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Analysis of the Impact of R&D Expenditures on Corporate Financial Performance - A Case Study of Alibaba

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Abstract: *This study aims to shed light on the relationship between research and development expenditures and the financial performance of companies, and to provide valuable insights for companies on how to maximize the benefits of their investments in research and development. By gaining a better understanding of this dynamic, this is done through projecting on Alibaba, as one of the largest electronic companies in the world. This is through analyzing several tests such as the Dickey-Fuller test, Granger causality, the Johansen test for co-integration and simple linear regression. The study concluded that there is a significant relationship with statistical significance between research and development expenditures and the revenues of Alibaba, while there is a positive relationship, but it is not statistically significant between research and development expenditures and the cash flow of Alibaba.*

Keywords: R&D expenditure; financial performance; revenue; cash flow, Alibaba

1. INTRODUCTION.

The landscape of corporate investments has evolved considerably over the past few decades, with intangible assets like research and development (R&D) increasingly becoming a significant portion of companies' overall assets. Investment in R&D is vital for businesses aiming to achieve growth and foster innovation amidst rapid technological changes. This expenditure is intended to improve companies' competitiveness and increase their market share through the creation of new products and services or enhancements to existing processes.

In this setting, it is essential to investigate the connection between R&D spending and the financial performance of companies. Is there a positive relationship between the two? What factors impact this connection? To find answers to these inquiries, it is necessary to analyze the financial data of companies and assess the returns generated from R&D investments.

This research intends to explore this intricate relationship by assessing the effect of R&D spending on the financial performance of Alibaba, one of the largest e-commerce firms worldwide. The company's financial data from 2017 to 2024 will be scrutinized utilizing various sophisticated statistical methods, including cointegration tests, to ascertain if a long-term relationship exists between R&D expenditure and the company's financial performance.

Main Issue:

Based on the foregoing, the following issue can be raised:

In what ways do research and development expenses influence Alibaba's financial results?

Basic Questions:

To address the study's main question, it is organized into these basic questions:

1. Does investment in research and development contribute to better financial performance for a company over the long term?
2. In what ways is the financial performance of companies measured?
3. Is there a correlation between research and development spending and the financial performance of Alibaba?

Study Hypotheses:

To address the research question and its fundamental inquiries, the following hypotheses may be proposed:

1. Some argue that investments in research and development are essential for achieving growth and fostering innovation, while others argue that such spending is unnecessary and should be minimized;
2. The financial performance of companies can be assessed through various indicators, including company revenues, cash flow, return on investment, and return on assets, among others;
3. There exists a statistically significant correlation between research and development spending and the revenues of Alibaba;
4. There is a statistically significant correlation between research and development spending and Alibaba's cash flow;
5. Other external factors to the model remain constant.

Importance of the Research:

This research investigates the crucial connection between investment in research and development (R&D) and the financial performance of corporation. By examining how businesses can enhance their R&D expenditures, this research aims to improve understanding of this relationship. The objective is to guide strategic choices regarding the distribution of resources and focus, promoting sustainable innovation and economic growth.

Study objectives:

This research aims to achieve the following specific goals:

1. To create a theoretical framework: Build a strong theoretical structure that examines the relationship between R&D spending and the financial performance of businesses, particularly emphasizing revenue and cash flow as critical performance indicators.

2. To identify the nature of the relationship: Explore and clarify the specific nature of the connection between R&D spending and essential financial performance indicators, including revenue and cash flow.

3. To measure the impact of R&D spending: Assess the degree to which R&D spending affects the company’s financial performance, making a distinction between direct and indirect effects.

4. To formulate recommendations for resource distribution: Based on the results of the study, offer practical recommendations to assist companies in effectively distributing financial resources toward R&D to maximize their return on investment.

Study Methodology:

Considering the nature of the research questions, a mixed-methods approach will be adopted for this study. A descriptive method will be used to investigate the fundamental theoretical foundations of R&D expenditures and their impact on corporate financial performance. In addition, a quantitative method will be applied to empirically analyze the relationship between the variables of the study. This will involve several econometric tests,

such as the Augmented Dickey-Fuller (ADF) test for unit roots, Granger causality tests, Johansen cointegration tests, and basic linear regression analysis. All statistical analyses will be performed using EViews 10 software.

