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The Impact of Investing in Research and Development on Performance: Evidence from Jordan

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Abstract: This research aimed to investigate the effect of investing in research and development on the performance of Jordanian companies. Investment in research and development was measured by the ratio of investment to sales and the number of researchers. Financial performance was measured by financial ratios. The population of the study consisted of 45 industrial companies listed on the Amman Stock Exchange. Data was obtained only from 21 companies for seven years. The results indicate that the level of investment in research and development is very low compared to international standards. The results also show no significant relationships between investment in research and development and the financial performance of the companies. The research provides some conclusions and recommendations in light of the results.

Keywords: Investment in Research and Development, Performance, Jordan

1 Introduction

Most organizations are concerned about improving their competitive position and market standing [1,2]. In a highly competitive, dynamic and changing business environment that is heavily affected by technological development, countries and organisations are obliged to have more emphasis on research and development(R&D) to maintain or improve their positions, and competitiveness in the marketplace [3,4,5,6,7,8,9,10]. Hence, terms like innovate or evaporate or innovate or perish have become very popular [11]. Therefore, R&D is the trigger behind innovation that leads to new technological development, creativity and knowledge generation. R and D enable efficient use of scarce resources leading to more production with less or similar amount of resources and enable successful transmission from inputs to outputs [12,13]. It also promotes economic growth [14,15,16,17,18]. Gumus and Selikay's (2015) study on 52 developed and developing countries concluded that expenditure on R&D causes growth in income on the long run. Kiselakova et al , (2018) argue that R and D is the most important determinant of the country competitiveness [5]. They revealed that an increase in the expenditure on R and D has significant influence on the European countries competitive position.

Research and Development can be defined as the innovative, methodological, and systematic work that aims at increasing knowledge; including human, cultural, and community knowledge and using it to come with new applications [17]. In other words, it includes all activities undertaken to innovate and introduce new products and services. Usually it represents the first stage in the development process and aims at taking new products and services to market and adding to the organization net income. The advancement and progress made by developed countries can be attributed to their efforts and concern about R&D. A clear example is the level of technological and economic development made by Germany and Japan after the Second World War. Another example is seen in a number of emerging countries which have been able to become important players in the world economy such as China, Brazil, India, and South Africa. In fact, some studies showed that higher investment in R and D correlates positively with high scores on Human Development Index [19,20].

Interest in R&D investment has grown in the past three decades, leading to increased average expenditure on R&D from 2.06% of the gross domestic product (GDP) in the year 2000 to reach a worldwide level of 2.63% of GDP in June 2022 [The World Bank Group](#). The UNESCO Institute for Statistics published data on R&D expenditure for 161 countries

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in the year 2016 [UNESCO Institute of Statistics](#). Israel topped all countries in terms of R&D expenditure as a percentage of its GDP. In June 2022, it reached 5.4 percent. South Korea, Sweden, and Japan followed, respectively. Meanwhile, looking at the expenditure in absolute numbers shows that the United States of America was the highest spending country, followed by China, Japan, Germany, and South Korea. Regarding the Arab World region, the average expenditure on R&D did not exceed 0.7%. As for Jordan, which is the main concern of the present study, the R&D activities expenditure in 2022, which is the latest statistic available, was estimated at 0.70% of its GDP [The World Bank Group](#).

According to the UNESCO Institute for Statistics (2022), the number of researchers involved in R&D activities in South Korea reached 8714 per one million of the population. This represents the highest number of researchers per million, followed by Sweden, Singapore, and Norway, respectively. When comparing countries based on the number of researchers regardless of their populations, China topped the list, followed by the USA. In Jordan, the number of researchers in the field of R&D reached 596 per one million people [UNESCO Institute of Statistics](#). This figure clearly shows the gap between Jordan and other countries in terms of human resources working in the field of research. Therefore, it can be concluded that investment in R&D in Jordan is low using both indicators: the number of working researchers per million and annual expenditure.

