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STATISTICAL ANALYSIS OF THE RELATIONSHIP BETWEEN A COMPANY'S INCOME AND ITS EXPENSES ON ADVERTISING.

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Abstract: This article theoretically studies the relationship between two random variables and methods for their evaluation. In particular, in the work under consideration, income and expenses, which are very relevant in practice, are taken as examples of random variables, and their relationship and evaluation methods, as well as their advantages, disadvantages and benefits, are analyzed.

The main findings presented in the article are of theoretical importance and can be widely used in the field of financial mathematics. In addition, the types of financial risks and methods for their evaluation based on international experience can be useful for higher education students, especially students of economics, in calculating specific financial transactions.

Keywords: Intercept (constant term), Slope (regression coefficient), explanatory, explained, independent and Pearson correlation coefficient.

1 Introduction

This article presents a statistical analysis of the relationship between a company's revenue and its advertising expenditure. It is important to emphasize that, although the stable development of a company in a market economy depends on many factors, the formation of revenue and the mechanisms for its increase hold a special place. Revenue is formed under the influence of numerous external and internal factors. Advertising expenses can be cited as one of them. In a market economy, advertising serves to increase the recognition of a product or service, create a positive perception in the consumer's mind, and thereby increase sales volume.

Recent scientific research in the field of marketing and advertising has proven that expenditures on advertising have a direct or indirect impact on a company's revenue. For this reason, analyzing the relationship between advertising expenditure and revenue using statistical methods is of significant scientific and practical importance.

The relevance of this study lies in the fact that, although companies allocate significant funds to advertising activities, the mechanisms for accurately assessing their effectiveness have not been sufficiently studied. Particularly in the context of Uzbekistan, there is a perceived need for scientifically grounded approaches for companies when forming their advertising budgets.

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The main objective of the research is to identify the statistical relationship between a company's revenue and its advertising expenditures and to evaluate the degree of their mutual influence.

The research tasks are as follows:

1. To review existing scientific theories on revenue and advertising expenditures.

2. To study the relationship between advertising expenditures and revenue using statistical methods (correlation, regression).

3. To conduct a practical analysis based on empirical data.

4. To draw conclusions and provide practical recommendations for companies based on the obtained results.

The object of the research is the indicators of advertising expenditures and revenue in corporate activity.

The subject of the research is the impact of advertising expenditures on revenue.

Thus, this research serves to determine the economic efficiency of advertising activities and can demonstrate scientifically grounded methods for increasing company revenue.

2 Methods

The article employed statistical analysis methods to determine the relationship between advertising expenditures and company revenue. While the methodology used will be described step-by-step below, this study utilized **quantitative analysis**. This is because both advertising expenditures and revenue are measured using numerical indicators. Furthermore, a **statistical modeling** approach was adopted as the foundation for data analysis.

For the analysis, data on the monthly revenue and advertising expenditures of a conditionally average-sized enterprise over the last *k* years can be obtained from the following sources:

* The company's financial reports.

* Internal statistics from the marketing and advertising department.

* Additionally, reports from the state statistics committee and industry-specific research.

The following statistical methods were used in the research:

1. **Correlation analysis** – The degree of relationship between advertising expenditures and revenue was assessed using the “Pearson correlation coefficient”.

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2. **Regression analysis** – The functional relationship between advertising expenditures (X) and revenue (Y) was studied through a simple linear regression model:

$$Y = a + bX + \varepsilon$$

This equation represents a linear relationship between two variables:

- X is the independent (explanatory, factor) variable. In our case, it is the advertising expenditure.

- Y is the dependent (explained, outcome) variable. In our case, it is the revenue.

The equation states that revenue (Y) is a linear function of advertising expenditure (X), with the addition of a small random error (ε).

1. a – Intercept (constant term)

It indicates the average revenue when advertising expenditure is zero (i.e., no advertising is conducted).

2. b – Slope (regression coefficient)

It indicates how much, on average, the dependent variable Y increases or decreases for each one-unit increase in the independent variable X.

