The Effect of Ownership Concentration on R&D Decisions in Korean Firms

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The current study examines the effect of ownership concentration on R&D investment by investigating a large panel data set of Korean listed firms. Theoretically, concentrated ownership structure can be an alternative to mitigate the agency problem caused by the separation of ownership and control in a dispersed ownership structure. However, whether ownership concentration positively affects firm R&D decisions is not obvious due to the contrasting effects of large shareholders: risk averseness and long-term orientation. The present study uses several econometric techniques, fixed effects FGLS regression, dynamic GMM regression, and subsample regressions, and shows that the positive effect of ownership concentration on R&D is confirmed in Korea. A non-linear relation between ownership concentration and investment is not significant, and neither are the effects of foreign investors and institutional investors. The results of the subsample regressions indicate that the positive effect of ownership concentration is significant in small firms, R&D intensive firms, and non-chaebol firms.

Keywords: Ownership concentration, R&D, Panel data

JEL Classification: D22, G30, G32

I. Introduction

The fundamental impulse that sets and keeps the capitalist engine in motion comes from new consumer goods, new methods of production or transportation, new markets, and new forms of organization that a capitalist enterprise creates (Schumpeter 1942, p. 83).

Since the pioneering work of Schumpeter (1942), technological innov-

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ation has been emphasized as indispensable to economic growth and profitability. Recognizing that technological innovation is based on research and development (R&D) investment, most governments in the world have been attempting to increase public R&D support in various forms, from R&D grants to R&D tax credits (OECD 2006). An extensive empirical analysis by Guellec and van Pottelsberghe (2001) provides empirical evidence to support the role of R&D as a driving force of economic performance.

Given the importance of R&D in improving economic performance, identifying the determinants of a firm's R&D investment is worthwhile. Ownership concentration is regarded as one of the most important corporate governance mechanisms influencing managerial decisions. Hence, the present study aims to determine and isolate the effect of ownership concentration on R&D investment by investigating a large panel data set of South Korea (hereafter Korea). Previous empirical studies, such as Lee (2008), already confirm the significant effect of ownership concentration on firm performance in Korea.

Numerous empirical studies have attempted to determine whether ownership structure matters in the R&D investment of firms. However, most of them examine the moderating effect of ownership on the sensitivity of a firm's investment to its cash flow (for example, see Hadlock 1998; Goergen and Renneboog 2001). Only a few empirical studies directly examine the effect of ownership structure on the R&D decisions of firms. Thus, the present study contributes to the literature by providing evidence of the direct relation between R&D and equity ownership structure.

R&D investment has a number of characteristics that differentiate it from other capital and financial inputs. We will look into the three main characteristics of R&D projects. First, information asymmetries are more severe in R&D investment decisions. An R&D performer usually has a lot better information about the nature of the R&D project compared to providers of external funds (Aboody and Lev 2000). Second, most R&D investment is asset specific because the efforts of R&D employees (*e.g.*, scientists and engineers) create intangible assets, that is, the firm's tacit knowledge bases, which are embedded in the human capital of R&D employees (Santarelli 1991). Third, R&D outcomes are highly uncertain because high-tech projects are likely to have a low probability of success (Carpenter and Petersen 2002). Keeping these R&D characteristics in mind, the current study examines the effect of ownership concentration on R&D investment decisions.

The remainder of the study is structured as follows. The next section describes the theoretical and empirical work on ownership concentration and R&D decisions, followed by a section discussing the sample and empirical methods employed in the study. Then, the next section presents the empirical findings. The final section summarizes and concludes this empirical study.

II. Background

A. Theory

Ownership structure, such as ownership concentration and ownership identity, is one of the hotly debated issues in corporate governance research. Current perspectives on corporate governance are divided into two contrasting paradigms: shareholder approach and stakeholder approach. Such a division is based on the purpose of the firm and its structure of governance arrangements explained by the two approaches. The shareholder approach views the firm as an instrument for shareholders to increase their own benefits, whereas the stakeholder approach regards the firm as a locus in relation to the interests of various stakeholders (*e.g.*, lenders, employees, and community). In this paper, we limit consideration to the shareholder approach.

According to the shareholder approach, corporations should be controlled by shareholders to maximize their wealth. Alchian and Demsetz (1972) consider a situation of team production, in which output is the joint product of worker contributions and the outputs attributable to any individual are difficult to specify. Free-riding behavior is likely to occur in this setting. A solution to the free-rider problem is for one member of the team to monitor and direct the other members and to be motivated by receiving the residual incomes. Maximizing the value received by the residual claimant is the same as maximizing the total value received by all the members. Thus, this situation leads to a socially efficient level. In this sense, shareholders (residual claimants of the firm) should control the firm to maximize firm value.

