FML_Assignment 4

Manaswini

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```
setwd("C:/Users/mpuru/OneDrive/Documents/R/Assignment4_fml")
Pharmaceuticals <- read.csv("~/R/Assignment4_fml/Pharmaceuticals.csv")
View(Pharmaceuticals)
head(Pharmaceuticals)
```

```
##   Symbol                Name Market_Cap Beta PE_Ratio  ROE  ROA
Asset_Turnover
## 1    ABT Abbott Laboratories      68.44 0.32     24.7 26.4 11.8
0.7
## 2    AGN      Allergan, Inc.       7.58 0.41     82.5 12.9  5.5
0.9
## 3    AHM        Amersham plc       6.30 0.46     20.7 14.9  7.8
0.9
## 4    AZN     AstraZeneca PLC      67.63 0.52     21.5 27.4 15.4
0.9
## 5    AVE             Aventis      47.16 0.32     20.1 21.8  7.5
0.6
## 6    BAY            Bayer AG      16.90 1.11     27.9  3.9  1.4
0.6
##   Leverage Rev_Growth Net_Profit_Margin Median_Recommendation Location
Exchange
## 1     0.42       7.54              16.1          Moderate Buy       US
NYSE
## 2     0.60       9.16               5.5          Moderate Buy   CANADA
NYSE
## 3     0.27       7.05              11.2            Strong Buy       UK
NYSE
## 4     0.00      15.00              18.0         Moderate Sell       UK
NYSE
## 5     0.34      26.81              12.9          Moderate Buy   FRANCE
NYSE
## 6     0.00      -3.17               2.6                  Hold  GERMANY
NYSE
```

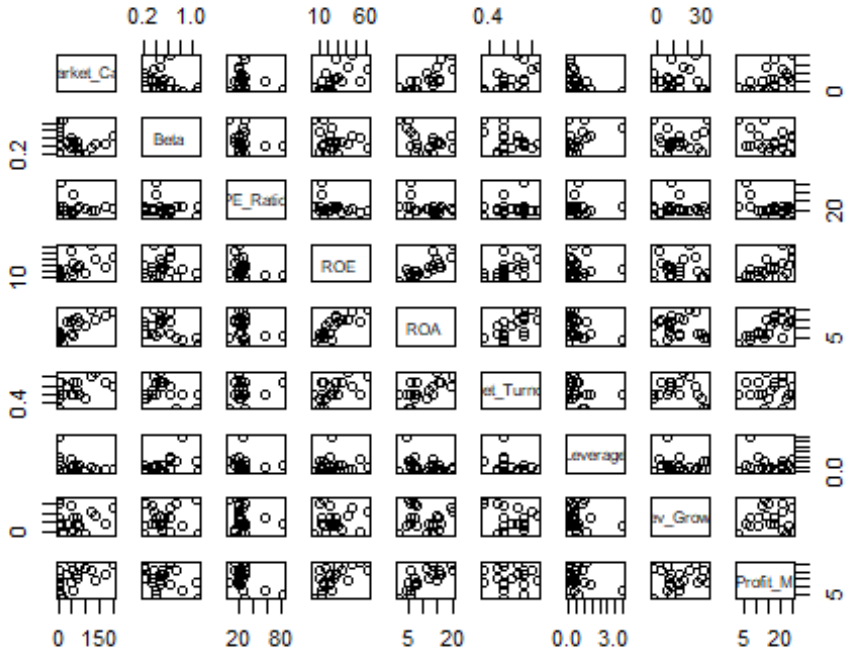
```
dim(Pharmaceuticals) #Dataframe has 14 variables and 21 records
```

