Mathematical Investigation

Coca-cola

Advertising and Revenue

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Introduction:

Ads and revenue play a paramount role in any company. Revenue meaning the total amount of money which was made without the expenses, and ads being the total money invested in advertising. It is believed that the advertisement and revenue have a correlation[1] of some sort. Although, is this factual? We will further explore this through this investigation. Supported by coca-cola's own database, I will discover the relationship among these two concepts.
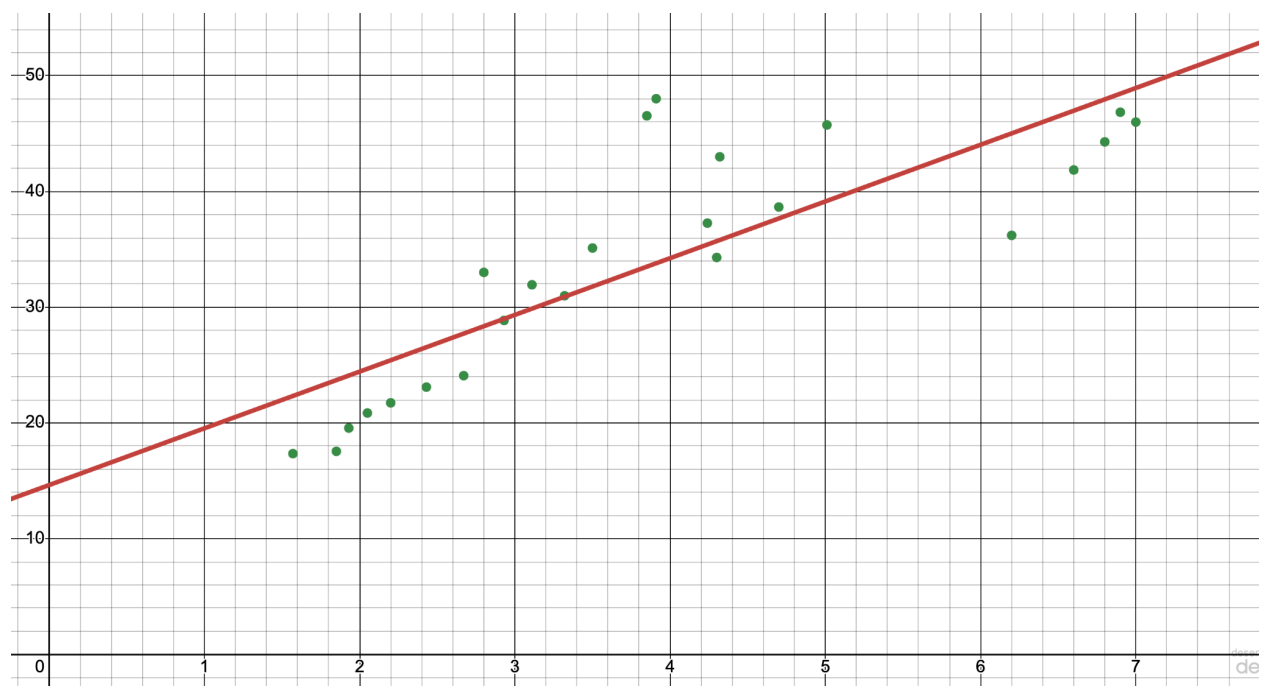
Hypothesis:

I hypothesize that there is a positive correlation between Coca-Cola's advertising expenditures and its revenue. This belief stems from the idea that increased advertising enhances consumer awareness and demand for the product, which ultimately leads to higher sales. Coca-Cola, as a globally recognized brand, has likely relied on significant advertising investments to maintain its market presence and drive growth. Factors such as targeted advertisements, evolving consumer trends, and the company's strategic campaigns are expected to contribute to this relationship. By analyzing the data, I aim to confirm that higher advertising spending directly influences revenue generation.

