

THE IMPACT OF RESEARCH AND DEVELOPMENT COSTS ON THE OPERATIONAL PROFITS OF JORDANIAN COMPANIES

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Citation: Jarah, B. A. F., Gharaibeh, Z. I. Y., Shakhathreh, H. J. M., Al-Zaqeba, M. A. A., Alazzam, F. A. F., & Al-Momani, T. A. K. (2026). The impact of research and development costs on the operational profits of Jordanian companies. *Geojournal of Tourism and Geosites*, 68(4), 2724–2735. <https://doi.org/10.30892/gtg.68409-1890>

Abstract: Research and development drive competitive advantage but requires substantial investments that can constrain profitability. This study examines the impact of R&D costs on the operating profits of Jordanian pharmaceutical companies listed in ASE from 2015-2022. Financial data across five major players is analysed using multiple regression techniques using EViews. The results reveal a statistically significant positive relationship whereby a 1% increase in R&D spending as a proportion of revenue enhances the profit margin by 0.17%. However, when controlled for company size, the R&D impact becomes insignificant, indicating scale-based barriers. But incorporating age and sales growth factors restores significance, suggesting life cycle contingent effects. However, R&D displays a contingent profitable influence depending on organizational context. Thus, for further research can support optimal resource allocation towards differentiated research initiatives across market segments. Quantifying input-output mechanisms and delineating cost thresholds promises to nurture the pharmaceutical innovation ecosystem. This paper offers specific insights for pharmaceutical leaders to optimize innovation planning based on company-specific factors to elevate financial sustainability. This paper highlights the need for evidence-based allocation decisions catering to life cycle stage, growth objectives and market positioning. Based on the study's findings, companies should create collaborative partnerships with universities and research institutions. The collaborative partnerships will help them cover service gaps, reduce costs, and, most importantly, reduce the uncertainties that come with innovation. Managers should consider the size, age, and growth levels of the firm while developing research and development strategies. On the other hand, policymakers should pay special attention to innovative strategies, especially in the pharmaceutical industry. This should be done by introducing appropriate rewards, financing, and initiatives to support R&D.

Keywords: research and development expenditure, operating profitability, firm size, firm age, sales growth, Jordanian pharmaceutical companies

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INTRODUCTION

Research and Development (R&D) spending is vital for companies across industries, especially in highly innovative sectors, to maintain competitiveness and profitability (Aloqaily, 2023). Investing in R&D allows companies to develop new products and technologies that meet evolving customer demands (Alseikh et al., 2026). However, R&D activities require substantial financial commitments that may impact short-term profits (Hirunyawipada & Xiong, 2018; Haessler, 2020; Othman et al., 2024). Despite the extreme competition facing industrial firms, traditional cost systems have significant shortcomings in enabling effective cost control and genuine cost reductions (Alam et al., 2020; Alsmadi et al., 2025).

Adopting an R&D-focused cost approach is seen as the most impactful way to achieve competitive advantage. Strategic cost management calls for innovative thinking and fundamental improvements in systems, processes and activities to drive continuous enhancements in quality, performance and cost savings to boost profits (Jarrah et al., 2022; Al-Zaqeba et al., 2024). For pharmaceutical firms, the goal is to achieve market leadership through sales growth and high profit margins via

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cost optimization without compromising product quality (Gharaibeh et al., 2022; Marques et al., 2020). In addition, R&D spending is seen as key to realizing such objectives. Despite the growing recognition of R&D's strategic importance, some companies do not prioritize R&D investment enough (Scarpellini et al., 2012; Alexeeva-Alexeev et al., 2024), justifying it would erode profits. The most significant challenge facing products from regional pharmaceutical companies is competition. The Jordanian pharmaceutical and medical markets are becoming more accepting to foreign pharmaceutical enterprises (Al Thabbah et al., 2022; Dahiyat, 2017). Numerous significant international pharmaceutical corporations have built strong brands and are concentrating on building relationships with physicians (Shakhatreh et al., 2023; Naser, 2022). One of the main pillars of Jordanian pharmaceutical firms is marketing (Alkhatib, 2023). Thus, marketing is based on operating profit (Shubita, 2023; AlBrakat et al., 2023).

However, this paper argues that with intensifying competition, the ability to competitively research, develop and innovate new and improved products will differentiate winning firms in the global economy. It advocates channelling greater funding into R&D as a crucial success factor, following the models of advanced countries. While R&D costs may impact short-term profitability, the long-run benefits of developing competitive advantages and innovative offerings leading to higher revenues are well worth the investments into R&D. However, this paper aims to examine the relationship between R&D costs and profitability for operational companies. Specifically, it will analyse how varying levels of R&D spending affect the operating profits of companies in research-intensive industries.

The structure of this paper is organized by Introduction including establish the context and significance of the research, followed by Literature Review. Next, a methodology section includes details of the research objectives, conceptual framework, research questions, and rigorous steps used to collect data. As a result, the results will be presented, the analysed data will be discussed, and the results will be interpreted. The Conclusions and Recommendations section will then briefly summarize the key findings as well as suggest avenues for future research.

