“The effect of related party transactions on R&D investment: Evidence from Korea”

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THE EFFECT OF RELATED PARTY TRANSACTIONS ON R&D INVESTMENT: EVIDENCE FROM KOREA

Abstract

This study aims to investigate the relationship between related party transactions and a firm's investment in research and development (R&D), as well as the moderating effect of a firm's financial health on such a relationship. The study applies a fixed-effect panel regression model with a sample of 13,619 Korean listed firms for the period from 2001 to 2020. The results indicate that related party transactions significantly and positively influence a firm's R&D investment at the 1% level for the study period. Specifically, when related party transactions are divided into operating and non-operating, the results show that only non-operating related party transactions significantly and positively affect firms' investment in R&D. Moreover, findings report that the effect of related party transactions is stronger for firms with financial distress, lower cash holdings, and in the high-tech industry. The results imply that related party transactions promote a firm's R&D investment, which is one of the primary business investments that create a firm's competitive advantage and value. Moreover, the results propose that related party transactions should be carefully evaluated when accessing the firm's investment behavior.

Keywords related party transactions, research and development, internal capital markets, R&D investments, R&D activities

JEL Classification D23, E22, O32

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INTRODUCTION

According to the International Financial Reporting Standard (IFRS), a related party transaction (RPT) is a "transfer of resources, services, or obligations between the reporting entity and a related party" (IASB, 2009, A1268), such as major shareholders, affiliates, or subsidiaries. Since the well-known accounting scandals such as Enron and Parmalat, RPTs have been a prominent topic in the capital market and have drawn significant attention from regulators and academics. Those scandals have been attributed to the extensive use of RPTs to conceal their fraudulent activities, revealing the inherent risk of RPTs. Such crises have obliged regulators and investors to raise concerns about whether conducting RPTs benefits shareholders and the firm itself.

Considering the importance of RPTs, extant research has examined the effects of RPTs on a firm's valuation, performance, and financial reporting (Cheung et al., 2009; Jian. 2003; Nekhili & Cherif, 2011). Nevertheless, there is no consistent evidence about the effects of RPTs. Specifically, there are two prevailing established hypotheses regarding RPTs: the conflict-of-interest and efficient transaction hypotheses. The former considers RPTs as harmful transactions that destroy firm value (Chen et al., 2011; Johnson et al., 2000; Rahman & Nugrahanti,

2021). In contrast, the latter contends that RPTs are efficient and effective transactions under imperfect information, lowering transaction costs and generating an internal capital market where firms can share information and resources (Stein, 1997; Williamson, 1975). These inconclusive views of previous studies clearly imply that it is still an empirical question whether RPTs are efficient contracting mechanisms or harmful transactions.

For the past decade, a firm's R&D activities have expanded considerably with the rapid development of technologies and have become one of the most crucial investments for a significant fraction of listed companies (Ocean Tomo, LLC, 2021). Extant studies show that R&D investments drive economic and firm growth (Kuznets, 1967; Lucas, 1988; Schumpeter, 1939). In this context, extant studies investigate drivers of R&D investments to identify factors that motivate firms to invest in R&D, given the considerable effects R&D investments have on firms and the economy (AlHares, 2020; Baldi & Bodmer, 2018; Geroski & Pomroy, 1990). Although there is considerable interest in R&D investments, only few studies have investigated the influence of RPTs on R&D investment.

1. LITERATURE REVIEW AND HYPOTHESES

In terms of the effect of RPTs, there are two contradicting perspectives supported by two different hypotheses from prior literature. According to the conflict-of-interest hypothesis, RPTs are harmful transactions intended to extract resources from minority shareholders. For instance, Berkman et al. (2009) demonstrate that controlling shareholders expropriate wealth by issuing loan guarantees to firms in which they hold large shares or are controlled by them. Similarly, Johnson et al. (2000) argue that controlling shareholders "tunnel" minority shareholders' wealth through transactions between related parties. Cheung et al. (2009) further present evidence of tunneling by showing that sales and purchase prices of RPTs are determined so that resources are transferred to controlling shareholders from minority shareholders.

Prior literature on RPTs also demonstrates that RPTs are strongly connected with financial reporting quality and earnings management (Beasley et al., 2010; Chen et al., 2011; Gordon & Henry, 2005; Haji-Abdullah & Wan-Hussin, 2015; Kohlbeck & Mayhew, 2017). Gordon and Henry (2005) and Jian (2003) document that RPTs are one of the major tools for managing earnings. Furthermore, Haji-Abdullah and Wan-Hussin (2015) assert that RPTs are highly related to a firm's real earnings management.

These prior studies imply that opportunistic use of RPTs causes an inefficient allocation of resources by allocating funds to related parties rather than R&D investment. They also show that the presence of RPTs signals the management's myopic behavior, such as earnings management and fraudulent activity. R&D is a long-term investment process with substantial uncertainty and risks. Thus, according to the conflict-of-interest hypothesis, firms with heavy RPTs are more likely to forego R&D investments for the controlling shareholders' private benefit and short-term performance. Collectively, under the conflict-of-interest hypothesis, RPTs would negatively affect the R&D investment of a firm.

