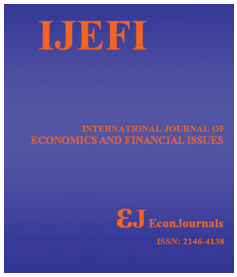

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Corporate Governance, Investment in Research and Development and Company Performance: A Data Envelopment Analysis Approach Based on Data from a Developing Country

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ABSTRACT

The aim of this paper is to investigate the role of investment in research and development (R and D) in relationship between corporate governance (CG) and company performance in the Tehran Stock Exchange. In this regard, ownership concentration and debt ratio were used as the criteria for CG. The statistical population included all companies listed in Tehran Stock Exchange, 161 of which were selected as the statistical sample and investigated from 2004 until 2014. The statistical regression analysis of mixed data in the Baron and Kenny model (1986) and hierarchical regression analysis were employed to test the research hypotheses. The results indicated that CG was a factor influencing company performance and R and D activities. The results also indicated that investment in R and D improved company performance. Furthermore, the research evidence showed a minor role for the R and D investment variable in mediating the relationship between CG and company performance, and thus could not play a moderating role in this relationship.

Keywords: Ownership Concentration, Debt Ratio, Company Performance, Investment in Research and Development
JEL Classifications: C61, G30, M41

1. INTRODUCTION

In recent decades, many researchers have comprehensively studied corporate governance (CG) and company performance (for instance, Ravenscraft and Shrer, 1987; Shleifer and Vishny, 1997; Bhagat and Bolton, 2008). The evidence presented in some of the studies indicated a direct relationship between these two variables (for example, Bhagat and Bolton, 2008; Jensen and Murphy, 1990). Nevertheless, some other studies indicated an indirect relationship between CG and company performance (such as Ravenscraft and Shrer, 1987; Bethel and Liebeskind, 1993; Shimizu and Hitt, 2005). The findings of previous studies showed that several variables including refocusing strategy (Bethel and Liebeskind, 1993), divestiture strategy (Shimizu and Hitt, 2005), merger and acquisition strategy (Ravenscraft and Shrer, 1987), CEO's extra-organizational consulting network (McDonald et al., 2008), investment in research and development (R and D) (Zhang et al., 2014) played a mediating role in this relationship. Consistent with a study conducted by Zhang et al. (2014), the current study investigated the relationship between CG and company performance from the perspective of investment in R and D.

Given the increasing competition among companies in recent years, the lifecycle of products have considerably declined. Therefore, investment in R and D has become an important issue for companies to survive (Lee and O'Neil, 2003). Zhang et al. (2014) stated that investment in R and D has substantially increased in China in recent years, a fact which in turn influences the future competitiveness. It actually means that investment in R and D is significant for companies, and it probably plays an important role in how CG influences company performance.

In the majority of previous studies, researchers investigated the relationship between each pair of these three variables, i.e., CG, company performance, and investment in R and D. For instance, Bethel and Liebeskind (1993), Shleifer and Vishny (1997), and Bhagat and Bolton (2008) studied the impact of CG on company performance. Moreover, researchers such as Barker and Muller

(2002), Lee and O'Neil (2003), and Atanassov (2013) studied the impact of CG on investment in R and D. In addition, Sougiannis (1994) and Hitt et al. (1997) investigated the impact of investment in R and D on company performance. Therefore, it appears that investment in R and D can play an effective role in the relationship between CG and company performance. Consequently, the main research questions are whether investment in R and D has a role in the relationship between CG and company performance among the companies listed in Tehran Stock Exchange? And if so, is it a mediating role or a moderating one?

The rest of this paper is organized as follows: In the next part, the research theoretical framework is discussed by stating the potential mediating and moderating impacts of investment in R and D in the relationship between CG and company performance. Then the research methodology is proposed, and the empirical results are presented. Finally, the conclusion, the research suggestions and limitations are presented.

2. RESEARCH LITERATURE

The current study is associated with three main approaches to the existing research literature. The first research approach emerges from the relationship between CG and company performance. Although there is no agreement on the direct or indirect relationship between these two variables, the evidence of previous studies indicates that company performance is influenced by CG (Bethel and Liebeskind, 1993; Shleifer and Vishny, 1997; Boone et al., 2007; Bhagat and Bolton, 2008). For instance, the effective CG would make sure that managers invest in profitable projects (Shleifer and Vishny, 1997). In addition, the effective CG can encompass managers and shareholders' interests better; therefore, it increases the company value (Boone et al., 2007). Therefore, given the fact that the effective CG provides investors and creditors with useful information, it influences company performance to a considerable extent.

