investments? New evidence from Taiwan

How do ownership concentration and family control affect R&D investments? New evidence from Taiwan

Abstract

This study finds a nonlinear relationship between ownership concentration and R&D investments. Specifically, ownership concentration is positively related to R&D investments at a low level of ownership concentration; the relationship becomes negative when ownership concentration is at a high level. However, the impact of ownership concentration on R&D investments is lessened in family-controlled firms; that is, family control moderates the relationship between ownership concentration and R&D investments. Overall, this study suggests that the ownership concentration's nonlinear impact on R&D investments differs between family-controlled firms and non-family-controlled firms.

Keywords: ownership concentration; R&D investment; family control; moderating effect

CHAPTER 1: INTRODUCTION

Research and development (R&D) is vital to creating knowledge and innovation activities, which in turn generate competitive advantage for firms. Prior studies indicate that ownership concentration affects a firm's R&D investments; however, findings on the nature of this effect are inconclusive. Baysinger et al. (1991) find a positive relationship, while Zeng and Lin (2011) and Rapp and Udoieva (2016) find a negative relationship. Admati et al. (1994) indicate that an increase of ownership concentration aligns the interests of blockholders with corporate control with those of minority shareholders, while Claessens et al. (2008) argue that shareholders with concentrated ownership may pursue self-interests at the expense of minority shareholders. Thus, whether or not ownership concentration is beneficial for R&D investments depends on its level. This study calls into question the apparently intuitive conclusion of prior studies about whether or not there is a nonlinear relationship between ownership concentration and R&D investments. Since family-controlled firms tend to be more heterogeneous than non-family-controlled firms, as argued by Chrisman and Patel (2012) and Martínez and Requejo (2017), this study shows how family control moderates the relationship between ownership concentration and R&D investments.

After addressing the endogeneity issue of ownership concentration based on Lee and O'Neill (2003) and Chen et al. (2014), our empirical results indicate that R&D investments increase along with ownership concentration up to a critical point, after which the relationship turns negative. Admati et al. (1994) find that blockholders with concentrated ownership may make long-term-oriented decisions, which may explain the positive relationship at a low level of ownership concentration. When ownership concentration is high, however, our result suggests that firms are more reluctant to make R&D investments. This result is consistent with the argument of Dilling-Hansen et al. (2003) and La Porta et al. (2000) that blockholders become risk-averse due to self-interests once a mass of blockholders' wealth is highly concentrated in a firm.

In addition, using family control as a moderator, we find a significant moderating effect of family control on the ownership–R&D investment relationship. Specifically, we find an inverse U-shaped, or nonlinear, relationship between ownership concentration and R&D investments for non-family-controlled firms. However, the inverse U-shaped relationship is less pronounced among family-controlled firms because family owners, who are tied by marriage or blood, normally make business decisions based on family bonds; besides, the family shareholders, whose wealth are highly concentrated in the firm, tend to be conservative and risk-averse (Schulze et al., 2003, Graves and Thomas, 2006, Chang et al., 2006).

The findings of this study are robust to a battery of tests in the Taiwanese context. Taiwan is particularly well-suited for this study for two reasons. First, Taiwan is well-known for having an environment that encourages corporate R&D investments, contributing to its consistently high levels of economic growth. In the 2016 Global Innovation 1000 Study, the R&D spending of Taiwanese firms is reported to total NT$392.8 billion (US$12.4 billion), approximately three percent of their combined revenue.[1] Second, Claessens et al. (2000) and Yeh et al. (2001) indicate that high levels of ownership are concentrated in the hands of Taiwanese public-listed family-controlled firms. The control structure in Taiwan, wherein blockholders are influential on firms' strategic decisions, enables us to investigate the distinct effects of ownership concentration on R&D investments and obtain insights into family-controlled firms throughout Asia.

This study differs from prior research in a number of ways. Although the effect of ownership structure on R&D investments is well-documented by studies such as Baysinger et al. (1991), Lee and O'Neill (2003), and Zeng and Lin (2011), these studies consider neither the differences between family-controlled and non-family-controlled firm nor the nonlinear relationship between ownership concentration and R&D investments. By contrast, this study reveals considerable differences between family-controlled and non-family-controlled firms in terms of a nonlinear effect. In addition, prior studies such as Schulze et al. (2003), Chang et al. (2006), Muñoz-Bullón and Sanchez-Bueno (2011), and Chrisman and Patel (2012) compare family-controlled to non-family-controlled firms regarding their respective effects on R&D investments; however, they ignore the potential effects of ownership concentration. Moreover, while Chen et al. (2014) and Lo et al. (2016) explore the nonlinear effects of ownership structure on innovation performance and leverage decision, respectively, this study considers the impact of ownership concentration on R&D decisions while including family control as a moderator.

With respect to the association between family ownership and R&D investments, prior studies such as Chen and Hsu (2009), Munari et al. (2010), Block (2012), and Choi et al. (2015) find a linear effect of family ownership on R&D investment. Of these, Chen and Hsu (2009), examining data from a sample of Taiwanese electronics companies covering 2002 to 2007, is the most closely related to this study. We extend Chen and Hsu (2009) by investigating not only family ownership but also the ownership of blockholders, as well as by enhancing the regression models to test the nonlinear effect. Consistent with Chen and Hsu (2009), this study shows that the higher the ownership is, the fewer the R&D investments are; however, this negative relationship exists only at high levels of ownership.

