Multivariate Analysis of Network

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This data captures trade in various types of products/materials among countries. Let explore our data.

```
str(trade)
```

```
##  num [1:5, 1:24, 1:24] 0 0 0 0 0 0 1 1 1 1 ...
##  - attr(*, "dimnames")=List of 3
##   ..$ : chr [1:5] "MINERALS" "CRUDE_MATERIALS" "FOODS" "MANUFACTURED_GOODS" ...
##   ..$ : chr [1:24] "ALGERIA " "ARGENTINA " "BRAZIL " "CHINA " ...
##   ..$ : chr [1:24] "ALGERIA " "ARGENTINA " "BRAZIL " "CHINA " ...
```

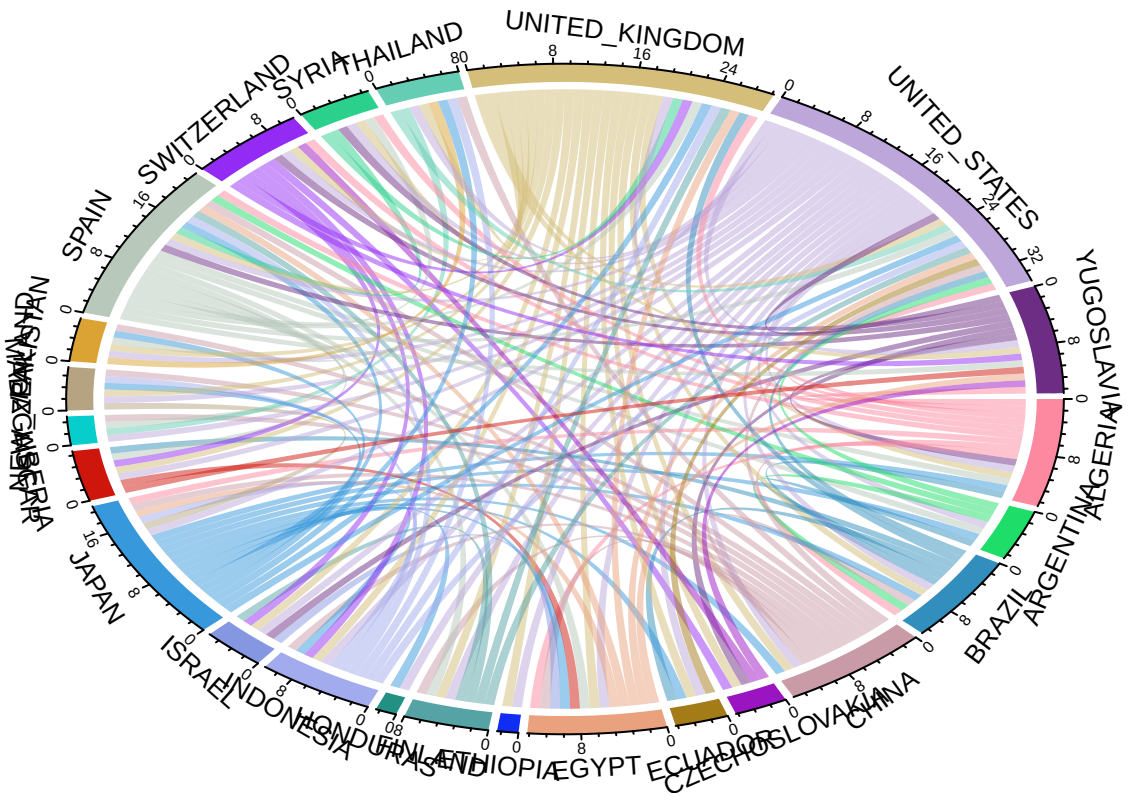
```
#What kind of trades?
row.names(trade)
```

```
## [1] "MINERALS"            "CRUDE_MATERIALS"     "FOODS"
## [4] "MANUFACTURED_GOODS"  "DIPLOMATIC_EXCHANGE"
```