The above-mentioned statistics reflect the level of investment in research and development at the macro level. An important question that should be raised is the degree of investment in R&D at the micro level. This question is one of the main objectives of the present study. It is worth mentioning that previous studies indicate that industrial companies that allocate resources for R&D, also termed "R&D intensity", get 10-15% revenue on this investment and could reach up to 30% in certain circumstances [21]. In other words, investment in R and D seems to have a significant impact on the performance of companies and can be viewed as a wise and successful investment strategy. Does that apply to the case of Jordan? The present research is concerned with (1) measuring the extent of investment in R&D by the Jordanian industrial companies listed on the Amman Stock Exchange, (2) investigating the impact of investing in R&D on the financial performance (i.e., return on assets, return on equity, and earnings per share) of industrial companies listed on the Amman Stock Exchange, and (3) examining the impact of characteristics of industrial companies listed on the Amman Stock Exchange (size, age, and capital) on the relationship between investment in R&D and financial performance of these companies.

2 Literature review and hypotheses development

Rahman and Howlader (2022) investigated the relationship between expenditure on R and D and each of firm performance (measured by return on assets and return on equity) and firm value (measured by Tobin's Q) in a south Asian emerging country [22]. They proved that R and D have a significant correlation with all indicators of performance included in the study. In another study on a south Asian country (India) by [23], it was found that R&D investment has a positive impact on the financial performance of the sampled companies. However, this result is not consistent with another study by [24] on Indian companies, who found that sales of the company are negatively related to investment in R and D in the short and medium term. They also concluded that labor, capital, and marketing efforts are more likely to have a significant impact on financial performance than R and D.

Li and Luo (2021) studied medical companies in China during the period 2010–2019 [25]. They aimed at testing the relationship between R&D inputs and enterprise performance. Results showed that R&D investment correlates positively with corporate performance. Sue et al. (2020) investigated the relationship between intensity of investment in R and D and the operational performance of listed small and medium-sized companies in China [26]. They concluded that the relationship between R&D investment and operational performance is significantly negative for small and medium-sized enterprises when an R&D intensity is greater than 5%. Furthermore, the relationship was not significant for companies with an R and D investment of less than 5%.

The impact of government subsidies and R&D investment on the performance of Chinese pharmaceutical companies over the period 2009–2015 was examined by [27]. The results pointed out that government subsidies to R and D stimulate corporate R and D, but they have no significant influence on innovation performance. On the contrary, corporate R&D investment has a positive impact on innovation performance. Eldawayaty (2020) tested the impact of research and development intensity on financial performance (measured by return on equity and return on sales) and firm value of listed companies in Egypt [28]. She found a negative relationship between research and development intensity and both performance and firm value.

The importance of intangible investment (i.e., human capital and R&D) to small and medium-sized enterprises was highlighted by [26]. They argue that investment in intangibles is not a waste of money for small and medium-sized companies. In fact, their empirical study proved that such investments have a positive impact on both profitability and the company's value. Based on the EU Industrial R&D Investment Scoreboard, a 2003–2013 information panel was developed for 548 companies. De Almeida et al. (2019) found that investment in R&D has a positive influence on sales and operating

profit for companies as a whole [29]. However, this relationship varies according to the R&D intensity. In other words, companies that have high investment in R and D have a stronger relationship between R and D and performance.

Xu et al. (2019) surveyed South Korean listed companies during the period 2012-2016 [30]. They found that expenditure on R and D by large companies has no significant influence on the financial performance (return on assets and sales) of these companies but has a negative impact on the performance of small companies. The long-term impact of investment in R and D was the main concern of [31]. They revealed that R&D investment in a given period may reduce business performance, but on the long run, it has a positive influence on performance. In other words, it has a positive lag effect. The study also found that larger firms tend to use more resources for R&D, leading to more sophisticated technology and profitable results.

In an empirical study on Russian industrial companies by [32], results pointed out that investment in R and D and innovation expenses led to the improvement of companies' performance, and this relationship was stronger after a critical mass of innovation investment had been reached. Donkor et al. (2018) explored the role of innovation capabilities and R&D on the financial performance of 340 small and medium enterprises (SMEs) in Ghana [33]. They reported a strong positive impact of R&D and innovation capabilities on financial performance measured by return on assets. Lin (2017) evaluated the impact of R&D investment on companies' growth and performance in Taiwan in the period (2005–2014) [34]. Results revealed that investment in R&D has a positive association with the performance and market value of the sampled companies.

