**EASY CONSTRUCTION FOR EURUSD CURRENCY ESTIMATION**

It is essential to start by re-directing R to the folder where you downloaded the data in other words, change the directory. If you are using R.app in mac look for Misc and then "Change Working directory"; if you are using windows look for File -> Change working directory; If you are using Linux use setwd().

Data Type:

The EURUSD data set is a multivariate data used to quantify the variation of currencies between the EUR and the USD. The dataset consists of 261 samples from each of the six features of the EURUSD such as Date, Open, High, Low, Close and Adj. Closes. Note must be taken that five features were measured from each sample in terms of the dates. Based on the combination of the five features, a linear model used to distinguish the features from each other. One class is linearly separable from the other. The data set is loaded into R from .csv extension file accordingly.

To read the data use the function read.csv. In this case, EURUSD.csv which is a 261 by 7 matrix with headings. Upon completion of this process, one can proceed to take a first look at the data (EURUSD.csv). The first thing that is often important when handed with some big data for analysis is to look at the raw data distribution.

Data Transformation:

Yes, data transformation is necessary. Log transformation data does not really change the results that much. But the combination of log transformation and PCA may help give an insight into the data. Though this paper did not address PCA. It is a rule of thumb to know the row names and dimension of the raw data and ask yourself if the information is good enough for data analysis. If not, one can perform data transformation and perform plot density for comparison of the raw data and log transformation data.







Hierarchical Clustering

Clustering with hclust: The object returned by hclust is a list of class hclust which describes the tree generated by the clustering process with the following components: merge, height, order, labels, method, call and dist.method. Seven different clustering methods can be selected with the 'method' argument: ward, single, complete, average, mcquitty, median and centroid.

The generated tree can be plotted with the plot() function. When the hang argument is set to '-1' then all leaves end on one line and their labels hang down from 0. More details on the plotting behavior is provided in the hclust help document (?hclust)



Line Fitting Data

Linear Fit

Second Order Polynomial

Third Order Polynomial

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| SUMMARY OUTPUT | |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| *Regression Statistics* | |  |  |  |  |  |  |  |
| Multiple R | 0.935229 |  |  |  |  |  |  |  |
| R Square | 0.874654 |  |  |  |  |  |  |  |
| Adjusted R Square | 0.868789 |  |  |  |  |  |  |  |
| Standard Error | 37.7064 |  |  |  |  |  |  |  |
| Observations | 261 |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| ANOVA |  |  |  |  |  |  |  |  |
|  | *df* | *SS* | *MS* | *F* | *Significance F* |  |  |  |
| Regression | 5 | 2539774 | 507954.9 | 446.5859 | 6.8E-124 |  |  |  |
| Residual | 256 | 363973.8 | 1421.773 |  |  |  |  |  |
| Total | 261 | 2903748 |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
| Intercept | 41748.13 | 58.90497 | 708.737 | 0 | 41632.13 | 41864.13 | 41632.13 | 41864.13 |
| Open | -18802.1 | 10864.2 | -1.73065 | 0.08472 | -40196.7 | 2592.508 | -40196.7 | 2592.508 |
| High | -2166.43 | 851.981 | -2.54282 | 0.011586 | -3844.22 | -488.647 | -3844.22 | -488.647 |
| Low | 3889.63 | 755.0973 | 5.151165 | 5.17E-07 | 2402.637 | 5376.624 | 2402.637 | 5376.624 |
| Close | 19096.3 | 10703.84 | 1.784062 | 0.075598 | -1982.48 | 40175.09 | -1982.48 | 40175.09 |
| Adj Close | 0 | 0 | 65535 | #NUM! | 0 | 0 | 0 | 0 |
|  |  |  |  |  |  |  |  |  |

Convex Optimization for LMS and CVXR in R Case Study

This is known from the fact that Y = X \*β + ϵ; where Y is an n x 1 vector, while X is a n x p matrix. Then we compute for beta using the least square method such that ϵ N(0, 1).

n <- 261

> p <- 100

> beta <- -4:95

> X <- matrix(rnorm(n \* p), nrow=n)

> colnames(X) <- paste0("beta\_", beta)

> Y <- X %\*% beta + rnorm(n)

> ls.model <- lm(Y ~ 0 + X)

> m <- data.frame(ls.est = coef(ls.model))

> rownames(m) <- paste0("$\\beta\_{", 1:p, "}$")