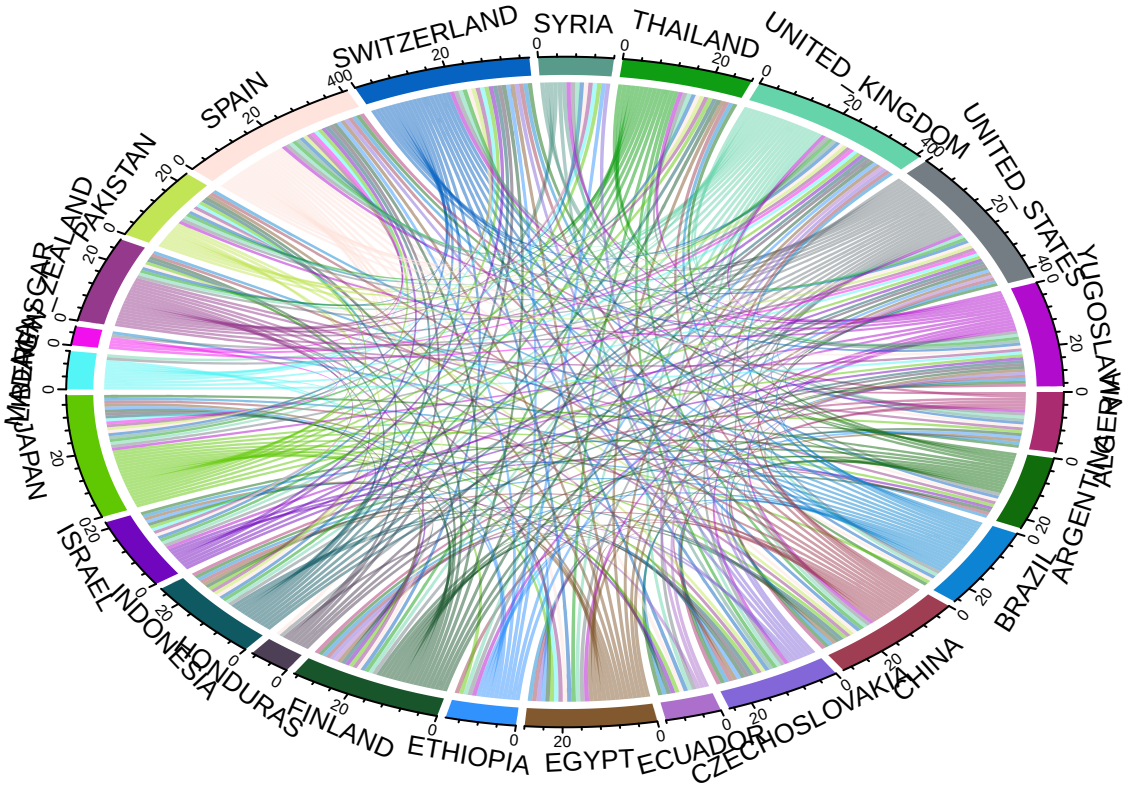
```
#What all countries participate?
colnames(trade)
```

```
##  [1] "ALGERIA "        "ARGENTINA "      "BRAZIL "
##  [4] "CHINA "          "CZECHOSLOVAKIA " "ECUADOR "
##  [7] "EGYPT "          "ETHIOPIA "       "FINLAND "
## [10] "HONDURAS "       "INDONESIA "      "ISRAEL "
## [13] "JAPAN "          "LIBERIA "        "MADAGASCAR "
## [16] "NEW_ZEALAND "    "PAKISTAN "       "SPAIN "
## [19] "SWITZERLAND "    "SYRIA "          "THAILAND "
## [22] "UNITED_KINGDOM " "UNITED_STATES "  "YUGOSLAVIA"
```

