

Marketing and Customer Analytics

Individual Assignment Product Optimization

Product Optimization Exercise

The problem statement for this homework: You are producing beverage mugs and are trying to identify the best price-feature-vector. Assume the following attributes and attribute levels:

- Price: \$30, \$10, \$5
- Time Insulated: 0.5 hrs, 1 hr, 3 hrs
- Capacity: 12 oz, 20 oz, 32 oz
- Cleanability: Difficult (7 min), Fair (5 min), Easy (2 min)
- Containment: Slosh resistant, Spill resistant, Leak resistant
- Brand: A, B, C

Assume the following as the "proposed market scenario", i.e. the scenario with the current competitors and our proposed candidate.

Incumbents

- 1: \$30, 3 hrs, 20 oz, Clean Easy, Leak Resistant, Brand A
- 2: \$10, 1 hrs, 20 oz, Clean Fair, Spill Resistant, Brand B

Our proposed candidate

- 3: \$ 30, 1 hrs, 20 oz, Clean Easy, Leak Resistant, Brand C

Assume the following cost structure:

- Time Insulated: 0.5 hrs costs \$0.5, 1 hr costs \$1, 3 hrs costs \$3
- Capacity: 12 oz costs \$1.00, 20 oz costs \$2.6, 32 oz costs \$2.8
- Cleanability: Difficult (7 min) costs \$1, Fair (5 min) costs \$2.2, Easy (2 min) costs \$3.0
- Containment: Slosh resistant costs \$0.5, Spill resistant costs \$0.8, Leak resistant costs \$1

You are given data on the preference parameters of 311 consumers in **mugs-preference-parameters-full.xlsx**. The CSV version of this file is also provided as **mugs-preference-parameters-full.csv**.

Questions:

1. Using the compensatory rule with logit adjustment: Compute and report our candidate's share, cost, margin and expected profit per person under the "proposed market scenario" given above. This question is a strict subset of the next question. If you have done the next question successfully, then all you need to do for this question is report the numbers for Product Candidate 45 which corresponds to our proposed candidate in the "proposed market scenario" given above. Even though this question is a strict subset of the next question, we are asking for it separately. This is because not all students may be able to do the next question successfully as it is a larger and more general computation. Hint to check your answer: The number you should get for expected profit per person is between 4 and 4.5.

2. Discrete Optimization: Consider each of the three levels for each of the five attributes and enumerate all the possibilities in lexical order with Price as the leftmost attribute changing slowest and taking levels sequentially \$30, \$10, \$5, then Time Insulated as the left-second-most attribute changing second-slowest and taking values sequentially 0.5 hrs, 1 hr, 3 hrs and so on. You will have 243 product candidates. (The lexical order produces indices as shown in **mugs-products-lexical-order.csv**. Please make sure you list your products in that exact same order. The lexical order of products is obtained by looping as shown in **mugs-products-lexical-order-loop.R**, which has close similarity in python. Again, using the compensatory rule, compute and report the following four columns of numbers for each candidate: the share, the cost, the margin and the expected profit per person (all under the current competition incumbents). The table that you submit needs to have all 243 rows. Hint to check your answer: product candidate 230 has a negative expected profit per customer of between -1.75 and -1.85, and product candidate 106 has an expected profit per customer of between 0.7 and 0.8.
3. Using the 243-row table you produced in the previous step: Identify the product with the highest expected profit per person. For this optimal product, list the values of the five attributes and its share, cost, margin and expected profit per person.
4. According to the pure algorithmic analytical approach, the best product is the one with the highest expected profit per person (abbreviated here as "EPPP"). However, depending on the objectives of the company, your product manager boss may not agree that this is the best product. He/she may argue you need to consider, as primary criterion, one or more of the remaining three metrics: Share or Cost or Margin or Revenue.
 1. What would be the business rationale to launch the product with the highest market share (instead of the product with the highest EPPP)? Respond in 1-5 sentences. In the 243-row table, identify the product with the highest market share and give the values of the five attributes. To answer this question, it may help to plot the 243 products on EPPP versus share like is shown on Product-Price Optimization Slide 19.
 2. What would be the business rationale to launch the product with the highest margin (instead of the product with the highest EPPP)? Respond in 1-5 sentences. In the 243-row table, identify the product(s) with the highest margin and give the values of the five attributes.
 3. What would be the business rationale to launch the product with the lowest cost (instead of the product with the highest EPPP)? Respond in 1-5 sentences. In the 243-row table, identify the product(s) with the lowest cost and give the values of the five attributes.
 4. What would be the business rationale to launch the product with the highest revenue per person in the market (instead of the product with the highest EPPP)? Respond in 1-5 sentences. In the 243-row table, identify the product(s) with the highest revenue per person in the market and give the values of the five attributes. Note that revenue per person in the market can be computed as share times price.

