

FACTORS INFLUENCING RESEARCH & DEVELOPMENT EXPENDITURES OF MANUFACTURING COMPANIES OF BANGLADESH

Mousumi Rani Pal¹, Md. Sohel Rana², Ruksana Parvin³

Power Grid Company of Bangladesh Ltd, Bangladesh¹

Jahangirnagar University, Savar, Dhaka, Bangladesh²

German University Bangladesh, Gazipur, Bangladesh³

Abstract

The objective of this study is to identify the factors that have an impact on research and development expenditures of manufacturing companies of Bangladesh. Data for the year 2013 to 2016 were used to accomplish the purpose. Total 32 companies have been selected from seven manufacturing industries. All of these companies are listed in DSE. Panel data analysis has been employed to examine the data. Dependent variable of this study is R&D expenditures intensity whereas independent variables are classified into two categories. They are firm specific factors and corporate governance factors. The results indicate that experienced firms are intended to spend more on R&D. Gross profit and firm size have significant negative association with R&D intensity. Leverage has significant impact on R&D of sample firms with positive coefficient. Number of independent directors in the board has significant negative correlation with firm's R&D expenditures. Sample size is a key limitation of this study. So far most of the empirical study considers either firm specific factors or corporate governance factors. This study is an attempt that takes into account both kind of factors. It will provide a glimpse of what factors can determine the R&D expenditure except industry type.

Keywords: Research and Development Expenditure, Innovation, Corporate governance factors, Firm specific factors, Manufacturing industry

1. Introduction

Research and development is one of the momentous segment of a company's business activities. Search plays lead role for organizational evolvement and prosperity (Chen & Miller, 2007). Conducting research in proper way accelerate the desired success. Scientific research leads to technological innovation as well as economic growth (Fleming & Sorenson, 2004). R&D not merely generate new information, it also helps a firm to make the best use of present information (Cohen & Levinthal, 1989). And these are the activities by which a company survives in long run.

Undoubtedly, competition is increasing in today's business world. Because of intensive competition level, the performance of a company on the arena of innovation becomes crucially important. Basically firms are differentiated by the way of their search from others (Katila & Ahuja, 2002).

Most of the times innovation becomes major causes for getting positive economic benefit (Kane, Ubilava, & Xu, 2007). Investment in research and development is quite risky in nature and involves a long period of time (Chen & Hsu, 2009). Though, R&D activity has the strong potentiality to bring positive changes, it is also fraught with risk and so can be the cause of magnitude loss (Greve, 2003). Bring to light on the influencing factors of research and development may be in great help to understand it properly and reducing related uncertainty.

The aim of this study is to ascertain factors that influence R&D expenditures of manufacturing companies. In this paper, factors are divided in two categories. One category contains firm specific factors and another contains corporate governance factors.

Technological change has been given less importance in developing countries in comparison to developed countries (Subodh, 2002). While economic growth of a country is decided by the improvement in technology (Ferdaous & Rahman, 2017). Investment in R&D can bring technological change. The economy of Bangladesh is growing significantly. A growing economy must have to focus on its manufacturing sector to continue this progress. Manufacturing sector need to make investment on R&D for improving the business besides competing successfully in the market. Determining influencing factors of R&D will smooth this whole activity.

The notion of R&D expenditure is not very old in the context of Bangladesh (Ferdaous & Rahman, 2017). Yet many companies do

not incur any R&D expenditure. It is one of the major obstacles for enhancing economic growth. Some particular industry requires heavy investment on R&D. Before enhancing R&D expenditures, the influencing factors should be identified. That will be helpful for manufacturing firms to understand the situation and ameliorate their R&D activity. The result of the study will help the policy maker to understand the situation more clearly and take decision about incurring research & development expenditure.

Some particular features make this paper isolate from others. Many previous literatures took place on a particular industry such as family business group (Min & Smyth, 2015), electronic industry (Chen H. L., 2012), agribusiness companies (Kane et al., 2007), pharmaceutical industry (Mahlich & Roediger-Schluga, 2006) etc. And some research were about manufacturing industry by Pamukcu and Utku-Ismihan (2009), Yanghua (2010) etc. These studies concentrated on the market of South Korea, Taiwan, Malaysia, France, Turkey, Japan etc.

One study took place in Bangladesh by Ferdaous and Rahman (2017) which examined effects of R&D expenditure on firm performance in pharmaceuticals industry. Very few study is available about influencing factors of R&D expenditures as well as about manufacturing industry in Bangladesh. This paper attempts to lessen that research gap and contribute to unwrap the determining factors of R&D in manufacturing industries of Bangladesh. Next differentiating context is type of investigative factors. Most of the study

used either firm specific factors or some factors of corporate governance. Such as Chen and Hsu (2009) examined the relationship among family ownership, board independence and R&D investment. Some Studies investigated the relation between corporate governance and innovation (Goyer, 2001; Honore, Munari, & Potterie, 2015 ; Othman & Ameer, 2009). Becker and Pain (2008) used industry characteristics like sales & profitability, product market competition and some macroeconomic factors like interest and exchange rate to find the determining factors of R&D performance. Kane et al. (2007) used firm specific factors; Subodh (2002) used market structure variables; Pamukcu and Utku-Ismihan (2009) used sector and firm level factors to investigate the influencing factors of R&D expenditures in their study. This paper analyze both the firm specific factors and corporate governance factors using a panel data analysis. And thus this study is going to mitigate the research gap of previous literatures. This will also be a new footprint of literature as determining factors of R&D expenditures in the context of Bangladesh.

