**IMPACT OF RESEARCH AND DEVELOPMENT ON FIRM PERFORMANCE: A CASE STUDY OF APPLE INC.**

**Introduction**

Research and development (R&D) have emerged as essential concepts for nearly every firm, each unique. To thrive in the current competitive and challenging landscape, there is a growing necessity for robust research and development efforts (Ghaffar and Khan, 2014). These endeavours significantly impact a company's performance and serve as a means for enhancing overall effectiveness. According to Wang (2011), companies that allocate substantial resources to R&D are anticipated to outperform those that do not. The advantages gained from R&D are expected to outweigh the associated costs once equilibrium is reached.

**Apple Inc**

Apple Inc., previously known as Apple Computer, Inc., is a distinguished American manufacturer engaged in producing personal computers, smartphones, tablet computers, computer peripherals, and computer software (Levy, 2023). The company stands out as one of the globe's most recognisable brands. It is the first triumphant entity in the realm of personal computer companies and played a pivotal role in popularising the graphical user interface. The company's headquarters is a hub of innovation in Cupertino, California. The genesis of Apple traces back to April 1, 1976, when Steve Wozniak, Steve Jobs (1955–2011), and Ronald Wayne established it as the Apple Computer Company. Their primary objective was to create and market the Apple I personal computer, which was the brainchild of Wozniak. This venture took the formal shape of Apple Computer, Inc. in 1977 following its incorporation by Jobs and Wozniak. The subsequent launch of the Apple II, the company's second computer offering, became a resounding success, emerging as a bestseller and a trailblazing example of mass-produced microcomputers.

As of 2022, Apple is the world's largest technology company in terms of revenue, amassing a notable $394.3 billion (Apple, 2022). This accolade extends to its standing as the leading global company in market capitalisation as of March 2023 (Companies Market Cap, 2023). In addition, Apple is the fourth-largest personal computer vendor by unit sales as of June 2022, and it ranks as the second-largest mobile phone manufacturer worldwide. Its valuation journey is equally impressive, becoming the first publicly traded U.S. company to achieve a valuation exceeding $1 trillion in August 2018, subsequently crossing the $2 trillion mark in August 2020, and reaching an awe-inspiring $3 trillion valuation in January 2022. Its valuation continued to soar, with a value just surpassing $3 trillion in June 2023 (Noel and Tiyashi, 2023). However, amidst its accomplishments, Apple has encountered criticism concerning aspects of its corporate social responsibility, including labour practices among its contractors, environmental approaches, and business ethics, including anti-competitive conduct and sourcing of materials. Nonetheless, the company commands a devoted following and boasts exceptional brand loyalty. Consistently securing a spot among the world's most valuable brands, Apple's remarkable journey raises pertinent questions about the connection between investments in research and development (R&D) and the company's performance.

**R & D and firm performance**

Research and development (R&D) has consistently shown a correlation with firm performance in previous studies. Wang (2011) emphasizes the need for firms to allocate assets to ensure survival in competitive environments strategically. According to the resource-based view theory, valuable resources and capabilities that are hard to imitate or replace grant firms a competitive advantage. Substantial R&D investments contribute significantly to this advantage. Despite the significant financial outlay for R&D activities, its internal innovation capabilities and enhanced performance benefits far outweigh the costs (Wang, 2011). There is an emphasis on innovation as a core business function for profit generation. Thus, a competitive edge demands increased allocation of resources to R&D endeavours. R&D is pivotal in gaining an edge over present and future competitors. The nature of R&D expenses determines the advantages they bring. R&D expenditures safeguard against imitation and enable firms to secure above-average profits (Ghaffar and Khan, 2014).

Contrasting perspectives emerge. Donelson and Resutek (2012) counter that R&D levels and variations are not intrinsically linked to profits. They view R&D costs as expenses, whereas they are, in reality, investments that generate future revenue as profits. However, Cooper et al. (2008) contradict this view, citing a positive accounting relationship between R&D investments and firm earnings, despite a predicted negative financial relationship. Wang (2011) clarifies that a firm's performance ultimately outweighs the R&D investment. Equilibrium leads to R&D costs being balanced by the received benefits. Innovative ideas may not yield immediate substantial impacts but eventually transform into firm-specific assets, amplifying overall performance.