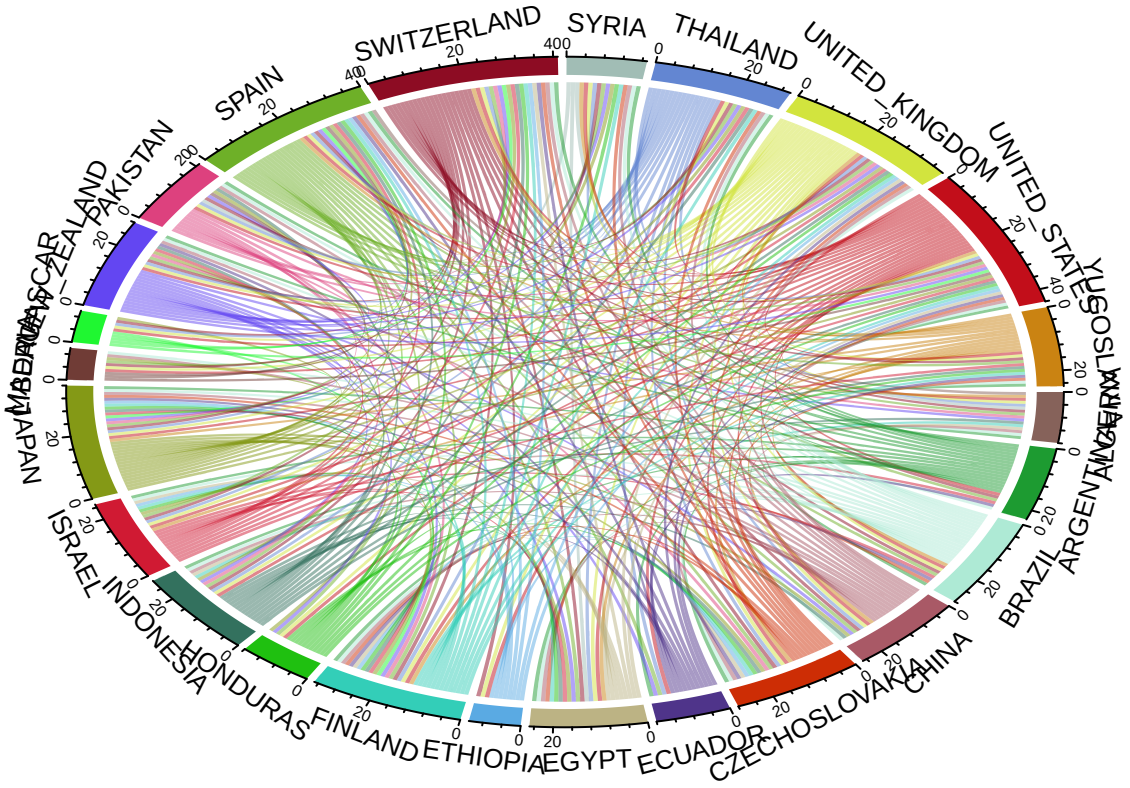
```
#Visualizing all trade networks
chordDiagram(trade[1,,])  #Minerals
```



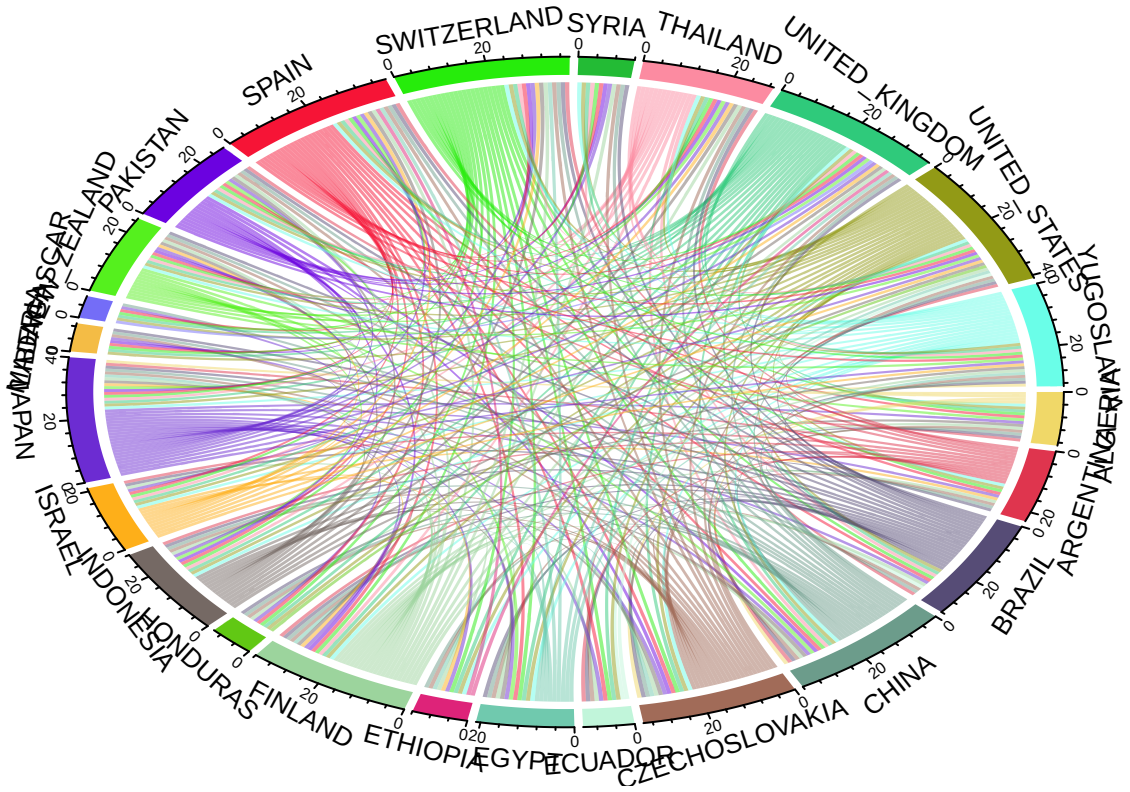

```
chordDiagram(trade[2,,])   #CRUDE_MATERIALS
```



