



IMPACT OF R&D INVESTMENT ON FIRM PERFORMANCE AND FIRM VALUE: EVIDENCE FROM DEVELOPED NATIONS (G-7)

IMPACTO DO INVESTIMENTO EM P & D NO DESEMPENHO FIRME E VALOR DA EMPRESA: EVIDÊNCIA DAS NAÇÕES DESENVOLVIDAS (G-7)

IMPACTO DE I + D INVERSIÓN EN EL DESEMPEÑO Y VALOR DE LA EMPRESA: EVIDENCIA DE LAS NACIONES DESARROLLADAS (G-7)

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ABSTRACT

The purpose of the study is to evaluate the impact of R&D investment on firm performance and firm value among G-7 countries. To testify such relationship, we use firm level and country level data collected from firms' financial statements, countries stock exchanges, and World Bank databases. Based on data structure (country level, industry level and firm level), we use

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HLM regression analysis technique along with robust standard error. By using diverse range of control variables (firm size, age, leverage, GDP growth, interest rate and financial crises dummy), results suggest that same year R&D investment has negative impact on firm performance and, positive impact on firm value. However, one year lagged period R&D investment has positive relationship with both firm performance, and firm value. Nevertheless, two years lagged period R&D investment has not effect on both firm performance -and value.

Keywords: R&D investment, Firm Performance, Firm Value, HLM Regression model, G-7 Countries

RESUMO

O objetivo do estudo é avaliar o impacto do investimento em P & D sobre o desempenho das empresas eo valor das empresas entre os países do G-7. Para testemunhar essa relação usamos dados de nível de empresa e nível de país coletados das demonstrações financeiras das empresas, das bolsas de valores dos países e das bases de dados do Banco Mundial. Com base na estrutura de dados (nível de país, nível da indústria e nível de empresa), utilizamos a técnica de análise de regressão HLM juntamente com o erro padrão robusto. Utilizando diversas variáveis de controle (tamanho da empresa, idade, alavancagem, crescimento do PIB, taxas de juros e crises financeiras), os resultados sugerem que o investimento em P & D no mesmo ano tem impacto negativo no desempenho da empresa e impacto positivo no valor da empresa. No entanto, um ano atrás, o investimento em P & D tem relação positiva com o desempenho da empresa e com o valor da empresa. No entanto, dois anos de atraso no período R & D investimento não tem efeito sobre o desempenho da empresa e valor.

Palavras-chave: Investimento em I & D, Desempenho da empresa, Valor da empresa, Modelo de regressão HLM, Países do G-7

RESUMEN

El propósito del estudio es evaluar el impacto de la inversión en I + D sobre el desempeño de las empresas y el valor de la empresa entre los países del G-7. Para aseverar tal relación, utilizamos datos a nivel de empresa y a nivel nacional recopilados en el estado financiero de las empresas, en las bolsas de valores de los países y en las bases de datos del Banco Mundial. Basado en la estructura de datos (nivel de país, nivel de industria y nivel de empresa) utilizamos

la técnica de análisis de regresión de HLM junto con un error estándar robusto. Los resultados sugieren que la inversión en I + D del mismo año tiene un impacto negativo en el desempeño de las firmas y un impacto positivo en el valor de la empresa, al utilizar diversas variables de control (tamaño de la empresa, edad, apalancamiento, crecimiento del PIB, tasas de interés y crisis financieras). Sin embargo, en un año de retraso del período de I + D la inversión tiene una relación positiva con el rendimiento de la empresa y el valor de la empresa. Sin embargo, la inversión en I + D con dos años de retraso no tiene ningún efecto en el desempeño ni en el valor de la empresa.