After wards the paper is organized in following manner. Section 2 contains a concise review of prior relevant literature. Section 3 is about research methodology which comprises variables and hypotheses along with specification of model. After furnishing empirical result in section 4, section 5 has drawn concluding comment with future research prospect.

2. Literature Review

Research and Development is also known as R&D. Research and development expenditures

signify the innovative factor and this is applicable for a company, an industry or a country. R&D is defined on OECD Factbook (2015-2016) as “Research and development comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge (including knowledge of man, culture and society) and the use of this knowledge to devise new applications.” Involvement with R&D activity can be used to measure the technological strength or competitive advantage of a company or a country (Yanghua, 2010). Research and development expenditures help to lessen existing product’s cost by exploring new process and increase the option to choose more products for consumers by innovating new product (Zemplerova & Hromadkova, 2012)

In recent time, R&D has been given significant weight by policy makers and researchers for ensuring long term economic progress (Becker & Pain, 2008). R&D helps a company to increase its wealth and attain sustainable development. A company can enjoy advanced quality and quantity of production because of successful innovation that results from R&D activity (Khan & Khattak, 2014). The challenge regarding competition faced by the firms at micro level (Yanghua, 2010) can be conquered by R&D activity.

R&D activity is notably uncertain in nature and intensive in sunk cost (Driver & Guedes, 2012). According to agency theory, managers are often risk averse and may be decided to choose the option that is better for himself only (Panda & Leepsa, 2017). Board monitoring may encourage risk aversion propensity of

managers which will lead to decrease the investment on R&D (Guldiken & Darendeli, 2016). It is quite difficult for corporation to predict future outcome precisely which subsequently originate a complex situation in relation to R&D investment. Action taken by independent board might be in help of reducing this complexity and prioritize increasing of innovative capacity (Kor, 2006).

Investment in R&D activity helps manufacturing firms to enhance competitive capability. As R&D performs more responsibility to commence new and innovative project in comparison to other function (Nohria & Gulati, 1996), without this it would be cumbersome to indemnify sustainable development. Manufacturing sector is such significant that it is account for a major portion of business sector R&D (Becker & Pain, 2008).

A large number of empirical literatures have been conducted on R&D based on different market in different country. Literary works on R&D can be partitioned into two broad categories. One branch focuses on relationship between firm performance and R&D activity. While another branch of research is about

determining factor of R&D expenditures. Empirical work on later one is more relevant to the current study.

Researcher investigated influencing factor of R&D in different industry. For instance, Lee and Hwang (2003) examined the determinants of corporate R&D investment by using financial data of 515 firms of both IT and non IT industry. The study used ordinary regression model, fixed effect model and random effect model. The study found that asset, sales growth rate, subsidy are positively correlated with R&D expenditure while dividend was negatively correlated. In another research, NISHI (2015) examined the effect of different board structures on R&D investment. Necessary data were collected from R&D database for Japanese electronic corporations for the financial year 2010-2014. Panel fixed effect model and Tobit model were used for analysis. The study concluded that outside director has negative association with R&D intensity. Apart from this, review of some previous literatures is concisely narrated in the following table.

Table 1. Recent studies about influencing factors of R&D

Author (Year)	Country	Sample size	Variable	Findings
(Limani, 2015)	Turkey	765 observations for 2008, 734 observations for 2013	Dependent variable: binary variable (1 if firm invest in R&D and 0 if firm does not invest in R&D) Independent variable: Size, square of size, total export share, total national share, total foreign ownership, part of other bigger firm (dummy variable), public subsidy (dummy variable), importance of costumers (dummy variable), size indicator	<ul style="list-style-type: none"> ➤ R&D is positively related with firm size (sales) though increment is not linear to size. After a threshold, R&D start to decrease if firm size continue to increase. ➤ Export share in total sale, public support, being part of bigger firm have significant positive relationship with dependent variable. ➤ National share variable is negative and significant to the dependent variable. ➤ Foreign ownership share has negative association for 2008 and significant positive association for 2013.
(Othman & Ameer, 2009)	Malaysia	228 firm-year observations	Dependent variable: R&D intensity (R&D expenditure over sales and R&D expenditure per employee as a proxy for R&D intensity) Independent variable: Stock option, Slack (ratio of selling, general and administrative expenses to sales), tenure of CEO, experience of CEO (dummy variable), R&D capacity, sales growth, subsidiary, total sales to average total assets, total cash flow to sales ratio, ratio of total debt to total assets, tax exemption (dummy variable)	<ul style="list-style-type: none"> ➤ SLACK and sales growth have significant positive influence on R&D spending of the firms. ➤ Subsidiary has significant negative association ➤ CEO characteristics, tax exemption have no significant effect on R&D expense. Stock option and total debt to total asset variable are insignificant to dependent variable.

(Guldiken & Darendeli, 2016)	USA	467 firm-year observations	<p>Dependent variable: R&D intensity (ratio of R&D expenditures to firm sales)</p> <p>Independent variable: Directors equity holding as a proxy for board monitoring, proportion of directors appointed to the board before the tenure of the CEO (additional measure of board monitoring), average board tenure of outside directors as a proxy for firm specific human capital, total number of managerial positions that outside directors hold in the same industry as a proxy for industry specific human capital</p> <p>Control variable: CEO duality, CEO equity, past firm profitability, firm size, firm leverage, firm age, a dummy variable indicating, whether the firm acquired another firm in the high-tech industry to have access to its R&D (1=acquired; 0=not acquired), and board size</p>	<p>➤ R&D intensity does not decrease when outside directors possess high levels of firm-specific human capital.</p> <p>➤ Outside directors' either firm- or industry-specific human capital does not increase the rate at which board monitoring increases firms' R&D intensity.</p>
(Costa-Campi, Duch-Brown, & Garcia-Quevedo, 2014)	Spain	410 observations	<p>Dependent variable: R&D expenditure over sales, and R&D decision (Dummy = 1 if the firm has performed technological activities)</p> <p>Independent variable: Size, age, dummy variable (public fund, foreign capital, cooperation, group, Objective: Product, Objective: Process, Objective: Environment. Objective: Norms, Total innovation, process innovation, product innovation, cost barriers, knowledge barriers, market: incumbents, market: demand uncertainty)</p>	<p>➤ No positive relationship between size (number of employee) and R&D intensity.</p> <p>➤ New firms are involved with R&D more than older firms.</p> <p>➤ Public fund has positive effect on R&D.</p> <p>➤ Firms giving importance to process innovation, invest large amount in technological activities.</p>