The second research approach has been concentrated on the relationship between CG and investments in R and D. Researchers have named different factors pertaining to CG and influencing investment in R and D. Some of them may include ownership structure (Lee and O'Neil, 2003), characteristics, attitude, rights and managers' risk preferences (Barker and Muller, 2002), and institutional investors' investing priorities (Baysinger et al., 1991). Moreover, the external factors of CG such as market structure (O'Sullivan, 2000) and investors' support access to the financial support of stock market and legal rights (Brown et al., 2013) were among the factors influencing investment in R and D.

The third research approach discusses the relationship between investment in R and D and company performance. Morbey (1988) did not obtain a significant relationship between investment in R and D and company performance; however, the evidence of a study conducted by Ettlie (1998) indicated a significant relationship between investment in R and D and company performance. To Hitt et al. (1997), investment in R and D is necessary for innovation in technology, and the innovation capabilities of a company have considerable impacts on company performance in the long term. Moreover, R and D activities result in higher efficiencies in comparison with other companies (Dilling-Hansen et al., 2003), and R and D expenditures have a positive and important role in growing productivity (Wakelin, 2001). The results of previous studies also indicated that R and D activities were considerably related with the growth opportunities of a company (Dong and Gou, 2010).

As mentioned earlier, many studies were conducted to identify the variables having mediating or moderating roles in the relationship between CG and company performance (for instance, Ravenscraft and Shrer, 1987; Bethel and Liebeskind, 1993; Shimizu and Hitt, 2005; McDonald et al., 2008; Zhang et al., 2014); however, only Zhang et al. (2014) studied the mediating and moderating role of investment in R and D in the relationship between CG and company performance. Their research results in IT industry indicated that investment in R and D played a mediating role in the relationship between CG and company performance. The previous literature indicated that strategy was an important mediator in the relationship between CG and company performance (Zhang et al., 2014). In particular, strategy has a mediating role in the relationship between the concentration of stocks and company performance (Hill and Snell, 1988). Using the data pertaining to 157 large private companies, Filatotchev et al. (2007) studied the mediating role of strategy in the relationship between CG and company performance. Both credibility and innovation play mediating roles in the relationship between the variety of races in the directing board and company performance in a way that innovation is defined as a strategy for making new opportunities regarding the capabilities of company to create products or services (Miller and Del Triana, 2009. p. 756). It should be mentioned that investment in R and D indicates innovation in ordinary technology (Zhang et al., 2014). Using the hierarchical regression analysis, Yang (2009) indicated that CG would influence organizational performance through the mediation of organizational innovation.

Making balance in shareholders' interests including company owners, directing board, managers and others, the structure of CG increases the investment in innovative technologies (Zahra et al., 2000). Therefore, technological innovation decisions and investment in R and D are greatly influenced (Sapra et al., 2014). It increases the innovation capabilities of company in turn (Zhang et al., 2014). The theory of innovation indicates that the innovation capability of a company plays an important role in performance in the long term (Hitt et al., 1997). R and D are key factors for innovation (Becker-Blease, 2011) while increasing investment in R and D can stimulate innovation (Griffith et al., 2004). In addition, innovation is very important to company in order to achieve a competitive strategy (Conner, 1991). In particular, innovation can help company achieve a better financial performance (Zahra et al., 2000), a fact which indicates that CG can influence company performance through the mediation of investment in R and D (as a criterion of technological innovation) (Balkin et al., 2000; Miller and Del Triana; 2009). Therefore, if other conditions are constant, the first research hypothesis can be stated as follows: Investment in R and D plays a mediating role in the relationship between CG and company performance. In many of the previous studies, the structure of CG was investigated from intra-organizational and

extra-organizational perspectives. Thus, the current study used ownership concentration and debt ratio as the criteria for intra-organizational and extra-organizational CG, respectively. In this regard, the secondary hypotheses pertaining to the first research hypothesis can be stated as follows:

Hypothesis 1.1: Investment in R and D plays a mediating role in the relationship between ownership concentration and company performance.

Hypothesis 1.2: Investment in R and D plays a mediating role in the relationship between debt ratio and company performance.

Figure 1 indicates the hypothetical research model pertaining to the mediating role of investment in R and D in the relationship between CG and company governance.

