Workshop 8

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Overview of the problem and assumptions

- Coffee is chosen as the commodity of interest
    - Higher volatility compared to other commodities
- They hold inventories of coffee which they increase or sell depending on market prices. Market prices can have four states
    - low(price below \$2.0875/kg)
    - normal(price between \$2.0875/kg - \$2.8883/kg)
    - high(price between \$2.8883/kg - \$3.37/kg)
    - very high(price above \$3.37/kg)
- The maximum level of inventory is 1000 MT and the firm buys and sells inventory in discrete batches of 100 MT.
- Due to capacity restrictions, at any given month, the speculator can sell or buy at the most 200 MT
- The holding costs are about 2% year -> 0.167% month
- Assume a discount factor of 0.995/month

Estimate transition probabilities

- Divide the market price of coffee into 4 price ranges and label them as:

  low, normal, high, very_high
- Calculate Transition Probabilities estimation using following formula

$$\hat{p}_{ij} = \frac{n_{ij}}{\sum_{j=1}^{m} n_{ij}}$$

- Transition Probabilities for states:

	[,1]	[,2]	[,3]	[,4]
[1,]	0.95614035	0.04385965	0.0000000	0.0000000
[2,]	0.04424779	0.84955752	0.1061947	0.0000000
[3,]	0.00000000	0.11403509	0.7807018	0.1052632
[4,]	0.00000000	0.00000000	0.1052632	0.8947368

Solve the model and interpret your results

	low	normal	high	very_high
s0	2804.467	2428.320	2368.209	2260.047
s1	2977.947	2688.660	2684.883	2688.047
s2	3151.426	2949.000	3001.557	3116.047
s3	3322.013	3209.021	3315.664	3530.106
s4	3492.601	3469.042	3629.771	3944.165
s5	3660.148	3729.042	3942.283	4345.541
s6	3827.695	3989.042	4254.794	4746.918
s7	3992.047	4249.042	4566.794	5136.833
s8	4156.399	4509.042	4878.794	5526.749
s9	4317.399	4768.869	5190.794	5906.404
s10	4478.399	5028.696	5502.794	6286.060

At state inventory = 0, and market is low, present value of the profit in state is $2804.467

What are your recommendations?

- When the price is at low, normal and high state, keep holding the inventory till very high state then start to sell.
- This strategy works here because the holding cost is relatively low for the company to hold the inventory

When the discount factor change to 0.98/month

	s0	s1	s2	s3	s4
s0 .low			1.000		
s0 .normal	1.000				
s0 .high	1.000				
s0 .very_high	1.000				
s1 .low				1.000	
s1 .normal	1.000				
s1 .high	1.000				
s1 .very_high	1.000				
s2 .low					1.000
s2 .normal	1.000				
s2 .high	1.000				

At state inventory = 0, when market is low , buy 2 units; When market is normal ,high or very high, do nothing

When there is no limit to sell/buy amount

	s0	s10
s0 .low		1.000
s0 .normal	1.000	
s0 .high		1.000
s0 .very_high	1.000	
s1 .low		1.000
s1 .normal	1.000	
s1 .high		1.000
s1 .very_high	1.000	
s2 .low		1.000
s2 .normal	1.000	
s2 .high		1.000
s2 .very_high	1.000	
s3 .low		1.000
s3 .normal	1.000	
s3 .high		1.000
s3 .very_high	1.000	
s4 .low		1.000
s4 .normal	1.000	
s4 .high		1.000
s4 .very_high	1.000	

When market is low or high, buy maximum

When market is normal or very high, sell maximum

When the holding cost change to 0.02/month

	s0	s1	s2	s3	s4
s0 .low			1.000		
s0 .normal	1.000				
s0 .high			1.000		
s0 .very_high	1.000				
s1 .low				1.000	
s1 .normal	1.000				
s1 .high				1.000	
s1 .very_high	1.000				
s2 .low					1.000
s2 .normal	1.000				
s2 .high					1.000
s2 .very_high	1.000				

The holding cost changes. When the market is normal,
For the old holding cost the optimal policy is to buy 2 units
For the new holding cost the optimal policy is to do nothing

Appendix – R code to calculate transition matrix

```r
main <- read.csv('data.csv')
x <- c(main$stage)

p <- matrix(nrow = 4, ncol = 4, 0)
for (t in 1:(length(x) - 1)) p[x[t], x[t + 1]] <- p[x[t], x[t + 1]] + 1
for (i in 1:4) p[i, ] <- p[i, ] / sum(p[i, ])
p
```

```
           [,1]       [,2]      [,3]      [,4]
[1,] 0.95614035 0.04385965 0.0000000 0.0000000
[2,] 0.04424779 0.84955752 0.1061947 0.0000000
[3,] 0.00000000 0.11403509 0.7807018 0.1052632
[4,] 0.00000000 0.00000000 0.1052632 0.8947368
```