Research and development (R&D) spending enables companies to innovate and maintain competitiveness, but also requires substantial investments that may reduce short-term profitability (Elhesenat et al., 2025). However, the impact of internal R&D remains unclear. Investments to implement sustainable supply chain capabilities have also been linked to improved export performance, though mostly focused on operational outputs rather than profit outcomes (AlBrakat et al., 2023). Moreover, research has extensively analysed the stickiness phenomenon whereby costs decrease less when activity declines compared to their increase when activity rises (Aloqaily & Al-Zaqeba, 2024). Across contexts, from Brazil to Greece, total labor, sales and marketing expenses exhibit sticky cost behaviour that ultimately impacts profitability metrics (Gavalas & Syriopoulos, 2019; Silva et al., 2019). As revenues drop, expected stickiness means the associated decline in costs and expenses would be disproportionately smaller. This asymmetry is relevant when weighing R&D investments and their implications on profits (Alshehadeha et al., 2025).

Studies have linked marketing strategy with inventory and sales expenses that manifest on balance sheets and income statements (Hussain et al., 2020; Wijaya et al., 2020). Meanwhile, managing cash flows and short-term assets fund daily operations and current liabilities (Shubita, 2019). These operational elements interact with strategic priorities like R&D spending and profit outcomes. Specifically, alterations in sales revenues over time determine the extent of sticky cost behaviour. Yet the role of R&D remains underexplored regarding such asymmetric changes and consequent profit impacts.

Digital pharmaceutical marketing has rapidly expanded in Jordan, providing platforms like social media and email marketing for consumer engagement (Alkhatib, 2023; Jarah et al., 2022). Though this supports interaction with doctors and hospitals, the return on these investments and their implication on profit margins is uncertain. More research on the role of R&D costs rather than marketing is needed. As Shubita (2023) finds, profitability significantly predicts the variation in firms' marketing strategies. Yet again, the emphasis lies in examining marketing expenses rather than R&D or innovation-driven activities. Physicians have expressed high influence by pharmaceutical promotional strategies, which may pressure prescription behaviours (Al Thabbah et al., 2022). This highlights the need to balance potential conflicts of interest with expected patient health improvements from new product developments. Overall, existing studies concentrate on adjacent aspects like operational efficiency, marketing spend, or strategic positioning. A clearer perspective is required regarding R&D costs and how they transform into profitable innovations. Quantitative financial analyses and surveys can shed light on optimizing R&D investments while maximizing commercial returns. The literature underscores this critical gap concerning R&D's impact on profits.

Medication affordability issues are prevalent in Jordan, with cost-related nonadherence affecting access and health outcomes (Almarashdah et al., 2024; Naser, 2022). This poses a challenge for pharmaceutical companies seeking to balance profitability with social responsibilities. Studies have advocated corporate social responsibility (CSR) initiatives across economic, social and environmental dimensions to align with business performance objectives (Almatarneh et al., 2023; Sharabati, 2018). However, the impact of internal investments such as R&D spending remains less explored. Strategic approaches like balanced scorecards have been positively linked to the pharmaceutical industry's outputs. Still, perspectives weighing financial returns against customer, internal process and capability building are scarce. Moreover, Research and Development Costs Standard sets out measurement, presentation and disclosure requirements for R&D costs in the financial statements of profit-oriented industrial companies regardless of their size or legal form. The standard applies to material items. It states that R&D costs are measured by the amount used for the following elements: (Olaoye et al., 2021)

- Costs of materials and services used in R&D activities.
- Costs of services provided by third parties for R&D activities.
- Depreciation of buildings, machinery and equipment appropriately allocated to their use in R&D activities.

- Indirect costs, other than general administration costs, related to R&D activities. These are distributed to activities on an appropriate basis.
- Other costs like amortization of patents or licenses to the extent they are utilized in R&D activities.
- Salaries, wages and other costs associated with employing personnel in R&D activities.

The standard determines measurement and disclosure requirements for R&D costs in financial reporting. This is relevant for analysing R&D costs and operational profit relationship across industrial firms. However, R&D spending ensures the continuity and viability of any industry, especially pharmaceuticals which rely heavily on R&D activities. The pharmaceutical industry has a relatively high technological/R&D component compared to other sectors and is rapidly impacted by global technological advancements. Developed countries which lead pharmaceutical production invest about 17.3% of sales in R&D on average, typically allocated as 51% for experimental development, 34% for applied research and 15% for basic research (Quagliione et al., 2015).