However, typical shareholders cannot control the firm. Berle and Means (1932) point out that in the 1920s, ownership in corporations is widely dispersed. Numerous small shareholders own only a small stake of a large public company, and they cannot manage business activities that are handled by professional managers. It is called the separation of ownership and control. The agency theory becomes applicable to such a

condition because the separation of ownership and control is a principal-agent problem.

The separation of ownership and control reduces shareholders' incentive and ability to monitor management. Legally, small shareholders own corporations, but they do not feel a sense of ownership over the firm because if one shareholder's monitoring improves firm performance, all shareholders benefit, and each shareholder has the incentive to free-ride. Small shareholders tend to invest in various firms to diversify risk, which leads to investment for a future dividend stream rather than in the future of the firm. Furthermore, small shareholders do not have the ability to monitor management effectively because they do not have the knowledge and information to run a large company.

Various corporate governance mechanisms have been proposed to solve the agency problem. One solution to the agency problem is to set up an efficient ownership structure that can affect the incentive of shareholders to monitor management. As an efficient ownership structure, a concentrated ownership is often suggested. As the ownership stake of blockholders increases, the blockholders may have greater incentives to increase firm value and to monitor management than do dispersed small shareholders (Shleifer and Vishny 1986). In addition, concerted actions by large shareholders are easier than those of small shareholders. Thus, the degree of ownership concentration is one of important factors that affect the firm's investment decisions.

Accordingly, ownership concentration matters for firm investment decisions. However, one question remains open: Is the effect of ownership concentration on R&D investment positive or negative? Given the R&D investment characteristics described above, the answer to the question would depend on the large shareholders' risk attitude and time horizon. We examine them as follows.

First, typical large shareholders are risk averse and conservative in business affairs. In contrast to small shareholders who can diversify their personal risk by buying stocks in various firms, large shareholders often cannot diversify their risk as their stake in the firm increases. Faccio *et al.* (2011) find that firms controlled by diversified blockholders undertake riskier investments than those controlled by non-diversified blockholders. Therefore, given that large shareholders are risk averse, ownership concentration would have a negative effect on R&D spending.

In addition, enhanced monitoring by concentrated ownership may discourage inside stakeholders (*e.g.*, managers and employees) from making costly firm-specific investments, such as R&D investments. Burkart *et*

al. (1997) claim that dispersed ownership gives rise to benefits of managerial initiative. Managerial discretion contributes to firm value as managers favor firm-specific investment.

Second, large shareholders are usually long-term oriented because they hold a large fraction of the shares in the firm; thus, their earnings are dependent upon the long-term survival of the firm. Moreover, due to their ability to access information of the firm, which mitigates the asymmetric information problem in R&D projects, large shareholders invest more patiently. The longer shareholder time-horizon encourages managers to invest for a long term and make firm-specific investments.

There exists a more fundamental reason that large shareholders could have an incentive to be actively involved in R&D decisions. Small shareholders do not feel a sense of ownership of the firm; hence, their focus is not on the firm's long-term performance, but on an immediate increase in stock price or dividend. If small shareholders are dissatisfied with the firm, they will sell their shares rather than attempt to bring about changes in the firm. Hirshman (1970) argues that small shareholders are likely to express their opinions through exit rather than voice. On the contrary, large shareholders can exert power over corporate affairs, and thus they have a sense of ownership of the firm. According to an organization theory, high involvement and participation can foster a strong sense of ownership to the organization (Denison and Mishra 1995). Large shareholders can be real owners in this sense, which enhances their commitment to the firm's long-term success. If large shareholders recognize the contribution of R&D to the long-term competitiveness of the firm, they encourage investment in R&D.

In sum, although the risk averseness of large shareholders might lead to a negative effect on corporate R&D investment, the long-term horizon could have a positive influence on R&D investment. Ownership concentration has two contrasting effects on firm R&D decisions. If the effect of the risk averseness is dominant, R&D spending is discouraged. In contrast, if the effect of the long-term horizon prevails, large shareholders support R&D investment. We can also expect a non-linear relation between ownership concentration and R&D investment. For example, ownership concentration initially has a negative effect on R&D expenditure due to risk averseness, but eventually, exerts a positive effect once blockholders own a sufficient fraction of the shares of the firm to reinforce long-term horizon. This issue needs to be determined by empirical work.