Palabras clave: Inversión en I + D, Rendimiento de la empresa, Valor de la empresa, Modelo de regresión HLM, Países del G-7

1. Introduction:

This is an era of innovation. World is becoming a global village, in which markets are shrinking. Customers have open access to every market in the world. By this there is huge competition among the world producers to provide most innovative products that can satisfy the need of consumers (Kumar et al., 2012). R&D is the core activity of any firm (Helfat, 1997; Winter, 2003). R&D investment could be considered as a key driving factor towards firm performance. R&D effects firm's performance by developing innovative products, enlarging ability to learn new technology and endowing with solutions to satisfy consumer requirements (Yew et al., 2005). Last few decades have witnessed a remarkable growth in R&D investment. The importance of R&D could be understood by the fact, that in many high tech firms, R&D investments are more than their earnings (Andi et al., 2011).

Corporate R&D received considerable attention in past few years. Many studies were conducted to estimate the link between R&D and different indicators such as corporate governance, managerial discretion (Jing & Yan, 2009), government subsidy (Eui & Beom, 2010), company size, intangible resources (Yung-Lung et al., 2015), family ownership (Young et al., 2014), foreign entry (Sajid & Sizhong, 2013), legal share holder protection (Xiao, 2013), property right protection (Chen et al., 2009), managerial incentive, CEO characteristics (Chen et al., 2011), internationalization (Chaiporn & Olimpia, 2015), FDI (Leman & Ismat, 2015), and corporate social responsibility (Robert & Jose, 2010).

R&D investment is recognized as long term investment made by firm linked with high level of uncertainty, with no immediate return and influence growth, competitiveness and viability in coming periods (Morbey, 1988). High competitive markets pushed firms to search for growth opportunities, profitable business ventures and large market share before their competitor, by different innovative strategies and new products (Ike & Kingsley, 2010). R&D is also the critical element in profitability and competitive advantage of any business (Wang, Chun-Hsien et al., 2013). There is a race of innovation between firms, when a firm effectively completes its project of R&D earlier than other competitive firms, it would more likely to get the whole market share with respect to that innovative product. Other firms then reduce or sometimes stop their R&D investment on the similar projects due to low cash flow associated with the project (Gu, 2015).

There are two ways to get advantage in competitive market. One is through new product and, second is through innovative process. New product helps to get large market share and, innovative process assists to reduce current production cost. These activities make firm more competitive as well as profitable (Xu & Zhang, 2004). R&D intensive firms compete on the basis of product and process innovation, as it allows them to substantially increase their earnings and sales by retaining their customers as well as capturing new markets. After high investment in R&D, firms launch innovation on large scale and get high return (Das et al., 2009). The literature show somehow mixed or even conflicting results for the impact of R&D investment on firm performance. Some researchers investigate the positive impact (Fosfuri & Tribó, 2008; Morikawa, 2004; Sung & Dongnyoung, 2003) while others elaborate negative effect (Chan, S. H. et al., 1990; Hsu & Boggs, 2003; Majocchi & Zucchella, 2003; Mank & Nystrom, 2001). Few studies indicate impact of R&D investment is negative for operating performance (short run) and positive on firm value (long run) (Chaiporn & Olimpia, 2015; Cui & Mak, 2002).

The purpose of this study is to examine the impact of R&D investment on firm performance and firm value among developed (G7) countries. The reason for choosing developed nations for said study is the prevailing innovative environment in advanced nations. Firms in developed countries invest a huge sum of money on R&D activities and generate breakthrough innovations. On the contrary, firms operating in developing countries are less participative among global innovation. These firms are investing less amount of money on R&D activities and, highly dependent on technological innovation done by firms working in developed

countries. Moreover, due to scarcity of resources (technology, human, monetary etc.) and inefficient institutional environment (legal, financial, political etc.) firms located in developing nations are less involved in long term and highly uncertain investment i.e., innovative/R&D investment.

To evaluate aforesaid relationship, we use firm level data along with country level indicators, gather through multiple sources like firm financial statements, stock exchange, World Bank etc. By using different control variables and Hierarchical Linear Model (HLM) regression analysis technique, results suggest that current year R&D investments have negative impact on firm performance and positive impact on firm value. However in relation with one year lagged value of R&D investment such impact became positive. But we didn't find any statistical relationship with two year lagged R&D investment with firm performance and firm value. Policy implications advocate that R&D investment is beneficial for firm long term performance. However it has adverse impact on short term profit.