2. THEORETICAL FRAMEWORK OF THE STUDY:

Investment in research and development (R&D) is a crucial strategy for organizations aiming for sustainable growth and innovation. Such investment supports a range of activities that enhance scientific knowledge and link it to practical implementation. Ultimately, the goal of R&D is to create new or improved products, or to increase production efficiency, thus enhancing financial performance of the organization

2.1. Concept of R&D Expenditure:

a. Concept of Research and Development:

Research and development (R&D) refers to scientific and technological activities that involve targeted investments based on both technical and economic feasibility. Its purpose is to broaden scientific understanding in multiple fields, such as chemistry, physics, biology, and engineering. This process bridges scientific knowledge with practical implementation, resulting in new or enhanced products or greater production efficiency (Ma'rouf, 2006).

The Frascati Manual (Frascati, 2002) describes R&D as involving a range of research activities along with the utilization of the knowledge gained to create products and technologies. It integrates both fundamental research and innovation while focusing on cost-effectiveness and product enhancement. More recently, in 2015, R&D was defined as organized creative efforts aimed at broadening scientific, cultural, or social understanding and leveraging that knowledge to create new solutions and innovations (Frascati M. , 2015)

In conclusion, R&D consists of organized and imaginative activities conducted by entities (such as corporations, research organizations, or governmental agencies) to extend knowledge and develop novel applications.

b. R&D Expenditure:

Research and development expenditures signify the investments made by companies in fostering innovation and enhancing products, services, technologies, and processes. Typically classified as operating expenses, these costs are often recognized in the financial period they are incurred, although they might be capitalized if the R&D has potential future applications (Kindness, 2024). Investment in R&D is vital for advancement, and it is important to allocate an appropriate percentage of GDP toward it. Spending under 1% of GDP on R&D could restrict its effectiveness, while a range of 1-1.5% may not provide enough resources for meaningful progress. An allocation of 1.5-2% is generally deemed adequate for supporting the growth of certain sectors, and surpassing 2% reflects a strong dedication to R&D, which could result in technological progress across various production fields (Haroush & Talabiya, 2018)

3. FINANCIAL PERFORMANCE OF THE COMPANY:

Financial performance offers a comprehensive insight into the financial well-being of a company, including assets, liabilities, equity, expenses, revenues, and profitability (CFI, 2025). Various of financial formulas is utilized to evaluate a company's efficiency. It reflects how effectively the company generates revenue, manages its assets and liabilities, and fulfills the needs of stakeholders and shareholders (Kenton, 2024). indicators such as operating revenue, operating income, cash flow from

operations, and unit sales can be analyzed. Analysts and investors might also look into margin expansion and debt reduction. Financial performance can be measured through various methods, including:

3.1. Revenues:

Revenues represent the financial gain obtained from selling the company's products or services within a designated timeframe. This is determined by multiplying the unit selling price by the quantity sold. To determine net revenues, total revenues are adjusted by subtracting returns, discounts, and allowances (bdc, 2025) . Revenues also encompass the overall amount the company generates from the sale of its products or services over a specific period. The calculation of revenues is done by multiplying the unit selling price by the quantity sold. To arrive at net revenues, one must deduct returns, discounts, and allowances from the total revenues (sage, 2025).

3.2. Cash Flow:

Cash flow indicates the flow of money into and out of a business. Inflows include payments from customers and other income, while outflows consist of costs such as salaries, utilities, and rent (citizens bank, 2025). Free cash flow, determined by subtracting investing cash outflows from operating cash inflows, serves as a crucial indicator of a company's ability to generate cash. It shows the available cash for dividends, reducing debt, and making new investments. A comprehensive evaluation of performance requires comparing actual outcomes with previous forecasts (Kafi, 2009).

3.3. Return on Assets:

Return on assets serves as a measure of a company's profitability in relation to its total assets. It is determined by dividing the company's operating profit by its total assets (macrotrends, 2025) As the rate of asset growth increases, so does the necessity for expansion and the financing of such growth. Consequently, there is a need to boost the retained earnings ratio. In addition to return on assets, a higher return encourages greater investment, thereby promoting the retention of profits to take advantage of them (Al-Fateh, Unknown year of publication).