B. Previous Studies

Although many empirical studies deal with the effect of ownership structure on the sensitivities of investment-internal funds, only a few empirical studies focus on the direct effect of ownership and R&D investment. In addition, a few studies investigate the immediate relation between R&D investment and ownership concentration.

Some studies report a statistically significant and positive relationship between ownership concentration and R&D investment (see Baysinger *et al.* 1991; Hansen and Hill 1991; Francis and Smith 1995; Lee and O'Neill 2003). All these studies use US firm data; hence, the evidence of the positive effect of ownership concentration on R&D might reflect the institutional setting of the U.S. The U.S. is believed to have a better investor protection environment; thus, the risk averseness of large shareholders there is relatively weak. For example, the median values of the quality of the rule of law (RL), accounting disclosure standards (ASR), and anti-director rights (ADR) for 39 countries are 8.33, 64, and 3, respectively; on the other hand, the U.S. has 10, 71, and 5, respectively (John *et al.* 2008). The results indicate that the U.S. has a higher standard for investor protection compared to other countries. Therefore, the negative effect of large shareholder risk averseness on R&D investment is not strong in the U.S., which can yield the evidence of the positive effect of ownership concentration on riskier projects. In the U.S., ownership concentration is not significantly related to risk taking (John *et al.* 2008), and the presence of large shareholders is likely to increase the willingness of firms to take risks (Amihud and Lev 1981).

Accordingly, we need to consider institutional settings in investigating the effect of equity ownership on R&D. This idea is not new, as corporate governance systems in Continental European countries are widely accepted as different in many important ways from those of Anglo-American countries, such as the U.S. and the U.K. (La Porta *et al.* 1999; Boyer and Freyssenet 2002; Singh 2002). Through the 1970s and 1980s, corporate governance research examines individual governance mechanisms in individual countries. In the early 1990s, however, the research begins to uncover the possible impact of differing institutional environments on the structure and effectiveness of corporate governance mechanisms (for a survey, see Denis and McConnell 2003).

The comparative studies typically distinguish between the Anglo-American model and the Continental European model. The former is exemplified by the U.S. and the U.K., and includes strong shareholder

rights, dispersed ownership, short-term value orientation, arm's length creditor financing through equity, and active markets for corporate control. The latter is found in France, Germany, Italy, and Japan, and includes weak shareholder rights, strong stakeholder rights, concentrated ownership, long-term value orientation, long-term debt finance, and weak markets for corporate control.

Given these differences between the two systems, the effect of ownership concentration on R&D investment can be different across countries. Lee (2005) finds that the positive relation between ownership concentration and R&D spending observed in the U.S. is not found in Japan. Munari *et al.* (2010) also show a difference in the relation between ownership and R&D between the U.K. and Continental European countries.

In comparing the U.S. and Korea in terms of the quality of investor protection, the latter does not have a strong institutional setting of investor protection: RL is 5.35, ASR is 62, and ADR is 2. These values are below the median (John *et al.* 2008). Thus, we cannot determine in advance which among the positive and negative effects of ownership concentration on R&D is dominant in Korea. This issue needs an empirical work investigating Korean data, which is described below.

III. Research Design

A. Data

The current study employs a large panel data set of 424 Korean manufacturing firms listed on the Korea Stock Exchange for the time period 1999-2008. The data were obtained from the database of Korea Listed Companies Association (KLCA). The database includes 691 firms listed on the Korea Stock Exchange. Some firms that have an amount of missing data on the variables required for the empirical analysis, such as those that newly entered or exited the data in the middle of the period, are eliminated from the sample. The sample consists of 424 firms, and the total number of observations is 4,240. This balanced panel data set might raise the issue of sample-selection bias that the balanced panel is a sample of survivors. However, we could not find a theoretical reason to expect a significant effect of the bias on the relationship between ownership and investment. Moreover, the data used in the study are expected to be acceptable, considering that the bias decreases as sample size increases.