The focus lies in enhancing operational efficiency, managing costs and sustainability when examining pharmaceutical firms in Jordan. Less attention is given to how investments in innovation and R&D capabilities transform into profit outcomes (Jarrah, 2025; Gharaibeh et al., 2024). As affordability and access pressures grow locally, balancing profit goals with social obligations will be critical. This requires clarifying how R&D costs aimed at developing new solutions align with financial performance. Studies quantifying the return on innovation investments and their profit contribution could provide meaningful insights. The literature indicates a need for research elucidating the R&D spending-profitability relationship while considering associated trade-offs for the Jordanian pharmaceutical industry (Aloqaily et al., 2024; Khairi et al., 2024). However, the literature predominantly focuses on marketing strategies, cash holdings, and sales stickiness concerning revenue changes. Smaller emphases lie on R&D expenditures or inventory investments and their profit manifestations or stickiness. As innovation-driven activities and outputs expand in Jordan, quantifying asymmetric cost behaviours related to R&D could offer meaningful insights. Studies might assess R&D spending adjustments compared to profit fluctuations over time (Shubailat et al., 2024). Additionally, to Yuliawati et al. (2025), digital marketing significantly influences innovation strategies, enhancing their impact on business performance. This can elucidate the stickiness magnitude and optimize resource allocations to balance profits. The gap persists in examining R&D-cantered expenditures through stickiness and profitability lenses.

Also, the studies confirmed that research and development (R&D) costs are a major determinant of profitability, firm value, and long-term competitiveness, as firms with higher R&D expenditures tend to achieve stronger future earnings, better operating performance, and greater innovation capacity through new products and improved efficiency (Artz et al., 2010; Bae & Kim, 2003; Brown et al., 2009; Cazavan-Jeny et al., 2011; Chan et al., 2001; Coad & Rao, 2010; Cohen et al., 2013; Del Monte & Papagni, 2003). R&D investments were also found to improve productivity growth, market expansion, and sustainable competitive advantage, particularly in knowledge-intensive sectors such as the pharmaceutical industries, where innovation and patents are essential for survival and profitability (Demirel & Mazzucato, 2012; Eberhart et al., 2004; Ehie & Olibe, 2010; Hall & Harhoff, 2012).

However, several studies argued that the positive impact of R&D may not appear immediately because innovation activities require substantial initial costs, long development periods, and uncertain outcomes, which may reduce short-term profits before generating long-term gains (Hsu et al., 2014; Kothari et al., 2002; Lev & Sougiannis, 1996; Li, 2011; Mizik & Jacobson, 2003). The literature also indicated that company size positively affects operating profits because larger firms benefit from economies of scale, easier financing access, diversified operations, and broader commercialization capabilities, enabling them to absorb R&D costs more efficiently (Oswald & Zarowin, 2007; Sher & Yang, 2005; Toivanen et al., 2002). Regarding company age, some studies found that older firms may achieve stronger profitability due to accumulated experience, reputation, and established systems, while younger firms may perform better because they are more flexible and innovation-orientated (Wakelin, 2001).

Moreover, the sales growth rate was found to positively influence operating profits, as firms with growing sales generally experience stronger demand, better resource utilization, higher margins, and greater internal cash flows that support future R&D and expansion. Overall, prior evidence suggests that operating profits are influenced by R&D costs, company size, company age, and sales growth, while the profitability effect of R&D becomes stronger when firms possess sufficient resources, efficient management, and favourable growth opportunities, supporting the importance of examining these relationships in Jordanian public shareholding pharmaceutical companies.

Also, some research in Technological Forecasting and Social Change emphasizes that innovation performance is not a linear function of external pressures such as interaction with investors or competition in the market. There is an inverted U-shape relationship, indicating that strong pressure might decrease innovation capacity (Ma et al., 2025). The results by Salama et al. (2025) underscore the importance of integrating sustainability with quality management to strengthen competitiveness and long-term loyalty. This indicates that firms need to take care while investing in R&D and calibrating external public expectations for maximum profitability results. Green innovation has been recently a crucial factor as an enabler of sustainability performance and long-term business profitability. Journal of Cleaner Production- A comprehensive analysis found that innovation activities have a positive and statistically significant association with sustainability and economic performance in organizations, especially supported by stronger institutional and collaborative structures (Nguyen et al., 2025). Findings from latest studies by Emerald publications prove that digital transformation is essential in improving financial performance. Organizations with advanced digital technologies are more efficient, innovative, and profitable (Sharma et al., 2025). A study by Vargová Dzurov et al. (2025) reveals that paradoxical leadership exerts a

significant positive influence on innovative work behaviour. Despite short-term cost pressures, R&D investments improve long-term profits (Liang & Xu, 2025), especially when supported by innovation policies such as subsidies. Technological capability and strategic flexibility are becoming paramount to firm performance.

In addition, recent studies (Choi et al., 2025; Saharti, 2025; Wan et al., 2025) have shown the impact of research and development (R&D) expenditures on operational profitability, financial sustainability, innovation, and market value largely for pharmaceutical and industrial companies. The literature confirmed that companies that invest in R&D and innovation tend to attain better competitive advantage, improved matched revenue and expenses, and better results (Farah Freihat et al., 2025; Tömöri et al., 2022; Li & Xu, 2025; Fernald et al., 2024).