A large survey of 1244 information technology and communication companies operating in Germany, France, Sweden, and the United Kingdom in the period 2004–2013 by [35] aimed at testing the impact of R&D on revenues of the studied companies. The findings revealed a positive relationship between the adoption of R&D activities by information technology and communication companies and their revenues. The study also reported that the impact was greater for small companies, new companies, and those working in the fields of internet service, information technology, and communication elements manufacturing. In a study by [36], based on data collected for the period of 2012–2016 for 359 listed companies on the Vietnam Stock Exchange, it was confirmed that spending on research and development has a significant and positive relationship with return on assets. In a study on Indian pharmaceutical companies that examined the relationship between R&D intensity and profitability, [37] reported a positive, non-linear relationship between the intensity of R&D and profitability of the sampled companies. Chen et al.'s (2005) study of more than 4000 companies in Taiwan found a positive relationship between R&D intensity and revenue improvement [38].

A careful reading of the previous literature clearly shows a gap in Arabic and Jordanian literature, in particular, about the extent to which business organizations are concerned about R&D and the linkage between such investment and performance. Although [39] addressed this issue, their study focused only on six companies operating in the pharmaceutical sector. This sector cannot be considered representative of all industrial firms. Empirical evidence indicates that the pharmaceutical sector is expected to have a higher level of R&D intensity compared to other types of industrial firms. The current study includes all types of industrial companies operating in Jordan. It also has a larger sample and includes the number of employees involved in R and D as another indicator of investment in R and D in the independent variable. Based on the above literature review. The study hypotheses may be formulated as:

There is an impact of companies' characteristics on the relationship between investment in R&D and three indicators of financial performance.

3 Research model and variables

The research model, as shown in Figure 1, includes the independent variable "investment in research and development," measured by expenditure on R&D as a proportion of sales and the number of researchers involved in R&D activities. Meanwhile, the dependent variable "financial performance" is measured by a number of indicators: return on assets, return on equity, and earnings per share. The size of the company, its age, and the capital invested are control variables.

4 Research methodology and measurement

The study adopted a quantitative, descriptive, and analytical approach. This is an appropriate approach given the nature and purpose of the study. It enables the researcher to use various tools and methods to analyze the data and reach numerical outputs. The study used tabulated data and information to explain the impact and relationships in order to reach a conclusion [40,41]. The independent variable "investment in R&D" was measured using two indicators: expenditure on R&D and the number of researchers involved in R&D activities. R&D expenditure is usually measured by dividing money spent on R&D activities by sales volume. The study relied on the data included in the annual reports of the financial statements of the sampled companies issued by the Amman Stock Exchange ASE and Securities Depository Center SDC for the period 2013-2019.

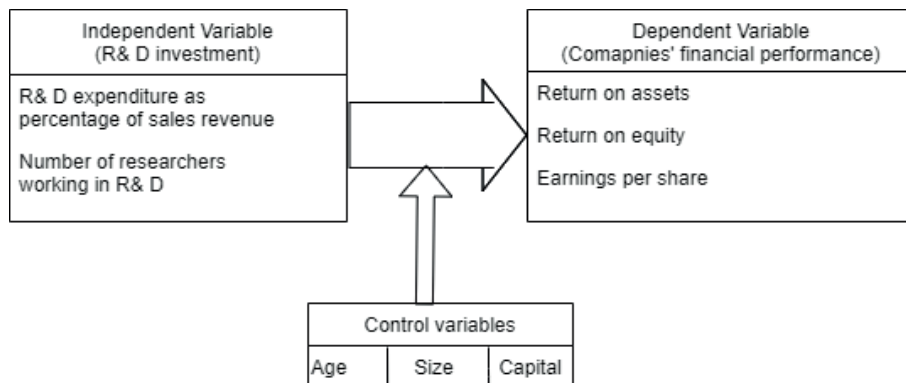


Fig. 1: The Research Model

The dependent variable "financial performance" was measured by three indicators: returns on assets (ROA), return on equity (ROE), and earnings per share (EPS). They are the most common criteria used for measuring financial performance [42,43,44,45,46]. The variables related to company characteristics included age, size, and capital. The operational definition of age is the number of years since the establishment of the company, whereas the number of workers is the operational definition of size, and the amount of capital invested measures the variable capital.

The population of the study consisted of 45 industrial companies listed on the Amman Stock Exchange. In other words, the entire population was contacted to be included in the study. Unfortunately, data was obtained only from 21 companies for seven years. Some companies did not have data about the variables of interest, or their financial statements did not have the data needed. It is believed that relying on data for a long period (seven years) is likely to yield a more comprehensive picture of financial performance than relying only on one year.

5 Data analysis

First objective: Measuring the extent of investment in R&D by the Jordanian industrial companies listed on the Amman Stock Exchange.