[1] Source: https://www.pwc.tw/zh/publications/assets/2016-global-innovation-1000-taiwan.pdf

This relationship is positive at low levels of ownership, indicating the need to consider the possibility of nonlinearity. Furthermore, this study's sample is larger than that used by Chen and Hsu (2009) and covers a longer period: it comprises all listed companies in Taiwan between 1990 and 2014.

Our findings contribute to the literature in at least two ways. First, we show empirically a nonlinear inverse U-shaped effect of ownership concentration on R&D investments. This nonlinear effect not only explains the mixed effects of ownership concentration on R&D investments, but also provides a new explanation for the finding of Chen et al. (2014) on the inverse U-shaped relationship between ownership concentration and innovation activities, because R&D investments could help improve innovation performance, as suggested by Berchicci (2013). Second, this study contributes to the literature by clarifying differences in R&D investments between family-controlled and non-family-controlled firms, thus corroborating the argument of Chrisman and Patel (2012) about the need to consider the heterogeneity of family-controlled firms.

The remainder of this paper is organized as follows. Section II reviews the literature and develops hypotheses. Section III describes this study's data and methodology. Section IV describes the tests and results. Finally, section V concludes this paper.

CHAPTER 2: LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Blockholders with corporate control are capable of using firms' resources without considering minority shareholders' rights or welfare (La Porta et al., 2000). Given these blockholders' self-serving behaviors, there is a need to empirically examine whether or not ownership concentration affects R&D investments. The literature on the effect of ownership concentration on R&D investments shows mixed results.

Among studies that find a positive relationship, Pindado and de La Torre (2009) find that blockholders have an incentive to invest more resources in R&D activities to create competitive advantages for the firm because this kind of investment contributes to higher market valuations in the financial market, as argued by Gupta et al. (2017). Following the agency theory, La Porta et al. (2000) argue that blockholders with corporate control worldwide tend to pursue self-interests at the expense of minority shareholders. The agency problem is particularly pronounced when the ownership of blockholders is low. Shleifer and Vishny (1986) and Admati et al. (1994) find that the agency problem is alleviated when concentrated ownership rises because controlling and minority shareholders' interests become aligned. Thus, this study conjectures that increases in ownership concentration at a low level encourage R&D investments, to the shareholders' benefits. Consistent with this argument, Baysinger et al. (1991) find that ownership concentration is beneficial for R&D investments. Lee and

O'Neill (2003) find that ownership concentration is positively related to R&D investments in the United States.

However, certain studies, such as Rapp and Udoieva (2016) and Zeng and Lin (2011), find that ownership concentration results in lower R&D investments. Shleifer and Vishny (1986) document the wealth of blockholders is undiversified and tightly tied up in the firms. Therefore, a high level of ownership concentration would make these shareholders become more risk-averse. Furthermore, Goel and Ram (2001), Kothari et al. (2002), and Oriani and Sobrero (2008) argue that R&D investments may lead to irreversible adverse effects due to the highly uncertain value of R&D activities. Therefore, when ownership concentration is high, risk-averse blockholders will restrain R&D investments as ownership concentration increases.

Based on the contradictory arguments described above, ownership concentration might lead to two opposing effects on R&D investments. We develop the following hypotheses:

Hypothesis 1a: When ownership concentration is at a low level, ownership concentration is positively associated with R&D investments.

Hypothesis 1b: When ownership concentration is at a high level, ownership concentration is negatively associated with R&D investments.

Several studies compare the effects of family-controlled and non-family-controlled firms on R&D investments. Muñoz-Bullón and Sanchez-Bueno (2011) find that family-controlled firms have lower R&D intensity than their counterparts due to limited resources and ability. Chrisman and Patel (2012) argue that family ownership's influence on R&D varies depending on the gap between aspiration and performance. Zellweger (2007) claims that family shareholders efficiently monitor corporate decision making. This argument is consistent with the view of Chrisman et al. (2015) that family involvement encourages R&D investments due to the family's economic motivation and business objectives.

On the other hand, the argument of hypothesis 1 may be lessened due to the unique characteristics of family control. First, family-controlled firms take the name because of various combinations of family members in several influential positions in the firms. In this regard, family managers and/or shareholders, who are members of the firm by either blood or marriage, can exert significant influences on corporate decision-makings (Ward, 2016). Family members' emotional bonding, sense of loyalty and responsibility, and affectionate ties can thus be observed in family-controlled firms (Kepner, 1991), all of which suggest that family members make decisions on R&D investments in family-controlled firms based on family bonds, but not the level of ownership. Second, family wealth

is highly concentrated in the family-controlled firm to certain extent regardless of the level of ownership concentration. Family shareholders tend to be conservative and risk-averse (Schulze et al., 2003, Graves and Thomas, 2006, Chang et al., 2006), and R&D investment decisions heavily depends on its effect on family wealth rather than the level of family ownership.

