INTRODUCTION TO ENTERPRISE ANALYTICS

ALY6050, WINTER 2020

MODULE 6 PROJECT ASSIGNMENT

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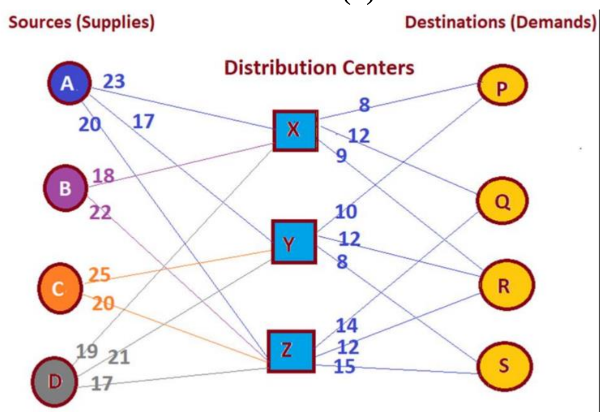
Introduction

The assignment provides practical knowledge in implementing the non-linear programming techniques in order to perform optimization of shipments, cost associated with them and their respective distributions. We have performed time series of the quarterly data of Honeywell using Hodrick-Prescott optimization by following the applications of Quadratic Programming.

Analysis

Part I

- The transshipment scenario describes a logistic company where there are four supplies from sources namely A, B, C, D to their destinations P, Q, R, S providing the required demands. The network involves intermediate destinations X, Y and Z, each having a carrying capacity of 50,000 units that can be loaded and unloaded. (1)



It can be seen from the diagram that, the logistic company has 4 sources that are sending their supplies to 4 destinations to complete their required demands through the three Distribution centers. Each of the transmission route denotes the cost of shipping involved.

Fig.1: Transshipment Model

- We have considered two indices, that indicates the number of units to be transported from "i" to "j". We have formulated the objective function as :
  Minimize : Z = Σ CijXij , i=A, B, C,D X, Y, Z; j=X,Y,Z,P,Q,R,S, which is used to minimize the cost associated with the transportation of units from source to destination and provide the optimal cost by using the non-linear optimization techniques. (2)
  Here, C and X are variables that represent the cost of transportation.

Sources Constraints (Supplies):
Source A: $X_{AX} + X_{AY} + X_{AZ} \leq 35500$
Source B: $X_{BX} + X_{BY} + X_{BZ} \leq 42200$
Source C: $X_{CX} + X_{CY} + X_{CZ} \leq 19000$
Source D: $X_{DX} + X_{DY} + X_{DZ} \leq 25500$
Destination Constraints (Demands):
Destination P: $X_{XP} + X_{YP} + X_{ZP} \geq 23500$
Destination Q: $X_{XQ} + X_{YQ} + X_{ZQ} \geq 36000$
Destination R: $X_{XR} + X_{YR} + X_{ZR} \geq 40700$
Destination S: $X_{XS} + X_{YS} + X_{ZS} \geq 19800$
Node Constraints (Conservation of Flow):
Node X: $X_{AX} + X_{BX} + X_{CX} + X_{DX} = X_{XP} + X_{XQ} + X_{XR} + X_{XS}$
Node Y: $X_{AY} + X_{BY} + X_{CY} + X_{DY} = X_{YP} + X_{YQ} + X_{YR} + X_{YS}$
Node Z: $X_{AZ} + X_{BZ} + X_{CZ} + X_{DZ} = X_{ZP} + X_{ZQ} + X_{ZR} + X_{ZS}$
Nonnegativity: $X_{ij} \geq 0$

Fig.2: Constraints

We have used constraints as Supplies: Units that can be shipped out of source A, B, C and D cannot be more than 35500, 42200, 19000 and 25500.
Demands: Units that can be shipped to destinations P,Q,R and S should have atleast 23500, 36000, 40700 and 19800 as values.
Node: The shipping from the source is equal to delivering at the destinations.
Nonnegativity: Xij $\geq$ 0

COSTS	X	Y	Z	P	Q	R	S
A	23	17	20	1000	1000	1000	1000
B	18	1000	22	1000	1000	1000	1000
C	1000	25	20	1000	1000	1000	1000
D	19	21	17	1000	1000	1000	1000
X	1000	1000	1000	8	12	9	1000
Y	1000	1000	1000	10	1000	12	8
Z	1000	1000	1000	1000	14	12	15

The table shows the costs involved in transporting the units from source to the intermediary units X, Y and Z and from these units to their destinations .

Fig.3: Table displaying Cost per unit for transportation

	X	Y	Z	P	Q	R	S	Shipped from:		Supply:
A	0	35500	0	0	0	0	0	35500	≤	35500
B	42200	0	0	0	0	0	0	42200	≤	42200
C	0	0	19000	0	0	0	0	19000	≤	19000
D	0	0	25500	0	0	0	0	25500	≤	25500
X	0	0	0	0	9300	40700	0	50000		Total Supply:
Y	4500	0	0	23500	0	0	22000	50000		77700
Z	3300	14500	5500	0	26700	0	0	50000		
	50000	50000	50000	23500	36000	40700	22000			
	≥	≥	≥	≥	≥	≥	≥			
Shipped to:	50000	50000	50000	23500	36000	40700	19800	Total Demand: 120000		

We have used the Excel Solver to find the optimal cost involved In transportation of units from source to destination by using the given values, constraints (inequalities), total supply and total demand. The intermediary departments X,Y and Z can handle 50,000 units.