On the other hand, the efficient transaction hypothesis contends that RPTs help firms to become economically efficient by reducing transaction costs, leading to efficient contracting under an incomplete information environment (Chang & Hong, 2000; Khanna & Palepu, 1997; Wang et al., 2019; Williamson, 1975). Studies supporting the efficient transaction hypothesis state that intra-group transactions provide firms with high incentives to share information and resources, reducing information asymmetry and adverse selection. Thus, RPTs can help firms improve operational efficiency and performance by reducing transaction costs (Shin & Park, 1999; Stein, 1997; Williamson, 1975).

Furthermore, prior studies contend that RPTs establish and facilitate internal capital markets within related parties (Chang & Hong, 2000; Fan et al., 2008; Gonenc, 2009). For example, Chang and Hong (2000) document that RPTs benefit from sharing financial resources and intangibles, enhancing firm performance and internal finance. Similarly, Fan et al. (2008) contend that firms can transfer resources

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through RPTs of raw materials and intermediate or final products. They also argue that non-operating RPTs, such as transactions of assets, debt guarantees, and low-interest loans, can facilitate the transfer of funds or other resources. Gonenc (2009) shows that firms can establish internal capital markets among related parties and share resources by performing several RPTs. Other research further documents that RPTs generate excess profits and cash by providing flexible price policies for sales and purchases between related parties (Cho & Kim, 2013), enhancing internal capital markets within related parties.

Collectively, previous studies show that RPTs, such as asset transactions, equity transfers, and direct cash payments among related parties, facilitate firms' ability to access internal capital and acquire required funds when external financing is limited.

R&D is one of the firm's investment activities with high risks, asymmetric information, and substantial uncertainty that hinders forms from accessing external capital (Zhang, 2015). These features of R&D also diminish the collateral value of R&D activities (Hall & Lerner, 2010). Previous studies show that when investors struggle to estimate the probability of R&D success and firm value, investors favor low-risk and short-term projects, increasing the cost of external financing (Hall & Lerner, 2010; Leland & Pyle, 1977). These studies suggest that investment in R&D activities necessitates internal financing, particularly in imperfect capital markets.

In this context, prior literature also highlights the critical impact of the internal capital market in facilitating R&D investments, as internal finance is a vital factor affecting firms' R&D activities (Belenzon & Berkovitz, 2010; Himmelberg & Petersen, 1994; Ren et al., 2021; Shin & Park, 1999; Xiang, 2021). Previous studies commonly argue that external financing for R&D activities is costly because of information asymmetry and capital market imperfections. Therefore, firms must rely on internal finance, implying that internal capital markets help firms alleviate financial constraints and thus promote the firm's R&D activities. Given that prior literature suggests internal capital markets established among related parties through RPTs could substitute imperfect external capital markets, RPTs will ease financial pressures on firms and encourage R&D investments.

In general, the previous research on the effects of RPTs yields conflicting predictions about the influence of RPTs on a firm's R&D investments. Thus, it remains an empirical question if there is a positive or negative influence of RPTs on R&D investment.

Extant studies state that R&D is a long-term investment project with substantial information asymmetry that hinders investors from accurately estimating the firm's value, leading to a higher cost of external capital (Hu et al., 2017; Kim & Park, 2015). Thus, a firm's internal financing ability is critical to make investments in R&D. When firms are experiencing financial difficulties, they rely more on internal finance or internal capital markets (He et al., 2013) than external finance, indicating that the role of RPTs in establishing internal capital markets is crucial. In addition, previous studies, such as that conducted by Habib et al. (2013) and Li et al. (2020), prove that companies in financial distress have a tendency to manage earnings, implying the opportunistic use of RPTs will increase when firms are financially distressed. An increase in the opportunistic RPTs will exacerbate the inefficiency in allocating resources. Therefore, for firms experiencing financial distress, there would be a stronger association between RPTs and R&D investment.

By examining the relationship between RPTs and R&D investment, this study intends to provide novel insight into the impact of RPTs. Moreover, this study investigates the moderating effect of a firm's financial condition on such a connection. Based on the prior literature reviews and arguments, this study anticipates a significant association between RPTs and a firm's R&D investment. In addition, the study predicts that the impact of RPTs will be stronger for financially distressed firms. This study, therefore, set the following hypotheses:

H1a: There is a negative relationship between RPTs and a firm's R&D investment (Conflict-of-interest hypothesis).

H1b: There is a positive relationship between RPTs and a firm's R&D investment (Efficient transaction hypothesis).

H2: The effect of RPTs on R&D investment is stronger for financially distressed firms.