Overall, R&D investment decisions of family control rely more on family self-interest than ownership concentration. Therefore, we propose the following hypothesis:

Hypothesis 2: Family control lessens the association between ownership concentration and R&D investments.

CHAPTER 3: DATA AND METHODOLOGY

This study employs a large panel dataset on public firms listed on the Taiwan Stock Exchange covering 1999 to 2014. The data were extracted from the Taiwan Economic Journal (TEJ)[2] database. Three criteria were applied to filter them: first, the total assets of each observation must be at least NTD 1 billion, to prevent the small firm effect; second, the observations must not have a missing value for any variable in our empirical models; third, the sample must not include financial institutions because they have different statutory requirements. The final sample thus derived comprised 15,721 firm-year observations.

We followed previous empirical studies and examined the relationship between R&D investments and ownership concentration using regression analysis. Following prior studies such as Hovey et al. (2003), two main measures were used to define "ownership concentration," *OC3 and OC5*, representing the respective percentages of shares held by the top three (*OC3*) and top five (*OC5*) blockholders. To control for potential industrial differences and intertemporal effects, we subtracted *OC3* (*OC5*) from the median *OC3* (*OC5*) of the firm's corresponding industry in that year. We added the value 1 to the industry-adjusted ownership concentration to prevent a negative ratio because the squared terms of both *OC3* and *OC5* were used in our regression models. The unadjusted means of *OC3* and *OC5* are 0.3567 and 0.3837, respectively, indicating that Taiwanese firms are generally concentrated in the hands of blockholders.

For family control, a dummy variable representing a firm controlled by a group of people with family relationships or a common family name was used, following Lo et al. (2016). Based on the definition given in the TEJ database, family-controlled firms are considered those in which (i) the

[2] See this page https://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapId=43502394 for an overview of TEJ, which provides timely and accurate data for various markets.

positions of chairman and chief executive officer are held by family members; (ii) board seating rights are greater than half, and outside directors make up not more than one-third of all directors; (iii) board control rights are at least 33 percent, and at least three family members hold positions as directors, supervisors, and/or managers; and (iv) the block shareholdings held by the family shareholder(s) total more than the critical control level.[3]

Following Lee and O'Neill (2003) and Chen et al. (2005), we use the two-stage least squares (2SLS) method to minimize the possible effect of endogeneity on ownership concentration in examining the relationship among ownership concentration, family control, and R&D investments. The following equations are formulated:

$$OC_{it} = \beta_0 + \beta_1 FamC_{it} + \beta_2 MB_{it} + \beta_3 Vol_{it} + \beta_4 FDir_{it} + \beta_5 IDir_{it} + \beta_6 Size_{it} + \beta_7 Age_{it} + \beta_8 ROA_{it} + \beta_9 CR_{it} + \sum_s \gamma_s Year_{s,it} + \sum_u \lambda_u Industry_{u,it} + \varepsilon_{it} \quad (1a)$$

$$R\&D_{it} = \beta_0 + \beta_1 OC_{it} + \beta_2 FamC_{it} + \beta_3 IDir_{it} + \beta_4 Size_{it} + \beta_5 Age_{it} + \beta_6 ROA_{it} + \beta_7 Profit_{it} + \beta_8 LTDR_{it} + \beta_9 CapI_{it} + \beta_{10} InvI_{it} + \beta_{11} CR_{it} + \sum_s \gamma_s Year_{s,it} + \sum_u \lambda_u Industry_{u,it} + \varepsilon_{it} \quad (1b)$$

where *OC* can be either *OC3*, the top three ownership percentage of firm *i* in year *t*, or *OC5*, the top five ownership percentage; *FamC* is the family control dummy; and *R&D* is the ratio of R&D expenditures to total assets, in line with studies such as Zeng and Lin (2011) and Gavious et al. (2015). In the first stage (Eq. 1a), this study regressed either *OC3* or *OC5* on family control, board-related features, and firm-related features. In the second stage (Eq. 1b), this study utilized the fitted values of *OC3* and *OC5* as the testing variable of OC obtained from Eq. 1b to represent the ownership concentration.

The other variables in this model are defined as follows: *MB* is the ratio of market value to the book value of equity; *Vol* is the standard deviation of *ROA* for firms in the industry; *FDir* is the ratio of foreign directors to total directors; *IDir* is the ratio of independent directors to total directors; *Size* is the natural logarithm of total assets; *Age* is the natural logarithm of years of establishment; *ROA* is the ratio of earnings before interest and taxes to prior-year total assets; *Profit* is the ratio of continuing operations' income after taxes to total sales; *LTDR* is the ratio of long-term debt to total assets; *CapI* is the ratio of fixed assets to total assets; *InvI* is the ratio of inventory to total assets; and *CR* is the ratio of current assets to current liabilities. The control variables are consistent with those used in

[3] Cubbin and Leech (1983), p. 358 define the critical control level as the "critical portion of shares which, if it is held as the largest bloc, has a certain degree of control, which is high enough for it to be said to dominate the firm."

studies such as Baysinger et al. (1991), Lee and O'Neill (2003), and Chen et al. (2014). Year and industry fixed effects are also included.