4. THE INFLUENCE OF R&D INVESTMENT ON A COMPANY'S FINANCIAL RESULTS:

Numerous researchers have explored the connection between R&D spending and the financial performance of companies. These investigations focus on stock market analyses of firms that have made investments in intangible assets. The aim is to establish a correlation between changes in a company's market value and its intangible spending, which typically includes R&D, marketing, and patent costs. This market value comprises the total worth of both tangible and intangible assets (Jean & Sahutb, 2005). R&D can affect a company's financial performance, measured through indicators like income and sales growth. Some studies have confirmed the link between R&D and financial performance, found that companies with an intensive investment strategy in R&D have significantly greater financial performance. They also observed that companies with greater R&D expenditures tend to experience a higher rate of sales growth compared to the average market rate, and the opposite is true as well (Zhu & Feng , 2012).

5. APPLIED STUDY:

This research investigates the connection between R&D spending (the independent variable) and Alibaba's revenue and cash flow (the dependent variables) from 2017 to 2024. Advanced statistical methods will be utilized. Firstly, the stationarity of the time series will be evaluated using Augmented Dickey-Fuller (ADF) tests. Then, Granger causality tests will analyze the causal relationships among the variables. Johansen cointegration tests will be conducted to assess the long-term equilibrium between R&D spending, revenues, and cash flow. Finally, simple linear regression

will be used to examine the relationship between R&D expenditures and both revenue and cash flow.

5.1 The Dickey-Fuller Test for Time Series Stability:

These tests allow us to assess whether the data is stable or if it requires mathematical modifications to achieve stability, which is essential for accurately analyzing time series.

Upon conducting the Dickey-Fuller test on Alibaba's revenue (Y), we observe that the Prob value is 0.0000 at the first difference, falling below 1%. This indicates that we reject the null hypothesis asserting that the time series (D(Y)) contains a unit root, signifying that the time series is stable at a 1% significance level.

When we apply the Dickey-Fuller test to Alibaba's R&D expenditure (X), we find a Prob value of 0.0000 at the first level, which is also less than 1%. As a result, we reject the null hypothesis that the time series (D(X)) has a unit root, confirming that the time series is stable at a 1% significance level.

In the case of the cash flow values, the Dickey-Fuller test yields a Prob value of 0.0000 at the first difference, which is under 1%. Thus, we reject the null hypothesis that the cash flow time series (D(FL)) has a unit root; therefore, the cash flow time series (FL) is stable after taking the first differences at a 1% significance level.

5.1 The Grnger Causality Test Results:

Table (01): *Results of the Causality Test between R&D Expenditure and Alibaba's Revenues*

Pairwise Granger Causality Tests
Date: 02/03/25 Time: 20:45
Sample: 2017Q1 2024Q4
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
X does not Granger Cause Y	30	15.3513	0.0005
Y does not Granger Cause X		6.48806	0.0169

Source: *Prepared by the researchers based on EViews10 output*

The table shows the following:

- Null Hypothesis: X does not lead to Y

  The probability (Prob = 0.0005) suggests that we can reject the null hypothesis at a significance level of 1%. This indicates that there is strong evidence that X (R&D expenditure) influences Y (revenues).

- Null Hypothesis: Y does not lead to X

  The probability (Prob = 0.0169) suggests that we can reject the null hypothesis at a significance level of 5%. This implies that there is evidence that Y (revenues) could influence X (R&D expenditure).

Consequently, it can be concluded that there is strong evidence to support the claim that R&D expenditure (X) impacts Alibaba's revenues (Y), and there is also evidence that revenues (Y) could impact Alibaba's R&D expenditure (X).