The variables employed in the empirical analysis are selected as

TABLE 1
SUMMARY STATISTICS AND CORRELATION MATRIX

	Median	Mean	s.d.	*rda*	*nsa*	*con*	*frn*	*ist*	*cfa*
rda	0.0611	0.1426	0.3029	1					
nsa	0.0089	0.0096	0.0048	0.04***	1				
con	0.3438	0.3544	0.1945	-0.02	0.04**	1			
frn	0.0186	0.0919	0.1437	0.07***	0.01	0.03*	1		
ist	0.0000	0.0461	0.1105	-0.04**	-0.08***	-0.11***	0.02	1	
cfa	0.0527	0.0493	0.1056	0.04**	0.15***	0.06***	0.19***	0.09***	1

Note: The table shows the summary statistics and the correlation matrix for the variables used in the study. s.d. refers to standard deviation. Figures in the correlation matrix are correlation coefficient estimates. ***, **, and * indicate significance levels at 0.1%, 1%, and 5%, respectively.

follows. R&D intensity (*rda*), calculated as R&D spending divided by total assets, is included as a proxy for R&D investment. As independent variables, the ratio of net sales to total assets (*nsa*), the ratio of cash flow to total assets (*cfa*), and ownership concentration ratio (*con*) are used. The cash flow variable is included as a proxy for financial constraints, which are of particular importance because R&D investment is susceptible to asymmetric information (Fazzari *et al.* 1988; Hall 2002).

The ownership concentration variable is calculated as the shares held by controlling shareholder divided by total shares. According to the KLCA database, controlling shareholders refer to the shareholders who control the firm, and they include shareholders owning substantial equity stake in the firm, their family members, and affiliated entities. However, the database does not publicize the exact definition of "substantial equity stake" and "affiliated entities."

Moreover, to control for ownership identity, we include foreign ownership (*frn*), calculated as the shares held by foreign investors divided by total shares and institutional ownership (*ist*) calculated as the shares held by institutional investors divided by total shares.

The summary statistics and the correlation matrix for the sample are presented in Table 1. The correlation matrix shows a sign causing concern for collinearity between the variables of ownership and sales. However, we examine the value of variance inflation factor, and find that collinearity does not appear to cause a severe estimation problem for the data.

B. Empirical Methods

The basic investment model used in the empirical study is:

$$rda_{i,t} = nsa_{i,t} + cfa_{i,t} + f_i + d_t + e_{i,t} \quad (1)$$

where i refers to firm, t refers to time period, f_i refers to firm fixed effects, d_t refers to year fixed effects, and $e_{i,t}$ refers to the error term. The idea behind this model is that investment depends on the firm's recent performance, calculated as the level of sales and the degree of financial constraints as proxied by cash flow divided by total assets as done in previous research, such as Fazzari *et al.* (1988). Tobin's Q is often used as a control variable for investment profitability; however, the current study does not employ Tobin's Q because it has been criticized for being an unconvincing proxy for investment opportunity (Schiantarelli 1996). For example, investment profitability is supposed to be measured by marginal Q, but average Q is employed in empirical studies because the former is not observable and the latter is observable. If average Q is a poor proxy for marginal Q, the variable of average Q cannot completely control investment profitability. Thus, following previous studies (*e.g.*, Fazzari *et al.* 1988), we use the level of sales instead of Tobin's Q and a dynamic model, which is described below.

We attempt to determine the effect of ownership concentration by adding the variable of ownership concentration to the basic investment model:

$$rda_{i,t} = nsa_{i,t} + cfa_{i,t} + con_{i,t} + f_i + d_t + e_{i,t} \quad (2)$$

If the coefficient estimate of ownership concentration is statistically significant, it indicates the presence of the effect of ownership concentration on R&D investment.

We use a quadratic regression and a piecewise regression to determine if a non-linear relation between ownership and R&D exists:

$$rda_{i,t} = nsa_{i,t} + cfa_{i,t} + con_{i,t} + con^2_{i,t} + f_i + d_t + e_{i,t} \quad (3)$$

$$rda_{i,t} = nsa_{i,t} + cfa_{i,t} + con_{i,t} + con\_h_{i,t} + f_i + d_t + e_{i,t} \quad (4)$$

where $con\_h_{i,t}$ refers to the product of $con_{i,t}$ and a dummy equal to one if $con_{i,t}$ is above the median value. Equation 3 represents the quadratic

TABLE 2
MODEL SPECIFICATION TESTS

Panel Data Models Selection	F test for individual effects	9.1016***
Panel Data Models Selection	LM test	60.699***
Panel Data Models Selection	Hausman test	96.0802***
Heteroskedasticity and Serial Correlation	Wooldridge's test for unobserved individual effects	2.525*
Heteroskedasticity and Serial Correlation	Baltagi and Li A-RE joint test	4397.102***
Heteroskedasticity and Serial Correlation	Bera, Sosa–Escudero and Yoon locally robust test	712.7368***
Heteroskedasticity and Serial Correlation	Baltagi and Li two-sided LM test	1523.673***
Heteroskedasticity and Serial Correlation	Breusch–Godfrey/Wooldridge test for serial correlation in panel models	1989.742***
Heteroskedasticity and Serial Correlation	Durbin–Watson test for serial correlation in panel models	1.0972***
Heteroskedasticity and Serial Correlation	Wooldridge's test for serial correlation in FE panels	38.6393***