We examine the moderating effect of family control on the relationship between ownership concentration and R&D investments by including an interaction term of *OC* and *FamC*. We estimate the following equation:

$$\begin{aligned} R\&D_{it} = {} & \beta_0 + \beta_1 OC_{it} + \beta_2 FamC_{it} + \beta_3 OC \times FamC_{it} + \beta_4 IDir_{it} + \beta_5 Size_{it} + \beta_6 Age_{it} \\ & + \beta_7 ROA_{it} + \beta_8 Profit_{it} + \beta_9 LTDR_{it} + \beta_{10} CapI_{it} + \beta_{11} InvI_{it} + \beta_{12} CR_{it} \\ & + \sum_s \gamma_s Year_{s,it} + \sum_u \lambda_u Industry_{u,it} + \varepsilon_{it} \end{aligned} \quad (2)$$

CHAPTER 4: TESTS AND RESULTS

Panel A of Table 1 presents the descriptive statistics for the explanatory variables. *R&D* investments account for nearly 2 percent of the sample firms' total assets. The means and medians of *OC3* and *OC5* are close to 1, showing that they are industry-adjusted indicators. Mean family control (*FamC*) indicates that around 62 percent of the sample firms are family-controlled. The average market-to-book (*MB*) ratio of the firms is 157 percent, while the mean volatility (*Vol*) is 0.11. The proportion of foreign and independent directors on the board is approximately 2 percent and 14 percent, respectively. The average firm size (*Size*) is 8.64 (logged value), indicating average total assets of approximately NTD 5.653 billion. The average logged value of 3.09 years of establishment (*Age*) shows that the sample firms have been in business for 22 years. Regarding return-on-assets (*ROA*), the reported mean value is 0.07. Mean *Profit* indicates that the total income after taxes from continuing firm operations is 3 percent on average. The average total long-term debt-to-total assets ratio (*LTDR*) for the observed period is around 11 per cent. Furthermore, around 30 percent and 17 percent of the sample firms' total assets constitute fixed assets (*CapI*) and inventories (*InvI*), respectively. The average current ratio (*CR*) of 2.50 suggests that NTD 1 of the sample firms' current liabilities is covered by NTD 2.50 of their current assets.

Table 1 Descriptive Statistics (N = 14,573)

Panel A: Full sample					
Variable	Mean	Median	Quartile 1	Quartile 3	Standard Deviation
R&D	0.02	0.01	0.00	0.03	0.03
OC3	1.02	1.00	0.90	1.13	0.17
OC5	1.02	1.00	0.90	1.12	0.16
FamC	0.62	1.00	0.00	1.00	0.48
MB	1.57	1.21	0.80	1.88	1.41
Vol	0.11	0.10	0.08	0.13	0.04
FDir	0.02	0.00	0.00	0.00	0.07
IDir	0.14	0.00	0.00	0.29	0.17
Size	8.64	8.39	7.69	9.27	1.27
Age	3.09	3.18	2.75	3.53	0.58

ROA	0.07	0.06	0.02	0.12	0.12
Profit	0.03	0.04	0.01	0.10	2.67
LTDR	0.11	0.08	0.02	0.17	0.11
CapI	0.30	0.29	0.16	0.43	0.19
InvI	0.17	0.14	0.08	0.21	0.15
CR	2.50	1.73	1.29	2.53	5.20

Panel B: Sub-group analysis

Variable	Grouping by *FamC*				Grouping by *R&D*			
	Family-Controlled	Non-Family-Controlled	Difference	*t*-stat	High	Low	Difference	*t*-stat
R&D	0.0163	0.0311	-0.0149	-26.04***				
OC3	1.0414	0.9885	0.0529	19.34***	1.0160	1.0275	-0.0116	-4.21***
OC5	1.0367	0.9889	0.0478	17.67***	1.0136	1.0242	-0.0107	-3.93***
MB	1.4600	1.7119	-0.2519	-10.90***	1.7713	1.3925	0.3788	16.31***
Vol	0.1016	0.1135	-0.0119	-18.51***	0.1083	0.1049	0.0033	5.16***
FDir	0.0129	0.0252	-0.0123	-10.26***	0.0207	0.0155	0.0052	4.24***
IDir	0.1189	0.1670	-0.0482	-17.53***	0.1594	0.1256	0.0338	12.17***
Size	8.6861	8.6131	0.0730	3.48***	8.5670	8.7033	-0.1364	-6.48***
Age	3.2064	2.9351	0.2712	28.96***	3.0362	3.1451	-0.1089	-11.36***
ROA	0.0633	0.0766	-0.0133	-6.90***	0.0581	0.0420	0.0160	8.97***
Profit	0.0388	0.0161	0.0226	0.53	0.0404	0.0229	0.0175	0.39***
LTDR	0.1244	0.0967	0.0277	14.77***	0.0965	0.1244	-0.0278	-15.10***
CapI	0.3249	0.2706	0.0544	17.52***	0.2886	0.3147	-0.0261	-8.44***
InvI	0.1705	0.1596	0.0110	4.43***	0.1565	0.1802	-0.0237	-9.64***
CR	2.3251	2.6685	-0.3434	-4.12***	2.6082	2.4056	0.2026	2.35**