The rest of the paper includes: literature review and hypotheses development (chapter 2), methodology and empirical modeling (chapter 3), empirical analyses (chapter 4), conclusion (chapter 5), and lastly references.

2. Literature Review and Hypotheses Development:

2.1.R&D Investment and Firm Performance

R&D investment decisions are determined by available resources of firms as well as future returns. A large number of studies are conducted to examine the impact of R&D investment on firm performance. Most of the studies indicate the positive effect of R&D on firm performance. Eberhart et al. (2004), found positive effect of increase in R&D on firm performance and shareholder return. Ike and Kingsley (2010), investigated the effect of R&D investment on firm performance in US manufacturing and services industry between 1990 and 2007 and found positive effect of R&D investment on firm performance. They also estimated the effect of major destructive event such as 9/11 on the relationship between R&D and firm performance in manufacturing and services industries. Results of their study remained same and explained positive relationship between R&D investment and firm performance before and after 9/11.

Wang et al.,(2013), analyzed the effect of R&D and productivity on firm performance in 65

high tech industrial firms registered from 2003 to 2007 on Taiwan Stock Exchange Corporation. By controlling certain firm level variables, results indicated positive effect of productivity and R&D on firm performance. Aimen and Waseem (2014), examined the impact of R&D on firm performance among the listed pharmaceutical firms on Karachi Stock Exchange from 2007 to 2012. They found positive and significant relationship between R&D and firm performance. Vanderpal (2015), investigated impact of R&D expenses on corporate financial performance. He found positive impact of R&D expenses on future earnings, market capitalization, productivity growth and operating performance of firms.

On the contrary point of view, Hsu and Boggs (2003), found negative relationship between R&D investments on firm performance among U.S. multinational firms. In the same way, Majocchi and Zucchella (2003), explained adverse relationship among sample set of 220 Italy based SMEs firms. Bae et al. (2008), elaborated that there is S-shape association among R&D investment and firm performance. Cui and Mak (2002), showed that high R&D intensity presents negative linkage with ROA (Return on Assets). In a recent and most relevant study Chaiporn and Olimpia (2015), examined the short run and long run effect of internationalization and R&D intensity on firm performance. Researchers used 18,636 firm year observation data of US firms listed on NASDAQ and NYSE from 1990 to 2013. After controlling firm size, leverage and fixed asset ratio, results indicated that R&D intensity has negative affect on firm operating performance. Therefore, the relationship between R&D and firm performance is still indefinable.

Moreover, accounting treatment of R&D investment has a direct impact on firm performance. There are two methods for accounting treatment of R&D investment as per international accounting standards (IAS): Treat it as expense or treat it as intangible assets. If R&D investment is treated as expense then it goes through income statement, otherwise, if it is treated as intangible asset then it goes to balance sheet and amortized annually (Anagnostopoulou, 2008). On the both way it reduces firm short term earning, elaborated as profitability. According to above discussion we can draw our hypothesis as;

H1: R&D investment has negative effect on firm operating performance.

2.2.R&D Investment and Firm Value

In existing economic environment innovation ought to be considered as basis for firm growth

and competitive advantage. R&D investment is the key factor of innovation and deliberated as critical investment by firms to remain competitive, especially highly technical firms like IT, Science and Technology, Pharmaceutical, Automobile etc. (Chan, S. H. et al., 1990). Sung and Dongnyoung (2003), conducted a study to evaluate the effect of R&D investment on firm market value in Japan, Germany and USA. In all three nations, they found significant and positive relationship between R&D investment, firm market value and stock return volatility. They further elaborated that Japanese market appears to value most of R&D followed by German and US.