```
## [1] 21 14
```

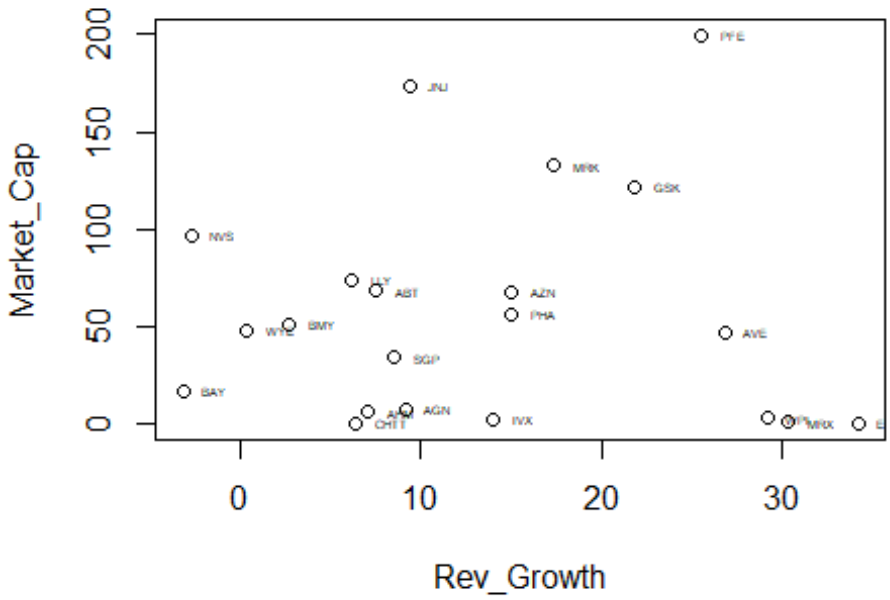
```
str(Pharmaceuticals) #Shows the No. of variable and their datatypes
```

```
## 'data.frame':    21 obs. of  14 variables:
##  $ Symbol             : chr  "ABT" "AGN" "AHM" "AZN" ...
##  $ Name               : chr  "Abbott Laboratories" "Allergan, Inc."
```

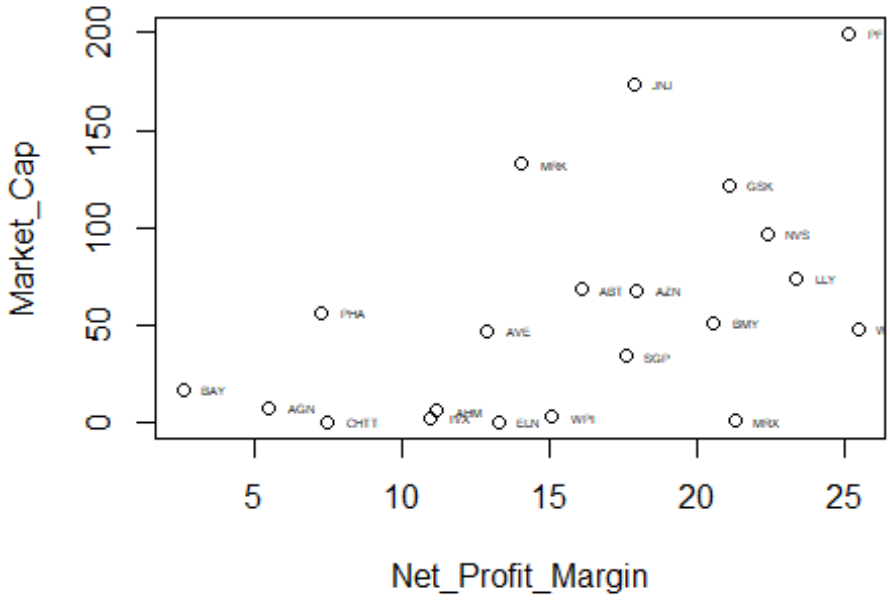
```
"Amersham plc" "AstraZeneca PLC" ...
##  $ Market_Cap           : num  68.44 7.58 6.3 67.63 47.16 ...
##  $ Beta                 : num  0.32 0.41 0.46 0.52 0.32 1.11 0.5 0.85 1.08
0.18 ...
##  $ PE_Ratio             : num  24.7 82.5 20.7 21.5 20.1 27.9 13.9 26 3.6
27.9 ...
##  $ ROE                  : num  26.4 12.9 14.9 27.4 21.8 3.9 34.8 24.1 15.1
31 ...
##  $ ROA                  : num  11.8 5.5 7.8 15.4 7.5 1.4 15.1 4.3 5.1 13.5
...
##  $ Asset_Turnover       : num  0.7 0.9 0.9 0.9 0.6 0.6 0.9 0.6 0.3 0.6 ...
##  $ Leverage             : num  0.42 0.6 0.27 0 0.34 0 0.57 3.51 1.07 0.53
...
##  $ Rev_Growth           : num  7.54 9.16 7.05 15 26.81 ...
##  $ Net_Profit_Margin    : num  16.1 5.5 11.2 18 12.9 2.6 20.6 7.5 13.3
23.4 ...
##  $ Median_Recommendation: chr  "Moderate Buy" "Moderate Buy" "Strong Buy"
"Moderate Sell" ...
##  $ Location             : chr  "US" "CANADA" "UK" "UK" ...
##  $ Exchange             : chr  "NYSE" "NYSE" "NYSE" "NYSE" ...