Note: This table provides descriptive statistics in our sample. Panel A is the summary statistics of full sample, while Panel B provides the tests of mean differences between family-controlled firms and non-family-controlled firms, and between firms with high R&D investments and firms with low R&D investments. *R&D* is the ratio of R&D expenditures to total assets. *R&D* is the ratio of R&D expenditures to total assets. *OC3 and OC5*, representing the respective percentages of shares held by the top three (*OC3*) and top five (*OC5*) blockholders. *FamC* is a dummy variable equal to one if the firm is a family-controlled firm, and zero otherwise. *MB* is the ratio of market value to the book value of equity; *Vol* is the standard deviation of *ROA* for firms in the industry; *FDir* is the ratio of foreign directors to total directors; *IDir* is the ratio of independent directors to total directors; *Size* is the natural logarithm of total assets; *Age* is the natural logarithm of years of establishment; *ROA* is the ratio of earnings before interest and taxes to prior-year total assets; *Profit* is the ratio of continuing operations' income after taxes to total sales; *LTDR* is the ratio of long-term debt to total assets; *CapI* is the ratio of fixed assets to total assets; *InvI* is the ratio of inventory to total assets; and *CR* is the ratio of current assets to current liabilities. ** and *** denote the significance levels at 5% and 1%, respectively.

This study's observations have been grouped in Panel B of Table 1 into two categories based on family control and R&D investment level. Family-controlled firms have significantly lower *R&D* and *MB* ratios than do non-family-controlled firms (0.0163 vs. 0.0311 and 1.4600 vs. 1.7119, respectively). Furthermore, firms are more likely to be non-family-controlled if they belong to groups characterized by higher volatility, higher proportions of foreign and independent directors, and higher *ROA* and current ratio. The mean difference tests also indicate that family-controlled firms are significantly larger, older, and more profitable than non-family-controlled firms are and have more fixed assets and inventories over total assets. Most of the differences are statistically significant at the conventional levels.

We split the sample into two groups (*R&D_Dum*) based on the level of R&D investment: firms are classified in the high (low) R&D investment group if their R&D investments are greater (less) than the yearly median value of R&D. The high R&D investment group thus consists of firms with R&D investments greater than the calculated median value and vice versa. A firm with higher R&D investments is more likely to have a higher *MB* ratio, greater volatility, a higher proportion of foreign and independent directors, larger ROA, greater profitability, and a higher current ratio, for which the mean differences tests are all significant at the conventional levels. Conversely, this univariate analysis reveals that firms with low R&D investments have significantly higher ownership concentration than do firms with high R&D investments. In addition, firms with low R&D investments tend to be significantly larger and older, have higher fixed assets to total assets, and have more inventories over total assets than do firms with high R&D investments.

Panel A of Table 2 reports the 2SLS regression results using *OC3* as the dependent variable at stage 1 and *R&D* as the dependent variable at stage 2. The empirical evidence at stage 1 shows that *FamC*, *MB*, *Vol*, *Age*, and *CR* are significantly and positively related to *OC3*, while *IDir* and *Size* have significantly negative impacts on *OC3*. At stage 2, the results show that ownership concentration positively influences R&D investments, suggesting that blockholders have incentives to make R&D investments as their shares increase. This study next examines how family control moderates the relationship between ownership concentration and R&D investments. A significant moderating effect of family control is observed, where the coefficient on *OC3* × *FamC* is -0.0968. Interestingly, the positive coefficient on *OC3* (0.0740) and the negative interaction variable (-0.0968) suggest that the slope for family control is close to zero (0.074 + (-0.0968) = -0.0228). The F-statistics of 3.66 is not significant at the conventional 5 percent significance level, confirming the zero net effect of family control. Overall, this finding indicates that the effect of family control on R&D investments is less strongly influenced by ownership concentration than are non-family-controlled firms.

Next, the positive coefficient on *OC3* (0.5303) and the negative coefficient on $OC3^2$ (-0.2163) point to a nonlinear relationship between ownership concentration and R&D investments. This result implies that, at a low level of ownership concentration, as ownership concentration increases, blockholders are willing to spend more on R&D investments. After a critical point, however, blockholders with more ownership concentration invest in R&D on a decreasing curve due to their risk aversion.

Another interesting result concerns the effects of the moderating coefficients on *OC3* × *FamC* and $OC3^2$ × *FamC*, which are significantly negative (-0.6179) and significantly positive (0.2518), respectively. These results again demonstrate the moderating role of family control, whereby *FamC*

moderates the non-linear relationship between ownership concentration and R&D investments. An untabulated F-test indicates that the net values of *OC3* and *OC3* × *FamC* are approximately zero (F-statistics = 0.18). A consistent result was obtained for the net values of $OC3^2$ and $OC3^2$ × *FamC* (F-statistics = 0.14), indicating that the relationship between ownership concentration and R&D investments forms an inverted U-shaped curve for non-family-controlled firms; however, the effect of ownership concentration is less pronounced among family-controlled firms. These results suggest that R&D investments in family-controlled firms are higher on average than are those in other firms in two scenarios: when ownership concentration is low and when ownership concentration is high. Following Lean et al. (2015), we use *OC5* as an alternative measure of ownership concentration; the estimations are shown in Panel B of Table 2. The results are qualitatively similar to those in Panel A of Table 2.