Table (02): *Results of the Causality Test between R&D Expenditure and Alibaba's Cash Flow*

Pairwise Granger Causality Tests
Date: 02/06/25 Time: 12:38
Sample: 2017Q1 2024Q4
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
X does not Granger Cause FL	29	4.57007	0.0208
FL does not Granger Cause X		2.50485	0.1028

***Source**: Prepared by the researchers based on EViews10 output*

- **Null Hypothesis: X does not lead to FL**

• As the probability (Prob = 0.0208) is below 5%, we dismiss the null hypothesis. This indicates that there is statistical evidence suggesting that R&D expenditures (X) influence cash flows (FL). In other words, variations in R&D expenditures may assist in forecasting changes in cash flows.

- **Null Hypothesis: FL does not influence X**

• Because the probability (Prob = 0.1028) exceeds 5%, we do not reject the null hypothesis. This implies that there is no strong statistical evidence showing that cash flows (FL) drive R&D expenditures (X). In other words, fluctuations in cash flows are not necessarily reliable indicators for anticipating shifts in R&D expenditures.

5.2. Johansen Cointegration Test:

The purpose of this test is to assess whether a long-term equilibrium relationship exists between R&D spending and revenues. In simpler terms, do these two variables tend to move in harmony over the long term, even if they may fluctuate independently in the short term?

a. Findings from the Trace Test:

The outcomes of the Johansen cointegration test are examined in relation to the data presented in the table found in Appendix No. (05) as detailed below:

- **Null Hypothesis: No cointegration**
  - The table presented in Appendix No. (05) indicates that the Eigenvalue = 0.789148, the Trace statistic = 61.44171, which exceeds the critical value = 29.79707, and the probability (Prop = 0.0000) is lower than 5%. Consequently, we reject the null hypothesis in favor of the alternative hypothesis. This suggests that there is significant statistical evidence supporting the presence of cointegration among the variables.
- **Null Hypothesis: At most 1 cointegration**
  - The second row of the table indicates that the Eigenvalue = 0.335376, and the Trace statistic = 16.30041, which is greater than the critical value = 15.49471, with a probability (Prop = 0.0378) that is less than 5%. As a result, we reject the null hypothesis and accept the alternative hypothesis. This implies that there is statistical evidence for the existence of an additional cointegration among the variables.

- **Null Hypothesis: A maximum of 2 cointegrations.**
  - In the third row, the Eigenvalue is 0.142342 and the Trace statistic is 4.452942, which exceeds the critical value of 3.841466. Additionally, the probability (Prop = 0.0348) is below 5%. Hence, we reject the null hypothesis and accept the alternative hypothesis. This indicates that there is statistical evidence suggesting the presence of an additional cointegration among the variables.

b. Findings from the Maximum Eigenvalue Test:

The findings from the Johansen cointegration test have been evaluated based on the data presented in the table in Appendix No. (05) as follows:

- **Null Hypothesis: No cointegration**
  - The table illustrates that the Eigenvalue = 0.789148 and the Max-Eigen statistic = 45.14130, which exceeds the critical value = 21.13162, and the probability (Prop = 0.0000) is below 5%. Consequently, we reject the null hypothesis and accept the alternative hypothesis. This indicates strong statistical evidence supporting the existence of cointegration among the variables.
- **Null Hypothesis: At most 1 cointegration**
  - The second row in the table reveals that the Eigenvalue = 0.335376 and the Max-Eigen statistic = 11.84747, which is lower than the critical value = 14.26460, and the probability (Prop = 0.1165) is greater than 5%. Thus, we do not reject the null hypothesis. This signifies that there is insufficient statistical evidence to support the existence of additional cointegration among the variables.
- **Null Hypothesis: At most 2 cointegrations**
  - The third row indicates that the Eigenvalue = 0.142342 and the Max-Eigen statistic = 4.452942, which is greater than the critical value = 3.841466, and the probability (Prop = 0.0348) is less than 5%. As a result, we reject the null hypothesis and accept the alternative hypothesis. This suggests that there is statistical evidence for the presence of an additional cointegration between the variables.

The results from the cointegration tests (Trace) demonstrate that three cointegration equations exist between the variables X, Y, and FL at a 5% significance level, while the Maximum Eigenvalue test points to two cointegration equations.