As previously mentioned, expenditure on R&D and number of researchers were used to measure the level of investment in R&D. Descriptive statistics were extracted in the form of means, standard deviations, minimum and maximum expenditure on R&D from sales and number of researchers for the years 2013-2019 as shown in table 1.

Table 1: Expenditure on R&D and Number of researchers

N=147	Mean	Standard deviation	Minimum value	Maximum value
Expenditure on R&D	0.0079	0.013	0	0,055
Researchers in R&D	4.90	2.68	2	11

Table 1 show that the mean expenditure on R&D activities is 0.0079 with a standard deviation of 0.013. The minimum expenditure is zero and the maximum is 0.055. Such result is much below the international average. The table also shows that some companies don't have any concern about R and D with zero value. The highest percentage of global research and development spending in the computing and electronic industries reached 22.5%, whereas the lowest was in the telecom industry with a percentage of 1.5% [47]. Therefore, it should be kept in mind that this percentage varies from one industry to another. For instance, the pharmaceutical industry is expected to have a higher level expenditure on R and D compared to other industries. In a survey on the 100 standard and Poor's companies it was found that the healthcare industry companies spent on average 16% of total revenues, whereas energy industry companies spent 3% of total revenues. Such variations may be attributed to the nature of the industry and to the fact that some industries are more dynamic than other industries. In other words, survival and growth of dynamic industries require them to have higher level of concern about R and D to be on par with competitors. Table 1 also shows that the mean number of researchers involved in R& D was 4.90 ranging from 2-11 employees. Unfortunately, no statistics is available about the mean number of researchers at the international level to compare with.

Second Objective: Investigating the impact of investing in R&D on the financial performance (return on assets, return on equity, and earnings per share) of industrial companies listed on the Amman Stock Exchange.

Multiple regression analysis was carried out to evaluate the impact of the two independent variables on each of the indicators of financial performance. The results are included in tables 2, 3 and 4. It can be seen from these tables that investment in research and development did not have significant influence on performance as measured by the three indicators of performance (return on assets, return on equity and earnings per share). Such result is not consistent with the findings of most previous studies [27, 33, 34, 35, 48].

Third Objective: Examining the impact of characteristics of industrial companies (size, age and capital) listed on the Amman Stock Exchange on the relationship between investment in R&D and financial performance of these companies.

To achieve this objective, the hierarchical multiple regression analysis was run. Three models are used; one for each indicator of financial performance. The first model measures the impact of investing in R&D on return on assets; with and without accounting for the variables; age, size and capital. Durbin-Watson test was applied to the model in a search for auto correlation and D coefficient was estimated at 1.103 which lies between 1-4 indicating lack of evidence suggesting statistically significant auto-correlation [49, 50, 51].

Table 2: Multiple regressions for the impact of R&D on financial performance measured by return on assets in the presence and absence of variables.

Variable	Beta	T	Level of significance	R	R ²	Variance	F	Sig.
First Form (without company's characteristics)				0.109	0.012	0.012	0.811	0.446
Expenditure as percentage of sales revenue	0.167	1.124	0.263					
Number of researchers	-0.086	-0.567	0.565					
Accounting for company's characteristics				0.208	0.0043	0.031	1.20	0.313
Expenditure as percentage of sales revenue	0.181	1.123	0.227					
Number of researchers	-0.074	-0.502	0.617					
Company age	-0.082	-0.908	0.365					
Company size	0.038	0.403	0.687					
Company capital	0.171	1.851	0.066					

Based on Durbin-Watson test, the result of multiple linear regressions could be taken. As shown in table 2, F-value was 0.811 while correlation coefficient (R) was 0.109 (significance level=0.446). The coefficient of determination (R²) was 0.012 indicating that 1.2% of the variation in return on assets can be explained by R&D investment which is very low and insignificant. Therefore, it could be inferred that there is no statistically significant relationship between investment in R&D and return on assets.

When adding the companies' characteristics; size, age and capital, minor changes were noticed but the model remained statistically insignificant. The changes were seen in F level reaching 1.2 changing 0.389 whereas R reached 0.208 with a significance level of 0.313. The coefficient of determination 0.0043 giving R² change level of 0.0077 indicating that only 0.43% of the variation in return on assets can be explained by R&D investment in the presence of the three characteristics which is considered extremely low and insignificant. Hence, the presence of company characteristic does not affect the impact of R&D expenditure on return on assets.