Table 2 2SLS Regression Results – Ownership Concentration (N = 14,573)

Panel A: Ownership concentration = *OC3*

Variable	Stage 1: *OC3*		Stage 2: *R&D*					
	Estimate	*t*-stat	Estimate	*t*-stat	Estimate	*t*-stat	Estimate	*t*-stat
Intercept	1.0995	67.88***	0.1075	13.84***	-0.0114	-0.96	-0.2529	-3.02***
OC3			0.0362	3.81***	0.0740	7.01***	0.5303	3.41***
OC3×FamC					-0.0968	-8.12***	-0.6179	-2.74***
$OC3^2$							-0.2163	-2.95***
$OC3^2$×*FamC*							0.2518	2.37**
FamC	0.0695	24.98***	-0.0086	-10.43***	0.0906	7.40***	0.3586	3.00***
MB	0.0058	5.40***						
Vol	0.3485	19.30***						
FDir	-0.0476	-0.79						
IDir	-0.0132	-12.48***	-0.0015	-6.61***	-0.0009	-3.73***	-0.0007	-2.49**
Size	-0.0189	-6.83***	-0.0096	-18.01***	-0.0075	-13.06***	-0.0072	-12.25***
Age	0.0787	6.33***	-0.0001	-0.04	-0.0063	-2.58***	-0.0079	-3.17***
ROA	0.0003	0.62	-0.0002	-1.77	-0.0002	-1.73*	-0.0002	-1.77*
Profit			-0.0238	-8.97***	-0.0231	-8.74***	-0.0228	-8.57***
LTDR			-0.0279	-16.71***	-0.0259	-15.55***	-0.0261	-15.66***
CapI			-0.0170	-7.29***	-0.0155	-6.67***	-0.0157	-6.74***
InvI			0.0002	3.40***	0.0002	3.28***	0.0002	3.34***
CR	0.0710	7.61***	0.0111	6.01***	0.0070	3.61***	0.0059	2.87***
Fixed effects	Yes		Yes		Yes		Yes	
Adj. R^2	0.0858		0.2441		0.2530		0.2534	

Panel B: Ownership concentration = *OC5*

Dependent variable	Step 1: *OC5*		Step 2: *R&D*					
Variable	Estimate	*t*-stat	Estimate	*t*-stat	Estimate	*t*-stat	Estimate	*t*-stat
Intercept	1.1262	70.68***	0.0172	1.55	-0.0127	-1.08	-0.1967	-2.65***
OC5			0.0409	4.46***	0.0733	7.24***	0.4207	3.06***
OC5×FamC					-0.0827	-7.47***	-0.5374	-2.80***
$OC5^2$							-0.1646	-2.55**
$OC5^2$×*FamC*							0.2190	2.41**
FamC	0.0643	23.46***	-0.0087	-11.26***	0.0758	6.69***	0.3105	3.07***

Control Variables	Yes	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes	Yes
Adj. R^2	0.0932	0.2500	0.2508	0.2531

Note: This table provides the 2SLS results. The main testing variable of ownership concentration is either *OC3* (Panel A) or *OC5* (Panel B). *OC3 and OC5*, representing the respective percentages of shares held by the top three (*OC3*) and top five (*OC5*) blockholders. *FamC* is a dummy variable equal to one if a firm is controlled by a group of people with family relationships or a common family name was used, following Lo et al. (2016), and zero otherwise. *MB* is the ratio of market value to the book value of equity; *Vol* is the standard deviation of *ROA* for firms in the industry; *FDir* is the ratio of foreign directors to total directors; *IDir* is the ratio of independent directors to total directors; *Size* is the natural logarithm of total assets; *Age* is the natural logarithm of years of establishment; *ROA* is the ratio of earnings before interest and taxes to prior-year total assets; *Profit* is the ratio of continuing operations' income after taxes to total sales; *LTDR* is the ratio of long-term debt to total assets; *CapI* is the ratio of fixed assets to total assets; *InvI* is the ratio of inventory to total assets; and *CR* is the ratio of current assets to current liabilities. Fixed effects include those of year and industry. *, **, and *** denote the significance levels at 10%, 5% and 1%, respectively.

Although ownership concentration has been widely used to measure concentrated ownership levels, this study ensures test robustness by employing excess control (*EC*) as another proxy of ownership concentration, following Cubbin and Leech (1983). Higher excess control implies higher ownership concentration, and owners with significant shareholding may take aggressive action concerning managerial decisions. According to Shyu and Lee (2009), excess control is calculated as the difference between the ownership controlled by the ultimate controlling shareholders and the minimum ("critical control") level of ownership required to ensure the retention of controlling rights.[4] We calculate ownership as the sum of the percentage of direct and indirect shares held by the ultimate controlling shareholders, which represents the amount of shares owned by the largest shareholder. We replicate the estimations in Table 2 using excess control. The results in Table 3 reconfirm the nonlinear relationship between excess control and R&D investments, which is also moderated by family control.

