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Impact of Research and Development Expenditures on Firm Level Innovation: Evidence from Developing Nations

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ABSTRACT

Developing countries are lagging behind in terms of research and development expenditure and innovation activities. The ability to innovate depends upon the worker's knowledge, skills, training, and experience. It is widely believed that innovation drives growth and plays a vital role in firm survival. The study's objective was to investigate the effect of a firm's research and development expenditures on innovation activities in less developing nations using World Enterprise Survey data. The study utilized the multilevel logistic regression model. The innovation is measured through the survey question, "During the last three years, has this establishment introduced new or significantly improved products or services". The results of the logistic regression model indicate that research and development expenditures has a positive impact on innovation. The all of other control variables such as registered firm, firm size, firm age and skilled worker also positively affected by research and development expenditures.

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1. Introduction

The innovation is most important for the performance of firms. Researchers all over the globe are much interested in investigating the procedure of innovation and the effects of innovation on firm performance and development (Acs & Isberg, 1991; Aminullah, Hermawati, Fizzanty, & Soesanto, 2017; Egbetokun, Atta-Ankomah, Jegede, & Lorenz, 2016; Imran et al., 2020; Martínez-Ros & Labeaga, 2009; McWilliams & Zilbermanfr, 1996; Santos-Vijande & Álvarez-González, 2007). Innovation shows the procedure of modification, conversion of knowledge, thoughts, and inventions into marketable feasible things, services or methods of production. It has developed all over the history although its evaluation in the literature of economics. Smith (1776) claimed that innovation originates from growth. Schumpeter and Opie (1934) had given the clear evaluation of innovation and its explanation and economic function. He said that essential technological changes leads to innovative damage and the creation of new ones, which control growth, while stimulation of this type of innovation leads to further growth. Innovation of firm determined by a constant development in the skill and knowledge (Kleinschmidt, De Brentani, & Salomo, 2007). The adaptation and acceleration of innovation has promoted the process of economic growth and social evolution (Pavitt, 1984). Lane and Godin (2013) discussed that Technological initiative countries became economic, social and innovative leaders. Development communicates the cycle of progress or the change of information, thoughts, and creations into industrially practical products, administrations, or cycles. It has advanced since the beginning through its examination in the financial matters writing verifiably contended that development drives growth (Santos-Vijande & Álvarez-González, 2007). The

more unequivocal examination of advancement, its definition, and the financial job were given by (Schumpeter, 1939). Generally speaking, advancement is viewed as a driver of monetary development, firm execution and trading exercises. In that capacity, it has become an appealing field of examination. The interaction of development might be just about as old as mankind as it addresses the dynamic and precise headway of items, measures and authoritative work strategies for numerous sorts. In the particular setting of firm advancement, the writing on development generally acknowledges crafted by Schumpeter (1934) as the spearheading commitment in the field. Firms take part in advancement to build their efficiency, intensity, and piece of the overall industry which eventually expands their benefits. The industry in which a corporation works also exerts influence on its characteristics and behavior. Research and development (R&D) investments may yield greater advantages for high-tech firms in comparison to traditional sectors. Moreover, the efficacy of research and development (R&D) expenditure in fostering innovation can be influenced by the competitive environment and market dynamics.

The effects of research and development (R&D) investments on innovation at the business level in developing countries exhibit variability, but they continue to play a significant role in advancing technology and fostering economic expansion. Keeping in view the important of innovation for the productivity of the firm, the current study aims to measure the effect of research and development expenditure on the innovation at firm level. Much of the work has been carried out in the context of determinants of innovation and effects of innovation at the macro level. But only few studies have found from the micro level point of view specifically relative to Pakistan. So the current study will be a significant contribution in the literature.