Wang (2011), found that both optimum -and minimum level of R&D investment has positive effect on firm value. In another study, Andi et al. (2011) empirically evaluated the effect of R&D on stock returns in thirteen European countries from 1999 to 2010. By controlling firm size and leverage, results showed positive effect of R&D on stock returns. They also explained that this positive relationship is higher in the countries which invest more in R&D.

In a study on Indian manufacturing firms, Kumar et al. (2012), examined the relationship between R&D intensity and firm value. Data of 2382 firms listed on Bombay Stock Exchange from 2001 to 2010 were collected. Results elaborated that there is positive and statistically significant effect of R&D intensity on firm value. They extended explanation that the relationship between R&D intensity and firm value indicate diminishing marginal return i.e., at beginning stage R&D intensity show positive effect on firm value until investment reached at the optimal level after that the investment lowers the firm value. Same results were found by Pantagakis et al. (2012) that R&D investment has positive effect on firm market value until an optimum point reached.

Başgoze and Sayin (2013), found positive and significant relationship between R&D intensity and stock returns among the firms listed on Istanbul Stock Exchange from 2006 to 2010. Mehdi and Mohammad (2014), explained positive effect of R&D spending on firm profitability and stock market value among listed firms on Tehran Stock Exchange from 2003 to 2008. Chan et al., (2015), conducted a study to examine stock market valuation of R&D expenditure and the role of corporate governance. By using 25,941 firm year observations from 1990 to 2007, results showed that R&D intensity has positive effect on stock returns with good corporate governance and no effect with poor corporate governance.

Chaiporn and Olimpia (2015), explained this point that R&D investment is usually associated with long term projects which have positive NPV. In initial year(s) R&D project's cash flow is negative that reduce firm operating performance as hypothesized above. But in long run R&D project's NPV is positive that increase firm value. R&D investment is also a tool for innovation because of which firms can attain competitive advantage. Competitive firms with innovative products and ideas attract investors as well as get large market share. By using aforesaid decision as base, we can hypothesize as;

H2: R&D investment has positive impact on firm value.

3. Methodology and Empirical Modelling:

3.1. Sample of Study

The sample of the study consists of G7 developed countries which include: Canada, France, Germany, Italy, Japan, United Kingdom, and United States. We take non-financial firm listed on each of above said countries' stock exchanges during the period of 2004-2016. Financial firms are excluded from the sample because of different regulatory and economic environment in which they operate. Delisted firms are also excluded from the sample. Firms with missing data are also omitted from the sample. The data on financial characteristics and different firm level variables are extracted from World Bank database, Country's stock exchange and Firms financial statements.

3.2. Variables Definition and Measurement

To testify the hypotheses of our study, we use firm performance and firm value as dependent variables. Firm performance is measured through Return on Asset, and Cash Flow by Operating Revenue. Firm value is calculated through Tobin's Q, and Market Capitalization. (Andi et al., 2011; Chaiporn & Olimpia, 2015; Chan, K. et al., 2015; Eberhart et al., 2004; Herzer et al., 2006; Kumar et al., 2012; Morck & Yeung, 1998; Rodrik, 2006; Wang, Chun-Hsien et al., 2013; Xing, 2014)

We use R&D intensity as our independent variable that is measured as R&D investment divided by total assets. We categorize R&D intensity into three levels based on its time period i.e., R&D intensity for current year (t), R&D intensity for one lagged year (t-1), and R&D intensity for two year lagged year (t-2). The main purpose of this division is to find any possible variation

in results with respect to the time of investment (if any). (Başgoze & Sayin, 2013; Chaiporn & Olimpia, 2015; Eberhart et al., 2004; Fagerberg, 2000; Frolov & Lebedev, 2007; Greenaway et al., 1999; Ike & Kingsley, 2010; Kumar et al., 2012; Sami et al., 2013; Sung & Dongnyoung, 2003; Wana Ismail; Wang, Chao-Hung, 2011)