2. METHOD

This study aims to examine whether RPTs significantly affect firms' R&D investments. For this purpose, this study extends models proposed by previous studies on firms' R&D investments (Bhagat & Welch, 1995; Xiang, 2021) by including RPTs as independent variables and estimating the following fixed-effect regression model:

$$\begin{aligned} RD_{it} &= \beta_0 + \\ &+\beta_1 RPT_{it-1}\left(OP\_RPT_{it-1}, NON\_OP\_RPT_{it-1}\right)+ \\ &+\beta_2 PPE_{it-1} + \beta_3 SIZE_{it-1} + \beta_4 ROA_{it-1} \\ &+\beta_5 LEV_{it-1} + \beta_6 CAPEX_{it-1} + \beta_7 LNAGE_{it-1} + \\ &+\sum IND + \sum YEAR + \varepsilon_t. \end{aligned} \quad (1)$$

In the model, *RD* denotes the firm's R&D intensity, which captures the total R&D expenditures of a firm. *RPT* is the firm's total amount of RPTs, which is the independent variable. This study categorizes RPTs as operating (*OP_RPT*) and non-operating (*NON_OP_RPT*) RPTs in order to verify the RPT type that significantly impacts a firm's R&D investment. Operating RPTs present transactions of services, materials, or goods, and non-operating RPTs capture the transactions related to fixed and investment assets (Kang et al., 2014). The model includes firm characteristics that may potentially influence R&D investments. Each variable in the model is described in detail in Appendix A. Standard errors are adjusted to confirm robustness within-firm cluster correlations (Petersen, 2009). Furthermore, this study employs a fixed effect model to account for the industry and year fixed effects. Lastly, the lead-lag test model is adopted to address the influence of omitted variables and causality issues by incorporating lagged independent and control variables.

To test the second hypothesis, samples are separated according to Altman's (1968) Z-score, which measures the degree of a firm's financial health. Specifically, this study divides sample firms into three subsamples depending on Z-score: (1) safe firms with Z-score > 2.99, (2) gray firms with 1.8 < Z-score <= 2.99, and (3) distressed firms with Z-scores < 1.8. To clarify the empirical result further, sample firms are separated into two subsamples based on the median of the industry. Then, this study investigates if the relationship between RPTs and R&D investment is stronger for firms in financial distress.

This study analyzes data on publicly traded Korean companies for the period 2001–2020. The data on the firm's financial information and RPTs are retrieved from the FnGuide and TS2000 databases, which are comparable to Compustat in the United States. From the sample, financial institutions are excluded due to their unique industry features. Moreover, to maintain sample homogeneity, firms without fiscal year-ends of December are also removed from the sample. Finally, firms without necessary data for variables are excluded, resulting in a large sample size of 13,619 firm-year observations.

Table 1 summarizes the descriptive statistics for variables used in the model. Each continuous variable is winsorized at the top and bottom 1%. The mean and median values of *RD,* the dependent variable, are 1.1524 and 0.1551, respectively. The value also indicates that the average of the *RPT* is 0.2540. *OP_RPT* and *NON_OP_RPT* have respective mean values of 0.0652 and 0.1868, indicating that the amount of non-operating RPTs is higher than that of operating RPTs.

Table 1. Descriptive statistics

Variable	N	Mean	Standard deviation	Median	25%	75%
RD	13,619	1.1524	2.1365	0.1551	0.0000	1.2817
RPT	13,619	0.2540	0.3193	0.1247	0.0142	0.3717
OP_RPT	13,619	0.0652	0.1717	0.0000	0.0000	0.0099
NON_OP_RPT	13,619	0.1868	0.3001	0.0351	0.0000	0.2382
PPE	13,619	0.1847	0.1678	0.1519	0.0620	0.2668
SIZE	13,619	26.7338	1.6636	26.4264	25.5692	27.6113
ROA	13,619	0.0311	0.2128	0.0297	0.0051	0.0669
LEV	13,619	0.4706	0.3815	0.4595	0.2890	0.6185
CAPEX	13,619	0.1855	0.3221	0.0973	0.0372	0.2119
LNAGE	13,619	3.4432	0.7041	3.6376	3.2581	3.8918

Notes: (1) All variables are defined in the appendix. (2) All continuous variables are winsorized at the top and bottom 1%. (3) All *p*-values are based on two-tailed tests.

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Table 2. Correlations

Variable	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
RD_{it} (1)	0.2069	(0.0067)	0.2237	(0.0237)	0.0331	0.0456	(0.0964)	0.0438	(0.0614)
	<.0001	0.4364	<.0001	0.0057	0.0001	<.0001	<.0001	<.0001	<.0001
RPT_{it-1} (2)	–	0.3703	0.8313	(0.0475)	0.0526	(0.0009)	(0.1244)	0.0407	(0.0205)
	–	<.0001	<.0001	<.0001	<.0001	0.9155	<.0001	<.0001	0.0169
OP_RPT_{it-1} (3)	–	–	(0.2046)	0.0574	(0.1208)	0.0112	(0.0076)	0.0848	(0.0681)
	–	–	<.0001	<.0001	<.0001	0.1912	0.3727	<.0001	<.0001
$NON\_OP\_RPT_{it-1}$ (4)	–	–	–	(0.0850)	0.1275	(0.0075)	(0.1270)	(0.0083)	0.0194
	–	–	–	<.0001	<.0001	0.3807	<.0001	0.3309	0.0236
PPE_{it-1} (5)	–	–	–	–	0.0127	0.0299	0.0740	0.0380	(0.0690)
	–	–	–	–	0.1393	0.0005	<.0001	<.0001	<.0001
$SIZE_{it-1}$ (6)	–	–	–	–	–	0.0237	0.1064	(0.1242)	0.0595
	–	–	–	–	–	0.0057	<.0001	<.0001	<.0001
ROA_{it-1} (7)	–	–	–	–	–	–	(0.1602)	0.0498	(0.0616)
	–	–	–	–	–	–	<.0001	<.0001	<.0001
LEV_{it-1} (8)	–	–	–	–	–	–	–	(0.0531)	(0.0090)
	–	–	–	–	–	–	–	<.0001	0.2929
$CAPEX_{it-1}$ (9)	–	–	–	–	–	–	–	–	(0.0691)
	–	–	–	–	–	–	–	–	<.0001
$LNAGE_{it-1}$ (10)	–	–	–	–	–	–	–	–	1