The second model investigated the impact of investing in R&D on return on equity with and without accounting for the companies' characteristics. First, Durbin-Watson Test was applied to test for auto-correlation and (D) factor was found to be 2.048 which lies between 1-4; the accepted range, and falls near to the optimum rate of 2 [51, 52, 53]. Thus, the results of multiple linear regressions, which will be used in this model, can be adopted.

Upon checking the results presented in the second model, shown in table 3, the (F) value was found to be 1.611 before accounting for companies' characteristics with correlation coefficient (R) being 0.152 with a significance level of 0.203 which is statistically insignificant (>0.05). The coefficient of determination (R²) was 0.23. This means that investment in

Table 3: Multiple regressions for the impact of R&D on the financial performance measured by the return on equity in the presence and absence of variables.

Variable	Beta	T	Level of significance	R	R ²	Variance	F	Sig.
Without company's characteristics				0.152	0.023	0.023	1.611	0.203
Expenditure as percentage of sales revenue	0.205	1.387	0.168					
Number of researchers	-0.264	-1.790	0.076					
Accounting for company's characteristics				0.177	0.031	0.008	0.859	0.511
Expenditure as percentage of sales revenue	0.193	1.290	0.199					
Number of researchers	-0.263	-1.767	0.414					
Company age	0.075	0.819	0.414					
Company size	-0.076	0.802	0.424					
Company capital	0.010	0.112	0.911					

R&D account for 2.03% of the variation in return on equity. This percentage is low and statistically insignificant. Thus, it can be concluded that investment in R&D has no effect on return on equity.

In the second model after accounting for companies' characteristics a minimal change occurred despite remaining statistically insignificant. The (F) value was found to be 0.859 giving a 0.752 change in (F) value, F change. Meanwhile, (R) value was 0.177 with a significance level of 0.511 which is also statistically insignificant. The (R²) value was 0.031 with R² change of 0.008. This indicates that investment in R&D explains only 3.1% of the variation in return on equity which is similarly considered low and statistically insignificant. These results confirm that investment in R&D in the presence of companies' characteristics has no impact on return on equity.

The third model measures the impact of investment in R&D on earning per share with and without accounting for companies' characteristics. The Durbin-Watson test was applied to test for auto-correlation relationship between the variables and the value of (D) coefficient was 1.019 which lies within the required range [54,55,56]. This shows that there is no evidence indicating the presence of statistically significant auto-correlation between these model variables and therefore the results could be adopted for this model. The results before accounting for the characteristics variables show that the value of (F) reached (0.017) with the value of correlation coefficient (R) reaching (0.016). The level of significance was 0.983 which is statistically insignificant. The coefficient of determination was 0.00256 indicating that investment in R&D explains only 0.026% of the variance in earnings per share, which is low and statistically insignificant.

However, after the introduction of companies' characteristics there were some minor changes in the explanatory power of the model as it became statistically significant with an (F) value of 5.179, indicating a change of F, F change, equaling to 5.162. The value of correlation coefficient (R) was 0.404 with a significance level of 0.000 which is statistically significant. The coefficient of determination (R²) was 0.162 with change in R² value, R² change equaling to 0.16274. The age and size of the company did not show any statistically significant association but capital showed statistically significant relation (level of significance= 0.000). Therefore, it could be concluded that investment in R&D activities in the presence of the characteristics explain 16.3% of the variation in earnings per share which is a statistically significant relationship.

From these results it can be concluded that there is no statistically significant effect of R&D on the financial performance of companies measured by return on assets, return on equity and earnings per share. It can also be concluded that in the event that the company's size, age and capital variables are taken into account, no statistically significant effect of R&D on financial performance (measured by return on assets and return on equity indicators), whereas a statistically significant effect was found with the company's capital only when financial performance is measured by earning per share.

Table 4: Multiple regressions for the impact of R&D on the financial performance measured by earning per share in the presence and absence of variables.