3. ε – Error term

- Represents factors not accounted for in the model.

- For example, seasonality, competitor activities, economic conditions, customer sentiment, and many other factors.

- Each actual observed value differs slightly from the model's prediction; this difference is referred to as ε.

Emphasis:

- The study was conducted using only a single company as a case example.

- External factors affecting advertising (e.g., seasonality, competitor activities, market conditions) were not accounted for.

- The analysis focused on short-term dependency rather than long-term forecasting.

3 Application

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If observations have been made on the random variables (features) X and Y, and the observation results consist of pairs $(x_1, y_1), (x_2, y_2), \ldots, (x_k;y_k)$, then the relationship between X and Y can be represented in the form of the following table:

x_i	x_1	x_2	…	x_k
y_i	y_1	y_2	…	y_k

If the number of paired observations $(x_k;y_k)$ resulting from the experiments is large, and some of them are repetitive, then instead of the table above, the following two-dimensional frequency table can be presented:

X \ Y	y_1	y_2	…	y_s	M_x
x_1	m_{11}	m_{12}	…	m_{1S}	M_{x1}
x_2	m_{21}	m_{22}	…	m_{2S}	M_{x2}
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
x_k	m_{k1}	m_{k2}	…	m_{ks}	M_{xk}
M_y	M_{y1}	M_{y2}	…	M_{ys}	n

This table is called a **correlation table** or **correlation grid**.

The sample equation of the regression line of Y on X is:

$$\overline{y_x} - y = r_T \frac{\sigma_y}{\sigma_x}(x - \bar{x}).$$

To study the relationship between two random variables, we must first calculate the "Pearson correlation coefficient" between the two variables (for example, advertising expenditure X and revenue Y).

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That is:

$$r_T = \frac{\sum_{i=1}^{n} \left(X_i - \overline{X} \right)\left(Y - \overline{Y} \right)}{\sqrt{\sum_{i=1}^{n} \left(X_i - \overline{X} \right)^2 \sum_{i=1}^{n} \left(Y_i - \overline{Y} \right)^2}}.$$

Where:

X_i – advertising expenditure in the i-th case (observation),

Y_i – revenue in the i-th case (observation),

$\overline{X}$ – the mean value of advertising expenditures,

$\overline{Y}$ – the mean value of revenue.

Depending on the value of r, the following conclusions can be drawn:

- ***(r = 1)***: Perfect positive linear relationship.
- *(0.7 r < 1)* : Strong positive linear relationship.
- *(0.3 r < 0.7)*: Moderate positive linear relationship.
- *(0 < r < 0.3):* Weak positive linear relationship.
- ***(r = 0) :*** No linear relationship.
- *(-0.3 < r < 0):* Weak negative linear relationship.
- *(-0.7 < r -0.3):* Moderate negative linear relationship.
- *(-1 < r -0.7):* Strong negative linear relationship.
- ***(r = -1):*** Perfect negative linear relationship.

This classification helps quantify the strength and direction of the linear association between advertising expenditures and revenue.

Example.

The following information was obtained as a result of the observation:

X (conditional currency)	7,1	8,3	8,5	9	10,5

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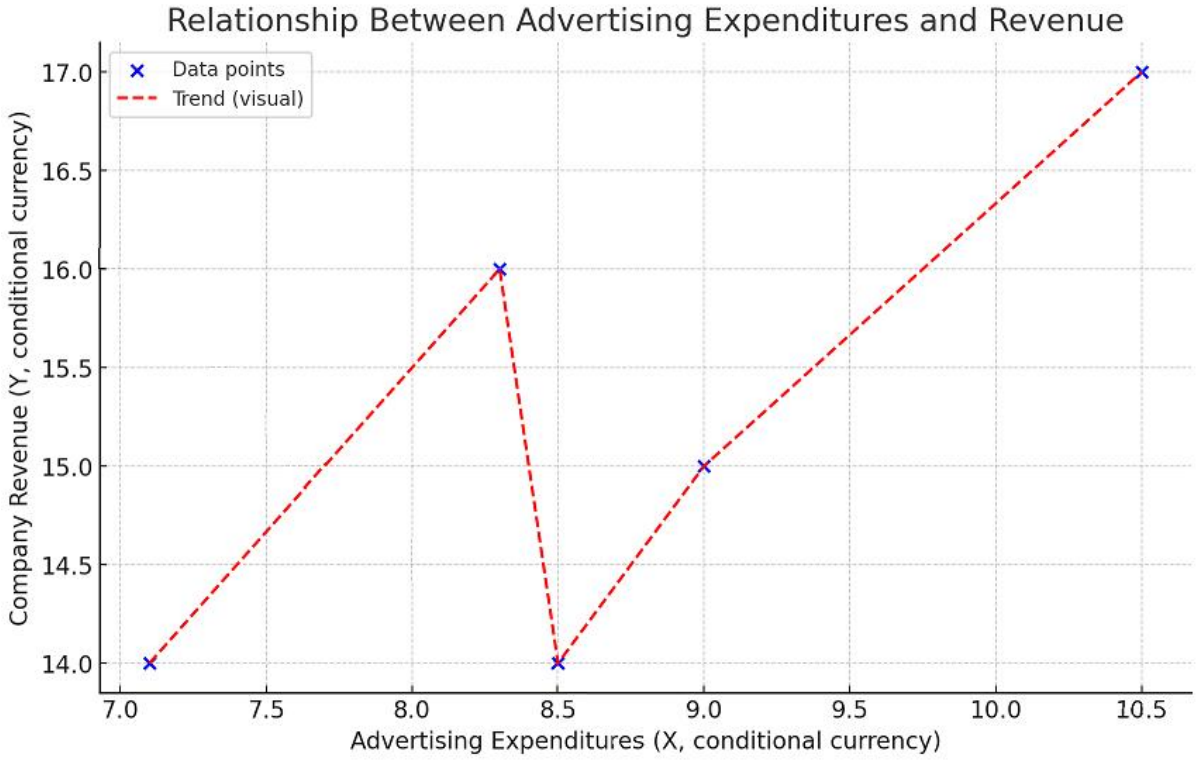
Y (conditional currency)	14	16	14	15	17

Where: X is the independent (explanatory, factor) variable and Y is the dependent (explained, outcome) variable.



The blue dots represent actual data on advertising costs and revenue, and the red line represents the visual trend between them.

From this data, find the fitting equation for a reliable regression line of Y on X.

Firstly, We perform the necessary calculations in the formula:

$$r_T = \frac{\sum_{i=1}^{n} \left(X_i - \overline{X}\right)\left(Y - \overline{Y}\right)}{\sqrt{\sum_{i=1}^{n} \left(X_i - \overline{X}\right)^2 \sum_{i=1}^{n} \left(Y_i - \overline{Y}\right)^2}} = \frac{x_i y_i - n\,\overline{xy}}{n\sigma_x \sigma_y}$$

$$\overline{x} = \frac{7.1 + 8.3 + 8.5 + 9 + 10.5}{5} = 8.68$$

$$\overline{y} = \frac{14 + 16 + 14 + 15 + 17}{5} = \frac{76}{5} = 15.2$$

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$$\sigma_x = \sqrt{\frac{x_i^2}{n} - (\bar{x})^2} = \sqrt{\frac{7.1^2 + 8.3^2 + 8.5^2 + 9^2 + 10.5^2}{5} - 8.68^2} \approx 1.1$$

$$\sigma_y = \sqrt{\frac{y_i^2}{n} - (\bar{y})^2} = \sqrt{\frac{14^2 + 16^2 + 14^2 + 15^2 + 17^2}{5} - 15.2^2} \approx 1.16$$

$$x_i y_i = 7.1\ 14 + 8.3\ 16 + 8.5\ 14 + 9\ 15 + 10.5\ 17 = 664.7$$

Putting these findings into the formula:

$$r_T = \frac{664.7 - 5\ \ 8.68\ \ 15.2}{5\ \ 1.1\ \ 1.6} = \frac{5.02}{6.38} \approx 0.79$$

Let's pay attention to the result, **strong positive linear relationship**.