Notes: (1) All variables are defined in the appendix. (2) All continuous variables are winsorized at the 1% and 99% levels. (3) The numbers in parentheses are *p*-values. (4) All *p*-values are based on two-tailed tests.

Table 2 reports the Pearson correlations, indicating that the *RD*, a dependent variable, positively correlates with the independent variable *RPT*. It also indicates that *RD* is positively correlated with non-operating RPTs (*NON_OP_RPT*), while operating RPTs (*OP_RPT*) are not. However, it is difficult to draw an accurate conclusion about the effect of RPTs on a firm's investment in R&D based on the Pearson correlation coefficient. The results of regression analyses are reported in the next section, taking into account all variables used in the analyses.

3. RESULTS

The empirical results for hypotheses 1a and 1b are presented in Table 3. As shown in Panel A of Table 3, the coefficient of *RPT* is 1.1621, which is positive and statistically significant at the 1% level. This result supports the efficient transaction hypothesis that RPTs facilitate a firm's investment in R&D. In addition, the study demonstrates that *SIZE*, *ROA*, *LEV*, *CAPEX*, and *LNAGE are highly associated with R&D investment, which is in line with previous research (*Bhagat & Welch, 1995; Hu et al., 2017*).*

Moreover, the study divides firm-level RPTs into operating and non-operating RPTs in order to identify the category of RPTs that influence a firm's R&D investment. Panel B of Table 3 reports that only *NON_OP_RPT* has a significant and positive coefficient estimate, while the coefficient of *OP_RPT* is not statistically significant. The coefficient of *NON_OP_RPT (1.4608) in column (2) is statistically positive at the 1% level. The full model in column (3) also demonstrates that among two types of RPTs, only non-operating RPTs (NON_OP_RPT) is significantly associated with R&D investment. The results imply that, on average, firms employ non-operating RPTs to facilitate R&D investment by transferring resources.*

Table 4 displays the results of the second hypothesis. Panel A of Table 4 reports the findings of the Z-score-based analysis that separates sample firms into three subgroups. The findings indicate that the effect of RPTs on the firm's investment in R&D is stronger for financially distressed and gray firms. The coefficients of *RPT* for gray and distressed firms are 1.2845 and 1.4191, respectively, and are statistically significant at the 1% level. However, for financially safe firms, the coefficient of *RPT* is not statistically significant, indicating that RPTs have a greater impact on financially distressed firms.

Table 3. Relate party transactions and firm R&D investments

Panel A: Effect of RPTs on firm's R&D investments

Variable	Dependent variable = RD_t	
	Coef.	p-value
Intercept	0.3419	0.7478
RPT_{it-1}	**1.1621**	**<0.01**
PPE_{it-1}	–0.0131	0.9568
$SIZE_{it-1}$	0.0637	0.0995
ROA_{it-1}	0.3250	0.0663
LEV_{it-1}	–0.3846	0.0815
$CAPEX_{it-1}$	0.1910	0.0920
$LNAGE_{it-1}$	–0.2073	0.0164
Firm Clustering	YES	
Industry-fixed effect	YES	
Year-fixed effect	YES	
Adj. R^2	0.135	
N	13,619	

Notes: (1) All variables are defined in the appendix. (2) The numbers in parentheses are *p*-values. (3) All *p*-values are based on two-tailed tests. (4) All continuous variables are winsorized at the top and bottom 1%.

Panel B: Effect of RPTs on firms' R&D investments based on the type of RPTs

Variable	Dependent variable = RD_t					
	Operating RPTs (1)		Non-operating RPTs (2)		Full Model (3)	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	0.4785	0.6835	0.4787	0.6435	0.4525	0.6620
OP_RPT_{it-1}	**–0.0502**	**0.7955**			**0.2457**	**0.2338**
$NON\_OP\_RPT_{it-1}$			**1.4608**	**<0.01**	**1.4770**	**<0.01**
PPE_{it-1}	–0.0584	0.8222	–0.0053	0.9823	–0.0033	0.9891
$SIZE_{it-1}$	0.0772	0.0821	0.0552	0.1391	0.0557	0.1350
ROA_{it-1}	0.2948	0.0700	0.3183	0.0698	0.3208	0.0688
LEV_{it-1}	–0.4940	0.0765	–0.3723	0.0758	–0.3685	0.0772
$CAPEX_{it-1}$	0.2526	0.0282	0.2073	0.0641	0.2020	0.0724
$LNAGE_{it-1}$	–0.2294	<0.01	–0.2106	0.0144	–0.2091	0.0152
Firm Clustering	YES		YES		YES	
Industry-fixed effect	YES		YES		YES	
Year-fixed effect	YES		YES		YES	
Adj. R^2	0.1066		0.1428		0.1431	
N	13,619		13,619		13,619	

Notes: (1) All variables are defined in the appendix. (2) The numbers in parentheses are *p*-values. (3) All *p*-values are based on two-tailed tests. (4) All continuous variables are winsorized at the top and bottom 1%.