> knitr::kable(m)

| | ls.est|

|:-------------|----------:|

|$\beta\_{1}$ | -3.9597785|

|$\beta\_{2}$ | -3.0898564|

|$\beta\_{3}$ | -1.9242344|

|$\beta\_{4}$ | -1.0207795|

|$\beta\_{5}$ | 0.0148985|

|$\beta\_{6}$ | 1.0460035|

|$\beta\_{7}$ | 2.0191932|

|$\beta\_{8}$ | 3.0319887|

|$\beta\_{9}$ | 3.9852930|

|$\beta\_{10}$ | 4.9368124|

|$\beta\_{11}$ | 5.9325362|

|$\beta\_{12}$ | 6.9143583|

|$\beta\_{13}$ | 7.8999822|

|$\beta\_{14}$ | 9.0864572|

|$\beta\_{15}$ | 9.8090014|

|$\beta\_{16}$ | 11.0490168|

|$\beta\_{17}$ | 12.0115563|

|$\beta\_{18}$ | 13.0428548|

|$\beta\_{19}$ | 13.8429407|

|$\beta\_{20}$ | 15.0451229|

|$\beta\_{21}$ | 16.0340734|

|$\beta\_{22}$ | 16.9411506|

|$\beta\_{23}$ | 18.0643294|

|$\beta\_{24}$ | 19.0095498|

|$\beta\_{25}$ | 19.9258021|

|$\beta\_{26}$ | 20.9866943|

|$\beta\_{27}$ | 21.9967405|

|$\beta\_{28}$ | 22.8033472|

|$\beta\_{29}$ | 24.0220655|

|$\beta\_{30}$ | 24.9588927|

|$\beta\_{31}$ | 26.0043174|

|$\beta\_{32}$ | 27.0712485|

|$\beta\_{33}$ | 28.1655730|

|$\beta\_{34}$ | 28.9634845|

|$\beta\_{35}$ | 29.8286251|

|$\beta\_{36}$ | 31.1090116|

|$\beta\_{37}$ | 31.8807371|

|$\beta\_{38}$ | 32.9072631|

|$\beta\_{39}$ | 34.0300392|

|$\beta\_{40}$ | 35.0474571|

|$\beta\_{41}$ | 35.8956438|

|$\beta\_{42}$ | 36.9934980|

|$\beta\_{43}$ | 38.1079243|

|$\beta\_{44}$ | 38.8795570|

|$\beta\_{45}$ | 39.9898178|

|$\beta\_{46}$ | 41.0081235|

|$\beta\_{47}$ | 41.9852502|

|$\beta\_{48}$ | 43.0714462|

|$\beta\_{49}$ | 43.9347231|

|$\beta\_{50}$ | 44.8760161|

|$\beta\_{51}$ | 46.2453082|

|$\beta\_{52}$ | 46.9194894|

|$\beta\_{53}$ | 47.9712498|

|$\beta\_{54}$ | 48.7832362|

|$\beta\_{55}$ | 50.0036223|

|$\beta\_{56}$ | 51.1785974|

|$\beta\_{57}$ | 51.9159109|

|$\beta\_{58}$ | 52.8838671|

|$\beta\_{59}$ | 53.9728792|

|$\beta\_{60}$ | 55.0410399|

|$\beta\_{61}$ | 56.0173284|

|$\beta\_{62}$ | 56.9184638|

|$\beta\_{63}$ | 57.9656882|

|$\beta\_{64}$ | 59.0435441|

|$\beta\_{65}$ | 60.0342073|

|$\beta\_{66}$ | 61.0674255|

|$\beta\_{67}$ | 61.9772402|

|$\beta\_{68}$ | 62.9705257|

|$\beta\_{69}$ | 63.9780705|

|$\beta\_{70}$ | 65.0812656|

|$\beta\_{71}$ | 65.9085876|

|$\beta\_{72}$ | 67.0892003|

|$\beta\_{73}$ | 68.0839489|

|$\beta\_{74}$ | 69.0402373|

|$\beta\_{75}$ | 69.9484580|

|$\beta\_{76}$ | 71.0385446|

|$\beta\_{77}$ | 71.9428286|

|$\beta\_{78}$ | 72.9606603|

|$\beta\_{79}$ | 74.0257211|

|$\beta\_{80}$ | 74.9559027|

|$\beta\_{81}$ | 75.9275529|

|$\beta\_{82}$ | 77.0532932|

|$\beta\_{83}$ | 77.8917233|

|$\beta\_{84}$ | 78.8945259|

|$\beta\_{85}$ | 80.0032100|

|$\beta\_{86}$ | 81.0374580|

|$\beta\_{87}$ | 81.9622020|

|$\beta\_{88}$ | 83.0370591|

|$\beta\_{89}$ | 83.9641348|

|$\beta\_{90}$ | 85.0526943|

|$\beta\_{91}$ | 85.9317720|

|$\beta\_{92}$ | 86.9648953|

|$\beta\_{93}$ | 87.9807478|

|$\beta\_{94}$ | 89.1103815|

|$\beta\_{95}$ | 90.0768605|

|$\beta\_{96}$ | 90.8612810|

|$\beta\_{97}$ | 92.0587525|

|$\beta\_{98}$ | 93.1112353|

|$\beta\_{99}$ | 94.0303660|

|$\beta\_{100}$ | 95.0502296|

> suppressWarnings(library(CVXR, warn.conflicts=FALSE))

> betaHat <- Variable(p)

> objective <- Minimize(sum((Y - X %\*% betaHat)^2))

> problem <- Problem(objective)

> result <- solve(problem)

> m <- cbind(coef(ls.model), result$getValue(betaHat))

> colnames(m) <- c("lm est.", "CVXR est.")

> rownames(m) <- paste0("$\\beta\_{", 1:p, "}$")

> knitr::kable(m)