Many of the previous studies investigated the moderating roles of different variables in the relationship between CG and company performance. For instance, the relationship between institutional ownership and social performance of companies was moderated with variables such as activity, coordination, and investment horizon (Neoboum and Zahra, 2006). The environmental mediators can also be pointed out in the relationship between the duality of CEO's responsibility and company performance (Boyd, 2006). In addition, the relationship between the duality of CEO's responsibility and accounting performance was moderated with the presence of family control factor (Lam and Lee, 2008). Nevertheless, some researchers believe that investment in R and D can play a moderating role in different areas. For instance, investment in R and D plays a moderating role in the relationship between foreign technology acquisition and company performance (Tsai and Wang, 2008). The effective CG guarantees scientific decision making (Sah and Stiglitz, 1991). This matter can reduce the high risk of investment in R and D and improve company performance. Excessive investment in R and D can result in representativeness problem (Hitt et al., 1997), a problem with intensifies the relationship between CG and company performance. Given what was mentioned earlier and from the perspective of Zhang et al. (2014), the impact of CG on company performance is greater in companies investing more in R and D. Therefore, if other conditions are constant, the second research hypothesis can be stated as follows: Investment in R and D plays a moderating role in the relationship between CG and company performance. Considering the criteria for CG, the secondary hypotheses of the second research hypothesis can be presented as follows:

Hypothesis 2.1: Investment in R and D plays a moderating role in the relationship between ownership concentration and company performance.

Hypothesis 2.2: Investment in R and D plays a moderating role in the relationship between debt ratio and company performance.

Figure 2 indicates the hypothetical research model pertaining to the moderating role of investment in R and D in the relationship between CG and company performance.

Figure 1: The hypothetical model pertaining to the mediating role of investment in research and development

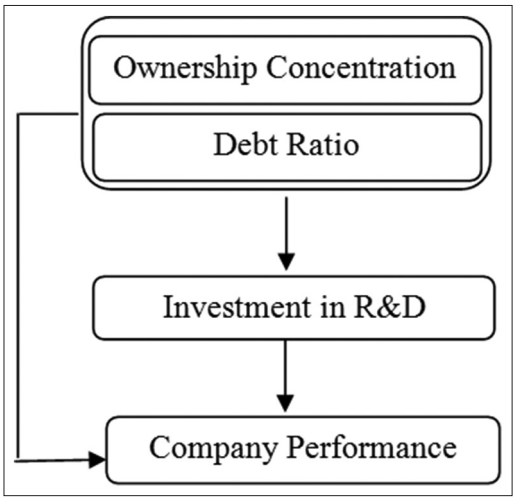
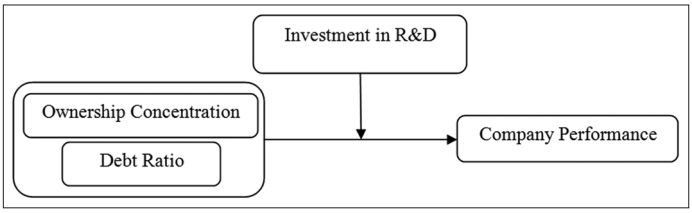


Figure 2: The hypothetical model pertaining to the moderating role of investment in research and development



3. RESEARCH METHODOLOGY

The current study seeks to test the theories and intends to provide evidence in new geographical settings for a theoretical framework previously tested in another study in order to strengthen, confirm and improve defects (Fieldman, 2004). The desk method was employed to collect data and information. Farsi and Latin books and journals were used to collect information pertaining to the theoretical foundations and research background. Using Tadbir Pardaz 2 and the Official Website of Tehran Stock Exchange, the information required from the companies was collected. Finally, Excel 2007 and DEA Frontier were employed to prepare data, and then SPSS 19 and Eviews 7 were used to analyze them.

The study period included 11 years based on the financial statements gathered from 2004 until 2014. The statistical population consisted of the companies listed in Tehran Stock Exchange. Due to some inconsistences among the subjects, the fiscal years of companies should end in March 19th, and they should not change their fiscal years from 2003 until 2013. In addition, the subjects should not be among banks and financial institutions (investing companies, financial mediators, or holding and leasing companies). Given the abovementioned conditions and limits, a number of 161 companies were selected as simple from 2004 until 2014.

3.1. Method of Testing Research Hypotheses

The descriptive statistics including the measures of central tendency and coefficients of dispersion such as mean, maximum, minimum, and standard deviation were used along with the

inferential statistics such as regression models to analyze data. The regression model for mixed data in the Baron and Kenny framework (1986), which is the moderated version of the Judd and Kenny model (1981), was used to test the first research hypothesis. In the Judd and Kenny framework (1981), three steps should be followed to investigate the mediating role of investment in R and D in the relationship between CG and company performance. In the first step, the mediating variable (investment in R and D) is predicted on independent variables (ownership concentration and debt ratio). In the second step, dependent variables are predicted on the independent variables. In the third step, the dependent variable is predicted on independent and mediating variables at the same time. Now if the coefficients of ownership concentration and debt ratio are significant in the regression models of the first and second steps, and the coefficient of investment in R and D is significant in the regression model of the third step when the coefficients of ownership concentration and debt ratio are not significant, then investment in R and D plays a completely mediating role in the relationship between CG and company performance. Given the fact that it is highly probable that the independent variables (ownership concentration and debt ratio) become significant in the real world in the third step, and considering that this was taken into account in the Baron and Kenny framework (1986), if the coefficients of ownership concentration and debt ratio are significant in the third step, then investment in R and D plays a partially mediating role in the relationship between CG and company performance.