5.3. Simple Linear Regression Test and Model Estimation:

a. **Estimation of the First Model:**

$$\boldsymbol{Y_r = a + bX_r + \varepsilon_r}$$

$\boldsymbol{Y_r}$: Revenues of Alibaba

$\boldsymbol{X_r}$: R&D expenditure of Alibaba

$\boldsymbol{\varepsilon_r}$: Random error term

Table (03): Results of the Analysis of the Impact of R&D Expenditure on Alibaba's Revenues

Dependent Variable: Y
Method: Least Squares
Date: 02/03/25 Time: 21:17
Sample (adjusted): 2017Q1 2024Q3
Included observations: 31 after adjustments

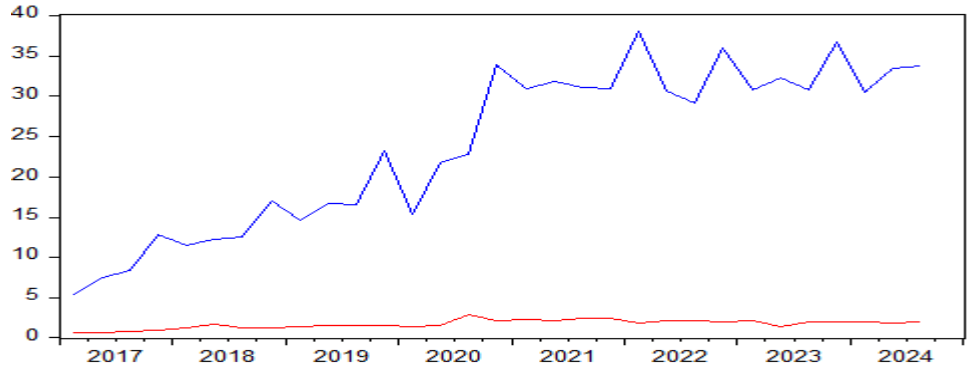
Variable	Coefficient	Std. Error	t-Statistic	Prob.
X	14.63452	2.250713	6.502171	0.0000
C	-1.082284	4.006870	-0.270107	0.7890

R-squared	0.593144	Mean dependent var	23.83700
Adjusted R-squared	0.579114	S.D. dependent var	10.03525
S.E. of regression	6.510441	Akaike info criterion	6.647032
Sum squared resid	1229.190	Schwarz criterion	6.739548
Log likelihood	-101.0290	Hannan-Quinn criter.	6.677190
F-statistic	42.27823	Durbin-Watson stat	1.564724
Prob(F-statistic)	0.000000		

***Source**: Prepared by the researchers based on the output of EViews 10 software.*

Through the simple linear regression model, it was demonstrated that the R-squared value indicates that 59.31% of the variance in revenues can be attributed to R&D spending, with other influencing factors not captured in the model. The probability value = 0.0000, which is lower than 5%, signifies that the model is statistically significant. The coefficient = 14.63452 is positive, indicating that an increase in R&D expenditure by 1 billion dollars results in an anticipated increase in revenues by 14.63452 billion dollars.

***Figure (01)**: The relationship between R&D spending and revenues for Alibaba during 2017 to 2024*



***Source**: Prepared by the researchers based on the output of EViews 10 software.*

The basic linear regression model indicates a positive correlation between R&D spending and revenue. In other words, as spending on R&D rises, revenues tend to also rise, and the opposite holds true. The data indicates that significant increases in R&D spending correspond with notable revenue gains from 2017 to 2024. This suggests that investing in R&D is resulting in revenue growth.

However, it has been noted that the pandemic may have influenced this relationship, especially in 2020 and 2021. Despite a slowdown in revenue growth during the pandemic, Alibaba the continued to boost its R&D investments. This implies that the company prioritized innovation and technology, despite the economic challenges.