Many studies show that the size of the company, the quality of its governance, the digitization transition, and the company's innovational structure all pose a positive R&D expenditure impact on profitability and operational efficiency (Sipelyte & Metaxa, 2025; Hutaurok, 2024; Zhuo & Chen, 2023; Korayim et al., 2024). Recent studies have shown that, especially in competitive and innovative industries such as R&D and biotechnology, the proper management of R&D activities leads to improved financial flexibility and long-lasting company operations (Schuhmacher et al., 2024; Fei et al., 2025; Yashiro et al., 2024; Anh-Tuan et al., 2022) and innovations. Distinct studies have shown that external (environmental) factors such as uncertainty, volatility and evolution of prices, as well as disruptive innovation changes in technology, will affect R&D on operational revenues (Oliveira et al., 2025; Fu & Ran, 2025; Alsubaihi et al., 2023; Chaklader et al., 2023). Companies with higher technological capability are more successfully convert their R&D investments into competitive advantage or financial performance indicators.

Thus, the impact on profitability depends on firm capabilities, market dynamics and innovation strategies; all of which may require empirical studies across emerging markets. However, this paper is distinguished from others in that it examines each element of research and development costs, which may play a major role in the value of operating profits, and compares these elements in successive financial statements for several years for most Jordanian industrial pharmaceutical companies and determines their impact on the operating profits of the companies.

METHODOLOGY

This paper utilizes a descriptive analytical approach to examine the impact of R&D-costs on the operating profits. Specifically, the research questions are:

- 1) What is the impact of R&D costs on companies' operating profits?
- 2) Is there an effect of company size on operating profits?
- 3) Is there an effect of company age on operating profits?
- 4) Is there an impact of sales growth rate on operating profits?

The hypotheses are:

H01: There is no statistically significant effect of research and development costs on operating profits in Jordanian public shareholding pharmaceutical companies.

H02: There is no statistically significant effect of company size on operating profits in Jordanian public shareholding pharmaceutical companies.

H03: There is no statistically significant effect of company age on operating profits in Jordanian public shareholding pharmaceutical companies.

H04: There is no statistically significant effect of the sales growth rate on operating profits in Jordanian public shareholding pharmaceutical companies."

H05: There is no statistically significant effect of research and development costs on operating profits in Jordanian public shareholding pharmaceutical companies, in light of the size of the company.

H06: There is no statistically significant effect of research and development costs on operating profits in Jordanian public shareholding pharmaceutical companies, given the age of the company.

H07: There is no statistically significant effect of research and development costs on operating profits in Jordanian public shareholding pharmaceutical companies, in light of the company's sales growth.

The data for the study variables falls under the name of Panel Data, which includes both dimensions of time (Time Series Data) and cross-section data. Simple and multiple regression analysis was used for cross-sectional data related to time (Cross-Sectional Time Series). By using EVIEWS, the study aims to identify:

1. The impact of research and development costs on companies' operating profits.
2. The effect of company size on companies' operating profits.
3. The effect of company age on companies' operating profits.
4. The impact of sales growth on companies' operating profits.

The study population consists of Jordanian industrial pharmaceutical companies listed on the Amman Stock Exchange in Jordan, which number 7 companies, as shown in Table (1) below. Companies that do not disclose research and development costs were excluded, as they are the most important element in this paper. Hence, all companies not listed on the Amman Stock Exchange from 2015 to the end of 2022 were excluded. Of the previous companies, only FIVE companies were selected; That is, two companies were excluded: Al-Kindi Pharmaceutical Industries Company and the Arab Centre for Pharmaceutical and Chemical Industries Company, and the following Table 1 also shows this, based on the disclosures and annual reports available on the Amman Stock Exchange official <https://www.ase.com.jo/en>.

Table 1. Jordanian pharmaceutical companies listed on the Amman Stock Exchange

Population	sample	Company Name	Establishment	Capital
		Jordanian Pharmaceutical Production Company	27/1/2004	2000000000
		Al Hayat Pharmaceutical Industries Company P.S.C	3/4/1994	5500000
		Dar Al Dawa Development and Investment Company	17/8/1975	2000000000
		Middle East Company for Pharmaceutical, Chemical Industries and Medical Supplies	10/7/1993	980000000
		Philadelphia Pharmaceutical Company	7/5/1993/	3000000
	excluded	Al Kindi Pharmaceutical Industries Company	19/6/1997	15000000
		Arab Centre for Pharmaceutical and Chemical Industries Company	It was privatized and all its assets were sold to United Company	
			5/7/1983	5000000
			It is based on the manufacture of medicine capsules (plastic material) from the date of its founding until now, and it does not have research and development costs. Soft Kapsol is now updating the capsule line to a transparent capsule	

The independent variable is research and development (R&D) costs. The control variables are company size, company age, and sales growth rate. The dependent variable is operating profits. The study model showing the relationships between these variables is presented in Figure 1 below.