$$R\&D_{it} = \alpha_0 + \alpha_1(CG_{it-1}) + \alpha_2(Size_{it-1}) + \alpha_3(BI_{it-1}) + \alpha_4(Age_{it-1}) + \varepsilon_{it}$$
(regression model in the first step) (1)

$$Performance_{it} = \alpha_0 + \alpha_1(CG_{it-1}) + \alpha_2(Size_{it-1}) + \alpha_3(BI_{it-1}) + \alpha_4(Age_{it-1}) + \varepsilon_{it}$$
(regression model in the second step) (2)

$$Performance_{it} = \alpha_0 + \alpha_1(CG_{it-1}) + \alpha_2(R\&D_{it}) + \alpha_3(Size_{it-1}) + \alpha_4(BI_{it-1}) + \alpha_5(Age_{it-1}) + \varepsilon_{it}$$
(regression model in the third step) (3)

In the above models, $R\&D_{it}$ refers to investment in R and D while CG_{it-1} represents the criteria for CG (once ownership concentration and once debt ratio), and $Performance_{it}$ indicates company performance all in the current year. Moreover, $Size_{it-1}$ refers to the size of company while BI_{it-1} indicates the independency of directing board, and Age_{it-1} refers to the age of company all in the previous year.

Regarding the second research hypothesis, the moderated multivariate regression analysis was used. When all the variables are independent, dependent, controlling and relative or distance moderating, the tests of homogeneity gradients, Chow and changes in the coefficient of determination (ΔR^2) can be used. Given the fact that the moderating and independent variables should be transformed into hierarchical variables to use Chow and homogeneity of gradients tests, they were not used in this study.[1]

1 The transformation of higher-level data (relative or distance) to lower levels (hierarchical) reduces the accuracy of results. It should also be mentioned that two methods of subgroup and moderated multivariate regression analysis can be used to carry out ΔR2 test. The moderated multivariate regression analysis was used in this study. The subgroup method is used mostly when the moderating variable has two or more states.

The equality of the coefficients of regression model should be studied to conduct the moderated regression analysis.

$$Performance_{it} = \alpha_0 + \alpha_1(CG_{it-1}) + \gamma(Size_{it-1}) + \beta(BI_{it-1}) + \omega(Age_{it-1}) + \varepsilon_{it} \quad (4)$$

$$Performance_{it} = \alpha_0 + \alpha_1(CG_{it-1}) + \alpha_2(R\&D_{it}) + \gamma(Size_{it-1}) + \beta(BI_{it-1}) + \omega(Age_{it-1}) + \varepsilon_{it} \quad (5)$$

$$Performance_{it} = \alpha_0 + \alpha_1(CG_{it-1}) + \alpha_2(R\&D_{it}) + \alpha_3(CG_{it-1}*R\&D_{it}) + \gamma(Size_{it-1}) + \beta(BI_{it-1}) + \omega(Age_{it-1}) + \varepsilon_{it} \quad (6)$$

If Models (5) and (6) do not show to be different from each other (for instance, $\alpha_2 \neq 0$ and $\alpha_3 = 0$), then investment in R and D is not a moderator, and it is only a predictor. In order for the investment in R and D to be a sheer moderating variable, Models (4) and (5) should not be different from each other; however, they should be different from Model (6) (for instance, $\alpha_2 = 0$ and $\alpha_3 \neq 0$). If Models (4), (5) and (6) show to be different from each other (for instance, $\alpha_2 \neq \alpha_3 \neq 0$), then investment in R and D is a quasi-moderator. The moderated multivariate regression analysis is carried out in the following steps:

A. Centering: The interaction impact of the independent variable and moderator should be estimated to investigate the impact of the moderator on the relationship between the independent and dependent variables. If the values of these two variables are multiplied by each other simply for each case, there will be a multiple linear problem while using the regression model. Centering should be done to solve this problem.
B. Conducting the hierarchical regression analysis.

3.2. Research Variables

3.2.1. Independent variables

3.2.1.1. Ownership concentration

The structure of ownership reflects the distribution status of shares among shareholders (Zhang et al., 2014). The previous researchers used the ownership concentration as a measurement of the structure of ownership (Baysinger et al., 1991; Bethel and Liebeskind, 1993; Fidrmuc et al., 2006; Zhang et al., 2014). It should be noted that in the current study, similar to a study conducted by Setayesh et al. (2015), the percentage of the first control shares was the basis considered to evaluate the ownership concentration. Given the surveillance role which large shareholders have over managers, the ownership concentration can have a positive impact on company performance.