(Kumar & Aggarwal, 2005)	India	4209 observations	<p>Dependent variable: R&D/Sales</p> <p>Independent variable: Firm size, technology import, export, outward investment, profit margin, multinational affiliation (dummy), technological opportunities (dummy)</p>	<ul style="list-style-type: none"> ➤ After a certain point, R&D spending rises more than proportionately with firm size. ➤ Both export and outward investment have significant positive association with dependent variable. ➤ Profit margin has significant negative impact on R&D. ➤ Engineering and chemical industries have higher R&D intensity in comparison to other industries.
(Honore et al., 2015)	European Countries	373 firm-year observations	<p>Dependent variable: R&D intensity (R&D expenditures/total sales)</p> <p>Independent variable: Limitations of anti-takeover devices, shareholders' consensus at the AGM, remuneration linked to financial performances, limitation of severance pay</p> <p>Control variable: Board score, audit committee score, operating income, intangible assets, log intangible assets</p>	<ul style="list-style-type: none"> ➤ Except limitation of severance pay, other independent variables have significant negative association with dependent variable at 5% probability threshold. ➤ Board score and audit committee score are positively significant at 10%. Intangible asset became positively significant at 1% probability.
(Chen & Hsu, 2009)	Taiwan	1,845 observations	<p>Dependent variable: Ratio of R&D expenditures to sales</p> <p>Independent variable: Family ownership, CEO duality, independent director ratio</p> <p>Control variable: Total assets, return on asset, leverage, firm risk, diversification, current liquidity, institutional stock ownership, management stock ownership, firm age</p>	<ul style="list-style-type: none"> ➤ As family ownership has negative association with dependent variable, so it discourages long term R&D investment. ➤ The firms having high family ownership, more independent director, separate CEO and chairman encourage R&D investment.

(Bhattacharya & Bloch, 2004)	Australia	1213 observations	<p>Dependent variable: Value of innovation (one if the business developed or introduced new or substantially changed products or services. Otherwise, it is zero.)</p> <p>Independent variable: Business size (sales), profit, growth, technology variable, concentration, export, import</p>	<ul style="list-style-type: none"> ➤ Size (sales) has positive impact on innovation for full sample size. ➤ In case of high tech industries, market concentration and export intensity has significant positive impact on innovation. ➤ Profitability significantly increases innovative activity in low tech industries.
(Min & Smyth, 2015)	South Korea	3,403 firm-year observations	<p>Dependent variable: R&D investment as a percentage of firm assets</p> <p>Independent variable: Growth opportunity, leverage, firm size, board payment, controlling shareholder equity ownership, operating cash flow, foreign ownership, audit committee, outside director, subsidiary member, stock return</p>	<ul style="list-style-type: none"> ➤ Growth opportunities, size of the firm and payment to executive board members have positive association with R&D intensity. ➤ Leverage has a negative effect on R&D intensity.
(Chen H. L., 2012)	Taiwan	227 observations	<p>Dependent variable: Ratio of R&D expenditures to sales</p> <p>Independent variable: Board size, director's education level and board meeting frequency</p> <p>Control variable: Firm size, firm performance, debt ratio, institutional stock ownership</p>	<ul style="list-style-type: none"> ➤ R&D investment is negatively correlated with board size but has positive correlation with director's education level. ➤ Though the association with board meeting frequency is positive, but it is insignificant.

2. Research Methodology

1.1 Selection of Sample

The research is conducted by taking sample from the manufacturing industries of Bangladesh listed in Dhaka Stock Exchange. Total seven sectors of manufacturing industry are chosen from all of the manufacturing industries. Some manufacturing industries are avoided because

those don't have any expenditure on research and development. Among seven manufacturing industries some particular industries are given more importance than others. Since some industries require more investment on research and development, a large number of samples are chosen from pharmaceuticals and chemicals & textile industry. Data are collected for period of 4 years. Time frame is extended from 2013 to 2016. Though there are 163

companies in seven manufacturing industry, 32 companies are taken as sample. Ultimately,

this study has strong balanced panel of 128 firm-year observations. Because of data

unavailability, sample size is not large enough.

Table 2. Type of industry and no of company chosen

No	Type of industry	Total No of Company	No of Company Chosen
1	Cement	7	2
2	Ceramic	5	1
3	Engineering	37	1
4	Food & Allied	17	7
5	Pharmaceuticals and Chemicals	31	10
6	Miscellaneous	13	1

7	Textile	53	10
Total		163	32

study, R&D expenditures included research and development expenditure, product development expense, laboratory expense, testing fee etc.

1.1 Sources of Data

Information for the particular variable are collected from the annual report of the companies. Some information is also collected from the website of any particular company in case of absence of that information on annual report.