Panel B of Table 4 illustrates the results when sample firms are divided into two subgroups based on the median of the industry. The results indicate that the association between RPTs and R&D investment is statistically significant. In addition, the results indicate that this connection is stronger for firms with Altman's Z-score below the median of the industry. For firms with a low Z-score, the coefficient of *RPT* is 1.4446 and statistically significant at the 1% level. Similarly, the coefficient of *RPT* (0.6731) for firms with high Altman's (1968) Z-score is also significant and positive (p-value = 0.0909). However, the coefficient of *RPT* is bigger for firms with low Z-scores than for those with high Z-scores. Statistically, their differences are significant at the 1% level. The findings corroborate the efficient transaction hypothesis, which states that RPTs influence a firm's investment in R&D by establishing and developing the internal capital market among related parties.

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Table 4. The effect of RPTs on a firm's R&D investments based on the firm's financial health

Panel A: Subsample analysis based on Altman's (1968) Z-score

Variable	Dependent variable = RD_t					
	Safe firms with Z-score > 2.99		Gray firms with 1.8 < Z-score <= 2.99		Distressed firms with Z-score < 1.8	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	–2.3965	0.2622	–2.2916	0.1434	1.7842	0.0309
RPT_{it-1}	**0.2831**	**0.4182**	**1.2845**	**<0.01**	**1.4191**	**<0.01**
PPE_{it-1}	1.1389	0.0877	0.6074	0.1763	–0.5267	<0.01
$SIZE_{it-1}$	0.2199	0.0109	0.1646	<0.01	–0.0214	0.4481
ROA_{it-1}	1.2797	0.1528	–0.8706	0.0791	0.0496	0.3054
LEV_{it-1}	–0.7301	0.1111	–0.4252	0.2666	–0.1747	0.1435
$CAPEX_{it-1}$	0.2516	0.1527	0.0731	0.6078	–0.0226	0.7956
$LNAGE_{it-1}$	–0.3979	<0.01	–0.1519	0.1461	–0.0401	0.6032
Firm Clustering	YES		YES		YES	
Industry-fixed effect	YES		YES		YES	
Year-fixed effect	YES		YES		YES	
Adj. R^2	0.1888		0.1454		0.1451	
N	3,724		3,989		5,906	

Notes: (1) All variables are defined in the appendix. (2) The numbers in parentheses are *p*-values. (3) All *p*-values are based on two-tailed tests. (4) All continuous variables are winsorized at the top and bottom 1%. (5) This table documents the OLS regression results of the relation between Relate Party Transactions and R&D conditional on firms' financial health using Altman's (1968) Z-score. Sample firms are partitioned into three groups based on Z-score: (1) safe firms with Z-score > 2.99, (2) gray firms with 1.8 < Z-score <= 2.99, and (3) distressed firms with Z-scores < 1.8.

Panel B: Subsample analysis based on the industry median of Altman's (1968) Z-score

Variable	Dependent variable = RD_t				Difference Test
	Firms with high Z-score		Firms with low Z-score		
	Coef.	p-value	Coef.	p-value	
Intercept	–2.3879	0.1571	1.7043	0.0457	
RPT_{it-1}	**0.6731**	**0.0223**	**1.4446**	**<0.01**	**<0.01**
PPE_{it-1}	0.8110	0.0653	–0.4746	<0.01	
$SIZE_{it-1}$	0.1932	<0.01	–0.0124	0.6655	
ROA_{it-1}	1.1616	0.1344	0.0296	0.6442	
LEV_{it-1}	–0.6820	0.0529	–0.1847	0.1415	
$CAPEX_{it-1}$	0.2222	0.1307	0.0142	0.8672	
$LNAGE_{it-1}$	–0.2861	0.0121	–0.0700	0.3774	
Firm Clustering	YES		YES		
Industry-fixed effect	YES		YES		
Year-fixed effect	YES		YES		
Adj. R^2	0.1606		0.1418		
N	6,810		6,809		

Notes: (1) All variables are defined in the appendix. (2) The numbers in parentheses are *p*-values. (3) All *p*-values are based on two-tailed tests. (4) All continuous variables are winsorized at the top and bottom 1%. (5) This table documents the OLS regression results of the relation between Relate Party Transactions and R&D conditional on firms' financial health using Altman's (1968) Z-score. Sample firms are partitioned into two groups based on industry median Z-score.