3.2.1.2. Debt ratio

Financing is one of the criteria for extra-organizational CG which was used in the majority of previous studies (Balakrishnan and Fox, 1993; Bahagat and Letch, 1995; Lang et al., 1996; Vicente-Lorente, 2001; Acharya and Viswanathan, 2011, and Zhang et al., 2014). Similar to the studies conducted by Namazi and Rezaei (2014) and Namazi et al. (2015), the debt ratio was measured by dividing the total short-term and long-term debts by the book value of total assets. Regarding debt ratio, it is expected that this variable has a negative relationship with company performance.

3.2.2. Dependent variables

In this study, company performance was considered to be a dependent variable. In recent studies, criteria such as return on equity (ROE), return on assets (ROA), earning per share (EPS), and economic value added were used to measure company performance. For instance, in a study conducted by Zhang et al. (2014), the first three of the latter criteria were used to measure company performance. However, the main problem of the relative analysis of financial statements is that each of the financial statements evaluates only one dimension of financial performance of an organization, whereas data envelopment analysis (DEA) technique integrates the ratios to allocate a unique grade named efficiency to each unit. Therefore, this study used DEA technique, which is a multifactor method of making decisions and evaluating company performance, based on the information pertaining to the input variables (founded) and output ones (taken), to measure company performance. According to the study conducted by Demerjian et al. (2012) and using DEA technique, the company efficiency (performance) is predicted in comparison with its sales and under the condition if the inputs used by each company includes the price of sold products, sales and office expenditures, net assets, machineries and equipment, operational rent, net expenditures of R and D, purchased ownership, and other unobserved assets.

3.2.3. Moderating or mediating variable

Similar to the study conducted by Zhang et al., (2014), investment in R and D was considered to be a variable which could play a moderating or mediating role in the relationship between CG and company performance in this study. Similarly, this variable was measured through the ratio of investment in annual R and D to total assets.

3.2.4. Control variables

The necessary control variables were selected by reviewing the texts in order to control other variables in a way that they influence the analysis of the research problem. The control variables are as follows:

1. Company size: Larger companies will probably allocate more resources to R and D activities (Guay, 1999) and have fewer tendencies to do the tasks well in comparison with smaller companies (Kim et al., 2004). In this regard, similar to the study conducted by Zhang et al. (2014), company size was considered to be a control variable. In this study, company size was measured with the natural logarithm of the market value of shareholders' equity.
2. The independency of directing board: According to the studies conducted by Lin et al. (2009), Sánchez (2010), Sueyoshi et al. (2010) and Bruce (2011), it can be expected that the independency of directing board had a positive impact on company performance. Therefore, the independency of directing board was used as a control variable in this study.
3. Company age: Garcia-Quevedo et al. (2014) indicated that company age was one of the factors influencing R and D activities. Moreover, according to the theory of lifecycle and in its different steps, companies have particularly financial behaviors (Xu, 2007). Therefore, company age was used as a control variable in this study.

4. RESEARCH FINDINGS

The descriptive statistics of the research variables can be shown in Table 1 in order for the initial analysis of data. According to the information provided in Table 1, the statistics pertaining to company performance (efficiency) indicated that companies obtained grades which were slightly a little over than the performance grade on average (the minimum and maximum performance grades are zero and one, respectively). However, some companies could obtain the maximum performance grade; therefore, companies listed in Tehran Stock Exchange should try to improve their outputs in comparison with inputs so that they can obtain a more appropriate status with respect to performance. Moreover, the mean of debt ratio indicated that almost more than a half of total assets at the companies listed in Tehran Stock Exchange were supplied by debts. In addition, the information inserted in Table 1 indicated that on average, more than a half of the directing board members in the studied companies did not hold executive positions. The statistics pertaining to investments in R and D indicated that companies allocated only a small percentage of their assets to R and D.[2]

The statics of research variables were studied in order to make sure that the regression models were not false. The results of evaluating the reliability of research variables through Levin, Lin and Chu's unit root test can be seen in Table 2. According to the results, the significance level of this test was lower than 0.05 for all the independence, dependence and control variables, a fact which indicates their reliability.

Table 3 shows the results of testing regression models used for the first research hypothesis. According to Table 3, when ownership concentration is considered to be a criterion for CG, the adjusted coefficients of determination (R^2_{adj}) in Models 1, 2 and 3 explained 5.7%, 6.6%, and 7.6% of the variance existing in the dependent variable, respectively (Investment in R and D in Model 1, and company performance in Models 2 and 3). Moreover, when debt ratio is considered to be the criteria for CG, the adjusted coefficients of determination (R^2_{adj}) in Models 1, 2 and 3 explained 7.4%, 6% and 7.1% of the variance existing in the dependent variable, respectively. In addition, Durbin Watson statistics, presented in Table 3, does not indicate the serial autocorrelation in the components of disturbing regression.