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[1] a measure of relationship between two variables

Data (2000-2023):

Year	Advertisement Billions (USD)	Revenue Billions (USD)
2000	1.57	17.35
2001	1.85	17.55
2002	1.93	19.56
2003	2.05	20.86
2004	2.20	21.74
2005	2.43	23.10
2006	2.67	24.09
2007	2.93	28.86
2008	3.11	31.94
2009	3.32	30.99
2010	3.50	35.12
2011	3.85	46.54
2012	3.91	48.02
2013	6.90	46.85
2014	7.00	46.00
2015	6.80	44.29
2016	6.60	41.86
2017	6.20	36.21

2018	4.30	34.30
2019	4.24	37.27
2020	2.80	33.01
2021	4.70	38.66
2022	4.32	43.00
2023	5.01	45.75

(figure 1)

$$y_1 \sim mx_1 + b$$

$$m = 4.90075 \qquad b = 14.63826$$

$$r = 0.8248$$

r^2 = correlation coefficient. (1.00-0.75) strong positive correlation.

m = slope

b = y-intercept

Analysis of data:

In figure 1 we see advertising acting as x-axis and revenue as the y-axis, both in USD billions, throughout the years 2000 to 2023. A strong positive correlation is established by the revenue and advertising, as I predicted. The scatter plot by itself provides a reading of the correlation. All of the points show a trend which supports the line of regression proving a pattern leading to a correlation. More investments made within the sector of advertisement attracts more consumers which essentially results in more revenue.

Possible liabilities:

The inevitable advancements of technology also play an important role throughout this exploration. Advertisements evolved along the years, now we see ads on buildings, tvs and many more. As a result, changing when ads are viewed and changing their prices. Ex: cable tv

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[2] Correlation coefficient. Illustrate the strength of the correlation.

is not frequently used anymore, therefore the cost of screen time in cable decreased as well as its audience. Evidently advertising has changed a lot through the past 24 years, this evolution would have affected my research to some extent. There's also room for error when looking into Coca-Cola's deals over the years, as well as their impacts on the brand.
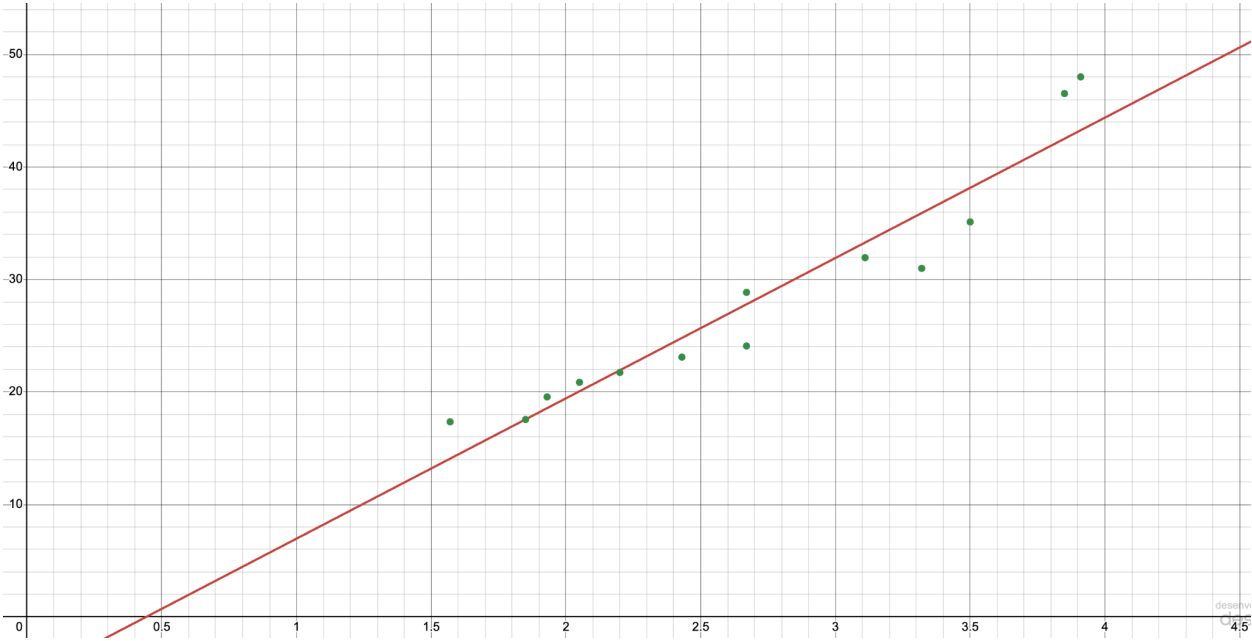
Improved Hypothesis:

I believe that if I were to choose a set of points, which are closer together in time, an even higher correlation coefficient will be the output. The reasoning behind such a statement comes from humanity itself from that given period of time. There were no significant events like the pandemic that could have affected coca-cola's market leaving less possibility for any outlier.

