**Retail Price Optimization and Margin Intelligence System**

## Problem Statement

Retailers frequently set prices without real-time insight into how price changes impact demand, competitor pricing trends, or true profitability after logistics costs. This often leads to:  
  
- Missed revenue opportunities  
- Unnecessary price wars  
- High freight expenses eating into margins

## Goal

Build a data-driven system to:  
  
- Model how price and competitor behavior affect sales volume  
- Predict revenue and profit under different pricing strategies  
- Recommend optimal prices for maximizing revenue or profit, considering competitor prices and freight costs

## Key Business Questions Answered

- How sensitive is customer demand to changes in product price?  
- When should we match, undercut, or ignore competitor pricing?  
- What pricing levels maximize profit—not just sales?  
- Are we losing profit due to high freight costs even with strong sales?  
- Which products are over- or under-performing due to pricing strategy?

## Stakeholder Needs

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| --- | --- |
| Stakeholder | Need |
| Marketing Team | Simulate the impact of price changes |
| Category Managers | Identify SKUs losing market share due to competition |
| Executive Leadership | Understand pricing decisions’ effect on revenue and market position |
| Operations Team | Determine how freight affects profitability and inventory strategy |

## Success Criteria

- Deliver price elasticity scores per product or category  
- Predict revenue/profit under new pricing structures  
- Recommend price points to maximize revenue or margin  
- Present at least 3 data-backed pricing scenarios (e.g. +5% price → -2% sales → +7% profit)

## Python Work Overview

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| --- | --- |
| Task Area | Details |
| Data Preparation | - Imported and cleaned dataset (retail\_price.csv) - Converted date columns to proper formats - Created new features: Revenue, Profit, Price Difference vs Competitor 1–3 |
| Exploratory Analysis | - Visualized:  - Average Profit by Category  - Unit Price vs Profit  - Price Difference Distributions |
| Modeling with XGBoost | - Built regression model to predict demand based on unit price, competitor prices, and category - Tuned hyperparameters for optimal performance |
| Simulation | - Used predicted demand to simulate new pricing scenarios - Visualized actual vs predicted outcomes |

## Tableau Dashboards

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| --- | --- | --- |
| Dashboard | What It Shows | Why It Matters |
| Sales Overview | KPIs, trend lines, category-wise profit | Provides executive summary of business health |
| Price Sensitivity | Unit Price vs Quantity Sold | Helps identify which products are price-sensitive |
| Competitor Impact | Price difference vs sales volume | Understand where we lose or gain against competitor pricing |
| Freight Cost Analysis | Freight % of revenue, Profit vs Freight (Dual-Axis) | Shows where freight is silently reducing profitability |
| What-If Simulator (Optional) | Simulated profit based on price change scenarios | Enables testing pricing strategies interactively |

## Notable Tableau Features & Interactivity

- Dynamic Competitor Selector (parameter-based)  
- Dual-Axis Chart for Profit vs Freight Cost  
- Interactive Filters by Category and Time Period  
- Tooltip Enhancements showing revenue, adjusted price, quantity, and profit  
- Scenario-Ready Views for strategic testing

## Tools & Technologies Used

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| --- | --- |
| Tool / Library | Purpose |
| Python (Pandas, Numpy) | Data preparation and feature engineering |
| XGBoost | Regression model for demand prediction |
| Tableau | Dashboarding and business intelligence |
| Matplotlib, Seaborn | Data visualization during EDA |
| Jupyter Notebook | Experimentation and documentation |
| Excel | Light early-stage slicing of raw data |

## Conclusion

This project successfully delivers an end-to-end solution for intelligent retail price optimization, combining machine learning, competitor benchmarking, and freight cost analysis into a unified strategy. By integrating XGBoost-based demand modeling with interactive Tableau dashboards, the system enables stakeholders to make informed pricing decisions that prioritize both revenue growth and margin protection.

Key outcomes include:

* Clear identification of price-sensitive products and categories
* Quantified impact of competitor price differences on sales performance
* Visibility into freight costs as a driver of hidden margin loss
* Tools for simulating and testing pricing strategies before implementation

Unlike static reporting dashboards, this solution empowers users to explore scenarios, analyze trade-offs, and tailor pricing strategies dynamically. The framework is adaptable across retail sectors and can be scaled further with real-time data or deployment in production environments. Ultimately, the project bridges the gap between data science and business decision-making — translating predictive insights into actionable profitability strategies.