1.1 Hypothesis development

1) R&D intensity

R&D intensity is used as dependent variable (Guldiken & Darendeli, 2016; Othman & Ameer, 2009). Several number of literatures mentioned in literature review section use this variable as a dependent variable. Moreover, research and development expenditure include several types of expenses. In this

2) Age

Which organization has long-term experience, they are engaged in more innovative operation and have better scheme of generating new product and process (Subodh, 2002). As the time passes, the firm attains more knack and managerial capabilities (Pamukcu & Utku-Ismihan, 2009). Experienced firms remain in advantageous position as they get more chances to accumulate the knowledge for future necessity. It is expected that there is a significant positive influence of age on undertaking R&D activity. Chen & Hsu (2009) used age to control for firm and ownership effects on the investment of research and development. Subodh (2002) also used age in his study to indicate experience of sample

firms.

H1: There is a significant association between age and R&D intensity

3) Gross Profit

Innovation activities are taken place so that firms can enjoy enhancing profits (Pamukcu, 2003). Profit margin can act as an indicator of competitive environment that an entity has to face in different time (Kumar & Saqib, 1996). In their study, they enunciate that profit margin helps to raise internal fund, which subsequently leads the possibility of having positive relationship with innovative operation. Subodh (2002) found positive and significant association between R&D and profit margin in electronics industry, but it was insignificant in drug and pharmaceutical industry.

H2: There is a significant association between gross profit and R&D intensity

4) Firm Value

There is a relationship between firm's value and some strategic decision made by the firm like investment in R&D. Literature mentioned above support this. Firm size determines whether the firm has the ability to invest in innovation. Firm size is used in several previous studies such as (Chen & Hsu, 2009; Lee & Hwang, 2003 ; Min & Smyth, 2015).

H3: There is a significant association between firm value and R&D intensity

5) Leverage Ratio

Pursuing innovativeness require to show lower leverage ratio (Yanghua, 2010). Equity

financing get more preference to debt financing in case of high asset specificity like R&D investment (Williamson, 1988). Another thing is that when there will be more debt financing that means external financing, that may not be very helpful for the company to keep their information secure. Generally firm will not be willing to share their information about R&D activities, as the firm may have to face loss in case of competitiveness (Min & Smyth, 2015). Leverage was present on the literature conducted by Chen and Hsu (2009) ; Min and Smyth (2015).

H4: Leverage has significant association with R&D intensity

6) Gender Diversity

Now days, female directors are getting importance in corporate governance. Female directors use their knowledge and different strategies to get work done and assert their dominance (Burke, 2003).Female directors of an entity have higher performance record in attending meeting in comparison to male directors and preference is given to female directors when member of different monitoring related committees are ascertained (Adams & Ferreira, 2009). It is expected that increasing number of female board member will have positive impact on firm's outcome as well as firm's R&D activity.

H5: Gender diversity is significantly associated to R&D intensity

7) Board of Director

It depends on the board size whether the firm will get it's necessary funds or not (Chen H. L.,

2012). A large number of directors also make the situation easy for the firm to get access in external resources (Shapiro, Tang, Wang, & Zhang, 2015). More directors in the board is one kind of good sign for the firm. As the firm can have different type of expertise. And the firm can make the best utilization of this opportunity. The firm may get wise decision from the directors in emergency. This variable was used in previous study by (Chen H. L., 2012).

H6: Board size is significantly associated to R&D intensity

8) Independent Director

A board having independent director is considered to be more stakeholders oriented and ensure stakeholder's interest (Goyer, 2001). According to this reference, the activities which reduce shareholder interest are avoided in the presence of independent director. In Bangladesh it is mandatory to have at least 1/5 independent director in the board for manufacturing companies. Chen and Hsu (2009) exercise independent director along with another variable to investigate board independence.

H7: Independent director has significant association with R&D intensity

9) Board Payment

If payment to board member is fixed, and there is no other incentive then the board member will not be interested to engage in any risky activities (Min & Smyth, 2015). As well as they will not be interested to think about R&D

expenditures. Moreover, shareholders will expect better performance from the board if the board get higher payment. Min & Smyth (2015) used this variable in their study and depict that to meet the higher expectation, the board members will be more cautious about their performance.

H8: Payment to board members has significant association with R&D intensity

10) Board Meeting Frequency

Through board meeting board members can discuss with each other, determine operational issues and some other problem which leads to better decision-making process and better firm performance (Al-Daoud, Saidin, & Abidin, 2016). Board meeting frequency was used by (Chen H. L., 2012) as independent variable in a study.

H9: Board meeting frequency has significant association with R&D intensity

1.1 Regression Model

Panel data analysis has been used to test the effect of corporate governance factors and firm specific factors on R&D expenditures. Hausman test is presented on the appendix to ensure brevity. The following empirical model has been developed by analyzing previous literature.

$$RDINT = \alpha + \beta_1 \text{Age (AGE)} + \beta_2 \text{Gross Profit (GP)} + \beta_3 \text{Firm Value (FV)} + \beta_4 \text{Leverage (LR)} + \beta_5 \text{Gender Diversity (GD)} + \beta_6 \text{Board of Director (BOD)} + \beta_7 \text{Independent Director (ID)} + \beta_8 \text{Board Payment (BP)} + \beta_9 \text{Board Meeting Frequency (BMF)} + \epsilon$$

Table 3. Definition of variables

Type of variable	Variables	Notation	Definition
Dependent Variable	R&D Expenditures Intensity	RDINT	(R&D expenditures/Sales) * 100
Independent variable (Firm specific factors)	Age	AGE	Number of the years of firm's incorporation
	Gross Profit	GP	Natural logarithm of gross profit
	Firm Value	FV	Natural logarithm of total asset
	Leverage Ratio	LR	Debt to equity ratio
Independent variable (Corporate governance factors)	Gender Diversity	GD	Percentage of female board members
	Board of Director	BOD	Total number of board of director
Independent Director		ID	Number of independent director
	Board Payment	BP	Payment to board members/ Assets
	Board Meeting Frequency	BMF	Number of board meeting frequency