The above questions involve compensatory analysis with logit adjustment, for which you should use a scaling constant value of $c = 0.0139$.

What and Where to Submit

For Q1 through Q4, submit the following via LMS

1. A PDF report containing your responses to all the questions. Please note that this file should be PDF only, not a Word document for example. Responses should include only the values or explanations asked in the above questions. Do not copy the questions in the report.
2. Your R or python code in the zip file form specified above (.ipynb, .rmd or .html)
3. A listing of the 243 products for Q3.

Hints and explanatory notes for Q1 and Q2

Q1 and Q2 involve following steps analogous to the steps we followed in class in Product-Price Optimization slides 2 through 18. The excel files for the in-class exercise are **mugs-preference-parameters-limited.xlsx** and **mugs-analysis-limited.xlsx**. The first file gives the starting point with the preference data, the second file gives the ending point after the analysis has been completed.

Obviously, to do this HW, one first needs a thorough understanding of the file "mugs-analysis-limited.xlsx" and how it is executing the calculations described on slides 2 through 17. This is something that each student will need to do on his/her own and this will require fair competence in Excel. Here are some comments that may help you understand the structure of the "mugs-analysis-limited.xlsx" spreadsheet. Remember that to calculate the profit of a candidate product we need four critical inputs: (1) A description of the candidate product and the incumbent products, (2) the preference parameters, (3) the cost structure, and the dollar values for each price level, and (4) the "c" value for the logit probability formula. These four inputs appear in pale green color in cell blocks B2:D5, A20:Q30, P2:P10 and M1 respectively. These are the only inputs to the model. Every other cell in the spreadsheet is a computation that depends on these four cell blocks. Let us walk through these cell blocks now:

1. Cell block B2:D5. This gives the level number for each of the four attributes for each of the three products. The level number indicates which level a certain attribute takes. The levels are given on Slide 3. The level number for each level is just the numerical position that level appears in on Slide 3. Therefore, for Price, level=1 means \$30, level=2 means \$10, level=3 means \$5. By similar logic, for Capacity, level=1 means 12oz, level=2 means 20oz, level=3 means 32oz. The similar logic applies for Cleanability and Brand as well. Consider the numbers in cells B2:B5 for Prod1. For Product 1, we see from Slide 3 price=\$30, this corresponds to level 1, and so we enter 1 in cell B2. Continuing with Product 1, it has Capacity=20 oz, Cleanability=Easy and Brand=A, which correspond to level numbers 2, 3 and 1 respectively and these are the numbers we enter into cells B3, B4 and B5 respectively. Similarly, we enter the level numbers for the attributes for the other two products.
2. Cell block A20:Q30. This just gives the importances for the various attributes and the preference measures for each attribute level for each attribute. These are the raw data given to us.
3. Cell block P2:P10. In cells P2:P4 we enter the dollar value each price level number corresponds to. In cells P5:P10, we enter the cost contribution for each attribute level

in every attribute other than price or brand (neither of these two contribute directly to manufacturing cost).

4. Cell block M1. Here we enter the "c" value, which we computed on Slide 14.

Given the above four sets of inputs, the spreadsheet does the following computations in sequence, closely following the steps in the lecture slides.

- A. Compute the product of importance and preference level for each attribute level. These are done in cells S20:AD30.
- B. The utility for each product is just the sum of quantities compute in (A) above, except that we just pick the factor that applies to the particular attribute level that a certain product has. This is accomplished by doing a matrix multiplication, where we multiply the matrix obtained in step (A) above by the dummy variable matrix describing the level taken by each attribute for each product. The dummy variable matrix is given in cell block H2:J13. Note that this dummy variable matrix is created by use of a simple IF function based on the attribute levels given in input (1) of the four inputs. Using the matrix multiplication, we utilities appear in AF21:AH30.
- C. Given the utilities, we multiply by "c" and exponentiate. This is done in cells AI21:AK30.
- D. We compute the sum of the above exponentials, and this is done in cells AO21:AO30.
- E. We use the sum to divide each exponential and get the purchase probability. This is done in cells AP21:AR30
- F. We average these choice probabilities to give the market share estimates for each product and this is in cells AP19:AR19
- G. Now we have to compute the margin of the candidate product. For this we need to pull the price from the candidate product description, and this is done in cell R3. Then we compute the cost, which is done by looking at the candidate product description and adding the component costs, which is in cell T3. The margin is in cell V3.
- H. The final number we need is Expected Profit per person, which is margin times share and computed in cell X3.

Once you understand this sequence of steps, it should be moderately easy to write R code or python code to execute the tasks required for Q1 and Q2.