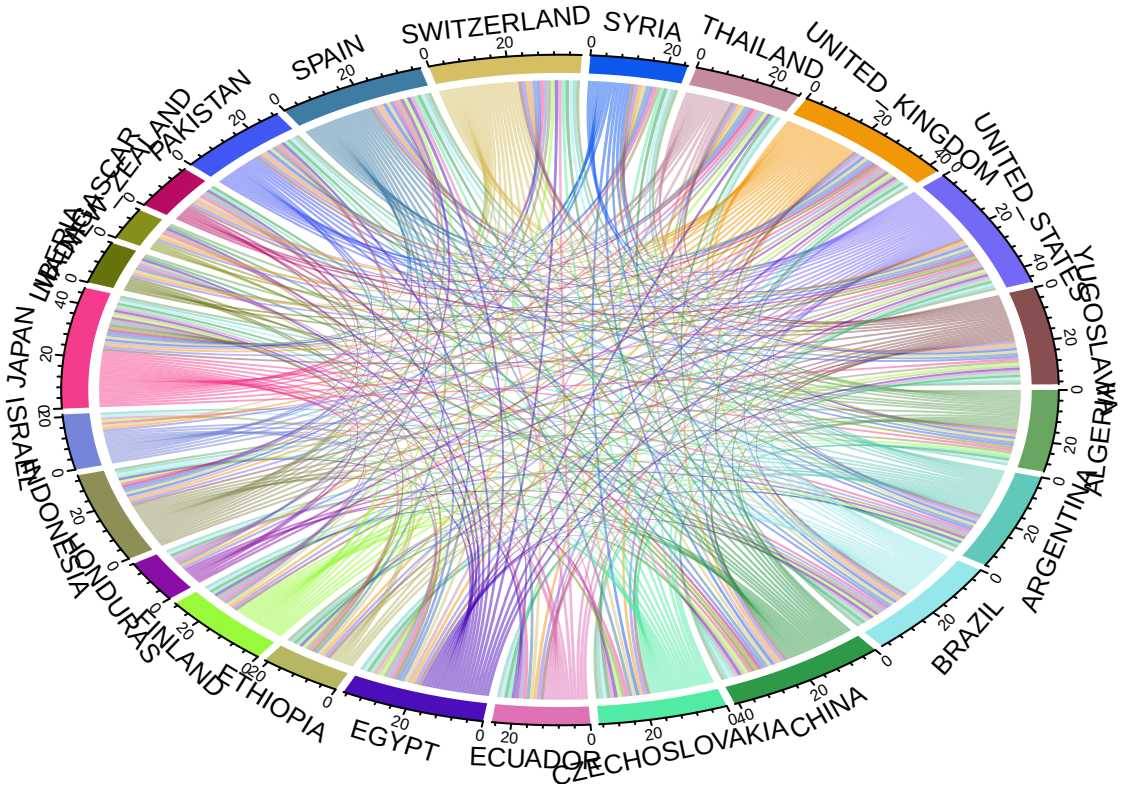

```
chordDiagram(trade[3,,])   #FOODS
```




```
chordDiagram(trade[4,,])   #MANUFACTURED_GOODS
```




```
chordDiagram(trade[5,,])   #DIPLOMATIC_EXCHANGE
```



(a) Clustering

Computing a hierarchical clustering of the trade networks, based on the Hamming distance. Comparing this with a two-dimensional MDS solution on the same data.