| | lm est.| CVXR est.|

|:-------------|----------:|----------:|

|$\beta\_{1}$ | -3.9597785| -3.9597785|

|$\beta\_{2}$ | -3.0898564| -3.0898564|

|$\beta\_{3}$ | -1.9242344| -1.9242344|

|$\beta\_{4}$ | -1.0207795| -1.0207795|

|$\beta\_{5}$ | 0.0148985| 0.0148985|

|$\beta\_{6}$ | 1.0460035| 1.0460035|

|$\beta\_{7}$ | 2.0191932| 2.0191932|

|$\beta\_{8}$ | 3.0319887| 3.0319887|

|$\beta\_{9}$ | 3.9852930| 3.9852930|

|$\beta\_{10}$ | 4.9368124| 4.9368124|

|$\beta\_{11}$ | 5.9325362| 5.9325362|

|$\beta\_{12}$ | 6.9143583| 6.9143583|

|$\beta\_{13}$ | 7.8999822| 7.8999822|

|$\beta\_{14}$ | 9.0864572| 9.0864572|

|$\beta\_{15}$ | 9.8090014| 9.8090014|

|$\beta\_{16}$ | 11.0490168| 11.0490168|

|$\beta\_{17}$ | 12.0115563| 12.0115563|

|$\beta\_{18}$ | 13.0428548| 13.0428548|

|$\beta\_{19}$ | 13.8429407| 13.8429407|

|$\beta\_{20}$ | 15.0451229| 15.0451229|

|$\beta\_{21}$ | 16.0340734| 16.0340734|

|$\beta\_{22}$ | 16.9411506| 16.9411506|

|$\beta\_{23}$ | 18.0643294| 18.0643294|

|$\beta\_{24}$ | 19.0095498| 19.0095498|

|$\beta\_{25}$ | 19.9258021| 19.9258021|

|$\beta\_{26}$ | 20.9866943| 20.9866943|

|$\beta\_{27}$ | 21.9967405| 21.9967405|

|$\beta\_{28}$ | 22.8033472| 22.8033472|

|$\beta\_{29}$ | 24.0220655| 24.0220655|

|$\beta\_{30}$ | 24.9588927| 24.9588927|

|$\beta\_{31}$ | 26.0043174| 26.0043174|

|$\beta\_{32}$ | 27.0712485| 27.0712485|

|$\beta\_{33}$ | 28.1655730| 28.1655730|

|$\beta\_{34}$ | 28.9634845| 28.9634845|

|$\beta\_{35}$ | 29.8286251| 29.8286251|

|$\beta\_{36}$ | 31.1090116| 31.1090116|

|$\beta\_{37}$ | 31.8807371| 31.8807371|

|$\beta\_{38}$ | 32.9072631| 32.9072631|

|$\beta\_{39}$ | 34.0300392| 34.0300392|

|$\beta\_{40}$ | 35.0474571| 35.0474571|

|$\beta\_{41}$ | 35.8956438| 35.8956438|

|$\beta\_{42}$ | 36.9934980| 36.9934980|

|$\beta\_{43}$ | 38.1079243| 38.1079243|

|$\beta\_{44}$ | 38.8795570| 38.8795570|

|$\beta\_{45}$ | 39.9898178| 39.9898178|

|$\beta\_{46}$ | 41.0081235| 41.0081235|

|$\beta\_{47}$ | 41.9852502| 41.9852502|

|$\beta\_{48}$ | 43.0714462| 43.0714462|

|$\beta\_{49}$ | 43.9347231| 43.9347231|

|$\beta\_{50}$ | 44.8760161| 44.8760161|

|$\beta\_{51}$ | 46.2453082| 46.2453082|

|$\beta\_{52}$ | 46.9194894| 46.9194894|

|$\beta\_{53}$ | 47.9712498| 47.9712498|