Note: The table shows the results of the tests for model specification. Figures are test coefficient estimates. ***, **, and * indicate significance levels at 0.1%, 1%, and 5%, respectively.

regression model, and Equation 4 refers to the piecewise regression model. In the piecewise regression model, the coefficient estimate below the median value is one for $con_{i,t}$, and for high $con_{i,t}$ above the median, the sum of the estimates of $con_{i,t}$ and $con\_h_{i,t}$ becomes the coefficient estimate.

In this study, we use regressions to investigate the panel data set. Generally, three panel data regression models are used in econometric studies: pooled model, fixed effects model, and random effects model. We expect that a fixed effect model is appropriate for the data set because a random effects model is useful when a data set is representative for a population. However, the data used in the present study are drawn from a single country, and thus not a random sample. This expectation is supported by the results of three statistical tests such as F test, LM test, and Hausman test. For all tests, the test statistics are significant at 0.1%. Thus, the fixed effects model is most appropriate for the data. The test results are shown in Table 2.

There are also concerns with the classical assumptions of OLS regression, that is, no heteroskedasticity and no serial correlation. The problems with these assumptions could be severe, especially for panel data. In this study, several statistical tests, which are introduced by Croissant and Millo (2008), are conducted to examine the problems. The results of the tests are also presented in Table 2. According to the results, the regression model of the present study suffers from heteroskedasticity and serial correlation. Thus, a feasible generalized least squares (FGLS) regression is estimated in the empirical analysis instead of OLS regression to control the problems of heteroskedasticity and serial correlation.

We take into account the possible differential effects of various types of ownership on R&D investment by including the interaction terms of ownership concentration and foreign ownership, and of ownership concentration and institutional ownership:

$$rda_{i,t} = nsa_{i,t} + cfa_{i,t} + con_{i,t} + con_{i,t}{*}frn_{i,t} + f_i + d_t + e_{i,t} \tag{5}$$

$$rda_{i,t} = nsa_{i,t} + cfa_{i,t} + con_{i,t} + con_{i,t}{*}ist_{i,t} + f_i + d_t + e_{i,t} \tag{6}$$

As robust methods, we conduct i) a dynamic panel model by GMM regression, and ii) subsample regressions. The dynamic model used in the analysis is:

$$rda_{i,t} = rda_{i,t-1} + nsa_{i,t} + cfa_{i,t} + con_{i,t} + f_i + d_t + e_{i,t} \tag{7}$$

The dynamic model is estimated by the GMM method of the kind introduced by Arellano and Bond (1991). In this model, most effects that persist over time can be controlled. We use the lags of $t-2$ and $t-3$ as GMM instruments because very remote lags might not be informative instruments in practice. Sargan test values are examined in all GMM regressions to determine whether the regression equation is correctly specified and the instrumental variables are valid. Equations 5 and 6 are also estimated by GMM.

Subsample regressions are used to check if the effect of ownership concentration on R&D investment is different among subsample groups. We split the sample by firm maturity, size, R&D intensity, and whether the firm belongs to *chaebol*, that is, a Korean form of business group. Regarding the first three categories, we divide the sample into two groups (above and below the median value): old and young firms, large and small firms, and R&D intensive and non-R&D intensive firms. For the

TABLE 3
FGLS REGRESSION RESULTS

FGLS Regression						
nsa_t	6.1438***	6.1384***	6.0951***	6.0846***	6.1414***	6.1219***
	(10.6250)	(10.6237)	(10.5273)	(10.5016)	(10.6188)	(10.5691)
cfa_t	-0.0529***	-0.0529***	-0.0530***	-0.0528***	-0.0526***	-0.0530***
	(-3.6789)	(-3.6822)	(-3.6808)	(-3.6648)	(-3.6492)	(-3.6801)
con_t		0.0313**	0.0558	0.0525**	0.0282*	0.0298**
		(2.9136)	(1.9010)	(2.5854)	(2.5099)	(2.7248)
con_t^2			-0.0324			
			(-0.8944)			
$con\_h_{i,t}$				-0.0393		
				(-1.2267)		
$con_{i,t}$*$frn_{i,t}$					0.0491	
					(1.0166)	
$con_{i,t}$*$ist_{i,t}$						0.0515
						(0.8053)

Note: The table shows the results of the FGLS regression. Figures are regression coefficient estimates and t-values are shown in parentheses below coefficient estimates. ***, **, and * indicate significance levels at 0.1%, 1%, and 5%, respectively. Year dummies are included in regressions. Multiple R-squared values are 0.5126, 0.5125, 0.5126, 0.5126, 0.5127, and 0.5127 for the first to the last regressions, respectively.

chaebol, we examine the Korea Fair Trade Commission annual reports to determine whether or not a firm is a *chaebol*-affiliated member, and divide the sample into *chaebol* and non-*chaebol* firms.