**Data analysis**

This section presents the results of various data analyses to determine the influence of R&D on Apple Inc. 's performance and revenue. Apple’s annual reports for the eight fiscal years (FY) from 2015 to 2024 served as the secondary data source (Appendix 1).

**Variables**

**Return on asset (ROA)**

This financial metric assesses a company's profitability to its total assets. It measures how efficiently a company is utilising its assets to generate profits. The formula for calculating ROA is:

**ROA = (Net Income / Average Total Assets)**

Where:

Net Income is the company's total earnings after deducting expenses and taxes.

Average Total Assets is the average value of the company's assets over a certain period, usually a year.

ROA is typically expressed as a percentage. A higher ROA indicates that a company is generating more profit relative to its assets, which is generally considered favourable.

**Return on equity (ROE)**

Return on Equity is a financial ratio that measures a company's profitability to its shareholders' equity. ROE indicates how effectively a company uses its equity capital to generate profits and assess its financial performance. It's a widely used metric for investors and analysts as it provides insights into how well a company is utilising the funds invested by its shareholders to generate earnings. It's important to note that a high ROE might also indicate using financial leverage (debt) to amplify returns, which carries risks. The formula for calculating ROE is:

**ROE = Net Income / Shareholders' Equity**

Where:

Net Income is the company's total earnings after deducting expenses and taxes.

Shareholders' Equity is the residual interest in the company’s assets after deducting liabilities. It represents the shareholders' ownership in the company.

ROE is usually expressed as a percentage. A higher ROE is generally considered favourable as it suggests that the company generates more profit for each unit of shareholder equity invested.

**Earning per share (EPS)**

Earnings Per Share (EPS) is a financial metric representing the portion of a company's profit attributable to each outstanding share of its common stock. It's a key indicator of a company's profitability and is often used by investors and analysts to evaluate its financial performance and compare it with other companies. EPS is calculated using the following formula:

**EPS = (Net Income - Preferred Dividends) / Weighted Average Number of Outstanding Shares**

Where:Net Income is the company's total earnings after deducting all expenses and taxes.

Preferred Dividends are any dividends paid to preferred shareholders. Common shareholders have a residual claim on earnings after preferred dividends are paid.

The weighted Average Number of Outstanding Shares accounts for any changes in the number of shares outstanding during the reporting period. This helps adjust for the impact of new issuances, buybacks, or other changes in the share count.

EPS is reported in currency (e.g., dollars) per share. It's a useful metric for several reasons profitability comparison, investor decision and valuation.

**Return on Investment (ROI)**

ROI is a financial metric used to measure the profitability and efficiency of an investment. It compares the net gain or profit earned from an investment to its initial cost, expressed as a percentage. A higher ROI indicates that the investment has generated greater returns relative to its cost, making it a useful tool for comparing different projects, business initiatives, or assets. While simple and widely used, ROI does not account for factors such as time, risk, or intangible benefits, so it is often complemented with other performance indicators for a more complete analysis. The basic formula for Return on Investment (ROI) is:

**ROI = Net Profit (or Gain) from Investment / Cost of Investment**

**Descriptive statistics**

The characteristics of the data are provided in Table 1. The table presents the variables' mean, standard deviation, minimum, maximum and skewness. The data for all variables are almost symmetrical, with values close to 0.

**Table 1:** Descriptive statistics of the data on firm performance, revenue and R&D

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Variables** | **N** | **Mean** | **Standard Error** | **Standard Deviation** | **Minimum** | **Maximum** | **Skewness** |
| **Revenue (In million $)** | 10 | 301333.70 | 23183.62 | 73313.05 | 215639.00 | 394328.00 | 0.32 |
| **R&D (In million $)** | 10 | 18834.80 | 2620.89 | 8287.98 | 8067.00 | 31370.00 | 0.33 |
| **ROA** | 10 | 20.43 | 1.90 | 6.00 | 12.88 | 28.29 | 0.28 |
| **ROE** | 10 | 98.86 | 19.48 | 61.59 | 35.62 | 196.96 | 0.45 |
| **ROI (%)** | 10 | 41.80 | 5.79 | 18.31 | 20.91 | 66.70 | 0.40 |
| **EPS (in thousands $)** | 10 | 7.83 | 0.90 | 2.84 | 3.31 | 12.01 | 0.20 |