Improved data (2000-2012) :

Year	Advertisement Billions (USD)	Revenue Billions (USD)
2000	1.57	17.35
2001	1.85	17.55
2002	1.93	19.56

2003	2.05	20.86
2004	2.20	21.74
2005	2.43	23.1
2006	2.67	24.09
2007	2.67	28.86
2008	3.11	31.94
2009	3.32	30.99
2010	3.50	35.12
2011	3.85	46.54
2012	3.91	48.02

(figure 2)

$$y_1 \sim mx_1 + b$$

$$m = 12.4776 \qquad b = -5.51881$$

$$r = 0.9572$$

r = correlation coefficient. (1.00-0.75) strong positive correlation.

m = slope

b = y intercept

Improved data analysis:

Figure 2 is a very similar graph as to figure 1, the difference is that figure 2 only shows the points between 2000-2012. Both graphs represent the correlation between the money invested in Coca-Cola advertisements and its revenue. Now by calculating the r value I'm able to affirm my improved hypothesis is correct, the points closer to each other in time demonstrate a higher correlation.

Original data correlation:

$r = 0.8248$

Improved data correlation:

$r = 0.9572$

Evidently the correlation grew accordingly to my hypothesis. Thus also proving that advertisement itself went through its changes.

Outlier:

In the dataset from 2000 to 2023, the most notable outlier occurs in 2012, where Coca-Cola's advertising expenditure was 3.91 billion USD, yet the revenue reached 48.02 billion USD, significantly higher than in surrounding years. This unusual spike in revenue can be attributed to several possible factors. External market conditions or favorable economic circumstances may have played a role in boosting sales. Additionally, a highly successful promotional campaign could have contributed to the revenue surge. Another consideration is the cumulative effect of previous advertising efforts, which might have continued to influence consumer behavior in 2012. Furthermore, in 2011, Coca-Cola's CEO, Muhtar Kent, closed a $12 billion deal to acquire its North American bottling operations from Coca-Cola Enterprises, which could have had a substantial positive impact on revenue in the following year.

Extrapolate:

Extrapolation is a valuable tool for predicting future revenue based on Coca-Cola's planned advertising investments. By using the equation $y = 4.90075x + 14.63826$, Coca-Cola can estimate potential earnings. For example, if the company spends 13 billion dollars on

advertising, the projected revenue is approximately 78.35 billion dollars. This method is particularly helpful for strategic planning, as it provides insights into how advertising budgets might translate into revenue growth. However, its accuracy can be affected by market changes, unexpected events, or shifts in consumer behavior. Despite these limitations, extrapolation remains a powerful way to anticipate outcomes and guide decision-making.

$y = mx + b$

$y = 4.90075x + 14.63826$

$y = 4.90075(13) + 14.63826$

$78.34801 = 4.90075(13) + 14.63826$

Interpolate:

Interpolation serves as a precise tool for estimating revenues corresponding to advertising expenditures within the observed data range. By applying the regression equation $y = 4.90075x + 14.63826$, Coca-Cola can predict outcomes for specific expenses levels. For instance, with an advertising expenditure of 3.11 billion dollars, interpolation estimates a revenue of approximately 29.88 billion dollars.

Measured value (3.11, 31.94)

Apply formula to find actual value

$y = 4.90075x + 14.63826$

Sub in for x

$y = 4.90075(3.11) + 14.63826$

$29.8795925 = 4.90075(3.11) + 14.63826$

$$\frac{29.8795925-31.94}{31.94} \times 100\% = \text{percentage error}$$

$$\frac{29.8795925-31.94}{31.94} \times 100\% = 6.45\%$$

Percentage error $= 6.45\%$

Conclusion:

This investigation examined the link between Coca-Cola's advertising expenditures and revenue from 2000 to 2023. The data shows a strong positive correlation, supporting the idea that increased advertising spending tends to lead to higher revenue. By using statistical methods like correlation, extrapolation, and interpolation, we were able to make predictions about future revenue and estimate outcomes based on different ad budgets.

However, external factors such as market changes and economic conditions can impact these results. The 2012 outlier, where revenue spiked despite moderate advertising, highlights the influence of other variables. While extrapolation helps predict future trends, its accuracy can be affected by unforeseen events.

In conclusion, advertising plays a significant role in Coca-Cola's revenue growth, but it's important to consider a range of factors when planning advertising strategies to account for market fluctuations and other external influences.

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