U<-unique(Pharmaceuticals) # This shows there are no duplicate rows
dim(U)

## [1] 21 14

pairs(Pharmaceuticals[3:11]) #All possible combinations of Discrete variables
plotted
library(DataExplorer)
```




```
introduce(Pharmaceuticals) #Shows the number of Discrete/continuous variables
and missing value, if any.

##   rows columns discrete_columns continuous_columns all_missing_columns
## 1   21      14                5                  9                   0
##   total_missing_values complete_rows total_observations memory_usage
## 1                    0            21                294         9680

#There are 5 discrete Variables, 9 Continuous variables and no missing
variables.

set.seed(64060)
plot(Market_Cap~Rev_Growth, Pharmaceuticals)
with(Pharmaceuticals, text(Market_Cap~Rev_Growth, labels=Symbol, pos=4,
cex=0.4)) #A rough estimate of how the distribution is for Market cap vs
revenue growth
```




```
plot(Market_Cap~Net_Profit_Margin, Pharmaceuticals)
with(Pharmaceuticals, text(Market_Cap~Net_Profit_Margin, labels=Symbol,
pos=4, cex=0.4))
```



```r
#K-means clustering model
library(tidyverse)
```

```
## -- Attaching packages --------------------------------------- tidyverse
1.3.1 --
```

```
## v ggplot2 3.3.5     v purrr   0.3.4
## v tibble  3.1.6     v dplyr   1.0.8
## v tidyr   1.2.0     v stringr 1.4.0
## v readr   2.1.2     v forcats 0.5.1
```

```
## -- Conflicts ------------------------------------------
tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

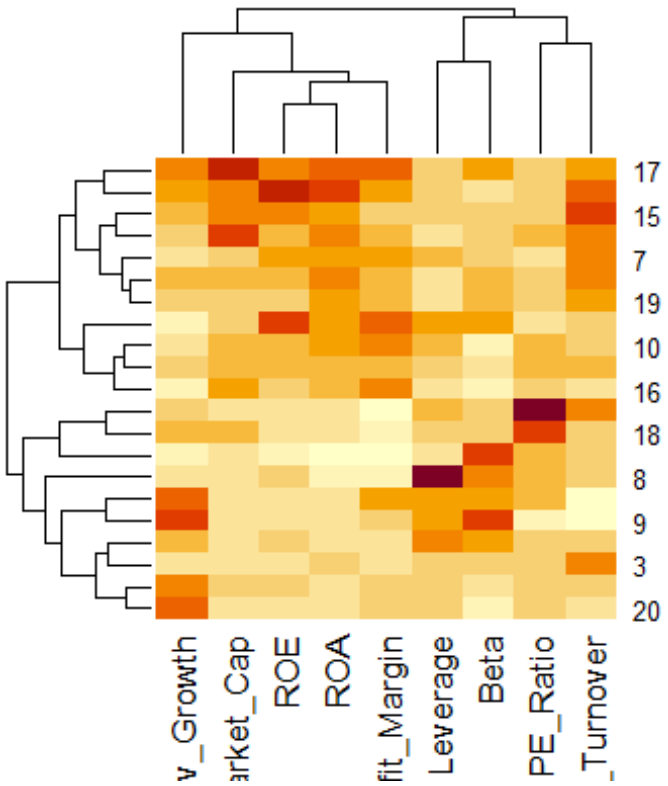
```r
library(factoextra)
```

```
## Welcome! Want to learn more? See two factoextra-related books at
https://goo.gl/ve3WBa
```

```r
library(ISLR)
Pharmaceuticals1 <- scale(Pharmaceuticals[, c(3:11)], center = TRUE, scale =
TRUE)
dist_pharmaceuticals <- get_dist(Pharmaceuticals1)
print(dist_pharmaceuticals, digits = 3)
```

```
##       1    2    3    4    5    6    7    8    9   10   11   12   13   14
15
## 2  4.42
## 3  2.02 3.95
## 4  1.67 4.91 2.36
## 5  2.11 4.64 2.49 2.63
## 6  4.69 4.85 3.64 5.07 4.76
## 7  1.81 5.42 2.60 1.57 3.40 5.27
## 8  5.02 5.61 4.76 5.72 5.10 4.97 5.29
## 9  4.90 6.70 4.70 4.97 3.75 4.61 5.38 4.68
## 10 1.42 5.14 3.24 2.41 2.91 5.80 2.19 5.66 5.55
## 11 3.69 6.75 4.90 2.96 4.48 7.55 3.10 7.08 6.73 3.63
## 12 2.62 4.47 2.32 3.28 2.39 3.66 3.28 2.95 3.12 3.54 5.28
## 13 2.33 5.32 3.59 1.96 3.64 5.72 2.51 6.31 6.07 2.72 2.99 4.35
## 14 3.92 5.48 4.12 4.27 2.93 4.85 4.73 4.79 2.39 4.19 6.19 2.83 5.31
## 15 2.68 5.44 3.36 1.86 3.47 5.92 2.43 6.10 5.92 3.38 2.22 4.16 1.81 5.53
## 16 1.92 5.47 3.33 3.06 3.33 5.33 2.87 6.06 5.73 1.58 4.78 3.90 3.08 4.48
4.11
## 17 3.89 6.91 5.27 3.11 4.50 7.16 3.67 7.18 6.12 3.78 2.45 5.36 2.45 5.52
2.83
## 18 2.91 2.37 2.93 3.72 2.72 3.96 4.41 5.00 5.01 3.75 5.77 3.07 4.11 3.83
4.45
## 19 1.31 4.73 1.70 1.08 2.46 4.43 1.48 5.35 4.67 2.21 3.78 2.76 2.60 3.91
2.71
```