We also use different firm and country level control variables i.e., Firm Size, Firm Age, Leverage, GDP growth, Interest Rate. Along with these indicators with also control for financial crises 2008-09, which extensively impact on firms' financial performance and G7 countries performance. These control variables are widely used in past studies and reported both positive and negative impact on firm performance, and firm value. (Chaiporn & Olimpia, 2015; Ike & Kingsley, 2010; Kumar et al., 2012; Majumdar, 1997; Sami et al., 2013; Vanderpal, 2015; Yoo, 2008; Zhang, 2007)

Table 1: Variable Definitions and Notations

Variable	Notation	Definition
R&D Intensity	RDI	Investment by a firm on research and development (R&D) divided by the firm's total assets
Return on Assets	ROA	ROA shows how profitable a firm's assets are in generating profit.
Cash Flow/Operating Revenue	CFOR	Cash flow divided by operating revenue
Market Capitalization	MC	Outstanding shares*market price of shares
Tobin's Q	TOQ	TOQ is the ratio of the firm's market value to the replacement cost of its assets.
Firm Size	FS	An empirical measure to assess size of firm through total assets.
Firm Age	FA	Firm age is the total age of firm since incorporation.
Leverage	LEV	Leverage indicates the amount of loan used to finance a firm's assets.
GDP	GDP	Monetary value of goods and services produced in certain time period in a country,
Interest Rate	IR	Interest rate is the cost of borrowing in percentage.
Crisis-08	Crisis08	Dummy variable for 2008
Crisis-09	Crisis09	Dummy variable for 2009

3.3.Econometric Modelling

Our dataset consists of three levels i.e., firstly country level, secondly industry level, and thirdly firm level. To statistically analyze such kind of dataset, we use Heretical Linear Model (HLM)

analysis technique. This regression analysis technique allow us to divide full dataset into different levels and better investigate relationship among R&D intensity, firm performance and firm value. Moreover based on dependent, independent and control variables, we draw following empirical regression models.

$$ROA_{it} = \beta_0 + \beta_1 RDI_{it} + \beta_2 FS_{it} + \beta_3 FA_{it} + \beta_4 LEV_{it} + \beta_5 GDP_{tc} + \beta_6 IR_{tc} + \beta_7 Crisis08_c + \beta_8 Crisis09_c + \varepsilon_{itc} \quad (1-3)$$

$$CFOR_{it} = \beta_0 + \beta_1 RDI_{it} + \beta_2 FS_{it} + \beta_3 FA_{it} + \beta_4 LEV_{it} + \beta_5 GDP_{tc} + \beta_6 IR_{tc} + \beta_7 Crisis08_c + \beta_8 Crisis09_c + \varepsilon_{itc} \quad (4-6)$$

$$TOQ_{it} = \beta_0 + \beta_1 RDI_{it} + \beta_2 FS_{it} + \beta_3 FA_{it} + \beta_4 LEV_{it} + \beta_5 GDP_{tc} + \beta_6 IR_{tc} + \beta_7 Crisis08_c + \beta_8 Crisis09_c + \varepsilon_{itc} \quad (7-9)$$

$$MC_{it} = \beta_0 + \beta_1 RDI_{it} + \beta_2 FS_{it} + \beta_3 FA_{it} + \beta_4 LEV_{it} + \beta_5 GDP_{tc} + \beta_6 IR_{tc} + \beta_7 Crisis08_c + \beta_8 Crisis09_c + \varepsilon_{itc} \quad (10-12)$$

Models 1 to 6 elaborate the impact of R&D intensity on firm performance at different stages of *R&D intensity i.e., current (t), one year lagged (t-1), and two year lagged (t-2). Models 7 to 12 examine the effect of R&D investment on firm value for different stages of *R&D intensity (t, t-1, and t-2).