5.4. Estimation of the second model:

$$FL_r = a + bX_r + \varepsilon_r$$

- FL_r: Alibaba cash flow
- X_r: R&D expenditure of Alibaba
- ε_r: Random error term

Table (04): *Results of the analysis of the impact of R&D expenditures on Alibaba's cash flow*

Dependent Variable: FL
Method: Least Squares
Date: 02/06/25 Time: 11:44
Sample (adjusted): 2017Q1 2024Q3
Included observations: 31 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
X	5.570975	2.888412	1.928733	0.0636
C	6.056694	5.142143	1.177854	0.2484

R-squared	0.113692	Mean dependent var	15.54281
Adjusted R-squared	0.083130	S.D. dependent var	8.725604
S.E. of regression	8.355057	Akaike info criterion	7.145952
Sum squared resid	2024.402	Schwarz criterion	7.238467
Log likelihood	-108.7623	Hannan-Quinn criter.	7.176109
F-statistic	3.720011	Durbin-Watson stat	1.829458
Prob(F-statistic)	0.063604		

Source*: Prepared by the researchers based on the output of EViews 10 software.*

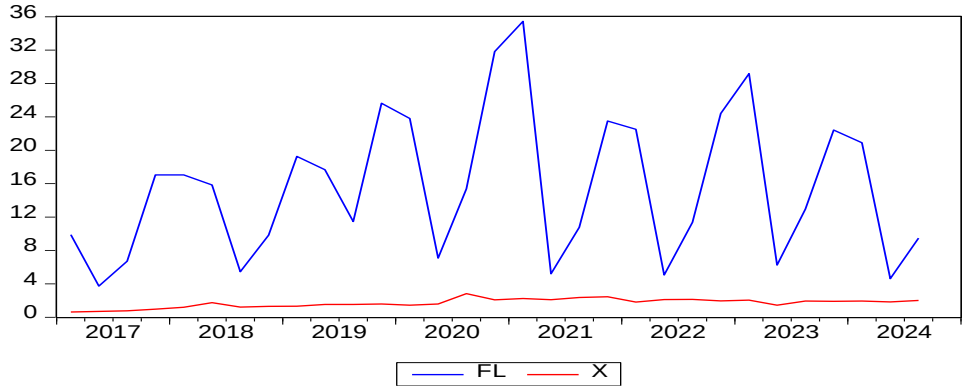
The basic linear regression analysis shows a positive correlation between R&D spending and cash flow. This means that as spending on R&D rises, cash flow also tends to rise, and the reverse is true as well. The coefficient of 5.570975 indicates that a 1 billion dollar rise in R&D spending is linked to a 5.570975 billion dollar increase in cash flow.

However, the R-squared value of 11.36% reveals that only 11.36% of the variations in cash flow can be attributed to R&D spending. This implies that other factors, which are not accounted for in this model, significantly affect Alibaba's cash flow.

Furthermore, the probability value (Prob = 0.0636) exceeds 5%, suggesting that the association between R&D spending and cash flow is not statistically significant at the 5%

threshold. Therefore, although the coefficient shows a positive trend, we cannot assert with confidence that R&D spending has a statistically notable effect on cash flow.

***Figure (02)**: The relationship between R&D spending and cash flow for Alibaba during 2017 to 2024*



***Source**: Prepared by the researchers based on the output of EViews 10 software.*

The chart demonstrates the changes in cash flow alongside research and development (R&D) spending for a company over a defined period (from 2017 to 2024). The red line reveals a modest upward trajectory in R&D spending over the years, suggesting that the company is slowly raising its investment in R&D.

The blue line indicates notable variations in cash flow over the years, with a steep decline noted in 2020. This decline aligns with the start of the COVID-19 pandemic and its economic ramifications worldwide. This drop is likely attributed to various pandemic-related factors, including heightened costs and postponed payments.

After 2020, a slow recovery in cash flow can be seen, albeit with ongoing fluctuations. This indicates that the company has started to rebound from the pandemic's effects, but still encounters certain hurdles.

In general, the graph implies a favorable long-term correlation between R&D spending and cash flow, as the company's dedication to R&D seems to have aided its recovery despite the pandemic's difficulties. Nevertheless, the cash flow variations also underline the necessity of managing short-term financial obstacles and adjusting to evolving economic conditions.

RESULTS AND DISCUSSION.

3. Conclusion.

By exploring the relationship between spending on research and development (R&D) and the financial performance of companies, and by examining how R&D expenditures affect financial outcomes such as revenues and cash flow, this study aims to illuminate the intricate dynamics between R&D investment and the financial results of Alibaba, a prominent e-commerce leader globally. Through an analysis of the company's financial data from 2017 to 2024 and the application of various advanced statistical tests, the research has yielded significant insights that enhance our understanding of this relationship.