2. Literature Review

Jiang, Hossain, Khan, Chen, and Badeeb (2023) analyzed the impact of research and development expenditure on green innovation. The study revisited this relationship to find the robust results across the developing countries and ends up with the conclusion that research and development expenditure boost trade of the nations and augment the innovation activities. Hobday (2005) examined the research and development expenditure to evaluate the robustness, coherence, and possible constraints of the evidence presented on the innovation. The allocation of resources towards research and development (R&D) is of significant importance in promoting innovation and facilitating economic progress, particularly in developing countries. The primary objective of the study is to analyze the correlation between research and development (R&D) spending and innovation at the company level within emerging countries. The study concluded that an augmentation in research and development expenditures resulted in heightened levels of innovation and technical progress, hence leading to eventual economic expansion. Numerous studies have indicated a robust and statistically significant correlation between research and development (R&D) investments and the degree of innovation exhibited by firms operating in developing countries (Bernier, Hafsi, & Deschamps, 2015; Kallerud et al., 2013; Koschatzky, 2001; Stahl, 2012; Yin, Crowley, Doran, Du, & O'Connor, 2023). Remarkably, some studies have indicated an inverse correlation between research and development (R&D) spending and innovation within specific developing nation environments (Caputo, Lamberti, Cammarano, & Michelino, 2016; Jung & Kwak, 2018; Viscusi & Moore, 1993). In their study, Penner-Hahn and Shaver (2005) conducted an analysis of data obtained from South Korean enterprises. Their findings revealed that an excessive allocation of resources towards research and development (R&D) activities might potentially result in declining returns in terms of innovation outcomes. The authors suggested that it is important for organizations to achieve a harmonious equilibrium between research and development (R&D) investments and other strategic endeavors in order to optimize the generation of creative outputs.The varying results on the influence of research and development (R&D) investments on innovation in developing countries can be largely ascribed to methodological discrepancies seen across different studies. Various factors, including as the selection of measuring methods, the magnitude of the sample size, and the quality of the data, can exert a substantial influence on the outcomes.

3. Data and Methodology

To calculate how much research and development expenditure affects innovation activities in developing countries we have model the functional relationship as:

$$Innovation = f(Research\ and\ Development\ Expenditure, Registered\ firm, Age\ of\ the\ firm, Size\ of\ the\ firm, Skill\ Workers)$$

This study is based on the data taken from World Enterprise Survey. For empirical estimation, to measure the effect of research and development expenditure on innovation activities in developing countries. We created a mathematical model for the functional relationship shown in Equation 1 above.

$$INNOV = \alpha + \Omega_1 \mathrm{R\&D_i} + \Omega_4 \mathrm{REGFIR_i} + \mathrm{FAGE_i} + \Omega_8 \mathrm{FSIZE_i} + \Omega_9 \mathrm{SWOR_i}$$

INNOV is Innovation, R&D is research and development expenditure, REGFIR is registered firms, FAGE is age of the firms, FSIZE is size of the firm, SWOR is skilled workers. The deterministic relationship can be seen in the mathematical model created by Equation 2. However, in reality, the firm's innovation is not only dependent on the variables listed in Equation 2. We have included the error term as a random variable in Equation 2 to capture the effect of all omitted variables in order to obtain reliable findings. Equation 3 provides the econometric model that was utilized to obtain the BLUE estimations.

$$INNOV = \alpha + \Omega_1 R\&D_i + \Omega_4 \mathrm{REGFIR_i} + \mathrm{FAGE_i} + \Omega_8 \mathrm{FSIZE_i} + \Omega_9 \mathrm{SWOR_i} + \mathrm{e_i}$$

The data of 110 developing nation has been utilized in this study. The latest wave of the World Enterprise Survey of all the developing nation is used in this study.

4. Results and Discussion

The Summary Statistics to calculate the impact of research and development expenditure on innovation are displayed in Table1. The average increase in research and development is 2.75. Innovation has a mean value of 2.81. A registered company's mean worth is 47.29. Age is represented by a mean of 0.753. Size has an average value of 3.73. The skilled worker mean value is 0.706. The chosen sample is subjected to the Jarque-Bera normality test to determine whether the sample's variables are normal. This test reveals that the sample's variables are all normally distributed.

Table 1: Summary Statistics

Variables	R&D	INNOV	REGFIR	AGE	SIZE	SWOR
Mean	2.753333	2.813333	47.29667	0.753333	3.736667	0.706667
Median	3.000000	3.000000	50.00000	1.000000	5.000000	1.000000
Maximum	5.000000	5.000000	68.00000	1.000000	5.000000	1.000000
Minimum	1.000000	1.000000	25.00000	0.000000	1.000000	0.000000
Std. Dev.	1.343567	1.348288	9.446310	0.431791	1.744745	0.456051
Skewness	0.439124	0.333961	-0.021130	-1.175367	-0.777379	-0.907846
Kurtosis	2.201162	2.106434	2.694318	2.381488	1.741304	1.824185
Normality Test						
Jarque-Bera	17.61826	15.55725	1.190346	73.85635	50.01986	58.49102
Probability	0.000149	0.000419	0.551467	0.000000	0.000000	0.000000
Observations	300	300	300	300	300	300

The correlation analysis to calculate the impact of research and development expenditure on innovation is displayed in Table 2. According to the correlation matrix's findings, research and development expenditure and innovation are positively correlated. Increased research and development will result in an 86.21% rise in innovation. A positive link exists between innovation and the variables of registered businesses, age, size, and skilled labor.