Empirical Analysis and Finding

Descriptive statistics

Table 4. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
RDINT	128	.171097	.3728803	0	2.593537
AGE	128	23.71875	15.51171	3	67
GP	128	20.2524	1.226591	18.06701	23.71212
FV	128	22.0342	1.107678	20.16417	24.2885
LR	128	1.206641	1.52595	.02	14.27
GD	128	.1968314	.1697275	0	.5
BOD	128	7.007813	1.6577	4	11
ID	128	1.796875	.4918129	1	3
BMF	128	9.8125	7.204275	4	58
BP	128	.0020567	.002993	0	.0249506

Total number of observations =128

Descriptive statistics measure central tendency of data. Along with central tendency, it covers coefficients of dispersion like minimum, maximum, standard deviation. The average age of the selected firms is approximately 23 years, which evidence firms are well experienced. Maximum age of sample firms is 67 years while minimum age is 3 years. That means data of this study represent both new and experienced firms. The mean value of leverage ratio is 1.2066 which indicates companies considered in this study hold high amount of debt in comparison to their equity.

Percentage of female director in the board varies from 0 to 50 percentages of total board members. Standard deviation is 0.1697, which is near to the mean value .1968. This result alludes sample firms have very small number of female director in the board. All sample companies have at least one independent director with maximum number of three. Average number of board meeting is approximately 10 that clearly indicate board members meet several times to discuss different crucial issues. Minimum value of board payment is 0 as some company didn't pay at all to their directors in that respective year. Average R&D intensity represent a small portion of sales are R&D expenditures. Maximum expenditures of R&D is 2.59% of sales.

1.2 *Regression Analysis*

The result of hausman test (appendix table - A4) shows that fixed effect model is suitable

for the analysis. To find out the relationship between dependent and independent variables panel data analysis has been conducted. R square of the fixed effect model is .8323 which indicates every independent variables of this model explain approximately 83% of the variability of RDINT of selected manufacturing companies of

Bangladesh. Value of "F" is higher than the value of "Prob>F". Value of "F" is 47.98 that indicates this model significantly explain the variations. The results expose that significant level is below 5%. So it can be said that F statistic and P value are significantly strong enough to influence the dependent variable of this study. The study result shows that dependent variable RDINT has significant relationship with five independent variables namely AGE, GP, FV, LR and ID. For this relationship, significant level is less than 5%. RDINT has significant and positive relationship with Age. If one unit of age increases, RDINT will increase by 0.0368. It is observed that the most experienced firms spend much amount in Research and Development expenditures as the relationship between the age and R&D intensity is positive for this study. This result is consistent with past study (Lall, 1983; Subodh, 2002). Gross profit is significantly associated with R&D but this association is negative. An increase of one unit gross profit will decrease RDINT by 0.1172. Value of t is -2.06 and p value is 0.043 which is less than 5%.

Table 5: Regression analysis using fixed effect model

. xtreg RDINT AGE GP FV LR GD BOD ID BMF BP, fe						
Fixed-effects (within) regression				Number of obs=128		
Group variable: Com				Number of groups=32		
R-sq:				Obs per group:		
within = 0.8323				Min=4		
between = 0.0317				Avg=4.0		
overall = 0.0011				Max=4		
				F(9,87)= 47.98		
corr(u_i, Xb) = -0.8331				Prob> F=0.0000		
RDINT	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
AGE	.0367809	.0107051	3.44	0.001	.0155033	.0580585
GP	-.1171931	.0569959	-2.06	0.043	-.2304787	-.0039076
FV	-.1358497	.0678777	-2.00	0.048	-.2707639	-.0009355
LR	.151761	.0128678	11.79	0.000	.1261849	.177337
GD	.132126	.2802093	0.47	0.638	-.4248204	.6890725
BOD	.0348556	.0228084	1.53	0.130	-.0104785	.0801898
ID	-.0696058	.0347878	-2.00	0.049	-.1387504	-.0004612
BMF	.0073252	.0040933	1.79	0.077	-.0008108	.0154611
BP	-4.630709	5.64333	-0.82	0.414	-15.84744	6.58602
_cons	4.274811	1.355176	3.15	0.002	1.581251	6.96837
sigma_u	.66989548					
sigma_e	.08371547					
Rho.98462315 (fraction of variance due to u_i)						
F test that all u_i=0: F(31, 87) = 51.87 Prob > F = 0.0000						

We can explain that the profitable firms don't want to spend much on R&D as they are already profitable and it is obvious that less profitable firms will spend much on their Research and Development to make them profitable. Kumar and Saqib (1996) found negative and significant association between gross profit and R&D activity at 5% level. Firm value is measured by natural logarithm of assets. This independent variable has negative and significant coefficient with dependent

variable. This result differs from some previous literature where significant positive association was obtained between firm size and R&D (Lee & Hwang, 2003 ; Min & Smyth, 2015). The findings show that large firms spend less amount in R&D. Comparatively small firms prefer to spend much on R&D.

Posterior independent variable is leverage ratio. This study found significantly positive association between this independent variable

and the only dependent variable (Research and Development expenditure). Value of t is 11.79 while coefficient is 0.1518. It indicates that the higher the debt of the firm, the higher the R&D expenditure is. Several previous literatures found negative association between leverage and R&D (Chen & Hsu, 2009 ; Min & Smyth, 2015). But outcome of this study doesn't find any evidence about negative relationship.