4. Empirical Analyses:

To testify the hypotheses of our study, we use both firm level indicators and country level indicators. Table 2 explains descriptive statistics of data use in this study. Dataset is comprised of firms operating in G-7 countries under 8 different industries as per GICS classification. We have an average of 0.292 firms R&D intensity with a range from 0.000 to 13744.740. We also use lag one period and lag two period of R&D intensity having average value of 0.311 and 0.047 respectively. To estimate firm operating performance, we use ROA and cash flow by operating revenue which display mean value of -1.349 and 10.370 correspondingly.

As like firm operating performance, we use two variables to calculate firm value i.e., Tobin's Q (mean=7.783) and Market Capitalization (mean=11.987). As per firm size (measured as log of total asset), we have firms with lower size as 0.086 and bigger as 19.919. According to the dataset, we have on average 40.715 year of firm age with leverage of 0.547. Due to the financial crisis of 2008-09, GDP growth among G-7 countries shows average of 1.092 with lower as -5.567 and higher as 4.215. Lending interest rate in sample countries demonstrates mean value of 2.889.

Table 2: Descriptive Statistics

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Variable	Observation	Mean	Std. Dev.	Min	Max
R&D Intensity	61,856	0.292	55.278	0.000	13744.740
R&D Intensity (t-1)	53,549	0.311	59.400	0.000	13744.740
R&D intensity (t-2)	46,253	0.047	0.441	0.000	40.385
ROA	61,856	-1.349	226.256	-55971.390	2529.100
Cash Flow/Operating Revenue	50,441	10.370	10.468	0.000	99.800
Tobin's Q	61,856	7.783	274.695	0.000	44990.320
Log Market Capitalization	61,856	11.987	2.287	0.811	20.260
Firm Size	61,856	12.435	2.438	0.086	19.919
Firm Age	61,856	40.715	31.896	1.000	144.000
Leverage	61,856	0.547	17.176	0.000	3172.479
GDP Growth	61,856	1.092	2.073	-5.567	4.215
Interest Rate	61,856	2.889	1.641	1.380	8.050

Collinearity among variables cause a serious problem which leads to biased estimation. So, before analyzing regression models, it is highly recommended to observe study data with respect to collinearity point of view. To analyze possible existence of collinearity among study dataset, we use Pearson Correlation Matrix along with significance level. According to the result of correlation matrix presents in table 3, there is no issue of collinearity among variable. Most of the variables are statistically significant and according to the past studies.

Table 3: Pearson Correlation Matrix

	RDI	LRDI	LLRDI	ROA	CFOR	TOQ	MC	FS	FA	LEV	GDP	IRS
RDI	1.000											
LRDI	0.001	1.000										
LLRDI	0.037*	0.028*	1.000									
ROA	-0.672*	-0.001	-0.060*	1.000								
CFOR	0.024*	0.047*	0.056*	0.032*	1.000							
TOQ	0.041*	0.002	0.044*	-0.425*	0.008*	1.000						
MC	-0.012*	-0.010*	-0.019*	0.023*	0.237*	-0.016*	1.000					
FS	-0.035*	-0.022*	-0.043*	0.073*	0.117*	-0.116*	0.878*	1.000				
FA	-0.008*	-0.006	-0.016*	0.013*	-0.168*	-0.017*	0.253*	0.370*	1.000			
LEV	0.002	0.000	0.037*	-0.586*	0.029*	0.373*	-0.020*	-0.055*	-0.008*	1.000		
GDP	-0.010*	0.003	0.007	0.004	0.084*	0.002	0.044*	-0.023*	-0.066*	0.003	1.000	
IR	0.002	0.002	0.007	-0.004	0.250*	0.007*	0.005	-0.106*	-0.238*	0.002	0.125*	1.000

*P<0.1

As discussed earlier, we have dataset consists of three levels i.e., country level, industry level and firm level. To analyze such kind of heretical data, we use HLM regression analysis technique with robust standard error. We also use diverse range of firm specific and country specific variables together with financial crisis dummies. Results (table 4) suggest that current year R&D investment intensity has negative impact on firm performance measure as ROA and

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cash flow by operating revenue. On the opposite, present year R&D intensity has positive relationship with both indicators of firm value i.e., Tobin's Q and Market Capitalization. These results are consistent with past studies (Chaiporn & Olimpia, 2015) and show that current R&D investment as an expense reduces firm operating performance. However such innovative investment gives optimistic indication to markets, which in return perform positively.

