# ESTIMATING THE IMPACT OF ADVERTISING SPEND ON RETAIL REVENUE USING SAS REGRESSION

## 1. Overview

**Client:**

A national U.S. retail chain specializing in home furnishings and lifestyle products

**Objective:**

To use multiple linear regression in SAS to measure the influence of multi-channel advertising spend on monthly retail sales. The analysis was intended to support marketing budget decisions and quantify media effectiveness.

## 2. Background

The client allocated a fixed quarterly advertising budget across traditional and digital channels without a data-backed understanding of their individual impacts on revenue. They sought a robust regression model using SAS to disentangle the contribution of each channel and optimize future spending.

## 3. Data Summary

**Time Period:**

January 2019 – December 2022 (48 monthly observations)

**Dataset Fields:**

| Variable | Type | Description |
|---|---|---|
| Monthly_Revenue | Continuous | Total sales revenue (in USD) – dependent variable |
| TV_Spend | Continuous | Monthly TV advertising spend (USD) |
| Digital_Spend | Continuous | Monthly digital advertising spend (USD) |
| Print_Spend | Continuous | Monthly print advertising spend (USD) |
| Promotions_Count | Continuous | Number of concurrent product promotions |
| Holiday_Season | Dummy | 1 if month includes holiday season, else 0 |
| Inflation_Index | Continuous | Index adjusting for inflationary changes |

# 4. Methodology

**Software Used:**

SAS 9.4 (Base + STAT modules)

**SAS Workflow:**

1. **Data Preparation:**
    - PROC IMPORT to read .csv
    - Created dummy variable for Holiday_Season using DATA step
    - Checked for missing and outlier values
2. **Initial Exploration:**
    - PROC CORR to assess correlations
    - PROC UNIVARIATE for distributions
    - Plotted scatterplots and time series overlays
3. **Model Estimation:**
    - PROC REG to estimate multiple linear regression
    - Used VIF to check multicollinearity
    - Model specification:

$$\text{Revenue} = \beta_0 + \beta_1 \cdot \text{TV} + \beta_2 \cdot \text{Digital} + \beta_3 \cdot \text{Print} + \cdots$$

4. **Diagnostics:**
    - Checked residuals for normality and homoscedasticity
    - Cook's Distance to identify influential points
    - AIC/BIC for model comparison

# 5. Key Results

| Predictor | Coefficient (β) | p-value | Interpretation |
|---|---|---|---|
| TV_Spend | 0.84 | 0.001 | \$1K in TV ads → \$840 boost in revenue |
| Digital_Spend | 1.32 | <0.001 | Strongest ROI among all channels |

| | | | |
|---|---|---|---|
| Print_Spend | 0.29 | 0.045 | Modest impact, declining in recent years |
| Promotions_Count | 3.75 | 0.008 | Each additional promo → \$3.75K increase in revenue |
| Holiday_Season | 12.8 | <0.001 | Holiday season boosts revenue by \$12.8K |

**Adjusted $R^2$:** 0.91 **Durbin-Watson:** 2.04 (no autocorrelation) **VIF:** All < 2 (no multicollinearity)

# 6. Visual Outputs (SAS)

- Actual vs. Predicted Revenue Line Chart
- Residual Plot for Homoscedasticity Check
- Contribution Plot per Advertising Channel
- Histogram of standardized residuals

# 7. Deliverables

- .sas program with detailed comments
- Regression report (16 pages) including:
    - Data dictionary and assumptions
    - Model specification and diagnostics
    - Channel-wise impact interpretations
    - Graphs and summary tables
- Executive dashboard slide deck (4 slides):
    - Summary of ROI by channel
    - Recommendations for budget redistribution
    - Forecasting implications for next fiscal year

# 8. Client Outcome & Application

- Marketing team shifted 20% of TV budget to digital based on higher marginal return
- Quarterly review meetings now include SAS-generated regression updates

- Results used in FY24 media planning to set ROI-based channel budgets

## 9. Strategic Value Delivered

- Replaced intuition-driven media planning with **statistical evidence**
- Quantified advertising ROI across channels for **data-backed budget decisions**
- Delivered a **scalable, repeatable analysis** using SAS that integrated into ongoing operations