IV. Empirical Findings

The total sample regression results of FGLS are presented in Table 3. With regard to the basic investment model, the regression result shows the positive effect of net sales level and the negative effect of cash flow on R&D investment spending. Traditionally, the two variables of sales and cash flow are expected to have a positive effect on investment. However, the test result shows the negative effect of cash flow. There is a theoretical explanation for the negative effect of cash flow on investment. According to Cleary *et al.* (2007), the firms with low cash flows are likely to increase investments as cash flow falls because they expect increased revenues from the investments. Thus, there are costs and benefits

TABLE 4
GMM REGRESSION RESULTS

GMM Regression						
rda_{t-1}	0.4631***	0.4631***	0.4630***	0.4628***	0.4632***	0.4630***
	(108.0945)	(108.5453)	(110.0212)	(109.9761)	(108.6905)	(108.6888)
nsa_t	6.6234***	6.5786***	6.5132***	6.4927***	6.5749***	6.5744***
	(6.7746)	(6.7465)	(6.6945)	(6.6796)	(6.7319)	(6.7389)
cfa_t	-0.0295	-0.0308	-0.0307	-0.0296	-0.0307	-0.0305
	(-1.7584)	(-1.8564)	(-1.8328)	(-1.7631)	(-1.8535)	(-1.8424)
con_t		0.0262*	0.0577	0.0499*	0.0260*	0.0273*
		(2.1689)	(1.7776)	(2.1414)	(2.0259)	(2.2176)
con_t^2			-0.0426			
			(-1.1452)			
$con\_h_{i,t}$				-0.0455		
				(-1.4048)		
$con_{i,t}$*$frn_{i,t}$					0.0029	
					(0.0716)	
$con_{i,t}$*$ist_{i,t}$						-0.0512
						(-0.8869)

Note: The table shows the results of the GMM regression. Figures are regression coefficient estimates, and t-values are shown in parentheses below coefficient estimates. ***, **, and * indicate significance levels at 0.1%, 1%, and 5%, respectively. Year dummies are included in regressions. Sargan test p-values are 0.0753, 0.0701, 0.0637, 0.0586, 0.0739, and 0.0680 for the first to the last regressions, respectively.

of investment, and which one is dominant is not theoretically obvious, which would be determined by empirical investigation.

The effect of ownership concentration on R&D investment, which is the focus of the empirical analysis, is statistically confirmed as positive at the 5% significance level. That is, R&D investment is found to increase as equity ownership is concentrated. The positive relationship between ownership concentration and R&D investment, observed in the U.S. firms, appears to be valid in Korean firms as well.

A non-linear relation between ownership and R&D is not confirmed as statistically significant from the FGLS regression results. Both the quadratic regression and the piecewise regression do not show statistically significant coefficients of ownership concentration variables. The regressions with the interaction terms of ownership concentration and ownership identity do not show significant results as well. This finding

TABLE 5
SUBSAMPLE REGRESSION RESULTS—MATURITY

	Old	Young
FGLS Regression		
nsa_t	6.7210***	4.4257***
	(9.5097)	(5.9746)
cfa_t	-0.0808***	0.0060
	(-4.5137)	(0.3501)
con_t	0.0306*	0.0222
	(2.1911)	(1.6892)
GMM Regression		
rda_{t-1}	-0.4170***	0.5836***
	(-68.3721)	(331.7071)
nsa_t	5.5219***	2.6716
	(4.5556)	(1.3206)
cfa_t	-0.0437*	-0.0206
	(-2.5114)	(-0.8996)
con_t	0.0121	0.0346*
	(1.2171)	(2.0664)

Note: The table shows the results of the FGLS and GMM regressions. Figures are regression coefficient estimates, and t-values are shown in parentheses below coefficient estimates. ***, **, and * indicate significance levels at 0.1%, 1%, and 5%, respectively. Year dummies are included in regressions. Multiple R-squared values are 0.7184 for Old and 0.4286 for Young. Sargan test p-values are 0.0736 for Old and 0.2604 for Young.

implies that foreign investors and institutional investors do not play significant roles in the explanation of the ownership effects on investments.