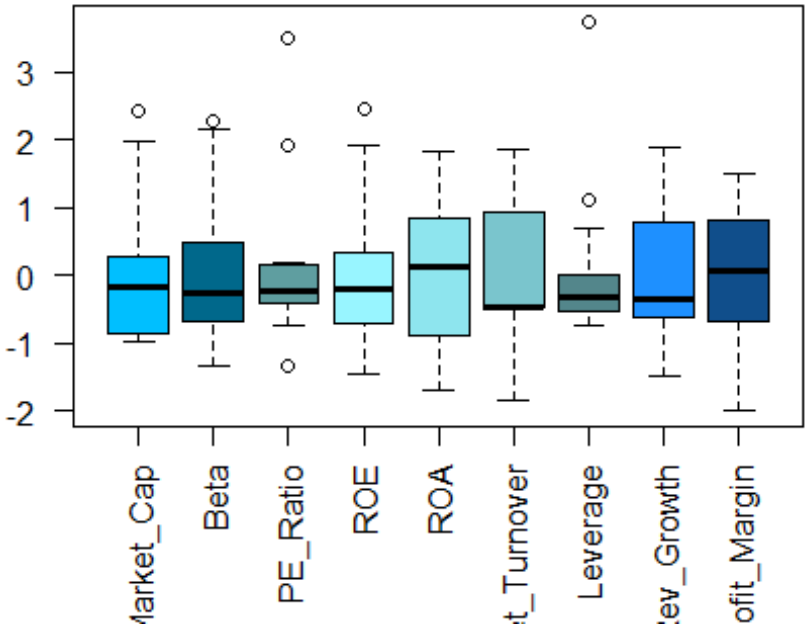
```
## 20 2.88 5.01 2.94 3.41 1.30 5.06 4.12 5.54 3.76 3.41 5.44 2.86 4.59 2.65
4.57
## 21 3.04 6.45 4.19 3.32 4.25 5.95 2.27 5.13 5.31 2.75 3.67 3.72 3.86 4.71
3.94
##      16   17   18   19   20
## 2
## 3
## 4
## 5
## 6
## 7
## 8
## 9
## 10
## 11
## 12
## 13
## 14
## 15
## 16
## 17 4.54
## 18 3.88 5.59
## 19 2.54 3.96 3.45
## 20 3.63 5.40 3.17 3.03
## 21 3.53 4.03 5.29 3.15 4.92

heatmap(Pharmaceuticals1, scale = "column")
```



```
#Company 8 and 17 are the furthest from each other as the distance between
them is the largest i.e 7.18.
Pharmaceuticals[c(8,17),] #From this we can see that there is a huge
difference in terms of Market capital, Rev_Growth and Net Profit margin of
both these companies
```

