Planning Promotions for Fast-Moving Consumer Goods

Reference: The Impact of Linear Optimization on Promotion Planning
by M.C. Cohen, N.-H.Z. Leung, K. Panchamgam, G. Perakis, and A. Smith.
Published in *Operations Research*, http://dx.doi.org/10.1287/opre.2016.1573

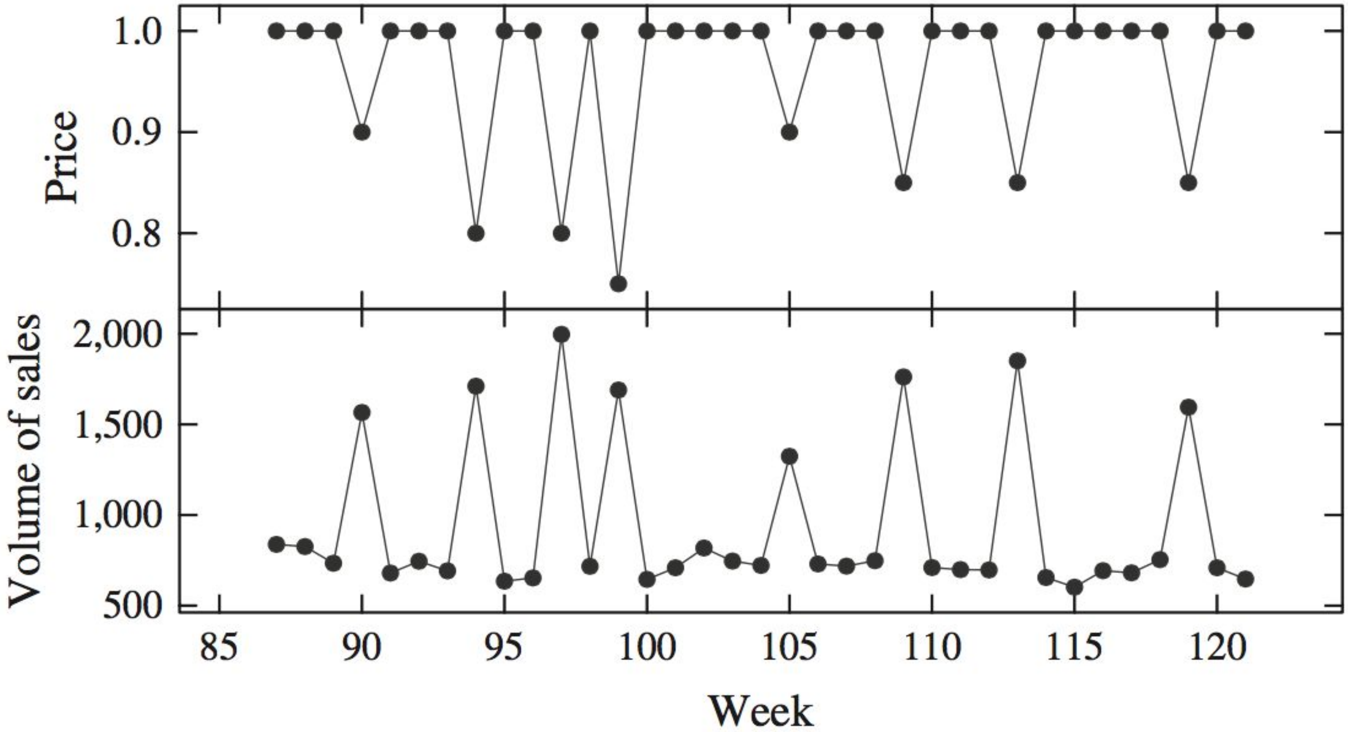
FMCGs and Promotions

- Fast-Moving Consumer Goods: goods that are consumed quickly, such as: canned food, soft drinks, salty snacks, candy, chocolate, coffee, toiletries, laundry detergent, etc.

- It’s estimated that FMCG manufacturers spend about **$1 trillion annually** on promotions (Nielsen 2014)

- Same study also found that 12%-25% of supermarket sales in Great Britain, Spain, Italy, Germany, and France were made on promotion

Figure 1. Prices and sales for a particular brand of coffee at a supermarket over a span of 35 weeks.