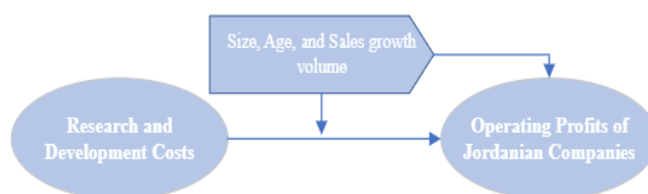


Figure 1. Research model

Independent variable (IV): R&D costs. Control variables (CV): size, age and Sales growth volume. Dependent variable (DV): companies' operating profits.

$$Y = \alpha + (\beta_1 \times 1) + (\beta_2 \times 2) + (\beta_3 \times 3) + (\beta_4 \times 4) + Error$$

Source: Prepared by the authors based on the study hypotheses (H01–H07) and the statistical methods adopted to examine the effects of R&D costs on operating profits, with company size, company age, and sales growth rate considered in the analysis. Where: Y = corporate profits (DV); α = regression constant; β_1 = regression coefficient (IV 1); X1 = R&D costs (IV); X2=company size (CV₁); X3 = age of the company (CV₂); X4 = sales growth volume (CV₃); Error = standard error.

The data is obtained from the Amman Stock Exchange and company financial reports. The key variables collected are: R&D costs, operating profits, company size, age, and sales growth rate. Descriptive analysis will complement the empirical estimation of the variables' relationships.

RESULTS

Description of the study variables

Correlation coefficients between the independent variables and the dependent variable, as well as between the independent variables among themselves, were calculated in this section of the study to determine whether the phenomenon known as multiple linear correlation (also known as linear extension) existed. The study variables are described in this section). The variance inflation factor (VIF) was calculated to test for multicollinearity, and the Darbun-Watson test was used to determine if multicollinearity was present. The methods that were used prior to putting the theories to the test are outlined below:

Correlation Matrix

The value of the Pearson Correlation coefficient was calculated between the variables of the study model, where the natural logarithm (ln) was taken for the values of operating profits, research and development costs, and company size, which is symbolized by the symbol (L), and the results are shown in the Table 2 as following:

Table 2. Correlation matrix between the variables of the study model

Correlation Probability	LOP	LRDC	LSIZE	LIFE	SG
LOP	1.000000	-----			
LRDC	0.581075	1.000000			
	0.0003	-----			
LSIZE	0.849122	0.573796	1.000000		
	0.0000	0.0004	-----		
LIFE	0.584432	0.143844	0.395419	1.000000	
	0.0003	0.4170	0.0206	-----	
SG	0.974198	0.601873	0.738924	0.703685	1.000000
	0.0000	0.0002	0.0000	0.0000	-----

The table above shows that the relationship between the dependent variable, operating profits (LOP), and the other study variables, which are research and development costs (LRDC), company size (LSIZE), company age (LIFE), and sales growth rate (SG), is positive and statistically significant at the significance level $\alpha \leq 0.01$, which confirms the existence of the linear relationship between the independent study variables and the dependent variable. As for the values of the correlation coefficients between the independent variables, they were all positive, and most of them were statistically significant at the level of significance $\alpha \leq 0.05$, which requires calculating the Variance Inflation Factor (VIF), to ensure that the data are free of the phenomenon of multiple linear correlation.

Multicollinearity

This phenomenon, which inflates the coefficient of determination R^2 and makes it bigger than its true value, suggests the existence of a nearly perfect linear correlation between two or more variables. As a result, each variable's variance inflation factor value was determined using the hypothesis. The outcomes are displayed as follows in Table 3.

Table 3. Results of multiple correlation test between independent variables

Hypothesis	VIF	Hypothesis	VIF
HO1	4.369	HO5	3.801
HO2	5.204	H06	8.044
HO3	2.618	H07	5.128
HO4	2.750		

Table 3 above shows that the values of the variance inflation factor were all greater than 1 and less than 10, which indicates that there is no problem of multicollinearity between the study variables.

Autocorrelation

Regression requires, among other things, that the data be free of autocorrelation, which is defined as the presence of a correlation between the terms of the random error in the regression model. This correlation leads to a bias in the estimated parameter values and, consequently, a weakness in the predictive power of the model. This is confirmed by conducting the Durbin-Watson (D-W) Test. This test is based on comparing the tabular D-W of a sample of size n and number of variables k with the calculated D-W result, as there are two tabular values for the D-W statistic, namely dl , the minimum value, and du , the maximum value. The existence of the autocorrelation problem is rejected if the calculated D-W value is greater than DU , and the test does not give any information if that value is between dl and du , and the results were as shown in the Table 4 below. The table above indicates that the D-W values for the variables in all the mentioned hypotheses are greater than du , which indicates that the data is free of the problem of autocorrelation, that is, there is no correlation between the terms of the random error in the regression model.