Table 4: Impact of R&D Intensity on Firm Performance and Firm Value

	ROA	CFOR	Tobin's Q	MC
RDI	-4.063* (-410.71)	-15.235* (-14.1)	0.338* (8.21)	0.001* (6.05)
Firm Size	13.401* (16.93)	0.296* (6.21)	-88.400* (-27.74)	0.694* (190.76)
Firm Age	-0.334* (-3.54)	-0.022* (-5.89)	1.837* (4.92)	-0.003* (-8.09)
Leverage	-0.797* (-353.11)	0.199* (8.19)	1.447* (152.55)	0.001* (12.78)
GDP Growth	-0.053 (-0.12)	-0.008 (-0.3)	0.499 (0.26)	0.007* (2.86)
Interest Rate	-0.188 (-0.36)	0.181* (5.76)	0.028 (0.01)	0.049* (17.55)
Crisis-08	-0.595 (-0.31)	-1.091* (-9.58)	2.823 (0.34)	-0.504* (-48.06)
Crisis-09	0.371 (0.11)	-0.911* (-4.93)	-1.237 (-0.09)	-0.154* (-8.88)
Cons.	-151.424* (-14.98)	11.248* (8.21)	1026.830* (21.96)	3.385* (30.11)
Number of Observation	61,856	50,441	61,856	61,856
Wald chi2	297076.62	566.75	25218.21	42450.95
Prob > chi2	0.0000	0.0000	0.0000	0.0000
Log likelihood	-389168.81	-164937.41	-477427.28	-63200.23

*P<0.1, Z score in brackets

We also analyze above mentioned relation by using one year lagged period of R&D intensity. According to the results illustrate in table 5, one year lagged R&D intensity has positive impact on both firm performance and firm value except Tobin's Q. The positive relationship indicates that previous year R&D investment will mature in subsequent year in form of innovative product/process, which increase firm profitability and cash flow. Such increase in firm performance gives positive signal to investors, which subsequently foster firm value in terms of share prices. The possible explanation of contrary relationship of lag one period of R&D

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intensity with Tobin's is that, R&D is highly uncertain type of investment with high possibility of failure. Additionally, such kind of investments are based on external financing with higher interest rate. Due to such characteristics, R&D investment increase firm's debt level as compare to assets, which consequently impact on firm value estimated as Tobin's Q.

Table 5: Impact of R&D Intensity (t-1) on Firm Performance and Firm Value

	ROA	CFOR	Tobin's Q	MC
LRDI	0.044* (3.56)	2.075* (3.94)	-0.261* (-2.91)	0.001* (1.85)
Firm Size	11.243* (18.15)	0.506* (10.25)	-49.252* (-21.44)	0.737* (189.6)
Firm Age	-0.213* (-3.61)	-0.024* (-6.4)	0.936* (2.92)	-0.003* (-6.18)
Leverage	-0.774* (-318.17)	0.178* (7.26)	1.454* (308.94)	0.000* (13.6)
GDP Growth	-0.203 (-0.41)	-0.012 (-0.46)	1.518 (1.58)	0.001 (0.31)
Interest Rate	0.062 (0.1)	0.171* (5.1)	-0.526 (-0.41)	0.030* (9.9)
Crisis-08	-0.620 (-0.29)	-1.152* (-10.05)	5.158 (1.23)	-0.494* (-47.53)
Crisis-09	-0.889 (-0.25)	-0.990* (-5.35)	15.067* (2.18)	-0.187* (-11.05)
Cons.	-132.247* (-16.37)	8.190* (6.05)	595.475* (14.69)	2.866* (25.51)
Number of Observation	53,549	44,465	53,549	53,549
Wald chi2	103050.92	399.52	99092.09	42010.19
Prob > chi2	0.0000	0.0000	0.0000	0.0000
Log likelihood	-335009.54	-144378.19	-380749.87	-51496.8