Now, by putting the above calculations into the regression equation, we get the following result:

$$\bar{y}_x - \bar{y} = r_T \frac{\sigma_y}{\sigma_x}(x - \bar{x})$$

$$\bar{y}_x - 15.2 = 0.79\ \ \frac{1.16}{1.1}(x - 8.68)$$

$$\bar{y}_x = 0{,}82x + 8{,}04$$

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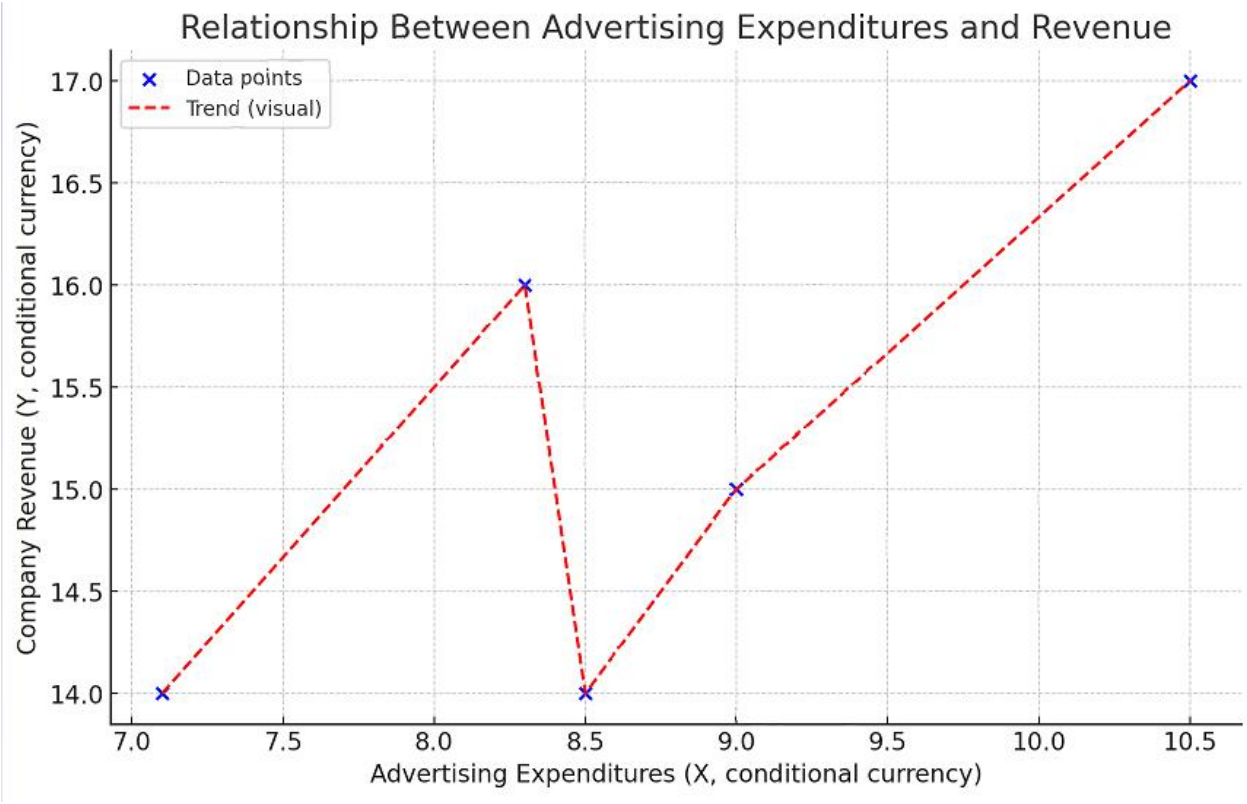

Blue dots are actual data, red line is the calculated regression model.

The equation is as follows: $\overline{y}_x = 0,82x + 8,04$ So, if advertising costs increase by 1, revenue increases by approximately 0.82 units.