Table 2: Correlation Analysis

	R&D	INNOV	REGFIR	AGE	SIZE	SWOR
R&D	1	0.8621	0.1121	0.5342	0.6185	0.5692
INNOV	0.8621	1	0.1382	0.5583	0.5562	0.5198
REGFIR	0.1121	0.1382	1	0.0621	0.2246	0.3189
AGE	0.5342	0.5583	0.0621	1	0.2553	0.9571
SIZE	0.6185	0.5562	0.2246	0.2553	1	0.2767
SWOR	0.5692	0.5198	0.3189	0.9571	0.2767	1

The empirical findings of the linear probability model of the variable used to calculate the impact of research and development expenditure on innovation are displayed in Table 3. The findings of the research and development variable reveal a positive probability, indicating that

there is a chance that the innovation will expand as R&D increases (Boon & Eijken, 1998; Gupta & Wilemon, 1996; Imran, Ur Rehman, & Khan, 2019). The findings of the registered firm variable show a positive probability, indicating that there is a chance that the innovation will expand as the number of registered firms rises (Chakraborty, 2016).

Table 3: The Result of Logistic Regression

Variable	Probability	Std. Error	T-Statistic	Prob.
R&D	0.682644	0.038763	17.61064	0.0000
REGFIR	0.002259	0.004039	0.559188	0.5765
AGE	0.320912	0.105523	3.041167	0.0026
SIZE	0.319815	0.076294	4.191865	0.0000
SWOR	0.617229	0.283707	2.175587	0.0304
C	0.274616	0.234022	1.173462	0.2416
R^2	0.781743			
F-statistic	210.6066			
Prob(F-statistic)	0.000000			
Observation	300			

The findings of the age variable reveal a positive probability, indicating that there is a chance that the innovation will expand as people get older. The findings of the size variable show a positive probability, indicating that there is a chance that the innovation will expand as size increases. The skilled worker variable's results reveal a positive probability, indicating that there is a chance that the innovation will expand as skilled workers increase (Elnaga & Imran, 2013; Imran et al., 2020; Peluffo, 2014).

Table 4: Marginal Effects

Variables	Coefficient	Standard Errors	Probability Value
R&D	0.4985	.3218858	0.121
REGFIR	0.3457	.1586641	0.029
AGE	1.6156	.263764	0.000
SIZE	0.1788	1.126534	0.053
SWOR	0.7123	9.1207	0.060

The coefficient of R&D is 0.4985137, meaning that if R&D increases, innovation will increase by 49.85 percent while holding all other variables equal. The REGFIR coefficient is 0.3457, meaning that if registered firms rise while holding all other variables constant, the innovation will increase by 34.57 percent. The AGE coefficient is 1.6156, meaning that older businesses improve innovation by 1.6156 while holding all other variables constant. The SIZE coefficient is 2.1788, meaning that increasing the firm's size will result in a 17.88% increase in innovation while holding all other variables equal. The SWOR coefficient is 0.7123, meaning that, assuming all other variables remain constant, an increase in the firm's skilled personnel will result in an increase in innovation of 0.7123.

5. Conclusion and Policy Recommendation

This study has used enterprise survey data of developing countries conducted by the World Bank. It is a survey of large, medium and small companies, which concentrates on topics connected to business surroundings. The linear probability model is used to estimate the effect of research and development expenditures on innovation. We have measured the innovation with research and development expenditures. The summary statistics shows that the sample's variables are all normally distributed. According to the correlation matrix's findings, research and development expenditures and innovation are positively correlated. The empirical findings of the linear probability model shows that the R&D variable reveal a positive probability, indicating that there is a chance that the innovation will expand as human capital increases. It is proposed that in order to improve the innovation, research and development expenditures must be boosted. To encourage businesses to enhance their creative activities, the government must offer incentives. According to the study's findings, registered businesses function better than unregistered ones, as seen by their ability to increase innovation. It is proposed that the number of registered firms be increased. The government needs to encourage businesses and lower the barriers to business registration. According to the findings, older firms have a favorable impact on a boosting innovation. Older businesses must receive the perks. The empirical analysis demonstrates that larger firms have a favorable impact on innovation, regardless of the size of the company. Larger companies must receive the incentives. According to the findings,

competent individuals have demonstrated how innovation has a good impact on a company's performance. The company needs to acquire qualified person to boost innovation. Based on these findings, developing countries can boost their innovation activities if they increase research and development expenditure at both the national and firm levels.

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