Furthermore, the R&D expenditure trend for the FYs is presented in Figure 1. It shows that Apple’s expenditure on R&D increases each FY from 2015 to 2024. Also, Apple’s revenue was not a consistent increase, with the lowest in 2016, then increased till 2018 and dropped in 2019, but from 2019 to 2022, there was a continuous increase in revenue with a slight increase in 2023 (Figure 2).

There was a decrease in ROA from 2015 to 2017 and an increase from 2018 to 2022; however, a decline occurred again in 2023 and 2024 (Figure 3). Similarly, ROE and ROI followed a similar trend (Figure 3). While EPS showed a varying change, there was a steep decline from 2019 to 2020, then an increase in 2021 (Figure 4).

**Figure 1:** Expenditure on research and development for Apple from 2015 to 2024

**Figure 2:** Revenue for Apple from 2015 to 2024

**Figure 3:** Firm performance (ROA, ROE and ROI) for Apple from 2015 to 2024

**Figure 4:** Earnings per share for Apple from 2015 to 2024

**Correlation analysis**

The relationship between R&D and firm performance/revenue was assessed using correlation analysis (Table 2). The analysis showed that ROA, ROE, ROI and revenue had a strong positive correlation with R&D and were statistically significant, while EPS had a moderate negative correlation with R&D (Table 2). The results are summarised by a scatter plot (figures 5 -8).

**Table 2:** Correlations between firm performance (ROA, ROE, ROI and EPS) and research and development

|  |  |  |
| --- | --- | --- |
| **R&D vs** | **Correlation coefficient** | **P value** |
| Revenue | 0.95 | 0.00002 |
| ROA (%) | 0.86 | 0.00145 |
| ROE (%) | 0.92 | 0.00015 |
| ROI (%) | 0.93 | 0.00010 |
| EPS (in thousands $) | -0.56 | 0.09227 |

A p-value <0.05 was considered statistically significant.

**Figure 5:** correlation between R&D expenditure and ROA for Apple

**Figure 6:** correlation between R&D expenditure and ROE for Apple

**Figure 7:** correlation between R&D expenditure and ROI for Apple

**Figure 8:** correlation between R&D expenditure and EPS for Apple

**Regression analysis**

Regression analysis was carried out to develop models that show the relationship between the variables and predict.

**Firm performance model**

This model used firm performance (the addition of ROA, ROE, ROI and EPS) as the dependent variable (outcome), while the predictor (independent) variable was R&D. The regression analysis results in Tables 3 and 4; *F*(1, 8)=46.23, *R2*= 0.85, *R2adjusted*= 0.83, indicating that R&D is a significant predictor of firm performance. The *R2* indicates that R&D explains about 85% of firm performance. Furthermore, the results show that *β*= 0.009, t(8)=6.799, *p*= 0.001 (Table 4), which implies that a unit increase in R&D will cause a 0.009 unit increase in firm performance.

The regression equation is Y= -6.92 + 0.009 X

Where Y is firm performance, and X is R&D

**Table 3:** ANOVA output and Regression model Summary for firm performance

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Model | Degree of freedom | F | R Square | Adjusted R Square |
| Regression | 1 | 46.23 | 0.85 | 0.83 |
| Residual | 8 |

**Table 4:** Regression Coefficients for firm performance

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **Coefficients** | **Standard Error** | **t stat** | **P value** | **95.0% Confidence Interval** | |
| **Lower Bound** | **Upper Bound** |
| Intercept | -6.915 | 28.022 | -0.247 | 0.811 | -71.534 | 57.705 |
| R&D | 0.009 | 0.001 | 6.799 | 0.000 | 0.006 | 0.013 |

A p-value < 0.05 was considered statistically significant

**Revenue model**

This model used revenue as the dependent variable (outcome), while the predictor (independent) variable was R&D. The regression analysis result in Tables 5 and 6; *F*(1, 8)=75.30, *R2*= 0.90, *R2adjusted*= 0.89 indicating that R&D is a significant predictor of revenue. The *R2* indicates that R&D explains about 90% of revenue. Furthermore, the results show that *β*= 8.41, t(8)=8.68, *p*= <0.001 (Table 6), which implies that a unit increase in R&D will cause a 9.90 unit increase in revenue.