Considering the significance level of statistics in Chu test for all three models inserted in Table 3, panel data model was used to test the secondary hypotheses pertaining to the first research hypothesis. Moreover, given the significance level of Hausman's test statistics in Model 1, when debt ratio is considered to be a criterion for CG, the constant effects model was used for testing; however, the random effects model was used for the other models inserted in Table 3.

According to the information provided in Table 3, the significance level pertaining to ownership concentration

2 This amount allocated to R and D (0.0095 of total assets on average) is very slight with respect to the inflammation in Iran. It should be mentioned that the inflammation in Iran influences the book value of assets at companies to a great extent.

indicated the positive and significant relationship of this variable with investment in R and D and company performance. The results of debt ratio also indicated its negative and significant relationship with investment in R and D and company performance. Investment in R and D had also a positive and significant relationship with company performance. Given the fact that the coefficients of ownership concentration and debt ratio were significant in Models 1, 2 and 3, and investment in R and D was significant in Model 3, the latter did not play a completely mediating role in the relationship between CG (ownership concentration and debt ratio) and company performance. Nevertheless, according to the Barron and Kenny framework (1986), investment in R and D played a mediating role in CG and company performance.

Table 1: Descriptive statistics of key variables

Variables	Minimum	Maximum	Mean	Standard deviation
Performance	0.0284	1	0.6442	0.2686
R and D	0	0.3667	0.0095	0.0215
OC	0.0617	0.9607	0.4890	0.1938
Lev	0.0537	1.4627	0.6181	0.1766
Size	8.3530	19.0211	13.7423	1.3046
BI	0.2000	1	0.6484	0.1822
Age	12	60	33.0400	12.4370

R and D: Research and development

Table 2: The result of test of reliability Levin, Lin and Chu

Variables	Performance	R and D	OC	Lev	Size	BI	Age
Test statistic	−32.2183	−42.6026	−32.1641	−35.3990	−37.2268	−26.5864	−53.0807
Significance	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005

R and D: Research and development

Table 3: The results of regression models for the first hypothesis

Model 1	$R\&D_{it} = \alpha_0 + \alpha_1(CG_{it-1}) + \alpha_2(Size_{it-1}) + \alpha_3(BI_{it-1}) + \alpha_4(Age_{it-1}) + \varepsilon_{it}$			
	$CG_{it-1}=OC_{it-1}$		$CG_{it-1}=Lev_{it-1}$	
	Coefficients	**t-statistic (significance)**	**Coefficients**	**t-statistic (significance)**
Constant	0.019	3.181 (0.0015*)	0.037	5.924 (0.00005*)
CG_{it-1}	0.017	6.394 (0.00005*)	−0.013	−4.566 (0.00005*)
$Size_{it-1}$	−0.002	−5.278 (0.00005*)	−0.002	−5.308 (0.00005*)
BI_{it-1}	0.003	1.229 (0.2192)	0.003	1.130 (0.2585)
Age_{it-1}	0.0002	5.807 (0.00005*)	0.0002	5.388 (0.00005*)
R^2 and R^2_{adj}	0.059	0.057	0.082	0.074
F-statistics and significance	25.345	0.00005*	10.999	0.00005*
DW-statistics	2.078		2.106	
Chow test and significance	5.395	0.00005	5.859	0.00005
Hausman test and significance	10.783	0.0291	2.187	0.7014
Model 2	$Performance_{it} = \alpha_0 + \alpha_1(CG_{it-1}) + \alpha_2(Size_{it-1}) + \alpha_3(BI_{it-1}) + \alpha_4(Age_{it-1}) + \varepsilon_{it}$			
	$CG_{it-1} = OC_{it-1}$		$CG_{it-1} = Lev_{it-1}$	
	Coefficients	**t-statistic (significance)**	**Coefficients**	**t-statistic (significance)**
Constant	−0.077	−1.051 (0.293)	0.076	1.004 (0.3152)
CG_{it-1}	0.138	4.430 (0.00005*)	−0.113	−3.297 (0.0010*)
$Size_{it-1}$	0.046	9.940 (0.00005*)	0.045	9.719 (0.00005*)
BI_{it-1}	−0.019	−0.593 (0.553)	−0.022	−0.677 (0.4985)
Age_{it-1}	0.0009	1.757 (0.0791)	0.0005	1.621 (0.1052)
R^2 and R^2_{adj}	0.068	0.066	0.063	0.060
F-statistics and significance	29.524	0.00005*	27.042	0.00005*
DW-statistics	1.639		1.643	
Chow test and significance	26.434	0.00005	26.480	0.00005
Hausman test and significance	17.703	0.0014	12.630	0.0132
Model 3	$Performance_{it} = \alpha_0 + \alpha_1(CG_{it-1}) + \alpha_2(R\&D_{it}) + \alpha_3(Size_{it-1}) + \alpha_4(BI_{it-1}) + \alpha_5(Age_{it-1}) + \varepsilon_{it}$			
	$CG_{it-1} = OC_{it-1}$		$CG_{it-1} = Lev_{it-1}$	
	Coefficients	**t-statistic (significance)**	**Coefficients**	**t-statistic (significance)**
Constant	−0.097	−1.308 (0.1908)	0.030	0.390 (0.6960)
CG_{it-1}	0.118	3.759 (0.0002*)	−0.096	−2.034 (0.0052*)
$R\&D_{it}$	1.185	4.081 (0.00005*)	1.262	4.363 (0.00005*)
$Size_{it-1}$	0.048	10.383 (0.00005*)	0.048	10.256 (0.00005*)
BI_{it-1}	−0.023	−0.716 (0.473)	−0.026	−0.801 (0.4228)
Age_{it-1}	0.0005	1.152 (0.2494)	0.0005	1.020 (0.3076)
R^2 and R^2_{adj}	0.077	0.074	0.074	0.071
F-statistics and significance	27.021	0.00005*	25.636	0.00005*
DW-statistics	1.636		1.638	
Chow test and significance	26.568	0.00005	26.585	0.00005
Hausman test and significance	14.102	0.0150	12.729	0.0260

