1 Introduction and Examples

1.1 Value of the stochastic Solution

cf. 1_1.jl

1.2 Price effect

cf. 1_1.jl

1.3 Binary first stage

Set

- F: fields, index i
- P: products, index j

Parameter

- $field_i$: size of field i
- $plant_j$: unit price of planting product j
- buy_j: unit price of buying product j
- $sell_j$: unit price of selling product j
- $cattle_j$: amount of product j to keep for the cattle
- $yield_j$: yield of product j for an unit of a field
- $capBeet$: max quantity of beet to be sold at a favorable price

Decision

- y_j= "amount of product j bought", $\forall j = 1...|P| - 1$
  sugar beets can't be bought on the market
- w_j= "amount of product j sold", $\forall j = 1...|P| + 1$
  the last one being the sugar beets sold at a lower price
- $x_{ij} = \begin{cases} 1 & \text{"if field } i \text{ is planted with product } j\text{"} \\ 0 & \text{else} \end{cases}$ $, \forall i = 1...|F|,\ \forall j = 1...|P|$

Mathematical model

$$\min \sum_{j=1}^{|P|} \sum_{i=1}^{|F|} plant_j \cdot field_i \cdot x_{ij} + \mathcal{Q}(x) \tag{1}$$

where x = $(x_{ij})_{i=1...|F|,j=1...|P|}$
s.t.:

$$\sum_{j=1}^{|P|} x_{ij} \leq 1 \qquad \forall i = 1...|F| \tag{2}$$

$$x_{ij} \in \{0,1\} \qquad \forall i = 1...|F|, \forall j = 1...|P| \tag{3}$$

with the recourse function $\mathcal{Q}$ defined as:

$$\mathcal{Q} = \sum_{j=1}^{|P|-1} buy_j \cdot y_j - \sum_{j=1}^{|P|+1} sell_j \cdot w_j \tag{4}$$

s.t.

$$y_j - w_j \geq cattle_j - yield_j \cdot (\sum_{i=1}^{|F|} field_i \cdot x_{ij}) \qquad \forall j = 1...|P| - 1 \tag{5}$$

$$-w_j - w_{j+1} \geq cattle_j - yield_j \cdot (\sum_{i=1}^{|F|} field_i \cdot x_{ij}) \qquad j = |P| \tag{6}$$

$$w_j \leq capBeet \qquad j = |P| \tag{7}$$

$$w_j \geq 0 \qquad \forall j = 1...|P| + 1 \tag{8}$$

$$y_j \geq 0 \qquad \forall j = 1...|P| - 1 \tag{9}$$

1.4 Integer second stage

Parameter

- *order*: order of magnitude of a contract, numerically here *order*=100
- $field$: total size of the field

Decision x_j= "amount of field used to produce product j", $\forall j = 1...|P|$

Model

$$\min \sum_{j=1}^{|P|} plant_j \cdot x_j + \mathcal{Q}(x) \tag{1}$$

where x = $(x_j)_{j=1...|P|}$
s.t.:

$$\sum_{j=1}^{|P|} x_j \leq field \tag{2}$$

$$x_j \geq 0 \qquad \forall j = 1...|P| \tag{3}$$

with the recourse function $\mathcal{Q}$ defined as:

$$\mathcal{Q} = \sum_{j=1}^{|P|-1} buy_j \cdot y_j - \sum_{j=1}^{|P|+1} sell_j \cdot w_j \tag{4}$$

s.t.

$$order \cdot (y_j - w_j) \geq cattle_j - yield_j \cdot x_j \qquad \forall j = 1...|P| - 1 \tag{5}$$

$$-order \cdot (w_j + w_{j+1}) \geq cattle_j - yield_j \cdot x_j \qquad j = |P| \tag{6}$$

$$order \cdot w_j \leq capBeet \qquad j = |P| \tag{7}$$

$$w_j \in \mathbb{N} \qquad \forall j = 1...|P| + 1 \tag{8}$$

$$y_j \in \mathbb{N} \qquad \forall j = 1...|P| - 1 \tag{9}$$

1.5 Computation

cf. 1_1.jl