Table 3 2SLS Non-Linear Regression Results – Excess Control (N = 14,573)

Variable	Stage 1/DV = *EC*		Stage 2/DV = *R&D*	
	Estimate	*t*-stat	Estimate	*t*-stat
Intercept	1.0184	74.13***	-2.1626	-7.85***
EC			3.4531	7.17***
EC×*FamC*			-2.1049	-3.83***
EC^2			-1.2562	-5.94***
EC^2×*FamC*			0.9768	4.11***
FamC	0.0679	28.77***	1.0764	3.39***
Control variables	Yes		Yes	
Fixed effects	Yes		Yes	
Adj. R^2	0.1513		0.2613	

Note: This table provides the 2SLS results. The main testing variable of ownership concentration is *EC* = Ownership – critical control level in percentage + 1, whereby ownership indicates the sum of percentage of direct and indirect shares held by the ultimate controlling shareholders. *FamC* is a dummy variable equal to one if a firm is controlled by a group of people with family relationships or a common family name was used, following Lo et al. (2016), and zero otherwise. *MB* is the ratio of market value to the book value of equity; *Vol* is the standard deviation of *ROA* for firms in the industry; *FDir* is the ratio of foreign directors to total directors; *IDir* is the ratio of independent directors to total directors; *Size* is

[4] Readers are requested to refer to footnote 3 for the definition of "critical control level."

the natural logarithm of total assets; *Age* is the natural logarithm of years of establishment; *ROA* is the ratio of earnings before interest and taxes to prior-year total assets; *Profit* is the ratio of continuing operations' income after taxes to total sales; *LTDR* is the ratio of long-term debt to total assets; *CapI* is the ratio of fixed assets to total assets; *InvI* is the ratio of inventory to total assets; and *CR* is the ratio of current assets to current liabilities. Fixed effects include those of year and industry. Fixed effects include those of year and industry. *, **, and *** denote the significance levels at 10%, 5% and 1%, respectively.

CHAPTER 5: CONCLUSION

We use the 2SLS regression method to reveal a nonlinear inverted U-shaped relationship between ownership concentration and R&D investments. This result implies that ownership concentration influences a firm's R&D investments. This effect should therefore be highlighted in innovation improvements. Our analyses suggest that shareholders with concentrated ownership increase their R&D investments up to a critical point, after which R&D investments decrease along with an increase in ownership concentration owing to risk aversion. However, we find that family control significantly lessens the ownership–R&D investment relationship. Specifically, the nonlinear inverse U-shaped relationship between ownership concentration and R&D investments is found mainly in non-family-controlled firms, but not in family-controlled firms. This finding suggests that family self-interest is the main factor of R&D investment decisions in family-controlled firms.

This study contributes to the literature. This study shows that the relationship between ownership concentration and R&D investments is nonlinear. This nonlinear effect explains the mixed effects of ownership concentration on R&D investments. This study also provides empirical evidence that family control may not always entail low R&D investment levels relative to those of other types of firms. Our 2SLS analyses confirm that differences exist in R&D investments between family-controlled and non-family-controlled firms.

References

Admati, A. R., P. Pfleiderer and J. Zechner (1994), 'Large shareholder activism, risk sharing, and financial market equilibrium', Journal of Political Economy, 102**,** 1097-130.

Baysinger, B. D., R. D. Kosnik and T. A. Turk (1991), 'Effects of board and ownership structure on corporate R&D strategy', The Academy of Management Journal, 34**,** 205-14.

Berchicci, L. (2013), 'Towards an open R&D system: Internal R&D investment, external knowledge acquisition and innovative performance', Research Policy, 42**,** 117-27.

Block, J. H. (2012), 'R&D investments in family and founder firms: An agency perspective', Journal of Business Venturing, 27**,** 248-65.

Chang, S.-J., C.-N. Chung and I. P. Mahmood (2006), 'When and how does business group affiliation promote firm innovation? A tale of two emerging economies', Organization Science, 17**,** 637-56.

Chen, H.-L. and W.-T. Hsu (2009), 'Family ownership, board independence, and R&D investment', Family Business Review, 22**,** 347-62.

Chen, V. Z., J. Li, D. M. Shapiro and X. Zhang (2014), 'Ownership structure and innovation: An emerging market perspective', Asia Pacific Journal of Management, 31**,** 1-24.

Chen, Z., Y.-L. Cheung, A. Stouraitis and A. W. S. Wong (2005), 'Ownership concentration, firm performance, and dividend policy in Hong Kong', Pacific-Basin Finance Journal, 13**,** 431-49.

Choi, Y. R., S. A. Zahra, T. Yoshikawa and B. H. Han (2015), 'Family ownership and R&D investment: The role of growth opportunities and business group membership', Journal of Business Research, 68**,** 1053-61.

Chrisman, J. J., J. H. Chua, A. De Massis, F. Frattini and M. Wright (2015), 'The ability and willingness paradox in family firm innovation', Journal of Product Innovation Management, 32**,** 310-18.

