Food Cost Minimize

Danielle Baker, Leslie Zhang, Nout Neijmeijer, Xun Chi

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Introduction

Basically, we want to

study various effects on the **costs of diets**.

We plan to research

1. the effects of penalizing for eating too few types of food,
2. import costs,
3. seasonal differences and
4. altering diets depending on nutritional needs and goals of an individual.

Basic Model

Let n be the number of foods and m be the number of considered types of nutrition, then:
c_j is the cost of food j where $j \in [1, n]$
x_j is the amount of food j needed per meal where $j \in [1, n]$
a_{ij} the amount of nutrition i of food j where $i \in [0, m], \quad j \in [1, n]$
b_i is the minimum value of nutrition i where $i \in [0, m]$
(i.e $b_1 =$ protein[g], $b_2 =$ carbohydrates[g], $b_3 =$ fat[g], $b_4 =$ calories[g])

$$Objective: \quad minimize\ c_1x_1 + c_2x_2 + ... + c_nx_n$$

$$s.t. \qquad b_i < \sum_{i=1,j=1}^{m,n} a_{ij}x_j$$

Quadratic

Let δ_j be the weight of the quadratic penalty assigned to food j where $j \in [0, m]$
$D \in \mathbb{R}^{j^2}$ is the matrix that contains all the weights δ_j along its diagonal axis. All other entries are 0. Then:

$$minimize \sum_{j}^{n} c_j x_j + \frac{1}{2} x^T D x$$

Quadratic — Example

$$\begin{bmatrix} c_1 & c_2 & c_3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \frac{1}{2} \begin{bmatrix} x_1 & x_2 & x_3 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

$$c_1 x_1 + c_2 x_2 + c_3 x_3 + \frac{1}{2}(x_1^2 + x_2^2 + x_3^2)$$

Quadratic — Example

$$\begin{bmatrix} c_1 & c_2 & c_3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \frac{1}{2} \begin{bmatrix} x_1 & x_2 & x_3 \end{bmatrix} \begin{bmatrix} 100 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

$$c_1 x_1 + c_2 x_2 + c_3 x_3 + \frac{1}{2}(100 x_1^2 + x_2^2 + x_3^2)$$

Import Tax

x_1 to x_a are imports.
α is the amount that the new tax rate.

$$\textit{minimize}\ \alpha \sum_{j=1}^{a} c_j x_j + \sum_{j=i}^{n} c_j x_j$$

Individual Needs

γ_i is an extra minimum value of an individuals special needs for nutrition i where $i \in [0, m]$ to increase his or her muscle or want to lose weight.
ϵ_i is the weight for nutrition i where $i \in [0, m]$ of an individual.

$$Objective: \quad minimize\ c_1x_1 + c_2x_2 + ... + c_nx_n$$

$$s.t. \qquad \gamma + \epsilon b < \sum_{i=1,j=1}^{m,n} a_{ij}x_j$$

Seasonal Effect

c_i is the average costs of product i where $i \in [0, n]$
$\beta_i sin(t)$ is the seasonal influence at time t. Note that to answer the question and run the program the total costs in the objective function have to be evaluated before running the program. By running the program with for multiple values of $t \in [0, 2\pi]$ the seasonal influences can be assessed.

$$Objective: \quad minimize\ (c_1 + \beta_1 sin(t))x_1 + (c_2 + \beta_2 sin(t))x_2 + ...$$

$$+(c_n + \beta_n sin(t))x_n$$

$$s.t. \qquad b < \sum_{i=1,j=1}^{m,n} a_{ij} x_j$$

Further Research

1. Quadratic Penalty among pair of foods $x^T * D * x$ and implementation

2. Making a regression function simulating real data of seasonal effects on produce

Quadratic — Example

$$\begin{bmatrix} c_1 & c_2 & c_3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \frac{1}{2} \begin{bmatrix} x_1 & x_2 & x_3 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