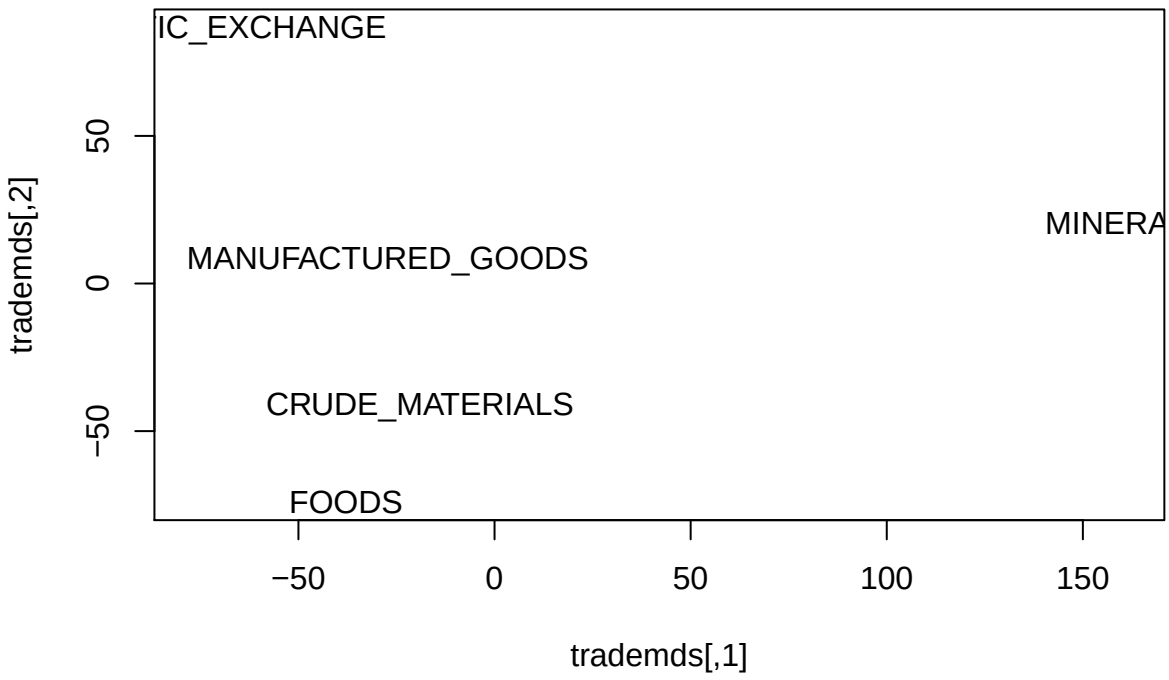
```
tradehd<-hdist(trade)
tradehd
```

```
##     1   2   3   4   5
## 1   0 204 224 201 248
## 2 204   0 118 115 158
## 3 224 118   0 121 170
## 4 201 115 121   0 127
## 5 248 158 170 127   0
```