*Significant level at 5%

The results pertaining to the control variables indicated that there was a negative and significant relationship between company size and investment in R and D. Nevertheless, the relationship between size and company performance was positive and significant. Company age had a positive and significant relationship with investment in R and D; however, it did not have a relationship with company performance. Finally, the relationship which the independency of directing board had with investment in R and D and company performance was not statistically significant.

Table 4 indicates the results of the hierarchical regression model used to test the second research hypothesis. In the first step, the criteria for CG (ownership concentration and debt ratio) were modeled with control variables (Model 4). According to the information provided in Table 4, when the ownership concentration was considered to be the criterion for CG, the coefficient of determination (R^2) explained 8.6% of the variance existing in company performance. In Model 5, the statistics ΔR^2 was also equal to 0.009 which explained the slight increase in the explanation of variance by 0.9% after adding investment in R and D separately. Finally, in Model 6 to which the mutual impact of ownership concentration and investment in R and D was added, this impact increased the explanation of variance by 0.1%. Moreover, ΔR in Models 4 and 5 indicated that these models were generally significant at the level of 95%, and its level in Model 5 increased by the level of 95% compared with Model 4; however, the changes in the statistics F were not significant in Model 6.

Furthermore, when debt ratio was considered to be the criterion of CG, the coefficient of determination (R^2) explained 8.1% of the variance existing in company performance. The statistics ΔR^2, presented in Model 5, was also equal to 0.010 which explained a slight increase in the explanation of variance by 1% after adding the moderating variable of investment in R and D separately. Finally, in Model 6 to which the mutual impact of debt ratio and investment in R and D was added, this impact increased the explanation of variance by 2%. The statistics ΔR of Models 4 and 5 indicated that these models were generally significant at the level of 95% reliability, and its value in Model 5 increased by 95% of reliability level in comparison with Model 4. However, the statistics F was not significant in Model 6. At last, when ownership concentration and debt ratio were used as the criteria for CG, the values of Durbin–Watson's statistics, presented in Table 4, were equal to 1.792 and 1.788, respectively. They did not indicate any serial autocorrelations in the components of disturbing regression at the level of all companies.

Similar to Table 3, the results presented in Table 4 indicate ownership concentration and investment in R and D had a positive and significant relationship with company performance. Moreover, there was a negative and significant relationship between debt ratio and company performance. Given the fact that the coefficient of investment in R and D was significant, but the coefficient expression of interactive investment in R and D and CG (ownership concentration and debt ratio) was not significant, investment in R and D did not have a moderating role in the relationship between CG (ownership concentration and debt ratio) and company performance.

5. CONCLUSION

Traditionally, the identification of factors influencing company performance has always been one of the main concerns among potential and actual investors, especially in Iran which is a developing country with a high risk of investment in Tehran Stock Exchange. It should also be noted that severe financial sanctions imposed in recent years make it essential to identify the factors determining company performance in Iran. On the other hand, R and D activities are among the practices which companies are supposed to do in order to survive in competitions. Thus, the current study was conducted to indicate the role of investment in R and D in the relationship between CG and company performance.