Variable	Beta	T	Level of significance	R	R ²	Variance	F	Sig.
Without company's characteristics				0.016	0.000256	0.000256	0.017	0.983
Expenditure as percentage of sales revenue	-0.001	-0.007	0.994					
Number of researchers	0.017	0.112	0.911					
Accounting for company's characteristics				0.404	0.163	0.163	5.179	0.000
Expenditure as percentage of sales revenue	0.004	0.030	0.976					
Number of researchers	0.048	0.345	0.731					
Company age	0.066	0.782	0.436					
Company size	-0.112	-1.272	0.205					
Company capital	0.408	4.713	0.000					

6 Discussion

The results showed a low level of interest in R&D activities by the Jordanian industrial companies listed on the Amman Stock Exchange. The mean expenditure on R&D was 0.0079% of sales, which is an extremely low percentage. Unfortunately, and to the best of the author's knowledge, no statistics are available about the average percentage of global R&D spending in the industrial sector to compare with. However, there are some statistics about each industrial sector separately. For instance, the average percentage of global R&D spending by the computer and electronics industry reached 22.5%, whereas the lowest was 1.5% in the telecommunications industry. Therefore, by all means, the average investment in R&D by the industrial companies in Jordan is very low. The maximum percentage spent on R and D in Jordan, as indicated in Table 1, was 0.055.

Lack of concern about R&D could be attributed to cultural reasons. The Jordanian culture is classified as an uncertainty-avoiding culture with a short-term orientation [43]. People who have a high level of uncertainty avoidance tend to be less willing to risk investing in long-term projects. Combining this feature with another characteristic of the Jordanian culture, which is a short-term orientation, could provide more insight or explanation about the low level of concern for research and development. An observer of the Jordanian culture and practices of business organizations can easily come to the conclusion that business organizations pay little attention to long-term planning. Another potential reason for having little concern about R and D could be attributed to the level of competition that exists in the Jordanian business environment. Compared to developed countries, competition among business organizations is not strong. In fact, some sectors have a high level of concentration, meaning that these sectors are dominated by a few producers. Furthermore, many business organizations in Jordan are less inclined to adopt an innovation strategy. On the contrary, they are more likely to use an imitation strategy, which involves less risk and lower cost compared to innovation and has little concern for research and development.

Based on the results, there is a clear need for future studies to address the reasons behind companies' reluctance and unwillingness to invest in R&D. Is it due to the belief that R&D activities are not worth it, or is it related to short-termism orientation or a lack of competition? The size of the country and the size of the company are variables worth investigating for their impact on willingness to invest in R and D. The Jordanian economy is relatively small, and most companies are either small or medium-sized (SMEs) in terms of their size. In fact, the evidence about the linkage between investment in R and D and the performance of SMEs is mixed. For instance, [37] found that this relationship is negative, whereas [57] reached a different conclusion.

The results also showed that R&D expenditure, measured by proportion of sales, and the number of researchers engaged in R&D activities have no impact on the financial performance of industrial companies listed on the Amman Stock Exchange. The significance levels were 0.446, 0.203, and 0.983, respectively, for the three indicators of performance (return on assets, return on equity, and earnings per share). These findings are not consistent with most findings of previous studies [27, 33, 34, 35, 38, 48, 57].

The absence of a significant relationship between investment in R and D and financial performance may be attributed to the modest amount of expenditure allocated for R and D. In other words, the amount invested is not sufficient to reflect the company's performance. In fact, empirical evidence in some countries supports such an explanation. [16] concluded that semiconductor companies in Taiwan must have a certain level of R and D intensity to facilitate profitable growth and develop new products and services. Sue et al. (2020) also concluded that when R&D investment is less than 5%, it has no significant relationship with performance [26]. However, further investigation is probably the best way to validate any of the above explanations and to conclude whether they are relevant for the Jordanian context.

The findings also indicated that R&D does not exert any impact on the financial performance measured by return on assets and return on equity when accounting for companies' size and age (significance levels of 0.313 and 0.511, respectively). Meanwhile, a statistically significant impact was found when R&D activities effects were measured in terms of earnings per share only when accounting for the company's capital (significance level = 0.000). One possible explanation is that the increase in capital may motivate companies to invest in R&D, believing that they have the resources needed for such an investment, which in turn affects financial performance.

7 Limitation and direction for future research

One limitation of this study is that it includes only industrial companies listed on the Amman Stock Exchange. These companies tend to be larger in size and capital and more complicated in their operations compared to small and medium-sized companies. Therefore, caution should be taken about generalizing results to other sectors of the economy. Hence, it is worth investigating this topic in other sectors of the economy and in small and medium-sized companies as well as unlisted companies. This may enhance the external validity of the findings and shed more light on the role of R&D in other sectors of the economy, such as the service sector and the financial institutions sector.

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Conflict of Interest

The authors declare that there is no conflict regarding the publication of this paper.

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