|$\beta\_{54}$ | 48.7832362| 48.7832362|

|$\beta\_{55}$ | 50.0036223| 50.0036223|

|$\beta\_{56}$ | 51.1785974| 51.1785974|

|$\beta\_{57}$ | 51.9159109| 51.9159109|

|$\beta\_{58}$ | 52.8838671| 52.8838671|

|$\beta\_{59}$ | 53.9728792| 53.9728792|

|$\beta\_{60}$ | 55.0410399| 55.0410399|

|$\beta\_{61}$ | 56.0173284| 56.0173284|

|$\beta\_{62}$ | 56.9184638| 56.9184638|

|$\beta\_{63}$ | 57.9656882| 57.9656882|

|$\beta\_{64}$ | 59.0435441| 59.0435441|

|$\beta\_{65}$ | 60.0342073| 60.0342073|

|$\beta\_{66}$ | 61.0674255| 61.0674255|

|$\beta\_{67}$ | 61.9772402| 61.9772402|

|$\beta\_{68}$ | 62.9705257| 62.9705257|

|$\beta\_{69}$ | 63.9780705| 63.9780705|

|$\beta\_{70}$ | 65.0812656| 65.0812656|

|$\beta\_{71}$ | 65.9085876| 65.9085876|

|$\beta\_{72}$ | 67.0892003| 67.0892003|

|$\beta\_{73}$ | 68.0839489| 68.0839489|

|$\beta\_{74}$ | 69.0402373| 69.0402373|

|$\beta\_{75}$ | 69.9484580| 69.9484580|

|$\beta\_{76}$ | 71.0385446| 71.0385446|

|$\beta\_{77}$ | 71.9428286| 71.9428286|

|$\beta\_{78}$ | 72.9606603| 72.9606603|

|$\beta\_{79}$ | 74.0257211| 74.0257211|

|$\beta\_{80}$ | 74.9559027| 74.9559027|

|$\beta\_{81}$ | 75.9275529| 75.9275529|

|$\beta\_{82}$ | 77.0532932| 77.0532932|

|$\beta\_{83}$ | 77.8917233| 77.8917233|

|$\beta\_{84}$ | 78.8945259| 78.8945259|

|$\beta\_{85}$ | 80.0032100| 80.0032100|

|$\beta\_{86}$ | 81.0374580| 81.0374580|

|$\beta\_{87}$ | 81.9622020| 81.9622020|

|$\beta\_{88}$ | 83.0370591| 83.0370591|

|$\beta\_{89}$ | 83.9641348| 83.9641348|

|$\beta\_{90}$ | 85.0526943| 85.0526943|

|$\beta\_{91}$ | 85.9317720| 85.9317720|

|$\beta\_{92}$ | 86.9648953| 86.9648953|

|$\beta\_{93}$ | 87.9807478| 87.9807478|

|$\beta\_{94}$ | 89.1103815| 89.1103815|

|$\beta\_{95}$ | 90.0768605| 90.0768605|

|$\beta\_{96}$ | 90.8612810| 90.8612810|

|$\beta\_{97}$ | 92.0587525| 92.0587525|

|$\beta\_{98}$ | 93.1112353| 93.1112353|

|$\beta\_{99}$ | 94.0303660| 94.0303660|

|$\beta\_{100}$ | 95.0502296| 95.0502296|

> suppressWarnings(library(CVXR, warn.conflicts=FALSE))

> betaHat <- Variable(p)

> objective <- Minimize(sum((Y - X %\*% betaHat)^2))

> problem <- Problem(objective)

> result <- solve(problem)

> m <- cbind(coef(ls.model), result$getValue(betaHat))

> colnames(m) <- c("lm est.", "CVXR est.")