First: Predictive Analytics

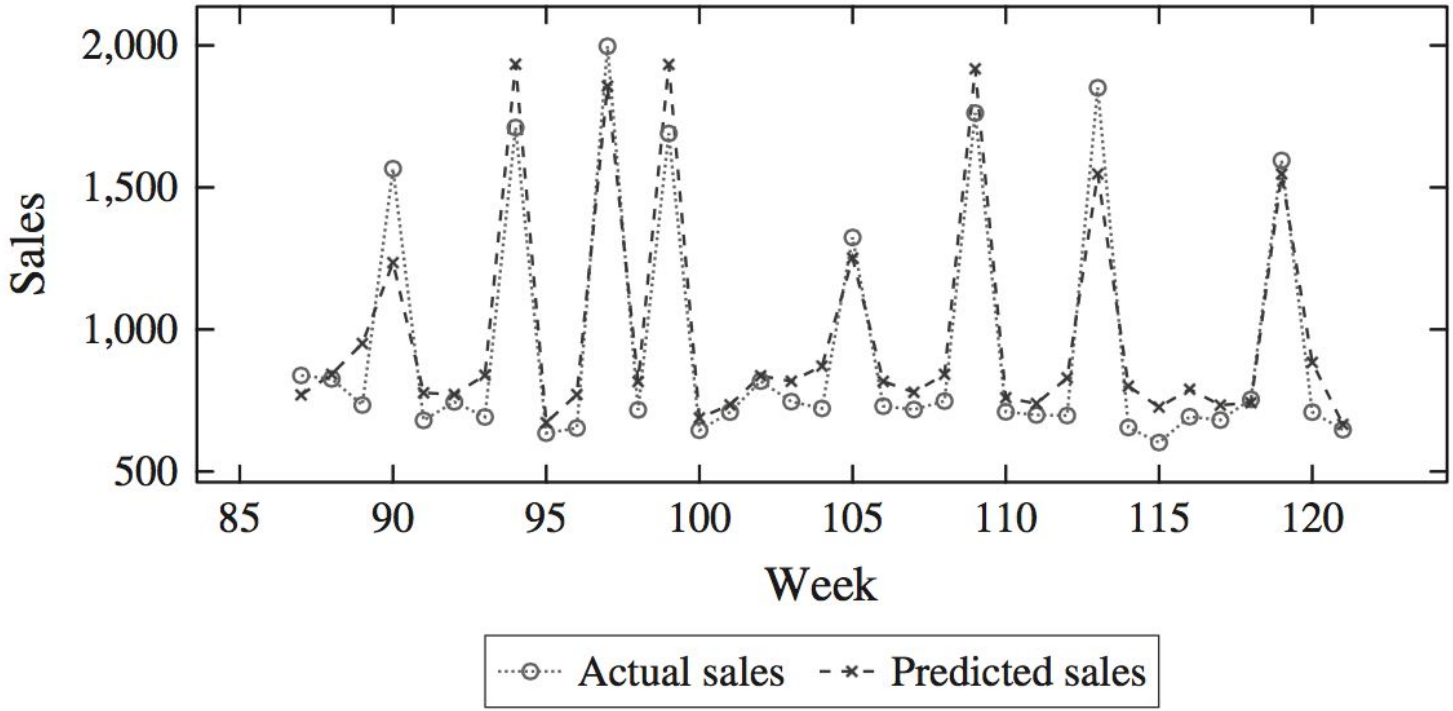
- Look at past data and create a demand model to predict what demand would be, given the prices (promotional or not) chosen for each week

- Non-linear regression: a log-log demand model commonly used in the industry:

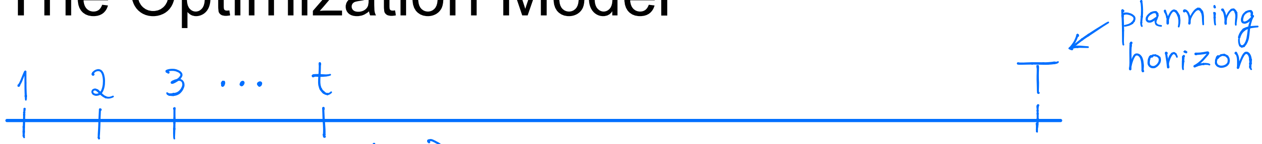
$$\log d_t = \beta^0 + \beta^1 t + \beta^2 \mathrm{WEEK}_t - 3.277 \log p_t + 0.518 \log p_{t-1} + 0.465 \log p_{t-2},$$

- How good is this model in practice?

Figure 4. Actual vs. forecasted sales over the 35 test weeks for Brand1.



The Optimization Model



original price → q_0 y_{0t}

decreasing prices ↓ q_1 y_{1t}, q_2 y_{2t}, ⋮, q_k y_{kt}

Binary variables: "do we pick this price for week t?"

- If $y_{0t} = 1$, no promotion on week t
- All y's for a given week add up to 1
- Price in week t $= p_t = q_0 y_{0t} + q_1 y_{1t} + \dots + q_k y_{kt}$

- At most L promotions allowed: sum of all y's, except $y_{01}, y_{02}, \dots, y_{0T}$, is $\leq L$

- Promotions not too close to each other: on every stretch of S weeks, sum of all y's, except $y_{0\_}$, is ≤ 1

- Maximize $(p_1 - c_1) d_1 + (p_2 - c_2) d_2 + \dots + (p_T - c_T) d_T$

  (p_1: chosen price; c_1: cost; d_1: demand that week (depends on chosen price))

Linearizing Objective to Create Approximation

- For each week, what would be the best price to use (promotional or not) if that was the only week with a promotion?

- This is an approximation because it ignores inter-week price effects

- There are T weeks, each of them with K possible prices, so can test T*K possibilities and pick a price for each week that produces best profit (B_t) if only week t = 1, 2, …, K has a promotion

- Objective becomes: maximize $B_1 y_1 + B_2 y_2 + \ldots + B_T y_T$

Binary: whether or not to promote that week

Figure 5. Profits for different scenarios using a log–log demand.