The result of this study shows that RPTs stimulate R&D activities, supporting the efficient transaction hypothesis that RPTs allow firms to enjoy internal capital markets among related parties established through RPTs. Previous studies show that a firm's cash holding level is a major determinant of its R&D investments (Myers & Majluf, 1984; Harford et al., 2014). Therefore, if RPTs facilitate R&D investments by allowing firms to obtain resources through internal capital markets among related parties, they will play a more significant role when the firm has low internal finance. This implies that RPTs will have a larger effect on a firm with lower cash holdings.

To verify this argument, this study divides sam-

ples into two subsamples based on a company's cash holdings. Table 5 displays the test results on the influence of RPTs on R&D investment based on the firm's cash holdings: firms with large cash holdings and firms with low cash holdings based on the median of the industry. The findings indicate that the regression coefficient of *RPT* for firms with low cash holdings is 1.4719 and statistically significant at the 1% level. Moreover, the coefficient of *RPT* for firms with lower cash holdings is stronger than that of firms with large cash holdings (0.8579, p-value < 0.01). In addition, they are significantly different at the 1% level, indicating that the influence of RPTs is stronger for firms with low cash holdings than those with large cash holdings.

Prior research indicates that the marginal value of internal finance is greater for companies in the high-tech industry. For example, Hu et al. (2017) argue that information asymmetry is high for companies in the high-tech industry, increasing the firm's cost of eternal capital and creating difficulties for investors in evaluating the firm's value. Additionally, Myers and Majluf (1984) claim that firms in the high-tech industry maintain significant information asymmetry strategically in order to preserve the return on R&D investment and enhance future competitiveness. Hence, firms in the high-tech industry have to finance their R&D investment through internal finance (Chen & Lee, 2018; Himmelberg & Petersen, 1994).

Given that firms in the high-tech industry are more likely to rely on internal finance or internal capital markets to support R&D activities, the positive relationship between RPTs and firms' R&D investments would be stronger for firms in the high-tech industry than those in the low-tech industry. To test this argument, this study conducts the additional analysis by dividing the samples into two subgroups. Following Kile and Phillips (2009), this study categorizes firms as those in the high-tech and low-tech industries. Kile and Phillips (2009) provide recommendations for industry categorization accuracy by generating samples of high-technology enterprises using Global Industry Classification Standards (GIC) codes, the Standard Industrial Classification (SIC), and the North American Industry Classification System (NAICS). The Kile and Phillips-developed SIC code can generate large samples of technology enterprises, resulting in more powerful statistical sampling. Therefore, in this study, the analysis was carried out by dividing the samples based on Kile and Phillips' (2009) method.

Table 6 reveals that the coefficient of *RPT* for firms in the high-tech industry is 1.0424, showing a positive and statistically significant value at the 1% level. Moreover, it is greater than the coefficient for firms in the low-tech industry, which is also positive (0.6671) and significant at the 1% level. Furthermore, their difference is statistically significant at the 1% level, demonstrating that the

Table 5. Effect of RPTs on firm's R&D investments based on the firm's level of cash holdings

Variable	Dependent variable = RD_t				Difference Test
	Firms with High Cash holdings		Firms with Low Cash holdings		
	Coef.	p-value	Coef.	p-value	
Intercept	0.1145	0.9303	0.6573	0.5871	
RPT_{it-1}	**0.8579**	**<0.01**	**1.4719**	**<0.01**	**<0.01**
PPE_{it-1}	0.0791	0.8066	–0.2089	0.4116	
$SIZE_{it-1}$	0.0774	0.1245	0.0441	0.3273	
ROA_{it-1}	0.8358	0.0523	0.1169	0.1043	
LEV_{it-1}	–0.2177	0.2603	–0.5971	<0.01	
$CAPEX_{it-1}$	0.1104	0.4517	0.2340	0.0630	
$LNAGE_{it-1}$	–0.2589	0.0244	–0.1259	0.1531	
Firm Clustering	YES		YES		
Industry-fixed effect	YES		YES		
Year-fixed effect	YES		YES		
Adj. R^2	0.134		0.1016		
N	6,809		6,810		

Notes: (1) All variables are defined in the appendix. (2) The numbers in parentheses are *p*-values. (3) All *p*-values are based on two-tailed tests. (4) All continuous variables are winsorized at the top and bottom 1%.

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Table 6. Effect of RPTs on firm's R&D investments based on the industry type

Variable	Dependent variable = RD_t				Difference Test
	High-Tech Industry		Low-Tech Industry		
	Coef.	p-value	Coef.	p-value	
Intercept	–5.4570	0.0650	1.7313	0.0320	
RPT_{it-1}	**1.0424**	**<0.01**	**0.6671**	**<0.01**	**<0.01**
PPE_{it-1}	–1.1104	0.0778	0.1614	0.4801	
$SIZE_{it-1}$	0.3929	<0.01	0.0095	0.7448	
ROA_{it-1}	0.2423	0.1169	0.4929	0.2306	
LEV_{it-1}	–0.0509	0.6004	–0.7602	<0.01	
$CAPEX_{it-1}$	0.1276	0.5471	0.0841	0.4649	
$LNAGE_{it-11}$	–0.4210	0.1837	–0.1862	0.0184	
Firm Clustering	YES		YES		
Industry-fixed effect	YES		YES		
Year-fixed effect	YES		YES		
Adj. R^2	0.117		0.1353		
N	2,842		10,777		

Notes: (1) All variables are defined in the appendix. (2) The numbers in parentheses are *p*-values. (3) All *p*-values are based on two-tailed tests. (4) All continuous variables are winsorized at the top and bottom 1%.

influence of RPTs is greater for firms in the high-tech industry. The result of the study supports the authors' contention that RPTs facilitate firms' investment in R&D by forming and enhancing the internal capital market within related parties.