Coefficient between R&D and independent director is -.0696, which appries negative association between these two variables. As t value is 2, this represents significant relationship. Kor (2006) also found negative association between outsiders on the board and R&D investment, but it was insignificant.

Apart from this, three independent variable namely gender diversity, board of director and board meeting frequency have positive association with R&D but that is not significant. Relationship between board payment and R&D is neither positive nor significant.

This narrated result supports hypothesis 1, hypothesis 2, hypothesis 3, hypothesis 4 and hypothesis 7. Among all the Hypotheses, these five Hypotheses are accepted as RDINT has significant association with the five respective independent variables. Other hypotheses have been rejected as there is no significant association between RDINT and other independent variables.

1.6 Conclusion

Bangladesh is not in a good position in the level of R&D expenditures in the world. But to ensure economic growth, get competitive

advantage and ensure sustainability some industry has no option to think about R&D expenditures. For that reason we need to know what factors actually influence R&D expenditures of manufacturing companies.

Panel data analysis has been used in this study to find out the factors that has effect on R&D expenditures intensity. A total number of 32 companies were chosen from seven manufacturing industries. Data were considered for four years. The result of the study shows that five independent variables have significant association with research and development expenditures. Here age, gross profit, firm value and leverage are firm specific factors and independent director is corporate governance factor. The findings of this study gives a notation about firm specific and corporate governance factors which affect firm's investment decision like innovation.

The explorative result shows that experienced firms who are conducting business longitudinally invest more in research and development than new firms. Gross profit has significant negative association with dependent variable. So this alludes that firms focus on higher R&D when they face lower gross profit. Another two firm specific factors, firm value and leverage have significant correlation with R&D. But impact on dependent variable for first one is negative, while second one is positive. As independent director is negatively and significantly associated with R&D, there is a possibility of having risk averse independent directors in the board.

Different companies of manufacturing industry, regulatory bodies of the country may find the outcome of this study useful. Business owners

will have more clear idea about the factors that influence R&D expenditures by which they will be able to take more effective decision for their business. This study result will make the policy makers rethink about the information of R&D expenditures that is disclosed by companies for public uses.

Limitations of this research open up ulterior research opportunities. Consideration of more years in further research can give better idea about the factors influencing research and development expenditures of manufacturing companies of Bangladesh. This study considers only seven manufacturing industries. There are some other industries which can also be used for further study. Specially IT sector is one of the most significant industry in this issue. Only listed companies are considered in this paper. So there is a prospect to conduct research on non-listed manufacturing company too. There is a scope of further research to consider other factors of two categories mentioned in this study as well as to consider factors other than these two classes.

References

- Adams, R. B. & Ferreira, D. (2009). Women in the board room and their impact on governance and performance. *Journal of Financial Economics*, 94, 291-309. doi:10.1016/j.jfineco.2008.10.007
- Al-Daoud, K. I., Saidin, S. Z. & Abidin, S. (2016). Board Meeting And Firm Performance: Evidence From The Amman Stock Exchange. *Corporate Board: Role, Duties &*, 12(2), 6-11. doi: 10.22495/cbv12i2art1
- Becker, B. & Pain, N. (2008). What Determines Industrial R&D Expenditure in The Uk? *The Manchester School*, 76(1), 66-87. doi:10.1111/j.1467-9957.2007.01050.x
- Bhattacharya, M. & Bloch, H. (2004). Determinants of Innovation. *Small Business Economics*, 22, 155-162. doi:10.1023/B:SBEJ.0000014453.94445.de
- Burke, R. J. (2003). Women on corporate boards of directors: the timing is right. *Women in Management Review*, 18(7), 346-348. doi:10.1108/09649420310498966
- Chen, H. L. (2012). Board Characteristics and R&D Investment: Evidence from Taiwan's Electronics Industry. *Advances in Management & Applied Economics*, 2(4), 161-170. Retrieved from <https://pdfs.semanticscholar.org/>
- Chen, H.-L. & Hsu, W.-T. (2009). Family Ownership, Board Independence, and R&D Investment. *Family Business Review*, 22(4), 347-362. doi:10.1177/0894486509341062
- Chen, W.-R. & Miller, K. D. (2007). Situational and Institutional Determinants of Firms' R&D Search Intensity. *Strategic Management Journal*, 28, 369-381. doi:10.1002/smj.594
- Cohen, W. M. & Levinthal, D. A. (1989). Innovation and Learning: The Two Faces of R & D. *The Economic Journal*, 99(397), 569-596. doi:10.2307/2233763