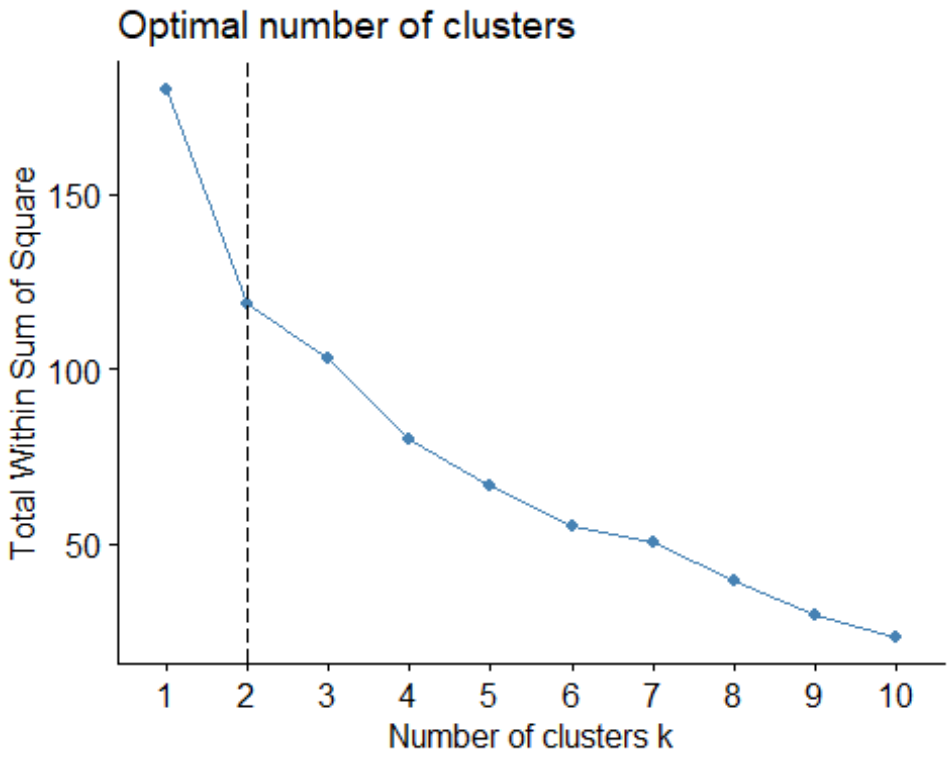
```
##    Symbol         Name Market_Cap Beta PE_Ratio  ROE  ROA Asset_Turnover
## 8    CHTT Chattem, Inc       0.41 0.85     26.0 24.1  4.3            0.6
## 17    PFE   Pfizer Inc     199.47 0.65     23.6 45.6 19.2            0.8
##    Leverage Rev_Growth Net_Profit_Margin Median_Recommendation Location
## 8      3.51       6.38               7.5          Moderate Buy       US
## 17     0.16      25.54              25.2          Moderate Buy       US
##    Exchange
## 8    NASDAQ
## 17     NYSE
```

```
boxplot(Pharmaceuticals1,
col=c("deepskyblue","deepskyblue4","cadetblue","cadetblue1","cadetblue2","cad
etblue3","cadetblue4","dodgerblue", "dodgerblue4"), las = 2) #visualization
of the outliers
```