Although this study addresses potential omitted variable problems by adopting a lead-lag test model for every analysis, this study also undertakes the change analysis to address causality issues between RPTs and R&D investment. If the level of RPTs determines the level of firm's investment in R&D, then a change in the level of RPTs will impact the firm's level of R&D investment. Thus, this analysis demonstrates if a change in RPTs influences a firm's R&D investment. Panel A of Table 7 demonstrates that the coefficient of ΔRPT_{it-1}, *which captures the change in RPTs, is still positive and significant by showing the coefficient estimate of 0.2574 with a p-value of 0.0801. This result is qualitatively in line with the main findings,* suggesting that the analysis is robust with regard to causality issues.

Table 7. Robustness test: Changes in RPTs and changes in the firm's R&D investments

Panel A: Change analysis by using total RPTs

Variable	Dependent variable = ΔRD_t	
	Coef.	p-value
Intercept	0.0523	0.0141
ΔRPT_{it-1}	**0.2574**	**0.0801**
ΔPPE_{it-1}	–0.6977	0.0503
$\Delta SIZE_{it-1}$	0.5335	<0.01
ΔROA_{it-1}	–0.2556	0.3250
ΔLEV_{it-1}	–0.6692	<0.01
$\Delta CAPEX_{it-1}$	0.0694	0.5684
$\Delta LNAGE_{it-1}$	–0.1189	0.6062
Firm Clustering	YES	
Industry-fixed effect	YES	
Year-fixed effect	YES	
Adj. R^2	0.04078	
N	13,619	

Notes: (1) All variables are defined in the appendix. (2) The numbers in parentheses are *p*-values. (3) All *p*-values are based on two-tailed tests. (4) All continuous variables are winsorized at the top and bottom 1%.

Table 7 (cont.). Robustness test: Changes in RPTs and changes in the firm's R&D investments
Panel B: Change analysis by dividing RPTs into operating and non- operating RPTs

Variable	Dependent variable = ΔRD_t					
	Operating RPTs (1)		Non-operating RPTs (2)		Full Model (3)	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	0.1083	<0.01	0.1047	<0.01	0.1044	<0.01
ΔOP_RPT_{it-1}	**–0.0043**	**0.9725**			**0.1843**	**0.2291**
$\Delta NON\_OP\_RPT_{it-1}$			0.2744	0.0733	0.3181	0.0629
ΔPPE_{it-1}	–0.7100	0.0465	–0.7194	0.0442	–0.7129	0.0450
$\Delta SIZE_{it-1}$	0.5344	<0.01	0.5421	<0.01	0.5432	<0.01
ΔROA_{it-1}	–0.2609	0.3153	–0.2542	0.3283	–0.2534	0.3297
ΔLEV_{it-1}	–0.6530	<0.01	–0.6553	<0.01	–0.6620	<0.01
$\Delta CAPEX_{it-1}$	0.0692	0.5700	0.0691	0.5707	0.0691	0.5706
$\Delta LNAGE_{it-1}$	–0.0824	0.7125	–0.0902	0.6868	–0.0836	0.7115
Firm Clustering	YES		YES		YES	
Industry-fixed effect	YES		YES		YES	
Year-fixed effect	YES		YES		YES	
Adj. R^2	0.037711		0.038074		0.03812	
N	13,619		13,619		13,619	

Notes: (1) All variables are defined in the appendix. (2) The numbers in parentheses are *p*-values. (3) All *p*-values are based on two-tailed tests. (4) All continuous variables are winsorized at the top and bottom 1%.

Additionally, the study conducts the change analysis by separating operating and non-operating RPTs from the total RPTs. Panel B of Table 7 shows that changes in non-operating RPTs are statistically significant and positive, indicating that non-operating RPTs are positively related to changes in the R&D investment of the firm. This demonstrates that the main result still holds even after addressing the causality issues.

4. DISCUSSION

The study finds a positive effect of RPTs on a firm's investment in R&D, implying that companies with higher RPTs are likely to invest more in R&D. This result supports the efficient transaction hypothesis that considers RPTs efficient transactions that maximize shareholder value. Prior studies argue that RPTs help firms create synergy between related parties by reducing information asymmetry and adverse selection problems and sharing resources. Specifically, they state that RPTs help firms achieve economic efficiency by generating and enhancing a firm's internal capital market. Given that features of R&D, such as high risks, uncertainty, and asymmetric information, hinder firms from accessing external capital to finance R&D, RPTs facilitate a firm's investment in R&D. This result is consistent with earlier research that supports the efficient transaction hypothesis, including Chang and Hong (2000), Fan et al. (2008), and Gonec (2009). However, the result contradicts studies supporting the conflict-of-interest hypothesis, such as Jiang et al. (2015) and Kim and Yoo (2017). In particular, this study shows the opposite result of Kim and Yoo (2017), who report the negative association between RPTs and a company's R&D intensity.