- Costa-Campi, M., Duch-Brown, N. & Garcia-Quevedo, J. (2014). R&D Drivers and Obstacles to Innovation in the Energy Industry. *Energy Economics*, 46, 20-30. doi:10.1016/j.eneco.2014.09.003
- Driver, C. & Guedes, M. J. (2012). Research and Development, Cash Flow, Agency and Governance: UK large companies. *Research Policy*, 41(9), 1565-1577. doi:10.1016/j.respol.2012.04.003
- Ferdaous, D. J. & Rahman, M. M. (2017). The Effects of Research and Development Expenditure on Firm Performance: an Examination of Pharmaceuticals Industry in Bangladesh. *Business & Entrepreneurship Journal*, 6(2), 1-20. Retrieved from http://www.sciencpress.com/Upload/BEJ%2fVol%206_2_1.pdf
- Fleming, L. & Sorenson, O. (2004). Science as a Map in Technological Search. *Strategic Management Journal*, 25, 909-928. doi:DOI: 10.1002/smj.384
- Goyer, M. (2001). Corporate Governance and the Innovation System in France 1985#2000. *Industry and Innovation*, 8(2), 135-158. doi:10.1080/1366271012007294 9
- Greve, H. R. (2003). A Behavioral Theory of R&D Expenditures and Innovations: Evidence from Shipbuilding. *Academy of Management Journal*, 46(6), 685-702. doi:10.5465/30040661
- Guldiken, O. & Darendeli, I. S. (2016). Too much of a good thing: Board monitoring and R&D investments. *Journal of Business Research*, 69, 2931-2938. doi:10.1016/j.jbusres.2015.12.062
- Honore, F., Munari, F. & Potterie, B. V. (2015). Corporate governance practices and companies' R&D intensity:Evidence from European countries. *Research Policy*, 44(2), 533-543. doi:10.1016/j.respol.2014.10.016
- Kane, M. R., Ubilava, D. & Xu, P. (2007). Effects of Firm-Specific Factors on R&D Expenditures of Agribusiness Companies. Retrieved from <http://ageconsearch.umn.edu/bitstream/7332/2/wp070004.pdf>
- Katila, R. & Ahuja, G. (2002). Something old, something new: A longitudinal study of search behavior and new product introduction. *Academy of Management Journal*, 45(6), 1183-1194. doi:10.2307/3069433
- Khan, J. & Khattak, N. U. (2014). The Significance of Research and Development for Economic Growth: The Case of Pakistan. *CURJ*, 4(1). Retrieved from https://www.researchgate.net/publication/272176830_The_Significance_of_Research_And_Development_For_Economic_Growth_The_Case_of_Pakistan
- Kor, Y. Y. (2006). Direct and interaction effects of top management team and board compositions on R&D investment strategy. *Strategic Management*

- Journal*, 27, 1081-1099. doi:10.1002/smj.554
- Kumar, N. & Aggarwal, A. (2005). Liberalization, outward orientation and in-house R&D activity of multinational and local firms: A quantitative exploration for Indian manufacturing. *Research Policy*, 34(4), 441-460. doi:10.1016/j.respol.2005.01.010
- Kumar, N. & Saqib, M. (1996). Firm size, opportunities for adaptation and in-house R & D activity in developing countries: the case of Indian manufacturing. *Research Policy*, 25(5), 713-722. doi:10.1016/0048-7333(95)00854-3
- Lall, S. (1983). Determinants of R&D in an LDC The Indian Engineering Industry. *Economics Letters*, 13, 379-383.
- Lee, M.-H. & Hwang, I. J. (2003). Determinants of Corporate R&D Investment: An Empirical Study Comparing Korea's IT Industry with Its Non-IT Industry. *ETRI Journal*, 25, 258-265.
- Limanli, o. (2015). Determinants of R&D Investment Decision in Turkey. *Procedia - Social and Behavioral Sciences*, 759-767. Retrieved from <http://creativecommons.org/licenses/by-nc-nd/4.0/>
- Mahlich, J. C. & Roediger-Schluga, T. (2006). The Determinants of Pharmaceutical R&D Expenditures: Evidence from Japan. *Review of Industrial Organization*, 28(2), 145-164. doi:10.1007/s11151-006-0010-z
- Min, B. S. & Smyth, R. (2015). Determinants of R&D intensity and its impact on firm value in an innovative economy in which family business groups are dominant:The case of South Korea. Retrieved from <https://ideas.repec.org/p/mos/moswps/2015-25.html>
- NISHI, T. (2015). Different Board Structures and R&D: Evidence from Japanese Corporation. *Corporate Board: Role, Duties & Composition*, 11(2-1), 171-182. doi:10.22495/cbv11i2c1art3
- Nohria, N. & Gulati, R. (1996). Is slack good or bad for innovation? *Academy of Management Journal*, 39(5), 1245-1264. Retrieved from <https://doi.org/10.5465/256998>
- OECD Factbook. (2015-2016). Economic, Environmental and Social Statistics.
- Othman, R., & Ameer, R. (2009). Determinants and persistence of research and development investments: Evidence from Malaysia. *International Journal of Emerging Markets*, 275-292. doi:10.1108/17468800910968427
- Pamukcu, T. (2003). Trade Liberalization and Innovation Decisions of Firms: Lessons from Post-1980 Turkey. *World Development*, 31(8), 1443-1458. doi:10.1016/s0305-750x(03)00087-1
- Pamukcu, T. & Utku-Ismihan, F. M. (2009). Determinants of R&D

- Decisions of Firms in Developing Countries the Case of Turkey. *Paper presented at EconAnadolu 2009: Anadolu International Conference in Economics.* Eskişehir, Turkey. Retrieved from <https://www.semanticscholar.org/paper/Determinants-of-R%26D-Decisions-of-Firms-in-Countries-Pamuk%26A7u-Utku-%26B0smihan//c4dda194ec8b50ee360949e4d966308df0c61ec3>
- Panda, B., & Leepsa, N. M. (2017). Agency theory: Review of Theory and Evidence on Problems and Perspectives. *Indian Journal of Corporate Governance*, 10(1), 74-95. doi:10.1177/0974686217701467
- Shapiro, D., Tang, Y., Wang, M. & Zhang, W. (2015). The effects of corporate governance and ownership on the innovation performance of Chinese SMEs. *Journal of Chinese Economic and Business Studies*, 13(4), 311-335. doi:10.1080/14765284.2015.1090267
- Subodh, K. (2002). Market Concentration, Firm Size and Innovative Activity: A Firm-level Economic Analysis of Selected Indian Industries under Economic Liberalization. *WIDER Discussion Paper No. 2002/108*.
- Williamson, O. E. (1988). Corporate Finance and Corporate Governance. *THE JOURNAL OF FINANCE*, XLIII(3), 567-591. doi:10.2307/2328184
- Yanghua, C. (2010). *Ownership Structure, Financial Structure and R&D Investments: Evidence from Korean Firms*. Master Thesis. Retrieved from https://ink.library.smu.edu.sg/etd_coll/69
- Zemplerova, A. & Hromadkova, E. (2012). Determinants of Firm's Innovation. *Prague Economic Papers*, 487-503. doi:10.18267/j.pep.436