*P<0.1, Z score in brackets

Furthermore, we evaluate study hypotheses by using two year lagged R&D intensity. The main reasons of using lagged one and two year R&D intensity are to examine the time period between which firms can acquire financial benefits from R&D investment. As per results explain in table 6, preceding two year R&D intensity has no statistical impact on firm performance and firm value except ROA. These statistical insignificant results clarify that R&D investment made two year back has no benefit for firm cash flow and firm value, (Kumar et al., 2012; Pantagakis et al., 2012). However it has negative impact on ROA, which possibly suggests that two year earlier R&D investment made through external financing will reduce profitability (by

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amortization and interest cost) of subsequent year because of maturity of project. But such relationship is became insignificant with three year lagged R&D intensity. Control variables are mostly significant and have positive (negative) relationship with firm performance and firm value as according to past studies.

Table 6: Impact of R&D Intensity (t-2) on Firm Performance and Firm Value

	ROA	CFOR	Tobin's Q	MC
LLRDI	-0.776* (-10.46)	0.788 (0.76)	0.151 (1.51)	0.001 (0.76)
Firm Size	2.304* (6.17)	0.561* (10.92)	-8.644* (-12.45)	0.787* (192.89)
Firm Age	-0.029 (-0.87)	-0.020* (-5.09)	0.102 (1.5)	0.000 (0.14)
Leverage	-0.754* (-565.17)	0.188* (7.95)	1.459* (807.95)	0.000* (15.54)
GDP Growth	-0.014 (-0.05)	-0.013 (-0.51)	0.278 (0.76)	-0.006* (-2.46)
Interest Rate	-0.031 (-0.09)	0.154* (4.36)	0.001 (0.00)	0.033* (10.44)
Crisis-08	-0.074 (-0.06)	-1.201* (-10.29)	0.122 (0.07)	-0.485* (-46.19)
Crisis-09	-0.378 (-0.19)	-0.939* (-5.14)	1.567 (0.6)	-0.204* (-12.41)
Cons.	-27.993* (-5.92)	6.854* (5.12)	106.924* (11.63)	2.122* (17.09)
Number of Observation	46,253	38,985	46,253	46,253
Wald chi2	322633.97	399.96	661860.18	43359.06
Prob > chi2	0.0000	0.0000	0.0000	0.0000
Log likelihood	-261111.39	-125458.5	-277430.99	-41800.98

*P<0.1, Z score in brackets

Conclusion:

The objective of this study is to examine the impact of R&D investment on firm performance and firm value among developed nation (G-7). To evaluate such relationship we use firm level and country level data, gathered through financial statements, stock exchanges, World Bank etc. Moreover for empirical analysis, we use HLM model based on our data structure i.e., heretical data structure. We found that current year R&D intensity has negatively impact on firm performance and positively impact on firm value. Such negative relation became positive

in very next year. However after that year (t-2) R&D investment became mature and have not impact on firm performance and value.

Results of the study explain that firm level R&D investment are important factor to enhance firm performance and value. However, current year R&D investment behaves adversely on firm performance but it will stimulate subsequent year firm performance and value. Policy implications suggest that firm want to increase its performance must invest in R&D and wait for a year to get performance benefits. However firm market value enhances as soon as R&D investment is made. Additionally, the best time period to attain benefits from R&D investment are first two years, after that it became mature. These results are generalized only for developed nations having same corporate and institutional setting as G-7 countries. But for developing or emerging countries result may be varied. We also not address for endogeneity issue in this study. Future research can be done on developing/emerging economies by considering endogenous relationship.

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