In addition, this study verifies which type of RPTs significantly affects a firm's investment in R&D. In a normal business transaction, RPTs occur throughout the accounting period, whereas non-operating RPTs are typically infrequent and substantial. Due to the recurring nature of operating RPTs and their high comparability with peer firms in the same industry (Fan et al., 2008; Kang et al., 2014), operating RPTs are often subject to stronger scrutiny than non-operating RPTs. Therefore, it may be difficult for firms to access internal capital markets established through operating RPTs and share resources efficiently if the price policies of transactions between related parties are abnormal compared to industry-average prices. Therefore, because regulators are more likely to scrutinize operating

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RPTs, firms are more likely to employ non-operating RPTs to transfer large sums of resources. Moreover, non-operating RPTs involve more discretion and subjective judgment than standard operating activities, allowing firms to share and allocate resources more efficiently (Kang et al., 2014). Hence, non-operating RPTs would be more influential than operating RPTs in facilitating a company's R&D investment. The study finds that only non-operating RPTs significantly affect a firm's investment in R&D, which is in line with the claims and findings in research by Fan et al. (2008) and Kang et al. (2014).

The result for H2 reveals that the favorable impact of RPTs on R&D investment is stronger for financially distressed firms. This finding lends credence to He et al. (2013), who show that firms with financial difficulties are more prone to rely on internal capital markets. Given that R&D characteristics result in a higher cost of external capital, the role of RPTs in establishing and facilitating the internal capital market is important in financing R&D activities. This implies that when firms are financially healthy and have sufficient abilities to finance R&D activities, the positive effect of RPTs on R&D investment may not be influential. By contrast, when firms are financially distressed and face difficulties in accessing external capital, the effect of RPTs will be stronger.

Collectively, in confirming that RPTs have a favorable influence on a company's R&D investment, the results provide new insight into the contradictory evidence on the impact of RPTs. It provides evidence in support of the efficient transaction hypothesis, which states that RPTs are efficient transactions that allow firms to achieve economic efficiency. Furthermore, the results indicate that the financial health of a firm is a significant moderator of the positive relationship between RPTs and R&D investment.

CONCLUSION

The objective of this study is to examine the impact of RPTs on R&D investment. Moreover, this study examines how the financial condition of a firm influences the relationship between RPTs and R&D investment.

The study's primary finding is that RPTs are positively related to a firm's R&D activities. The study also finds that the positive impact of RPTs on R&D activities is more pronounced for financially distressed firms. In addition, the study demonstrates that the impact of RPTs on a company's R&D investment is greater for firms in the high-tech industry and those with low cash holdings. The primary results of this study still hold even after addressing omitted variables and causality issues using the lead-lad test model and change analysis.

The study's findings provide new insight into the contradictory evidence on the effect of RPTs. This extends and advances the relevant literature by demonstrating that RPTs are significantly related to R&D investment, which is crucial to its future growth and long-term sustainability. While majority of research examines the impact of RPTs on firms' value, performance, and financial reporting, the study provides empirical evidence that RPTs are also a major driver of a firm's investment in R&D. Collectively, the study demonstrates that transactions among related parties facilitate R&D investment by helping their financing activities via internal capital markets. Moreover, the study provides the practical implication that market participants, including investors and regulators, should focus on the firm's RPTs to set effective investment decisions and desirable policies on RPTs as they could drive firms' investment in R&D, a crucial component of a firm's future growth and long-term sustainability.

AUTHOR CONTRIBUTIONS

Conceptualization: Ilhang Shin, Hansol Lee.
Data curation: Ilhang Shin.
Formal analysis: Ilhang Shin.
Funding acquisition: Ilhang Shin.
Investigation: Hansol Lee.
Methodology: Ilhang Shin.
Writing – original draft: Hansol Lee.
Writing – review & editing: Hansol Lee.

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APPENDIX A

Table A1. Variable definitions

Variable	Description
RD	Research and development expenditures divided by the beginning total assets
RPT	The magnitude of related party transactions scaled by the total sales
OP_RPT	The magnitude of operating related party transactions (sales of products or services and purchases of materials or merchandise) scaled by the total sales
NON_OP_RPT	The magnitude of non-operating related party transactions (sales and purchases of property, plant, and equipment (PPE) and investment assets) scaled by the total sales
PPE	Ratio of net property, plant, and equipment to the beginning total assets
SIZE	The natural log of the total sales
ROA	Return-to-assets ratio, calculated as the income before extraordinary items divided by the beginning total assets.
LEV	Leverage ratio, calculated as the sum of long-term and short-term debts divided by total assets
CAPEX	Capital expenditures scaled by the book value of total assets at the end of fiscal year *t*
LNAGE	Natural logarithm of one plus firm's age

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