The research hypotheses test results indicated that investment in R and D played a partially mediating role in the relationship between CG and company performance, although, it did not appear to have a moderating role. Other results of this research showed that investment in R and D improved company performance, and ownership concentration had a significant and positive relationship with investment in R and D and company performance. That is, in companies with high levels of ownership concentration, more resources were allocated to R and D activities, leading to a better company performance. Increasing ownership concentration in companies would increase R and D activities and performance.

Table 4: The result of regression models for second hypothesis

Model	$CG_{it-1} = OC_{it-1}$			$CG_{it-1} = Lev_{it-1}$		
	4	5	6	4	5	6
	Coefficients (significance)			Coefficients (significance)		
Constant	−0.217 (0.004*)	−0.241 (0.001*)	−0.237 (0.002*)	−0.061 (0.428)	−0.111 (0.150)	−0.110 (0.155)
CG_{it-1}	0.145 (0.0005*)	0.124 (0.0005*)	0.127 (0.0005*)	−0.117 (0.001*)	−0.099 (0.007*)	−0.102 (0.005*)
$Size_{it-1}$	0.056 (0.0005*)	0.058 (0.0005*)	0.058 (0.0005*)	0.055 (0.0005*)	0.058 (0.0005*)	0.058 (0.0005*)
BI_{it-1}	−0.031 (0.379)	−0.035 (0.320)	−0.035 (0.322)	−0.033 (0.347)	−0.037 (0.292)	−0.037 (0.286)
Age_{it-1}	0.001 (0.006*)	0.001 (0.032*)	0.001 (0.039*)	0.001 (0.006*)	0.001 (0.037*)	0.001 (0.031*)
$R\&D_{it}$	-	1.205 (0.0005*)	1.244 (0.0005*)	-	1.295 (0.0005*)	1.391 (0.0005*)
CG_{it-1}*$R\&D_{it}$	-	-	−1.426 (0.324)	-	-	3.525 (0.060)
DW-statistics	1.792			1.788		
R^2	0.086	0.095	0.096	0.081	0.092	0.094
ΔR^2	0.086	0.009	0.001	0.081	0.010	0.002
ΔF (significance)	37.973 (0.0005*)	15.476 (0.0005*)	0.971 (0.324)	35.545 (0.0005*)	18.058 (0.0005*)	3.550 (0.060)

*Significant level at 5%. CG: Corporate governance

Given the fact that investment in R and D had a partially mediating role in the relationship between ownership concentration and company performance, such activities in concentrated companies would result in higher impact of ownership concentration on company performance.

The results of this research also indicated that debt ratio had a negative and significant relationship with investment in R and D and company performance. More precisely, the companies which use more debt in the structure of their capitals had weaker performances and used fewer resources in R and D activities. Perhaps, one of the reasons for the poorer performances of this group of companies was the insufficient investment in R and D (due to the negative impact of debt ratio on investment in R and D). Given the mediating role of investment in R and D in the relationship between CG and company performance, a great deal of debts in the capital structure of companies would reduce their R and D activities (as a mediator), so company performance would decrease. Generally, the results of current research were consistent with the evidence from the study by Zhang et al. (2014). It should also be mentioned that Zhang et al. (2014) used ROE, ROA, and EPS to measure company performance in the study. However, the current study used DEA technique to measure company performance based on the information pertaining to the input and output variables.

The results pertaining to control variables indicated that there was a negative and significant relationship between company size and investment in R and D; however, there was a positive and significant relationship between company size and performance. Put another way, larger Iranian companies allocated fewer resources to R and D activities in comparison with smaller companies; however, larger companies showed better company performance rather than smaller ones. Other results of control variables also indicated that older companies investigated more in R and D activities. Finally, it should be mentioned that the relationship between company age and company performance was not significant. Moreover, the independency of directing board did not show a significant impact on the investment in R and D and company performance.

According to the results of descriptive statistics based on the fact that companies have averagely obtained slightly more than a half of the total performance score, and given the positive impact of investment in R and D on company performance and its mediating role in the relationship between CG and company performance, it may be recommended that CEOs should adopt policies to allocate more resources to R and D activities in order to improve company performance.

Furthermore, given the fact that debt ratio had a negative impact on company performance and R and D activities, CEOs may be advised to use fewer debts in their capital structure to improve company performance. They are also advised to invest in other companies to supply their financial support so that they can bear fewer debts in their capital structure. In this regard, the economic officials of the country may also be advised to take measures such as decreasing the interest rates for savings accounts and drive investors' money from the money market to the stock market. At the end, it should also be noted that some particular conditions in Iran, e.g. severe inflation, may influence the results of studies such as the current study, a condition that could not be controlled by the researchers.

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