> rownames(m) <- paste0("$\\beta\_{", 1:p, "}$")

> knitr::kable(m)

| | lm est.| CVXR est.|

|:-------------|----------:|----------:|

|$\beta\_{1}$ | -3.9597785| -3.9597785|

|$\beta\_{2}$ | -3.0898564| -3.0898564|

|$\beta\_{3}$ | -1.9242344| -1.9242344|

|$\beta\_{4}$ | -1.0207795| -1.0207795|

|$\beta\_{5}$ | 0.0148985| 0.0148985|

|$\beta\_{6}$ | 1.0460035| 1.0460035|

|$\beta\_{7}$ | 2.0191932| 2.0191932|

|$\beta\_{8}$ | 3.0319887| 3.0319887|

|$\beta\_{9}$ | 3.9852930| 3.9852930|

|$\beta\_{10}$ | 4.9368124| 4.9368124|

|$\beta\_{11}$ | 5.9325362| 5.9325362|

|$\beta\_{12}$ | 6.9143583| 6.9143583|

|$\beta\_{13}$ | 7.8999822| 7.8999822|

|$\beta\_{14}$ | 9.0864572| 9.0864572|

|$\beta\_{15}$ | 9.8090014| 9.8090014|

|$\beta\_{16}$ | 11.0490168| 11.0490168|

|$\beta\_{17}$ | 12.0115563| 12.0115563|

|$\beta\_{18}$ | 13.0428548| 13.0428548|

|$\beta\_{19}$ | 13.8429407| 13.8429407|

|$\beta\_{20}$ | 15.0451229| 15.0451229|

|$\beta\_{21}$ | 16.0340734| 16.0340734|

|$\beta\_{22}$ | 16.9411506| 16.9411506|

|$\beta\_{23}$ | 18.0643294| 18.0643294|

|$\beta\_{24}$ | 19.0095498| 19.0095498|

|$\beta\_{25}$ | 19.9258021| 19.9258021|

|$\beta\_{26}$ | 20.9866943| 20.9866943|

|$\beta\_{27}$ | 21.9967405| 21.9967405|

|$\beta\_{28}$ | 22.8033472| 22.8033472|

|$\beta\_{29}$ | 24.0220655| 24.0220655|

|$\beta\_{30}$ | 24.9588927| 24.9588927|

|$\beta\_{31}$ | 26.0043174| 26.0043174|

|$\beta\_{32}$ | 27.0712485| 27.0712485|

|$\beta\_{33}$ | 28.1655730| 28.1655730|

|$\beta\_{34}$ | 28.9634845| 28.9634845|

|$\beta\_{35}$ | 29.8286251| 29.8286251|

|$\beta\_{36}$ | 31.1090116| 31.1090116|

|$\beta\_{37}$ | 31.8807371| 31.8807371|

|$\beta\_{38}$ | 32.9072631| 32.9072631|

|$\beta\_{39}$ | 34.0300392| 34.0300392|

|$\beta\_{40}$ | 35.0474571| 35.0474571|

|$\beta\_{41}$ | 35.8956438| 35.8956438|

|$\beta\_{42}$ | 36.9934980| 36.9934980|

|$\beta\_{43}$ | 38.1079243| 38.1079243|

|$\beta\_{44}$ | 38.8795570| 38.8795570|

|$\beta\_{45}$ | 39.9898178| 39.9898178|

|$\beta\_{46}$ | 41.0081235| 41.0081235|

|$\beta\_{47}$ | 41.9852502| 41.9852502|

|$\beta\_{48}$ | 43.0714462| 43.0714462|

|$\beta\_{49}$ | 43.9347231| 43.9347231|

|$\beta\_{50}$ | 44.8760161| 44.8760161|

|$\beta\_{51}$ | 46.2453082| 46.2453082|

|$\beta\_{52}$ | 46.9194894| 46.9194894|

