EBGN 645 – Homework 1

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Course: Computational Economics
Assignment: Homework 1 – Linear Programming in GAMS
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Part A: Benny's Bakery Optimization

Q1a: Model Setup

Indices:

- Products: rolls, croissants, bread

Parameters:

- Revenue ($/item):
  - Roll: 2.251
  - Croissant: 1.51
  - Bread: 2.25
- Cost ($/item):
  - Roll: 1.51
  - Croissant: 5.51
  - Bread: 10.5
- Time (hours/item):
  - Roll: 0.75
  - Croissant: 2
  - Bread: 5
- Available time: 40 hours/week

Variables:

- x(p): Quantity of product p to produce
- profit: Total weekly profit

Objective Function: Maximize profit = ∑ [revenue(p) − cost(p)] × x(p)

Constraints:

- Time constraint: ∑ time(p) × x(p) ≤ 40
- Non-negativity: x(p) ≥ 0

Q1b: Counterfactual Constraint

These days, Benny orders at least two rolls for every croissant. Mathematically:

$x(\text{roll}) \geq 2 \times x(\text{croissant})$

This limitation was incorporated by a switch (--combo=1) in GAMS.

Q1c: GAMS Results

Scenario	Total Profit ($)
Reference (--combo=0)	62.22
Counterfactual (--combo=1)	45.33

Summary: Benny lost $16.89(62.22-45.33) of profit because of the counterfactual constraint. This demonstrates how binding demand for certain utensils can compress production flexibility and earnings.

Part B: June's Jellybean Factory

Q2a: Model Setup

Indices:

- Colors: yellow, blue, green, orange, purple
- Machines: X1, X2

Parameters:

- Net Revenue ($/bean):
    - Yellow: 1.10
    - Blue: 1.051
    - Green: 1.071
    - Orange: 0.951
    - Purple: 0.99
- Machine capacity: 40 hours × 100 beans/hour = 4000 beans/week per machine

Variables:

- Q(m,i): Quantity of color i produced by machine m
- profit: Total weekly profit

Objective Function: Maximize profit = $\sum Q(m,i) \times r(i)$

Constraints:

- $\sum Q(m,i) \leq 4000$ for each machine
- $Q(m,i) \geq 0$

Q2b: Reference Scenario Results

- **Total Profit:** $8560.00

Summary: June demands that she earn the most money possible for machine time spent on jellybeans with high revenue. Since there are no restrictions on colour balance and machine-based production operations, both machines can work flexibly.

Q2c: Equal Production Constraint (6%)

June has to make jellybeans of just about the same number for all colors, even, with an allowance of 6% differences.

Constraint: For all pairs (i, j):

- $Q\_total(i) \leq 1.06 \times Q\_total(j)$
- $Q\_total(i) \geq 0.94 \times Q\_total(j)$

Total Profit: $7962.72

Summary: Equality in production decreased profit by $597.28 (~7%). High-margin beans were cut to that level, leading to a more balanced, though less profitable product.

Q2d: Machine-Specific Production Limits

- **Machine X1:** yellow, blue, green
- **Machine X2:** yellow, orange, purple. Implemented using a conditional set in GAMS.

Total Profit: $7962.72

Summary: The machine-specific constraint did not further reduce profit compared to Q2d. This tells us that the equal production constraint already limited the model enough that machine restrictions didn’t impact the optimal solution.