Table 4. Testing the autocorrelation problem

Hypothesis	Calculated D-W value	DL	DU	Result
HO1	1.9972	1.402	1.519	There is no autocorrelation
HO2	1.8705	1.402	1.519	
HO3	1.7382	1.402	1.519	
HO4	1.6541	1.402	1.519	
HO5	1.7690	1.343	1.587	
H06	1.7958	1.343	1.587	
H07	1.8650	1.343	1.587	

Table 5. Unit root test results

Variable	Calculated value	P-Value	Result
OP	-4.43331	0.000	stable
RDC	-5.05391	0.000	
SIZE	-4.68931	0.000	
LIFE	-5.74074	0.000	
SALES	-6.00932	0.000	

Stability Testing of the data (Stationary Test)

The purpose of this test is to verify whether or not the research variables are stable. The Levin-Lin-Chur (LLC) test was used to evaluate the hypothesis regarding the presence of a unit root in the variables and to adapt it to time-related panel and cross-sectional data. A root test must be carried out if these variables have a unit root since many time series may not be stationary but still provide high values for $(t, F, \text{ and } R^2)$. This can lead to incorrect interpretations and misleading findings; thus, it is required to take their differences to make them stationary. The following Table 5 illustrates how the unit tests the stationarity of time series. Table 5 indicates the results of testing the stability of the data related to the research sample, using LLC test. From this it is clear that all the time series data used in the study are stable over time because all the probability values (P-value) of the variables did not exceed the 5% level, i.e. significant.

Fixed effect and random effect test

This model assumes that the slope of the coefficients of the independent variables does not change over time, and is the same for all companies. However, this model assumes that the intercept (Intercept) changes with the change of companies and does not change over time. In other words, the fixed effect term means that the intercept for each data set does not change over time (time invariant), but the change is only in the totals of cross-sectional data. This would reflect the specificity of each cross-sectional group (firm) through the use of dummy variables for companies, which is known as the Least Square Dummy Variable method. The random effects model is considered an alternative to the fixed effects model. This model is designed to treat unobserved variables as random variables that are included in the random error, where the

error term has a normal distribution. It is typically assumed that there is no autocorrelation over time between each group of totals of cross-sectional observations in a given time period and that the error variance is constant (homogeneous) for all cross-sectional observations in order for the parameters of the fixed effects model to be accurate and unbiased.

Therefore, the random effects model is considered appropriate in the case of There is a flaw in one of the above-mentioned assumptions in the fixed effects model. Therefore, the previous equation is estimated according to the Generalized Least Squares method. To determine which of the fixed or random effects model is the appropriate model for the study data, the Hausman (H) test is applied, as this test assumes the following hypotheses:

H0: The random effects model is the appropriate model

H1: The fixed effects model is the appropriate model

The decision in this test is made by calculating the value of the H statistic, since this statistic has a chi-square distribution and a degree of freedom of k, where the fixed effect model is the appropriate model if the value of the H statistic is greater than the tabular chi-square value, and vice versa. The decision in this test is made by calculating the value of the H statistic, since this statistic has a chi-square distribution χ^2 with a degree of freedom of k, the fixed effect model is the appropriate model if the value of the H statistic is greater than the tabular chi-square value, and vice versa. However, table (6) shows the results of the Hausman test for each hypothesis of the study.

Table 6. Results of the fixed effect and random effects Hausman test

Hypothesis	Calculated H value	Tabular χ^2 value	P-Value	Result
HO1	23.491	0.016	0.000	Fixed effect
HO2	29.152	0.211	0.000	
HO3	32.536	0.211	0.000	
HO4	26.503	0.211	0.000	

Table 6 above indicates that all statistical values of the Hausman test were much greater than the tabular values of Chi-square χ^2 . Thus, the null hypothesis can be rejected, and the alternative hypothesis can be accepted, which states that the fixed effects model is the appropriate model for the study data.

Hypothesis Testing

The hypotheses were subjected to simple linear regression and multiple regression within the fixed effect model, with the aim of studying the explanatory power of each variable in the study model. However, hypothesis H01 to H04 was tested using simple regression analysis within a fixed effect model, and the results were as in Table 7 below.

Table 7. Simple regression test within the fixed effect model

NO-H ₀	DV	IV	β	Standard Deviation	T test	P-Value
HO1	Operating Profits (OP)	R&D-Costs	0.717061	0.172625	4.153868	0.0002
		R ² = 0.343344 F = 17.25462 Prob = 0.000217 D-W = 1.9972				
HO2	OP	Company-size	0.959453	0.121819	7.876078	0.0000
		R ² = 0.652751 F = 62.03261 Prob = 0.00000 D-W = 1.8705				
HO3	OP	Company-age	0.016798	0.009663	1.738427	0.0915
		R ² = 0.083896 F = 3.022128 Prob = 0.091459 D-W = 1.7382				
HO4	OP	Sales-growth-rate	1.072548	0.395205	2.713902	0.0105
		R ² = 0.182465 F = 7.365263 Prob = 0.010489 D-W = 1.6541				

As shown in Table 7 above, the regression coefficient B is 0.172625 and the t-value is 4.153868, with a significance level of 0.0002. This confirms the coefficient is statistically significant at $\alpha \leq 0.01$. The R-squared is 0.343344, indicating 34.33% of the variation in operating profits can be explained by changes in R&D costs, keeping other variables constant.