|$\beta\_{53}$ | 47.9712498| 47.9712498|

|$\beta\_{54}$ | 48.7832362| 48.7832362|

|$\beta\_{55}$ | 50.0036223| 50.0036223|

|$\beta\_{56}$ | 51.1785974| 51.1785974|

|$\beta\_{57}$ | 51.9159109| 51.9159109|

|$\beta\_{58}$ | 52.8838671| 52.8838671|

|$\beta\_{59}$ | 53.9728792| 53.9728792|

|$\beta\_{60}$ | 55.0410399| 55.0410399|

|$\beta\_{61}$ | 56.0173284| 56.0173284|

|$\beta\_{62}$ | 56.9184638| 56.9184638|

|$\beta\_{63}$ | 57.9656882| 57.9656882|

|$\beta\_{64}$ | 59.0435441| 59.0435441|

|$\beta\_{65}$ | 60.0342073| 60.0342073|

|$\beta\_{66}$ | 61.0674255| 61.0674255|

|$\beta\_{67}$ | 61.9772402| 61.9772402|

|$\beta\_{68}$ | 62.9705257| 62.9705257|

|$\beta\_{69}$ | 63.9780705| 63.9780705|

|$\beta\_{70}$ | 65.0812656| 65.0812656|

|$\beta\_{71}$ | 65.9085876| 65.9085876|

|$\beta\_{72}$ | 67.0892003| 67.0892003|

|$\beta\_{73}$ | 68.0839489| 68.0839489|

|$\beta\_{74}$ | 69.0402373| 69.0402373|

|$\beta\_{75}$ | 69.9484580| 69.9484580|

|$\beta\_{76}$ | 71.0385446| 71.0385446|

|$\beta\_{77}$ | 71.9428286| 71.9428286|

|$\beta\_{78}$ | 72.9606603| 72.9606603|

|$\beta\_{79}$ | 74.0257211| 74.0257211|

|$\beta\_{80}$ | 74.9559027| 74.9559027|

|$\beta\_{81}$ | 75.9275529| 75.9275529|

|$\beta\_{82}$ | 77.0532932| 77.0532932|

|$\beta\_{83}$ | 77.8917233| 77.8917233|

|$\beta\_{84}$ | 78.8945259| 78.8945259|

|$\beta\_{85}$ | 80.0032100| 80.0032100|

|$\beta\_{86}$ | 81.0374580| 81.0374580|

|$\beta\_{87}$ | 81.9622020| 81.9622020|

|$\beta\_{88}$ | 83.0370591| 83.0370591|

|$\beta\_{89}$ | 83.9641348| 83.9641348|

|$\beta\_{90}$ | 85.0526943| 85.0526943|

|$\beta\_{91}$ | 85.9317720| 85.9317720|

|$\beta\_{92}$ | 86.9648953| 86.9648953|

|$\beta\_{93}$ | 87.9807478| 87.9807478|

|$\beta\_{94}$ | 89.1103815| 89.1103815|

|$\beta\_{95}$ | 90.0768605| 90.0768605|

|$\beta\_{96}$ | 90.8612810| 90.8612810|

|$\beta\_{97}$ | 92.0587525| 92.0587525|

|$\beta\_{98}$ | 93.1112353| 93.1112353|

|$\beta\_{99}$ | 94.0303660| 94.0303660|

|$\beta\_{100}$ | 95.0502296| 95.0502296|

> problem <- Problem(objective, constraints = list(betaHat >= 0))

> problem <- Problem(objective, constraints = list(betaHat >= 0))

> result <- solve(problem)

> m <- data.frame(CVXR.est = result$getValue(betaHat))

> rownames(m) <- paste0("$\\beta\_{", 1:p, "}$")

> knitr::kable(m)