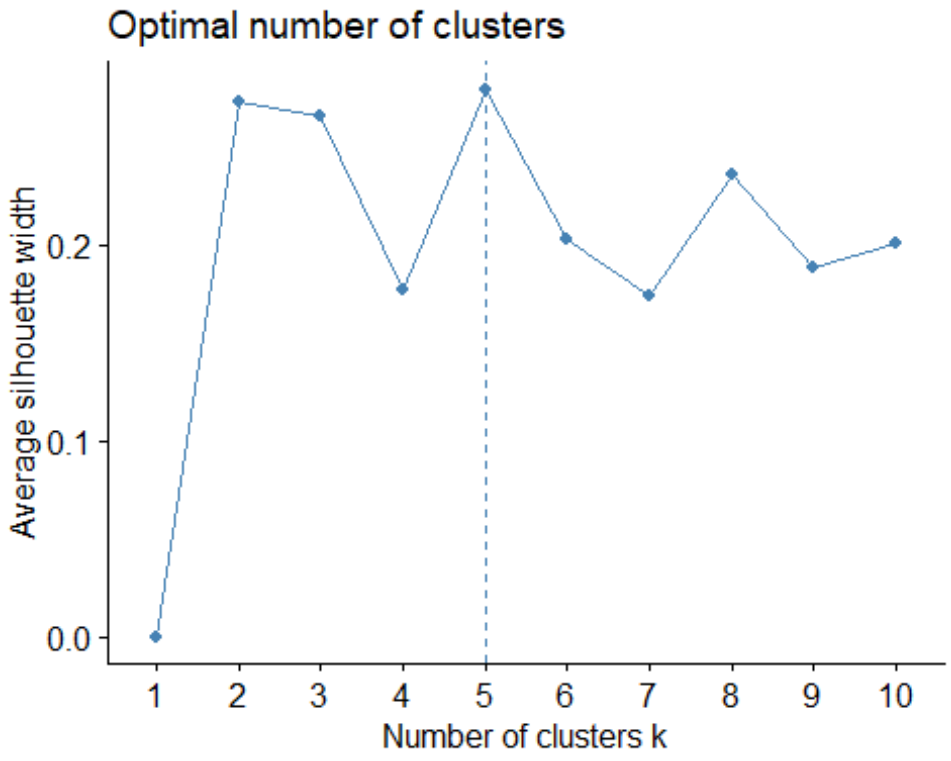


Finding optimal number for K as per Elbow method

```
fviz_nbclust(Pharmaceuticals1, kmeans, method = "wss") +
 geom_vline(xintercept = 2, linetype = 5)       #Elbow method
```




```
fviz_nbclust(Pharmaceuticals1, kmeans, method = "silhouette") #Silhouette
Method
```



Silhouette method of finding optimal number of K is highly influenced by outliers. Since our data has quite a few number of outliers.

On removing the outliers, the optimal value of K using the silhouette method also came out to be 2.

Hence, We can consider the optimal number of K using the Elbow method.

```
#k=2

k_mean_model2 <- kmeans(Pharmaceuticals1, centers = 2, nstart = 25)
fviz_cluster(k_mean_model2, data = Pharmaceuticals1)+ labs(subtitle = "k=2")
```


```
k_mean_model2

## K-means clustering with 2 clusters of sizes 11, 10
##
## Cluster means:
##   Market_Cap       Beta   PE_Ratio        ROE        ROA Asset_Turnover
## 1  0.6733825 -0.3586419 -0.2763512  0.6565978  0.8344159      0.4612656
## 2 -0.7407208  0.3945061  0.3039863 -0.7222576 -0.9178575     -0.5073922
##     Leverage Rev_Growth Net_Profit_Margin
## 1 -0.3331068 -0.2902163         0.6823310
## 2  0.3664175  0.3192379        -0.7505641
##
## Clustering vector:
##  [1] 1 2 2 1 2 2 1 2 2 1 1 2 1 2 1 1 1 2 1 2 1
##
## Within cluster sum of squares by cluster:
## [1] 43.30886 75.26049
##  (between_SS / total_SS =  34.1 %)
##
## Available components:
##
## [1] "cluster"      "centers"      "totss"        "withinss"
"tot.withinss"
## [6] "betweenss"    "size"         "iter"         "ifault"
```

b. Interpret the clusters with respect to the numerical variables used in forming the clusters.

Companies in cluster 2 have a higher Return on Equity than companies in cluster 1 for the identical Return on Equity values.

c. Is there a pattern in the clusters with respect to the numerical variables (10 to 12)? (those not used in forming the clusters)

Cluster 1 has highest rev_growth, highest net_profit_margin and has hold median recommendation.

Cluster 2 has low rev_growth, high net_profit_margin and has moderate buy recommendation.

d. Provide an appropriate name for each cluster using any or all of the variables in the dataset.

High market cap companies : cluster 1

Low market cap companies : cluster 2