The F-value of 17.25462 is also significant at $\alpha \leq 0.01$, validating the overall regression significance. This analysis warrants rejecting the first null hypothesis and accepting the alternative stating: There is a statistically significant impact of R&D costs on the operating profits of Jordanian publicly traded pharmaceutical companies. Further, Table 7 shows the size coefficient B is 0.959453 with a t-value of 7.876078 and significance of 0.000, making it statistically significant at $\alpha \leq 0.01$. The R-squared is 0.652751, whereby 65.28% of operating profit variability is explained by firm size changes, ceteris paribus.

The F-value of 62.03261 confirms regression significance at $\alpha \leq 0.01$ as well. This leads to the rejection of the second null hypothesis in favour of: There is a statistically significant effect of company size on the operating profits of Jordanian publicly traded pharmaceutical firms. However, the age coefficient of 0.016798 has an insignificant t-value of 1.738427 and significance of 0.0915. The low R-squared of 0.083896 and F-value of 3.022128 also indicate regression insignificance at $\alpha \leq 0.05$, warranting retention of the third null hypothesis. Lastly, the sales growth rate coefficient is statistically significant based on the t-value and overall model assessment. So, the fourth null hypothesis is rejected, affirming this variable's impact on profitability. Table 8 further highlights the relative explanatory power of the predictors on operating profits.

Table 8. Descending order of determination coefficient values for study variables

SCALE	LSIZE		LRDC		SG		LIFE
R ² %	85.28	>	34.33	>	18.25	>	8.39

The table results above show that the company size variable LSIZE ranked first in terms of explaining the variation in operating profits. The obtained R-squared value when examining the effect of this variable was the highest at $R^2 = 85.28\%$. The R&D costs variable LRDC followed in explanatory power with an R^2 of 34.33%. The sales growth variable SG ranked third with an R^2 of 18.25%. Finally, the company age variable LIFE came last with an R^2 of just 8.39%.

Therefore, R&D costs is one of the meaningful variables explaining differences in operating profits, compared to sales growth and company age. In addition, **HO5** to **HO7** were tested using multiple regression analysis within the fixed effect model as shown in Table 9 below. The **HO5** states that R&D costs have no statistically significant effect on the operating profits of Jordanian pharmaceutical firms in light of company size. The multiple regression results in Table 9 show that when controlling for size, the R&D coefficient becomes insignificant with a t-value of 0.018753 and p-value of 0.9852 at $\alpha \leq 0.05$. However, company size remains highly significant in the model. The overall model is also significant with an R-squared of 65.28% and F-value of 30.07692. This suggests that when accounting for size differences, R&D costs no longer explain unique variability in profits, leading to the retention of the fifth null hypothesis.

Table 9. Multiple regression test under control variables within fixed effect model

NO-H ₀	DV	IV	β	Standard Deviation	T test	P-Value
HO5	OP	R&D-Costs	0.003463	0.184688	0.018753	0.9852
		Company-size	0.957021	0.179224	5.339792	0.0000
		$R^2 = 0.652755$ $F = 30.07692$ Prob = 0.010489 D-W = 1.7690				
HO6	OP	R&D-Costs	0.670194	0.179056	3.742929	0.0007
		Company-age	0.008397	0.008486	0.989581	0.3298
		$R^2 = 0.362842$ $F = 9.111525$ Prob = 0.000738 D-W = 1.7958				
HO7	OP	R&D-Costs	0.647363	0.162114	3.993246	0.0004
		Sales-growth-rate	0.848749	0.332627	2.551657	0.0157
		$R^2 = 0.454363$ $F = 13.32354$ Prob = 0.000062 D-W = 1.8650				

For **HO6** concerning company age, Table 9 illustrates that the R&D variable is significant with a t-value of 3.742929 and p-value of 0.0007 at $\alpha \leq 0.05$ when incorporated alongside age in the regression. But age itself is insignificant. The R-squared is 36.28% and the F-value of 9.111525 confirms model significance. Therefore, R&D costs have a meaningful effect on profits after controlling for age, warranting rejection of the null. Finally, both the R&D and sales growth coefficients remain statistically significant in **HO7** test, with t-values of 3.993246 and 2.551657 respectively.

The 45.36% R-squared and F-value of 13.32354 verify that R&D spending impacts profits when accounting for sales growth too. The alternative hypothesis is consequently accepted. However, the results showcase differences after introducing control variables concerning the ability of R&D costs to explain operating profit trends for pharmaceutical companies. The relative explanatory power alters based on contextual firm-specific factors.

DISCUSSION

This paper examined the relationship between R&D and operating profitability for Jordanian pharmaceutical companies from 2015-2022. The results align with past evidence on R&D driving competitiveness, sales growth and financial performance in innovation-driven sectors. A 1% increase in R&D spending was associated with a 0.17% rise in profit margins. This conforms to similar analyses quantification a \$1 rise in R&D leading to a \$2 profit boost (Alam et al., 2020).