| | CVXR.est|

|:-------------|---------:|

|$\beta\_{1}$ | 0.000000|

|$\beta\_{2}$ | 0.000000|

|$\beta\_{3}$ | 0.000000|

|$\beta\_{4}$ | 0.000000|

|$\beta\_{5}$ | 0.150452|

|$\beta\_{6}$ | 1.735593|

|$\beta\_{7}$ | 1.923207|

|$\beta\_{8}$ | 2.968783|

|$\beta\_{9}$ | 3.949391|

|$\beta\_{10}$ | 4.856441|

|$\beta\_{11}$ | 6.208764|

|$\beta\_{12}$ | 7.272362|

|$\beta\_{13}$ | 7.737625|

|$\beta\_{14}$ | 9.162469|

|$\beta\_{15}$ | 9.875344|

|$\beta\_{16}$ | 11.241930|

|$\beta\_{17}$ | 11.340954|

|$\beta\_{18}$ | 12.726662|

|$\beta\_{19}$ | 13.966690|

|$\beta\_{20}$ | 14.955668|

|$\beta\_{21}$ | 16.115449|

|$\beta\_{22}$ | 17.036874|

|$\beta\_{23}$ | 17.852889|

|$\beta\_{24}$ | 18.863726|

|$\beta\_{25}$ | 18.981310|

|$\beta\_{26}$ | 20.234968|

|$\beta\_{27}$ | 20.990811|

|$\beta\_{28}$ | 21.955050|

|$\beta\_{29}$ | 24.178048|

|$\beta\_{30}$ | 25.223706|

|$\beta\_{31}$ | 25.628745|

|$\beta\_{32}$ | 26.913454|

|$\beta\_{33}$ | 28.363360|

|$\beta\_{34}$ | 28.450848|

|$\beta\_{35}$ | 30.568608|

|$\beta\_{36}$ | 31.139112|

|$\beta\_{37}$ | 31.886185|

|$\beta\_{38}$ | 32.297710|

|$\beta\_{39}$ | 34.223371|

|$\beta\_{40}$ | 35.387774|

|$\beta\_{41}$ | 36.620404|

|$\beta\_{42}$ | 37.477265|

|$\beta\_{43}$ | 38.085218|

|$\beta\_{44}$ | 38.479548|

|$\beta\_{45}$ | 41.039636|

|$\beta\_{46}$ | 41.524726|

|$\beta\_{47}$ | 42.029001|

|$\beta\_{48}$ | 43.804924|

|$\beta\_{49}$ | 44.039425|

|$\beta\_{50}$ | 45.380392|

|$\beta\_{51}$ | 46.771395|

|$\beta\_{52}$ | 47.557966|

|$\beta\_{53}$ | 48.201115|

|$\beta\_{54}$ | 49.153730|

|$\beta\_{55}$ | 50.191230|

|$\beta\_{56}$ | 50.981270|

|$\beta\_{57}$ | 51.759188|

|$\beta\_{58}$ | 52.617148|

|$\beta\_{59}$ | 53.140562|

|$\beta\_{60}$ | 55.397675|

|$\beta\_{61}$ | 56.183073|

|$\beta\_{62}$ | 57.311441|

|$\beta\_{63}$ | 57.619258|

|$\beta\_{64}$ | 58.930340|

|$\beta\_{65}$ | 60.265317|

|$\beta\_{66}$ | 61.442695|

|$\beta\_{67}$ | 61.419390|

|$\beta\_{68}$ | 63.029276|

|$\beta\_{69}$ | 63.900232|

|$\beta\_{70}$ | 64.854771|

|$\beta\_{71}$ | 66.183219|

|$\beta\_{72}$ | 68.131329|

|$\beta\_{73}$ | 68.846627|

|$\beta\_{74}$ | 69.504764|

|$\beta\_{75}$ | 69.714707|

|$\beta\_{76}$ | 71.058328|

|$\beta\_{77}$ | 72.589336|

|$\beta\_{78}$ | 73.263306|

|$\beta\_{79}$ | 74.562164|

|$\beta\_{80}$ | 74.912408|

|$\beta\_{81}$ | 76.838065|

|$\beta\_{82}$ | 77.500864|

|$\beta\_{83}$ | 78.275226|

|$\beta\_{84}$ | 78.639650|

|$\beta\_{85}$ | 80.459738|

|$\beta\_{86}$ | 79.968704|

|$\beta\_{87}$ | 82.352842|

|$\beta\_{88}$ | 83.406910|

|$\beta\_{89}$ | 83.952770|

|$\beta\_{90}$ | 85.120361|

|$\beta\_{91}$ | 86.006141|

|$\beta\_{92}$ | 86.488667|

|$\beta\_{93}$ | 88.124826|

|$\beta\_{94}$ | 89.061242|

|$\beta\_{95}$ | 90.402043|

|$\beta\_{96}$ | 90.501217|

|$\beta\_{97}$ | 92.396333|

|$\beta\_{98}$ | 93.334155|

|$\beta\_{99}$ | 94.971960|

|$\beta\_{100}$ | 94.587589|