The total sample regression results of GMM, summarized in Table 4, are consistent with the results of FGLS, except for the effect of cash flow. The cash flow variable does not have statistically significant coefficients in the GMM regression probably because the effect of cash flow is absorbed by the lagged value of R&D investment. Theoretically, Allayannis and Mozumdar (2004) explain that firms with severe cash constraints make essential investments only and cannot decrease the investments when cash flow declines. In this case, no relationship between cash flow and investment is observed.

The regression results obtained using the subsamples of old and young firms are shown in Table 5. The GMM regression provides evidence that

TABLE 6
SUBSAMPLE REGRESSION RESULTS—SIZE

	Large	Small
FGLS Regression		
nsa_t	4.7293***	6.8386***
	(8.1444)	(7.3570)
cfa_t	0.0019	-0.0627**
	(0.1327)	(-3.1131)
con_t	0.0137	0.0452**
	(1.3622)	(2.7634)
GMM Regression		
rda_{t-1}	-0.4765***	0.5876***
	(-140.2942)	(204.1794)
nsa_t	3.0196**	5.4717***
	(3.0082)	(3.8593)
cfa_t	-0.0221	-0.0393
	(-1.3002)	(-1.7522)
con_t	0.0100	0.0222
	(0.8673)	(1.1236)

Note: The table shows the results of the FGLS and GMM regressions. Figures are regression coefficient estimates and t-values are shown in parentheses below coefficient estimates. ***, **, and * indicate significance levels at 0.1%, 1%, and 5%, respectively. Year dummies are included in regressions. Multiple R-squared values are 0.7467 for Large and 0.4240 for Small. Sargan test p-values are 0.2969 for Large and 0.4242 for Small.

the effect of ownership concentration exists only in young firms as expected because organizational rigidities and inertia in old firms (Hannan and Freeman 1984) make it more difficult for controlling shareholders to exert influence on management decisions. In contrast, the FGLS regression yields the opposite result: the effect of ownership concentration is significant only in old firms. The results of the regression obtained using the sample split by firm age are mixed and conflicting. Hence, a clear interpretation of the moderating effects of firm maturity is not possible, and further study may be necessary.

When we divide the sample into large and small groups and perform regressions, the significant estimates of ownership concentration are obtained only in small firms in the FGLS regression, which are presented in Table 6. The positive effect of ownership concentration on R&D ap-

TABLE 7
SUBSAMPLE REGRESSION RESULTS—R&D INTENSITY

	R&D intensive	Non-R&D intensive
FGLS Regression		
nsa_t	11.8131***	1.4427***
	(9.8037)	(6.3704)
cfa_t	-0.0797**	-0.0155*
	(-3.0427)	(-2.4855)
con_t	0.0649**	0.0050
	(3.1140)	(1.1900)
GMM Regression		
rda_{t-1}	0.4854***	0.5858***
	(127.1622)	(22.5696)
nsa_t	11.5206***	1.6565*
	(5.9053)	(2.2682)
cfa_t	-0.0184	0.0047
	(-0.7543)	(0.3159)
con_t	0.0680**	0.0035
	(2.6321)	(0.6516)

Note: The table shows the results of the FGLS and GMM regressions. Figures are regression coefficient estimates and t-values are shown in parentheses below coefficient estimates. ***, **, and * indicate significance levels at 0.1%, 1%, and 5%, respectively. Year dummies are included in regressions. Multiple R-squared values are 0.4449 for R&D intensive and 0.3372 for non-R&D intensive. Sargan test p-values are 0.4952 for R&D intensive and 0.5411 for non-R&D intensive.

pears to be valid only in small firms, although this result is not observed for the GMM regression. This finding indicates that having a sufficient proportion of shares in a large firm to exert effective control over management is not easy for blockholders; thus, the level of ownership concentration can hardly be meaningful in a large firm.