Fig.4: Excel Solver for cost optimization

- The Total Cost after performing the optimization amounts to 31239300, which means that the logistic company can optimize its transportation operations for efficient transportation of units from source to destination and improve productivity.(2)

<u>Part II</u>

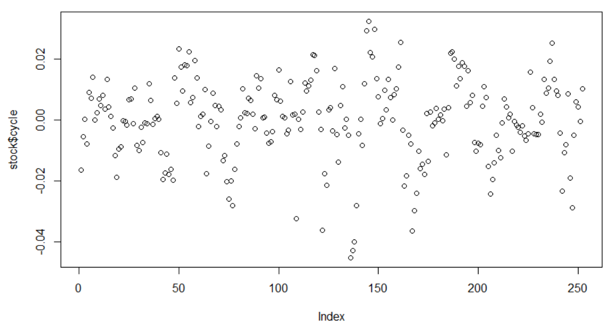
- We have used the Hodrick-Prescott filter for performing time series analysis on the Quarterly data of Honeywell dataset. The filter is used for performing data smoothening during data analysis in order to eliminate fluctuations in the data which result in long term efficient results. The Hodrick-Prescott filter is widely used in macroeconomics and is named after economists Robert Hodrick and Edward Prescott in the 1990s. This filter has been used in performing smoothening of the Conference Board's Help Wanted Index for it to be benchmarked in opposition to the Bureau of Labour Statistic's which is a data series that measures job openings in US.(3)
- This filter decomposes the time series into cyclic and trend components.
  Considering X_t as the logarithm of time series
  The filter performs the following decomposition, $X_t = C_t + T_t$, where
  C_t: Cyclic Component and T_t: Trend Component
  This helps in minimizing the quadratic equation as:

$$Z = \sum_{t=1}^{N} {C_t}^2 + \omega \sum_{t=2}^{N-1} (T_{t+1} - 2\,T_t + T_{t-1})^2$$

Where, ω is the smoothening parameter, the programming involves minimizing the objective over all T_1 to T_t

The concept of this programming is that the first sum minimizes the difference amongst data and its cyclical component and the second part minimizes the second derivative of the cyclical component.

- The advantages of Hodrick-Prescott decomposition is that it helps in solving the optimization problem by building the trend component. Also, it helps in calculating the smoothest trend component by minimizing the squared distances and tries to tend towards the original data. However, the method has some disadvantages that the analysis performed by using this technique is completely static and in a closed domain, noise in data shows normally distributed. Moreover, in case any shift rates occur in the data, the method will show trends that may not exist in the data.(3)
- We have used the R Studio in order to perform time series analysis for the quarterly period.



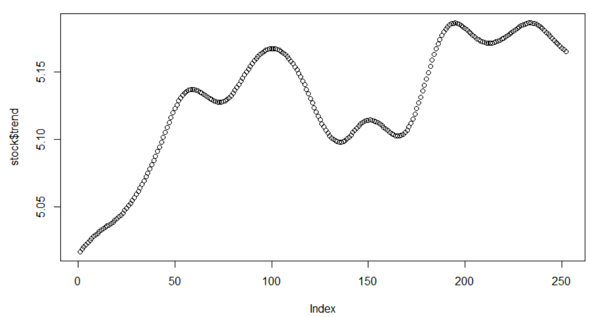
We have used the following R function to interpret the Cyclic and Trend components in Honeywell data.

```
plot(stock$cycle)
plot(stock$trend)
```

The graph shows the cyclic component in stocks of Honeywell, as they follow a repetition in stocks with increase in index.

Fig.5: Cyclic Component of Honeywell Data

The HP Filter has performed smoothening on the cyclic components in order to eliminate the unnecessary fluctuations in data.



The graph shows the Trend component of the Honeywell data.
We can see that there is a pattern followed by the data over increase in time. It shows the increase and decrease in data over the same direction of time.

Fig.6: Trend Component of Honeywell Data

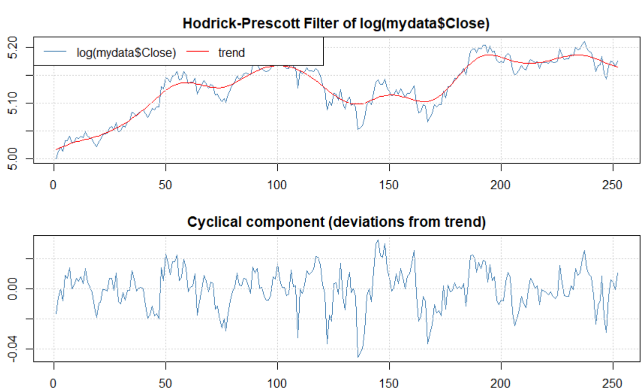


Fig. 7: Cyclical and Trend Components in Data

Observations: The graph shows the logarithmic trend over a period of time. The cyclical component of data shows some deviations form the trend, expansions and contractions in data over time. We have used the HP filter to minimize the fluctuations in data and perform smoothening. The filter shows inclination towards the original which helps in predicting the optimal results.

Conclusion

1. We have used the Honeywell data in order to analyse the stocks of the company over a given period of time using Hodrick-Prescott optimization.
2. The method was utilized to perform decompositions in logarithms of the trend and cyclic components of data.
3. After performing the decomposition, the trend component shows the pattern in data, by representing the increase and decrease in same direction of data over a period of time.
4. The cyclic component shows the periodic fluctuations about the trend and displaying expansion and contraction in the succession of phases of data after elimination of the noise.
5. The optimal cost required to transmit units from source to destination was calculated to be 31239300 using the excel solver.

Reference

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