Appendices

Table A-1. Regression Analysis

Reg RDINT AGE GP FV LR GD BOD ID BMF BP						
						Number of obs=128
Source	SS	Df	MS	F(9, 118) = 6.38		
Model	5.78025241	9	.642250268	Prob> F=0.0000		
Residual	11.8777934	118	.100659266	R-squared=0.3273		
Total	17.6580458	127	.139039731	Adj R-squared=0.2760		
						Root MSE=.31727
RDINT	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
AGE	-.0066386	.0026409	-2.51	0.013	-.0118684	-.0014088
GP	-.0095747	.0602037	-0.16	0.874	-.1287944	.1096449
FV	.0938062	.0524568	1.79	0.076	-.0100727	.197685
LR	.0916737	.0197717	4.64	0.000	.0525202	.1308271
GD	-.2566294	.1874868	-1.37	0.174	-.6279044	.1146456
BOD	-.0305107	.0233668	-1.31	0.194	-.0767834	.0157619
ID	.1202522	.0740897	1.62	0.107	-.0264656	.26697
BMF	-.0030945	.0045933	-0.67	0.502	-.0121904	.0060015
BP	49.05528	11.20427	4.38	0.000	26.86778	71.24278
_cons	-1.677376	.6614724	-2.54	0.013	-2.987271	-.3674803

Table A-2. Regression Analysis using fixed effect model

. xtreg RDINT AGE GP FV LR GD BOD ID BMF BP,fe						
Fixed-effects (within) regression				Number of obs=128		
Group variable: Com				Number of groups=32		
R-sq:				Obs per group:		
within = 0.8323				Min=4		
between = 0.0317				Avg=4.0		
overall = 0.0011				Max=4		
				F(9,87)= 47.98		
corr(u_i, Xb) = -0.8331				Prob> F=0.0000		
RDINT	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
AGE	.0367809	.0107051	3.44	0.001	.0155033	.0580585
GP	-.1171931	.0569959	-2.06	0.043	-.2304787	-.0039076
FV	-.1358497	.0678777	-2.00	0.048	-.2707639	-.0009355
LR	.151761	.0128678	11.79	0.000	.1261849	.177337

GD	.132126	.2802093	0.47	0.638	-.4248204	.6890725
BOD	.0348556	.0228084	1.53	0.130	-.0104785	.0801898
ID	-.0696058	.0347878	-2.00	0.049	-.1387504	-.0004612
BMF	.0073252	.0040933	1.79	0.077	-.0008108	.0154611
BP	-4.630709	5.64333	-0.82	0.414	-15.84744	6.58602
_cons	4.274811	1.355176	3.15	0.002	1.581251	6.96837
sigma_u	.66989548					
sigma_e	.08371547					
Rho.98462315 (fraction of variance due to u_i)						
Ftest that allu_i=0: F(31, 87) = 51.87 Prob> F = 0.0000						

Table A-3. Regression Analysis using random effect model

xtreg RDINT AGE GP FV LR GD BOD ID BMF BP,re						
Random-effects GLS regression				Number of obs=128		
Group variable: Com				Number of groups=32		
R-sq:				Obs per group:		
within = 0.8059				Min=4		
between = 0.0113				Avg=4.0		
overall = 0.1318				Max=4		
				Wald chi2(10)=356.63		
corr(u_i, X) = 0 (assumed)				Prob> chi2= 0.0000		
RINT	Coef.	Std. Err.	z	P>z	[95% Conf. Interval]	
Age	.0012568	.0044284	0.28	0.777	-.0074226	.0099363
LnGP	-.061491	.0522005	-1.18	0.239	-.1638021	.0408202
LnAsset	.0453395	.0504348	0.90	0.369	-.0535109	.1441899
Leverage	.1248799	.0107221	11.65	0.000	.1038648	.1458949
GD	-.1563101	.2298369	-0.68	0.496	-.6067821	.294162
BOD	.0228249	.0216796	1.05	0.292	-.0196663	.0653161
ID	-.0293832	.0350157	-0.84	0.401	-.0980128	.0392464
BMF	.0046815	.00391	1.20	0.231	-.002982	.012345
BP	5.707485	5.433875	1.05	0.294	-4.942714	16.35768
_cons	.1028574	.9477064	0.11	0.914	-1.754613	1.960328
sigma_u.31986448						
sigma_e.08371547						
Rho.93589298 (fraction of variance due to u_i)						

Table A-4. Hausman test

. hausman fixed, sigmamore				
Coefficients ----				
	(b)	(B)	b-B	sqrt(diag(V_b-V_B))
	Fixed	Random	Difference	S.E.
AGE	.0367809	.0012568	.035524	.0106675
GP	-.1171931	-.061491	-.0557021	.0325077
FV	-.1358497	.0453395	-.1811891	.0531019
LR	.151761	.1248799	.0268811	.0088197
GD	.132126	-.1563101	.2884361	.1964119
BOD	.0348556	.0228249	.0120307	.0116444
ID	-.0696058	-.0293832	-.0402226	.0135165
BMF	.0073252	.0046815	.0026437	.0020535
BP	-4.630709	5.707485	-10.33819	2.747102