ANALYZING THE INTERACTION BETWEEN MARKETING BUDGET AND CHANNEL TYPE ON SALES PERFORMANCE USING R

Client Overview:

A mid-sized e-commerce company based in New York approached me to analyze the effectiveness of their marketing spend across various digital channels (social media, paid search, email). They had anecdotal evidence that returns varied not only by budget size but also depending on the channel—especially at higher spending levels. They needed a robust regression model that could capture how marketing budget and channel type interacted to affect monthly sales.

Problem Statement:

The client's analytics team had been building simple linear models to analyze marketing performance but failed to capture non-additive effects. For instance, doubling the social media budget didn't always double the impact on sales. They suspected that **interaction effects** were present between budget size and channel type but lacked the expertise to implement and interpret interaction terms correctly.

Solution Approach:

I proposed a **Multiple Linear Regression model with interaction terms** in R to capture whether the effect of the budget on sales varied across marketing channels. The model would help:

- Quantify the marginal impact of marketing spend per channel

- Capture diminishing or accelerating returns from certain combinations

- Guide resource allocation across marketing strategies

1. Data Preparation

- The dataset included 24 months of data with:

    o Total_Sales (dependent variable)

    o Marketing_Budget (continuous, in \$1,000s)

    o Channel_Type (categorical: Social, Search, Email)

- Cleaned null values, standardized currency, and created dummy variables for channel type.

- Created an interaction variable:

  o Marketing_Budget × Channel_Type

2. Model Specification

Used the following regression equation in R:

lm(Total_Sales ~ Marketing_Budget * Channel_Type, data = marketing_data)

- This model included both main effects and interaction terms.

3. Diagnostic Checks

- Verified linearity through residual vs fitted plots.

- Performed VIF analysis to check for multicollinearity.

- Used Cook's Distance and leverage diagnostics to rule out outlier influence.

4. Interpretation

- **Base category:** Email

- The interaction term Marketing_Budget:Channel_TypeSocial was **positive and significant**, showing that social media budget produced **accelerating returns** compared to email.

- Marketing_Budget:Channel_TypeSearch showed **diminishing returns**—significant at lower levels but plateaued beyond \$25,000.

- Adjusted R² of the model: **0.81**

- F-statistic: Highly significant (p < 0.001)

5. Deliverables

- Final R Markdown report included:

  o Coefficient table with interaction interpretation

  o Predicted sales plots for each channel at various budget levels

  o Practical guidance on marginal ROI for each dollar spent per channel

- Delivered a visual dashboard (static HTML) to help the marketing team simulate scenarios

Business Impact:

- The model led to a **reallocation of \$40,000 from paid search to social media**.

- Enabled dynamic budgeting strategy for future campaigns.

- Resulted in a 9% increase in sales over the next quarter by targeting high-ROI channel-budget combinations.

Tools Used:

- **Software:** R (RStudio)

- **Libraries:** ggplot2, dplyr, broom, interactions, car

- **Reporting:** R Markdown with visual output in HTML and PDF formats