- The influence of R&D spending: R&D spending has a direct impact on a company's financial performance by boosting revenues, enhancing efficiency, and gaining a competitive edge, and an indirect impact by elevating the brand image and raising the market value of the company.

- The connection between R&D and revenues: The research identified a statistically significant connection between R&D spending and Alibaba's revenues, highlighting the importance of investing in R&D for achieving sustainable revenue growth.

- The connection between R&D and cash flow: The findings indicated a positive association between R&D spending and the company's cash flow, although this link is not statistically significant.

- Conclusions regarding Alibaba: These findings suggest that Alibaba understands the significance of R&D in meeting its strategic goals and aims to strengthen its competitiveness through investment in innovation and the development of new products and services. Nevertheless, the company must focus on cash flow management to ensure its capacity to fund R&D expenditures while balancing innovation investment with financial stability.

Study Recommendations:

In light of the study findings, the following suggestions are proposed:

- Enhanced Investment in R&D: Companies, particularly those in sectors with high growth potential, should boost their spending on research and development, as the study has highlighted the significance of this investment in attaining sustainable revenue growth.

- Strategic Budget Distribution**:** Organizations should allocate adequate budgets toward research and development, prioritizing areas that align with their strategic goals and objectives.

- Formation of Strategic Alliances**:** Companies can improve their R&D capabilities by establishing strategic alliances with other businesses, research institutions, and universities, both locally and globally.

- Knowledge Transfer Facilitation**:** These collaborations can enable companies to tap into specialized knowledge and expertise, expediting the creation of new products and services.

- Government Assistance for R&D**:** The government should back research and development by offering necessary funding and providing tax incentives to organizations that invest in R&D initiatives.

- Advancing R&D Infrastructure**:** The government ought to enhance the research and development infrastructure by establishing dedicated research centers and equipping them with modern facilities and equipment.

- Encouraging Public-Private Collaboration**:** The government should promote collaboration between the public and private sectors in research and development by facilitating partnerships among universities, research institutions, and businesses.

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Appendices:

Appendix 01: Dickey-Fuller unit root test for study variables:

Revenue Y

Null Hypothesis: D(Y) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-9.752569	0.0000
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(Y,2)
Method: Least Squares
Date: 02/03/25 Time: 20:40
Sample (adjusted): 2017Q3 2024Q3
Included observations: 29 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(Y(-1))	-1.557129	0.159663	-9.752569	0.0000
C	1.447147	0.727296	1.989765	0.0568

R-squared	0.778893	Mean dependent var	-0.063000
Adjusted R-squared	0.770703	S.D. dependent var	7.991677
S.E. of regression	3.826808	Akaike info criterion	5.588411
Sum squared resid	395.4005	Schwarz criterion	5.682708
Log likelihood	-79.03197	Hannan-Quinn criter.	5.617944
F-statistic	95.11259	Durbin-Watson stat	2.151671
Prob(F-statistic)	0.000000		

R&D Spending X

Null Hypothesis: D(X) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.222198	0.0000
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(X,2)
Method: Least Squares
Date: 02/03/25 Time: 21:04
Sample (adjusted): 2017Q3 2024Q3
Included observations: 29 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(X(-1))	-1.431357	0.174084	-8.222198	0.0000
C	0.063861	0.066154	0.965337	0.3429

R-squared	0.714601	Mean dependent var	0.003793
Adjusted R-squared	0.704031	S.D. dependent var	0.650828
S.E. of regression	0.354070	Akaike info criterion	0.827830
Sum squared resid	3.384877	Schwarz criterion	0.922126
Log likelihood	-10.00353	Hannan-Quinn criter.	0.857362
F-statistic	67.60453	Durbin-Watson stat	2.176923
Prob(F-statistic)	0.000000		

Source: Prepared by the researchers based on the output of EViews 10 software.

Cash Flow FL

Null Hypothesis: D(FL) has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.624374	0.0000
Test critical values:	1% level	-3.699871	
	5% level	-2.976263	
	10% level	-2.627420	

*MacKinnon (1996) one-sided p-values.