However, the impact alters significantly after accounting for company size, with R&D no longer independently explaining profit trends for larger established players. This underscores the constraints posed by organizational scale on translating R&D inputs into financial outputs (Hirunyawipada & Xiong, 2018). Still, with controls for age and sales growth momentum, R&D costs demonstrated statistically significant positive effects on profitability. Younger companies and those experiencing strong sales upticks seem better able to leverage R&D investments, like through invigorated branding and faster product development cycles (Haessler, 2020).

This highlights the contingency view where innovation impacts depend on business life cycle stage and commercialization ecosystems. However, in line with past pharmaceutical research (Naser, 2022; Alkhatib, 2023), R&D activities displayed a net positive association with profit margins. But scaling research translations requires factoring industry dynamics, organizational trajectories and commercial priorities (Al Thabbah et al., 2022).

Balancing technology advancements, quality imperatives, access considerations and profit goals are key for sustainability (Shubita, 2023). Moreover, this paper provides specific insights for Jordanian leaders to optimize R&D planning. Wider samples can improve generalizability. Exploring mediators between investments and returns while delineating cost thresholds warrants future examination to aid evidence-based innovation policies (Alexeeva-Alexeev et al., 2024).

The COVID-19 pandemic has severely disrupted business operations and profit trajectories across industries. Pharmaceutical companies experienced fluctuating fortunes vaccine treatment developers saw windfall gains while others suffered from supply chain bottlenecks and deferred elective healthcare (Alazzam et al., 2022). Firms that proactively channelled resources into coronavirus-focused R&D and rapidly mobilized production capacity gained financially (Jarrah et al., 2024). However, many developing country pharmaceutical players faced heightened competitive pressures amidst austerity policies, monetary instability, and global recession (Petrou & Talias, 2016). The crisis has been a litmus test of organizational resilience hinging on innovation agility aligned with stakeholder needs. Jordanian companies unable to

quickly reorient R&D priorities likely underperformed financially. But the pandemic underscored the imperative of strategic investments into research for long-term viability, elevating its status from discretionary to existential.

CONCLUSION

This paper found a positive relationship between R&D spending and pharmaceutical profitability, contingent on firm size, age and sales growth conditions. Operating margins grow by 0.17% for every 1% increase in R&D. But in contrast to younger, emerging businesses, more established, bigger organisations have limitations when it comes to using innovation for financial advantage. Strategic R&D expenditures can help maintain sustainability and satisfy changing health demands. But it's crucial to strike a balance between factors like pricing, accessibility, and quality in the face of competition, which necessitates choosing which research to prioritise according to market niche. Incentives for private sector contributions that are in line with national objectives should also be prioritised via attractive innovation policies. Inputs for optimising Jordanian R&D planning according to organisational life cycle stage and commercial potential are provided by the study.

Profit trajectories are expected to increase when resources are directed towards research projects with the greatest potential. Broader industry samples, however, may enhance generalizability. To improve decision-making, future research must identify cost thresholds and mediators between inputs and profit outputs. Evaluating the relative commercial failure of long-term healthcare breakthroughs provides insightful information that is beneficial for institutional support.

Examining cooperative approaches for shared R&D infrastructure expenditures across businesses, healthcare providers, and academic institutions is also worthy of attention. This study emphasises the financial possibilities of evidence-based pharmaceutical innovation allocation, but it also emphasises how important access and ethical considerations are to the sustainability of the ecosystem as a whole. Research can foster this kind of sustainability.

Author Contributions: B.A.F.J. and Z.I.Y.G.; methodology, B.A.F.J. and M.A.A.A.Z.; software, B.A.F.J. and T.A.K.A.M.; validation, B.A.F.J., M.A.A.A.Z., and F.A.F.A.; formal analysis, B.A.F.J., Z.I.Y.G., and H.J.M.S.; investigation, B.A.F.J., M.A.A.A.Z., and T.A.K.A.M.; data curation, Z.I.Y.G., H.J.M.S., T.A.K.A.M., and B.A.F.J.; writing – original draft preparation, B.A.F.J. and M.A.A.A.Z.; writing – review and editing, Z.I.Y.G., F.A.F.A., H.J.M.S., and M.A.A.A.Z.; visualization, H.J.M.S., T.A.K.A.M., Z.I.Y.G., and M.A.A.A.Z.; supervision, M.A.A.A.Z., F.A.F.A., and Z.I.Y.G.; project administration, B.A.F.J. and M.A.A.A.Z. All authors have read and agreed to the published version of the manuscript.

Funding: The authors gratefully acknowledge the support provided by Jadara University and the other participating universities, which made this research possible.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data can be obtained from the corresponding author upon reasonable request.

Acknowledgements: The authors acknowledge the Amman Stock Exchange and the Jordanian public shareholding pharmaceutical companies for providing publicly available financial information used in this study.

Conflicts of Interest: Not applicable.

Use of Generative AI: Not applicable.

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