Chrisman, J. J. and P. C. Patel (2012), 'Variations in R&D investments of family and nonfamily firms: Behavioral agency and myopic loss aversion perspectives', Academy of Management Journal, 55**,** 976-97.

Claessens, S., S. Djankov and L. H. Lang (2000), 'The separation of ownership and control in East Asian corporations', Journal of Financial Economics, 58**,** 81-112.

Claessens, S., E. Feijen and L. Laeven (2008), 'Political connections and preferential access to finance: The role of campaign contributions', Journal of Financial Economics, 88**,** 554-80.

Cubbin, J. and D. Leech (1983), 'The effect of shareholding dispersion on the degree of control in British companies: theory and measurement', The Economic Journal, 93**,** 351-69.

Dilling-Hansen, M., E. S. Madsen and V. Smith (2003), 'Efficiency, R&D and ownership–Some empirical evidence', International Journal of Production Economics, 83**,** 85-94.

Gavious, I., N. Hirsh and D. Kaufman (2015), 'Innovation in pyramidal ownership structures', Finance Research Letters, 13**,** 188-95.

Goel, R. K. and R. Ram (2001), 'Irreversibility of R&D investment and the adverse effect of uncertainty: Evidence from the OECD countries', Economics Letters, 71**,** 287-91.

Graves, C. and I. Thomas (2006), 'Internationalization of Australian Family Businesses: A Managerial Capabilities Perspective', Family Business Review, 19**,** 207-24.

Gupta, K., R. Banerjee and I. Onur (2017), 'The effects of R&D and competition on firm value: International evidence', International Review of Economics & Finance, 51**,** 391-404.

Hovey, M., L. Li and T. Naughton (2003), 'The relationship between valuation and ownership of listed firms in China', Corporate Governance: An International Review, 11**,** 112-22.

Kepner, E. (1991), 'The family and the firm: A coevolutionary perspective', Family Business Review, 4**,** 445-61.

Kothari, S., T. E. Laguerre and A. J. Leone (2002), 'Capitalization versus expensing: Evidence on the uncertainty of future earnings from capital expenditures versus R&D outlays', Review of accounting Studies, 7**,** 355-82.
La Porta, R., F. Lopez-De-Silanes, A. Shleifer and R. Vishny (2000), 'Investor protection and corporate governance', Journal of Financial Economics, 58**,** 3-27.
Lean, H. H., I. W. K. Ting and Q. L. Kweh (2015), 'Ownership concentration, family ownership and leverage: Evidence from Malaysia', Malaysian Journal of Economic Studies, 52**,** 117-33.
Lee, P. M. and H. M. O'neill (2003), 'Ownership structures and R&D investments of US and Japanese firms: Agency and stewardship perspectives', Academy of Management Journal, 46**,** 212-25.
Lo, H.-C., I. W. K. Ting, Q. L. Kweh and M. J. Yang (2016), 'Nonlinear association between ownership concentration and leverage: The role of family control', International Review of Financial Analysis, 46**,** 113-23.
Martínez, B. and I. Requejo (2017), 'Does the type of family control affect the relationship between ownership structure and firm value?', International Review of Finance, 17**,** 135-46.
Munari, F., R. Oriani and M. Sobrero (2010), 'The effects of owner identity and external governance systems on R&D investments: A study of Western European firms', Research Policy, 39**,** 1093-104.
Muñoz-Bullón, F. and M. J. Sanchez-Bueno (2011), 'The impact of family involvement on the R&D intensity of publicly traded firms', Family Business Review, 24**,** 62-70.
Oriani, R. and M. Sobrero (2008), 'Uncertainty and the market valuation of R&D within a real options logic', Strategic Management Journal, 29**,** 343-61.
Pindado, J. and C. De La Torre (2009), 'Effect of ownership structure on underinvestment and overinvestment: Empirical evidence from Spain', Accounting & Finance, 49**,** 363-83.
Rapp, M. S. and I. A. Udoieva (2016), 'Corporate governance and its impact on R&D investment in emerging markets', Emerging Markets Finance and Trade.
Schulze, W. S., M. H. Lubatkin and R. N. Dino (2003), 'Toward a theory of agency and altruism in family firms', Journal of Business Venturing, 18**,** 473-90.
Shleifer, A. and R. W. Vishny (1986), 'Large shareholders and corporate control', Journal of Political Economy, 94**,** 461-88.
Shyu, Y. W. and C. I. Lee (2009), 'Excess control rights and debt maturity structure in family-controlled firms', Corporate Governance: An International Review, 17**,** 611-28.
Ward, J. (2016), Perpetuating the family business: 50 lessons learned from long lasting, successful families in business: Springer.
Yeh, Y.-H., T.-S. Lee and T. Woidtke (2001), 'Family control and corporate governance: Evidence from Taiwan', International Review of Finance, 2**,** 21-48.
Zellweger, T. (2007), 'Time horizon, costs of equity capital, and generic investment strategies of firms', Family Business Review, 20**,** 1-15.
Zeng, T. and H.-C. Lin (2011), 'Ownership structure and R&D spending: Evidence from China's listed firms', Chinese Management Studies, 5**,** 82-93.