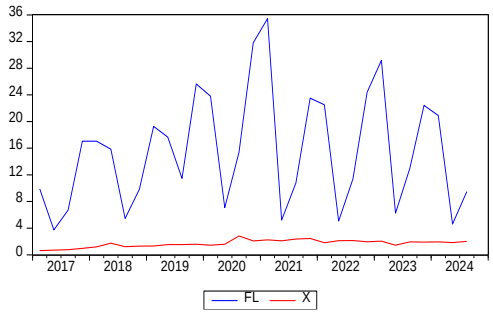
Augmented Dickey-Fuller Test Equation
Dependent Variable: D(FL,2)
Method: Least Squares
Date: 02/06/25 Time: 11:33
Sample (adjusted): 2018Q1 2024Q3
Included observations: 27 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(FL(-1))	-3.144188	0.364570	-8.624374	0.0000
D(FL(-1),2)	1.501029	0.230845	6.502313	0.0000
D(FL(-2),2)	0.616031	0.170113	3.621309	0.0014
C	0.518323	1.275037	0.406516	0.6881

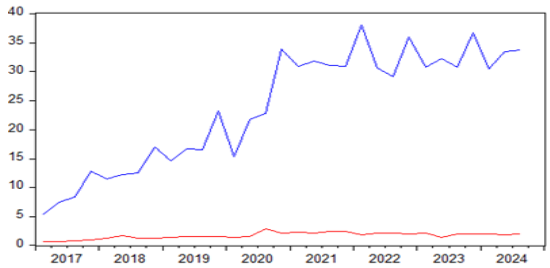
R-squared	0.880529	Mean dependent var	-0.203444
Adjusted R-squared	0.864946	S.D. dependent var	17.95566
S.E. of regression	6.598655	Akaike info criterion	6.747562
Sum squared resid	1001.472	Schwarz criterion	6.939538
Log likelihood	-87.09209	Hannan-Quinn criter.	6.804647
F-statistic	56.50510	Durbin-Watson stat	1.786016
Prob(F-statistic)	0.000000		

Appendix 2: Graph showing the relationship between research spending, revenue and cash flow for Alibaba

Model 1



Model 2



Source: Prepared by the researchers based on the output of EViews 10 software.

Appendix 03: Results of the impact of R&D spending and revenue for Alibaba

Model 1 Model 2

Dependent Variable: Y
Method: Least S
Date: 02/03/25
Sample (adjust
Included obsen

Variable

X
C

R-squared
Adjusted R-squ
S.E. of regressi
Sum squared re
Log likelihood
F-statistic
Prob(F-statistic

Dependent Variable: FL
Method: Least Squares
Date: 02/06/25 Time: 11:44
Sample (adjusted): 2017Q1 2024Q3
Included observations: 31 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
X	5.570975	2.888412	1.928733	0.0636
C	6.056694	5.142143	1.177854	0.2484

R-squared	0.113692	Mean dependent var	15.54281
Adjusted R-squared	0.083130	S.D. dependent var	8.725604
S.E. of regression	8.355057	Akaike info criterion	7.145952
Sum squared resid	2024.402	Schwarz criterion	7.238467
Log likelihood	-108.7623	Hannan-Quinn criter.	7.176109
F-statistic	3.720011	Durbin-Watson stat	1.829458
Prob(F-statistic)	0.063604		

Source: Prepared by the researchers based on the output of EViews 10 software.

Appendix 04: Results of testing the causality between R&D spending and revenue of Alibaba.

Model 1

Pairwise Granger Causality Tests
Date: 02/03/25 Time: 20:45
Sample: 2017Q1 2024Q4
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
X does not Granger Cause Y	30	15.3513	0.0005
Y does not Granger Cause X		6.48806	0.0169

Model 2

Pairwise Granger Causality Tests
Date: 02/06/25 Time: 12:38
Sample: 2017Q1 2024Q4
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
X does not Granger Cause FL	29	4.57007	0.0208
FL does not Granger Cause X		2.50485	0.1028

Source: Prepared by the researchers based on the output of EViews 10 software.