The regression equation is Y= 142,928.47 + 8.41 X

Where Y is revenue and X is R&D

**Table 5:** ANOVA output and Regression model Summary for revenue

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Model | Degree of freedom | *F* | R Square | Adjusted R Square |
| Regression | 1 | 75.30 | 0.90 | 0.89 |
| Residual | 8 |

**Table 6:** Regression Coefficients for revenue

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **Coefficients** | **Standard Error** | **t stat** | **P value** | **95.0% Confidence Interval** | |
| **Lower Bound** | **Upper Bound** |
| Intercept | 142928.47 | 19780.82 | 7.23 | <0.001 | 97313.81 | 188543.13 |
| R&D | 8.41 | 0.97 | 8.68 | <0.001 | 6.18 | 10.65 |

A p-value < 0.05 was considered statistically significant.

**Conclusion and Recommendation**

Apple's success story is intricately linked to its robust R&D strategies. Research and development play a pivotal role in shaping the performance and revenue of firms, as highlighted by previous studies. This report delved into the relationship between R&D investments and the performance of Apple Inc. The analysis demonstrates that Apple's continuous commitment to R&D has significantly impacted its performance and revenue. The correlation and regression analyses provide empirical evidence that supports the positive influence of R&D on both firm performance and revenue. The statistical significance and substantial coefficients underline the importance of R&D investments in enhancing Apple's overall financial outcomes.

Based on the findings and the importance of R&D, the following recommendations are put forward for Apple Inc.:

Apple should continue to allocate substantial resources to research and development activities. These investments have demonstrated a strong positive correlation with firm performance and revenue. The company should foster an environment that nurtures innovation. Collaborative efforts, open communication channels, and cross-functional teams can enhance the effectiveness of R&D initiatives. They should collaborate with external entities, such as research institutions and startups, to leverage diverse expertise and stay at the forefront of technological advancements. It should be ensured that R&D efforts align with customer needs and market trends to ensure that innovations lead to products and services that resonate with consumers.

**Appendix**

**Appendix 1:** Data from Apple Inc.'s annual report from Fiscal year 2015 to 2024

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Net income (In million $)** | **Total asset (In million $)** | **ROA (%)** | **Shareholders' equity (In millions $)** | **ROE (%)** | **EPS (in thousands $)** | **R&D (In million $)** | **Revenue (In million $)** | **ROI (%)** |
| 2015 | 53394 | 290345 | 18.38985 | 119355 | 44.73545 | 9.28 | 8067 | 233715 | 30.9201 |
| 2016 | 45687 | 321686 | 14.20236 | 128249 | 35.62367 | 8.35 | 10045 | 215639 | 22.4312 |
| 2017 | 48351 | 375319 | 12.88264 | 134047 | 36.07018 | 9.27 | 11581 | 229234 | 20.9082 |
| 2018 | 59531 | 365725 | 16.27753 | 107147 | 55.56012 | 12.01 | 14236 | 265595 | 29.6348 |
| 2019 | 55256 | 338516 | 16.32301 | 90488 | 61.06445 | 11.97 | 16217 | 260174 | 30.113 |
| 2020 | 57411 | 323888 | 17.72557 | 65339 | 87.86636 | 3.31 | 18752 | 274515 | 35.0054 |
| 2021 | 94680 | 351002 | 26.97421 | 63090 | 150.0713 | 5.67 | 21914 | 365817 | 54.9839 |
| 2022 | 99803 | 352755 | 28.29244 | 50672 | 196.9589 | 6.15 | 26251 | 394328 | 66.6994 |
| 2023 | 96995 | 352583 | 27.50983 | 62146 | 156.076 | 6.16 | 29915 | 383285 | 61.6127 |
| 2024 | 93736 | 364980 | 25.6825 | 56950 | 164.5935 | 6.11 | 31370 | 391035 | 65.6875 |