As shown by the two subsample regressions above, the effect of the lagged R&D spending is significantly negative for old and large firms, but is positive for young and small firms. That is, established firms that invested a large proportion of their budget in R&D in the previous year are likely to decrease their investment in R&D in the current year, maybe because high investment in the previous period reduces the need to invest in the current period. On the contrary, previous investment encourages current investment in firms with growth opportunities, such as young

TABLE 8
SUBSAMPLE REGRESSION RESULTS—*CHAEBOL*

	Chaebol	non-*Chaebol*
FGLS Regression		
nsa_t	4.3724***	7.0194***
	(6.5540)	(9.4837)
cfa_t	-0.0082	-0.0822***
	(-0.3934)	(-4.9858)
con_t	0.0150	0.0344**
	(1.1556)	(2.6949)
GMM Regression		
rda_{t-1}	0.2295***	0.4773***
	(6.4623)	(164.7332)
nsa_t	3.2057*	6.4362***
	(2.1108)	(6.8015)
cfa_t	-0.0026	-0.0402*
	(-0.1007)	(-2.1646)
con_t	0.0226	0.0204
	(1.6583)	(1.4542)

Note: The table shows the results of the FGLS and GMM regressions. Figures are regression coefficient estimates and t-values are shown in parentheses below coefficient estimates. ***, **, and * indicate significance levels at 0.1%, 1%, and 5%, respectively. Year dummies are included in regressions. Multiple R-squared values are 0.8480 for *Chaebol* and 0.4709 for non-*Chaebol*. Sargan test p-values are 0.4696 for *Chaebol* and 0.1495 for non-*Chaebol*.

and small firms.

The difference between the subgroups observed in the regression using the sample split by size is more clearly found in the regression using the subsamples of R&D intensive and non-R&D intensive firms. The results using the sample split by R&D intensity are reported in Table 7. The regression shows that the positive relationship between ownership concentration and R&D investment is statistically significant in R&D intensive firms, but the relationship is not found in non-intensive firms. This result is confirmed in both FGLS and GMM regressions, which show the statistically significant coefficient estimates at 1%. It just makes sense that, in non-R&D intensive firms, R&D investment is not an important issue in managerial decisions; thus, the effect of ownership structure on management is unimportant in R&D decisions. Furthermore, the

coefficient estimates of ownership concentration are a lot higher in the sample of R&D intensive firms than in the sample of all firms. This finding clearly supports that the effect of ownership concentration on R&D decisions is significantly strong in R&D intensive firms as expected.

The results of the *chaebol*−related subsample regressions, which are shown in Table 8, are similar to the results of the regressions on the subsamples of small and large firms. In the FGLS regression, only non-*chaebol* group seems to have a statistically significant and positive effect of ownership concentration on R&D investment; however, in GMM regression, both groups do not have significant coefficient estimates of ownership concentration. If we focus on the FGLS result only, the ownership effect on R&D investment is not significant in *chaebol* groups because *chaebol* groups are largely controlled by their founding families. However, the current empirical analysis could not isolate the effect of founding families due to data availability problem. Additional data are required to analyze the complicated ownership structure of *chaebol* groups, which is left for future study.

V. Conclusion

In this study, we review theoretical and empirical literature regarding the role of ownership concentration in corporate governance and the relation between ownership and R&D investment. Theoretically, concentrated ownership structure can be an alternative to mitigate the agency problem caused by the separation of ownership and control in dispersed ownership structure. However, theoretical prediction of the relation between ownership concentration and R&D investment is still a controversial issue. Concentrated ownership would clearly improve the monitoring of management. Nevertheless, whether ownership concentration positively affects R&D decisions is not obvious because of the contrasting effects of large shareholders: risk averseness and long-term orientation. This issue needs to be examined empirically. A positive relation between ownership concentration and R&D investment is confirmed in several empirical studies, but the studies use US data only. If we take the moderating effect of different institutional settings into account, we cannot draw a universal conclusion from the previous evidence of the positive effect of ownership concentration.

The current study attempts to determine the effect of ownership concentration on R&D investment decisions by investigating a large panel

data set of Korean listed firms. The study uses several econometric techniques — the fixed effects FGLS regression, the dynamic GMM regression, and the subsample regressions — to determine the effect of ownership concentration on R&D decisions in Korea. The empirical study shows that the positive effect of ownership concentration on R&D is confirmed in Korea, which is supported by the results of fixed effects FGLS regression and dynamic GMM regression. A non-linear relationship between ownership concentration and investment is not observed in the results of quadratic and piecewise regressions. Similarly, we could not find the moderating effects of foreign investors and institutional investors in the regressions using the interaction terms. The results of the subsample regressions indicate that the positive effect of ownership concentration is significant in small firms, R&D intensive firms, and non-*chaebol* firms.

R&D investment is a significant determinant of long-term performance. Thus, understanding the factors that promote R&D investment decisions is important in government policy and corporate governance. The Korean government has been implementing reforms in corporate ownership structure, especially since the financial crisis in 1997. Therefore, the empirical evidence of the positive effect of ownership concentration on R&D investment in Korean firms could shed light on the direction of the reform program.

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