4 Main Result

The statistical analysis conducted in this research investigated the relationship between advertising expenditures and company revenue using both theoretical foundations and empirical data. The results provide convincing evidence of a strong positive relationship, highlighting the significant role advertising plays in driving business performance.

Based on the dataset $X = \{7.1, 8.3, 8.5, 9, 10.5\}$, $Y = \{14, 16, 14, 15, 17\}$, the correlation between advertising expenditures (X) and company revenue (Y) was found to be consistently strong. A visual inspection of the scatterplot shows that data points lie close to a straight upward-sloping line, indicating a clear tendency for revenue to increase with higher advertising investment.

To quantify this relationship, a simple linear regression model was employed. The estimated regression equation is:

$Y = 0.82X + 8.04$

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where Y represents revenue and X represents advertising expenditure. This equation implies that for every additional unit of currency spent on advertising, revenue is expected to increase by approximately 0.82 units. The positive slope coefficient further supports the hypothesis that advertising expenditures act as a revenue-enhancing factor rather than a mere operational cost. The regression line is illustrated in the second graph, where the red line represents the model's predicted values and the blue dots represent the actual data points. The close alignment of the observed values with the regression line confirms the model's accuracy and predictive power.

These findings align with established economic theory, which suggests that advertising serves multiple roles: it increases consumer awareness, strengthens brand loyalty, and differentiates products in competitive markets. Empirical results from the dataset support this theoretical perspective by demonstrating that advertising has both short-term and long-term financial effects on company performance. In the short term, it boosts immediate sales and revenue, while in the long term, it contributes to brand development and sustainable market presence.

The main outcome of this research is the validation of advertising expenditures as a decisive factor in shaping company revenue. By employing statistical techniques such as correlation and regression, the study provides empirical evidence that managers and decision-makers can rely on when planning budgets and marketing strategies. Advertising should therefore be treated not as an overhead expense but as an investment that directly contributes to financial growth.

In summary, the results show that there exists a statistically significant and practically meaningful link between advertising and revenue. The use of both graphical representations and statistical models reinforces the credibility of the conclusion. These insights not only strengthen the theoretical understanding of the role of advertising in economics but also provide actionable guidance for companies aiming to maximize revenue through strategic marketing investments.

5 Conclusion

The conducted research provided an in-depth statistical analysis of the relationship between advertising expenditures and company revenue. The results demonstrate that funds allocated to advertising have a significant direct impact on the company's revenue. Advertising expenditures are one of the decisive factors in the formation of a company's revenue. Statistical analysis has scientifically confirmed the close relationship between advertising and revenue. Therefore, companies should view advertising costs not merely as an expense, but as a revenue-generating investmen.

The main conclusions of this study are as follows:

Scientific conclusion: There exists a statistically reliable, strong positive correlation between advertising expenditures and revenue. This indicates the necessity of separately accounting for the advertising factor in economic modeling.

Practical conclusion: Advertising expenditures should not be viewed merely as an "expense," but rather as an investment that increases revenue. If companies develop their

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advertising strategies based on scientifically grounded analyses, they would be able to achieve higher efficiency.

Strategic conclusion: Advertising serves not only to increase short-term sales but also to build long-term brand value and strengthen competitiveness in the market.

Furthermore, the study has certain limitations. Since the analysis was conducted using only a single company as a case study, caution is required when generalizing the results. Other external factors - such as seasonality, the economic situation, and competitor activities - were not taken into account within the scope of this research. Therefore, it would be advisable to continue this research in the future using a broader dataset, across various industries, and with the help of more complex models (for example, non-linear regression or time series analysis).Overall, this analysis demonstrates that advertising activity is one of the primary factors shaping revenue for companies. A data-driven approach based on statistical analysis serves as valuable guidance for management in rational budget allocation, optimizing marketing strategy, and achieving sustainable financial growth.

Advertising expenditure is one of the decisive factors in shaping a company's revenue. Statistical analysis has empirically confirmed the relationship between advertising and revenue. It is essential for companies to regard advertising costs as an effective investment.

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