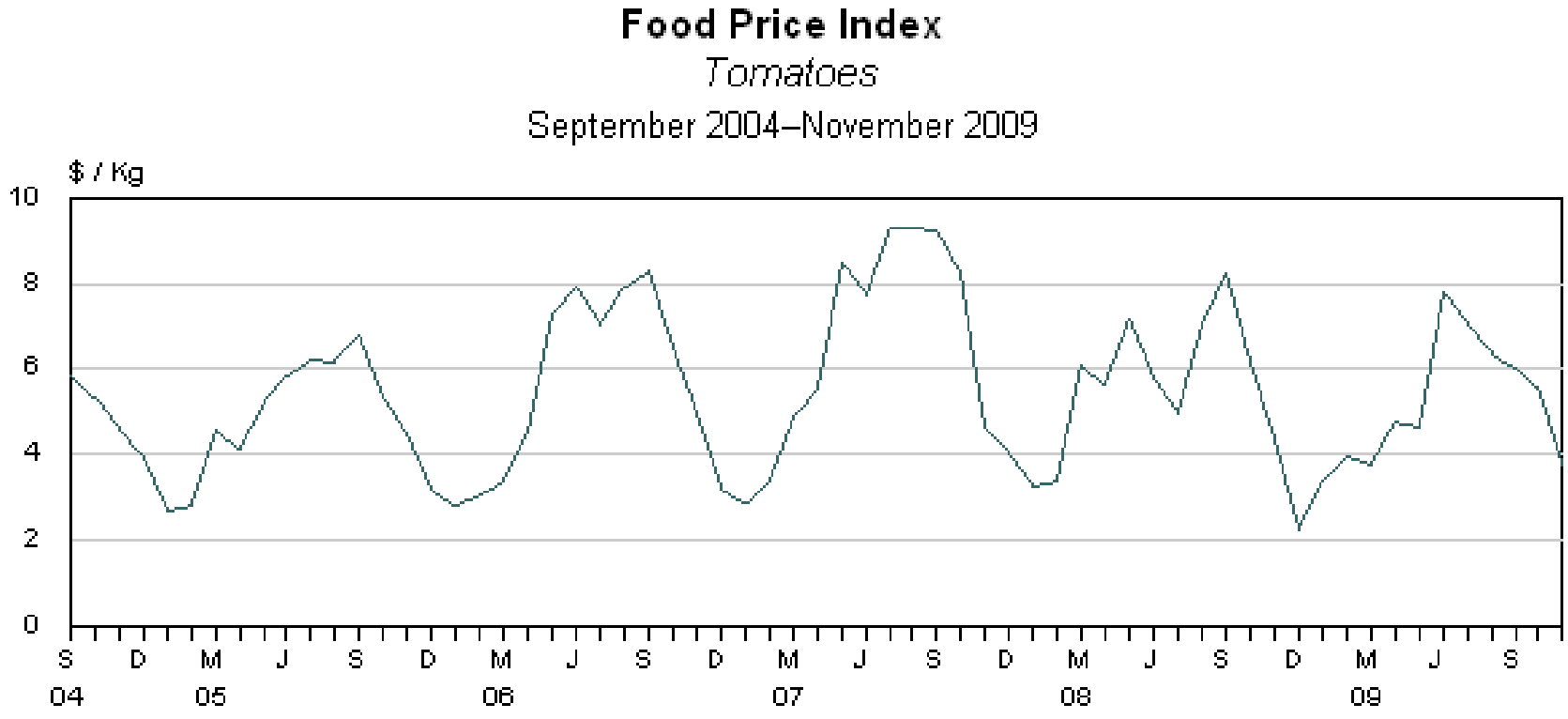
$$c_1 x_1 + c_2 x_2 + c_3 x_3 + \frac{1}{2}(x_1^2 + x_2^2 + x_3^2)$$

Quadratic — Example

$$\begin{bmatrix} c_1 & c_2 & c_3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \frac{1}{2} \begin{bmatrix} x_1 & x_2 & x_3 \end{bmatrix} \begin{bmatrix} 1 & 100 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

$$c_1 x_1 + c_2 x_2 + c_3 x_3 + \frac{1}{2}(x_1^2 + x_2^2 + x_3^2 + 100 x_1 x_2)$$

Seasonal Regression



Interesting Findings

Interesting Numbers from Import Tax

$10
$2
65,012
16253
$32,506
28,174

Interesting Findings from Individual Needs

Increase in protein increases cost
Decrease in calories decreases cost