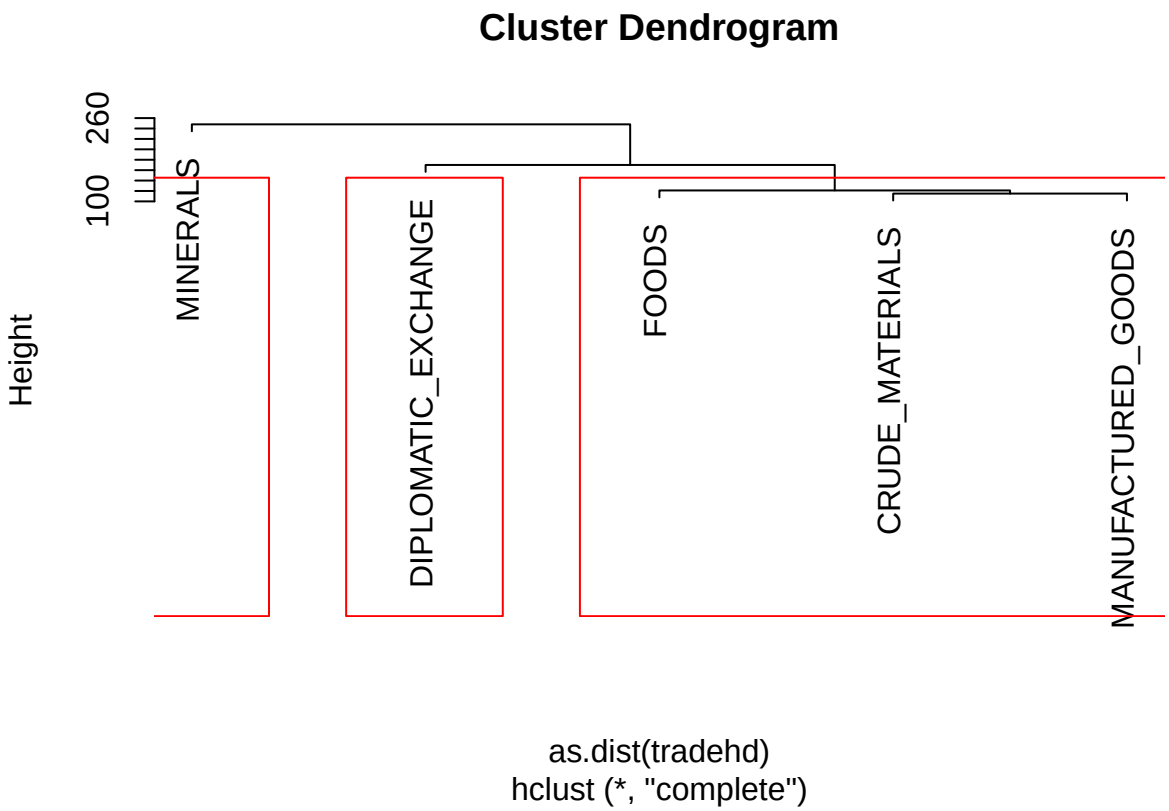
```
# Preparing MDS solution
trademds<-cmdscale(tradehd)
trademds
```

```
##        [,1]       [,2]
## 1 161.24239  20.559016
## 2 -18.99459 -41.374438
## 3 -37.84677 -73.752999
## 4 -27.22379   8.134394
## 5 -77.17724  86.434026
```

```
plot(trademds,type="n")
text(trademds,label=rownames(trade))
```




```
#plot clusters
tradehc<-hclust(as.dist(tradehd))
plot(tradehc,labels=c("MINERALS","CRUDE_MATERIALS","FOODS","MANUFACTURED_GOODS","DIPLOMATIC_EXCHANGE"))
rect.hclust(tradehc,k=3)
```



(b) PCA

Conducting PCA analysis to understand the relationship in the trade network.

```
tradecor <- gcor(trade)
tradecor
```

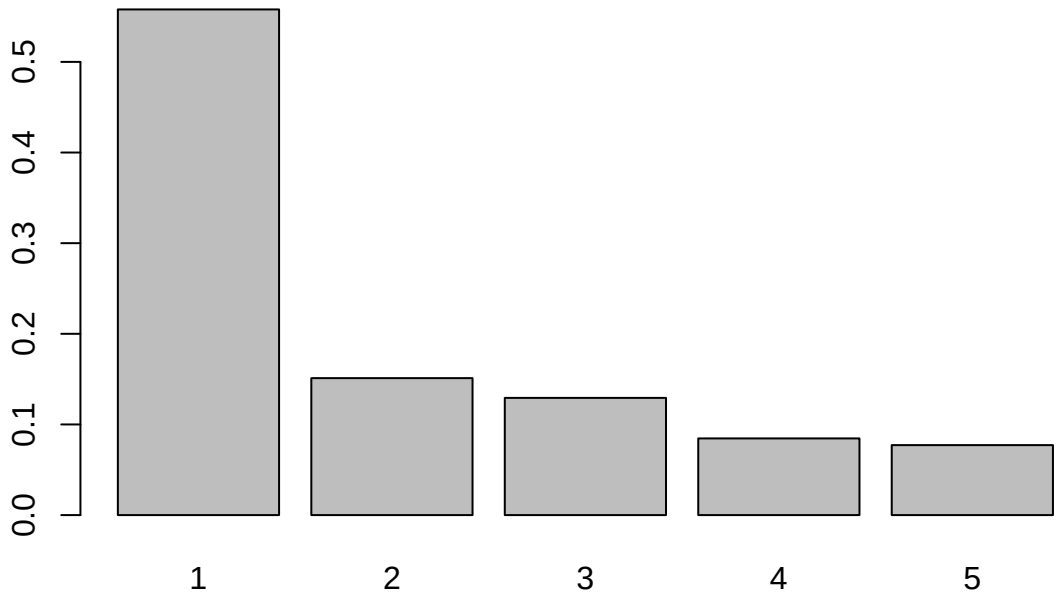
```
##           1         2         3         4         5
## 1 1.0000000 0.3725626 0.2877321 0.3922966 0.3380220
## 2 0.3725626 1.0000000 0.5670013 0.5775224 0.4165298
## 3 0.2877321 0.5670013 1.0000000 0.5554769 0.3700570
## 4 0.3922966 0.5775224 0.5554769 1.0000000 0.5333617
## 5 0.3380220 0.4165298 0.3700570 0.5333617 1.0000000
```

```
#Prepare Eigen
tradeeig <- eigen(tradecor)

evals<-tradeeig$value
evals/sum(evals)
```

```
## [1] 0.55785530 0.15109490 0.12929625 0.08457135 0.07718221
```

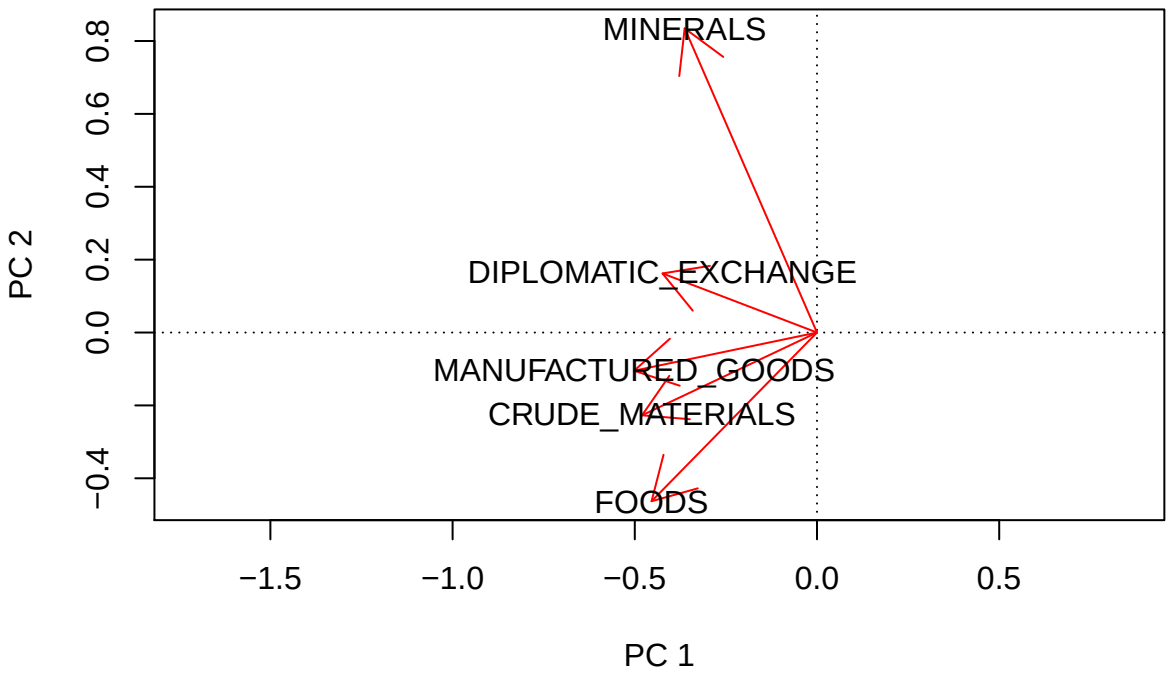
```
#Screenplot
barplot(evals/sum(evals),names.arg=1:length(evals))
```




```
#load 2 components
load<-tradeeig$vector[,1:2]
rownames(load)<-rownames(trade)
load
```

```
##                            [,1]       [,2]
## MINERALS            -0.3630871  0.8347337
## CRUDE_MATERIALS     -0.4801280 -0.2271629
## FOODS               -0.4540009 -0.4629607
## MANUFACTURED_GOODS  -0.5018676 -0.1047656
## DIPLOMATIC_EXCHANGE -0.4238597  0.1621982
```

```
#generate plot
plot(load[,1:2],type="n",asp=1,xlab="PC 1",ylab="PC 2")
abline(h=0,v=0,lty=3)
arrows(0,0,load[,1],load[,2],col=2)
text(load[,1:2],label=rownames(trade))
```



The variance in the underlying trade network can be explained sufficiently by the trade of minerals alone. Almost 56% variance is explained by the Minerals alone.

(c) Discussion

Discussing our PCA results with screen plots.

From the MDS plot we observe that there is something unqiue about Minerals that places it far away from the Diplomatic_Exchange and the cluster of Crude_materials, manufactured good and foods. This discussion validates with variation observed in the PCA plot. Minerals suffices for the 56% variance and that Minerals is far away from the rest of the trade networks.