ECON567 A1

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First load essential functions and libraries. Use stargazer to tabulate the data.

library(stargazer)  
library(plyr)  
library(ggplot2)  
library(ggthemes)  
library(plotly)  
library(plm)  
library(AER) #IV Regression  
library(np) #Local Polynomial  
library(nloptr)  
load("dialysisFacilityReports.Rdata")   
source("functions.R")

# Problem 1

Reproduce the descriptive data

tab <- t( apply(dialysis , 2, descriptive.statistic))  
colnames( tab) <- c(" Mean ", "St. Dev .", "N")  
stargazer (tab , type ="text")

##   
## ================================================  
## Mean St. Dev . N   
## ------------------------------------------------  
## provfs 0   
## year 2,010.232 2.571 48,224  
## comorbidities 4.710 0.942 40,242  
## hemoglobin 9.774 0.704 46,616  
## std.mortality 1.005 0.391 45,985  
## std.hosp.days 0.977 0.387 46,186  
## std.hosp.admit 0.997 0.311 46,153  
## pct.septic 11.311 5.975 46,870  
## n.hosp.admit 93.215 66.220 46,963  
## city 0   
## name 0   
## state 0   
## network 9.644 4.724 48,224  
## chain.name 0   
## profit.status 0   
## stations 17.942 8.246 44,997  
## total.staff 14.552 9.041 47,580  
## dieticiansFT 0.517 0.599 47,110  
## dieticiansPT 0.604 0.601 47,110  
## nurseFT 4.936 4.074 47,110  
## nursePT 1.006 1.888 47,110  
## ptcareFT 5.665 4.555 47,110  
## ptcarePT 0.838 1.567 47,110  
## social.workerFT 0.567 0.663 42,512  
## social.workerPT 0.564 0.594 47,110  
## patient.months 771.833 516.166 48,073  
## pct.fistula 55.264 13.588 47,009  
## pct.female 44.742 8.634 48,093  
## patient.age 61.437 6.056 48,093  
## patient.esrd.years 4.406 1.095 48,093  
## treatment.type 0   
## inspect.date 0   
## inspect.result 1.503 0.669 25,868  
## inspect.cfc.cites 0.294 0.902 44,306  
## inspect.std.cites 5.894 7.363 44,303  
## days.since.inspection 704.886 720.470 47,895  
## ------------------------------------------------

# Problem 2

Reproduce tables 1, 2, 3. In Preparation the data for tabulate, I constructed the patient year from patient months devided by 12. The total labor is defined to be the full time equivalent of nurses and technitians. In order to construct this variable, I sum up full time nurses and technitians as well as 0.5 times part time nurses and technitians. The net hiring and net investment are measured by the change of total labor and total capital, which is the number of stations in this context.

dialysis$for.profit <- dialysis$profit.status =="For Profit"  
dialysis$patient.years <- dialysis$patient.months/12  
  
dialysis$total.labor <- dialysis$ptcareFT + dialysis$nurseFT + 0.5 \* (dialysis$nursePT + dialysis$ptcarePT)  
  
dialysis$total.labor.prev <- panel.lag(dialysis$total.labor,dialysis$provfs,dialysis$year,lag=1)  
dialysis$staff.change <- dialysis$total.labor - dialysis$total.labor.prev  
dialysis$zero.net.hiring <- dialysis$staff.change == 0  
dialysis$net.hiring <- 0  
crit <- dialysis$staff.change != 0  
crit[is.na(crit)] <- FALSE  
dialysis$net.hiring[crit] <- dialysis$staff.change[crit]  
  
dialysis$stations.prev <- panel.lag(dialysis$stations,dialysis$provfs,dialysis$year,lag=1)  
dialysis$station.change <- dialysis$stations - dialysis$stations.prev  
dialysis$zero.net.investment <- dialysis$station.change == 0  
dialysis$net.investment <- 0  
crit <- dialysis$station.change != 0  
crit[is.na(crit)] <- FALSE  
dialysis$net.investment[crit] <- dialysis$station.change[crit]

### Table 1: Summary Statistics

var.names <- c("patient.years", "total.labor","zero.net.hiring","net.hiring",   
 "stations","zero.net.investment","net.investment",   
 "pct.septic","std.mortality" ,"for.profit")  
tab1 <- t( apply(dialysis [, var.names ], 2,descriptive.statistic))  
colnames( tab1) <- c(" Mean ", "St. Dev .", "N")  
rownames(tab1) <- c("Patient Years","FTE Staff", "Net Hiring", "Zero Net Hiring", "Stations", "Zero Net Investment", "Net Investment", "Septic Infection Rate", "Excess Mortality", "For Profit")  
stargazer (tab1 , type ="text")

##   
## =============================================  
## Mean St. Dev . N   
## ---------------------------------------------  
## Patient Years 64.319 43.014 48,073  
## FTE Staff 11.523 7.707 47,110  
## Net Hiring 0.165 0.371 39,180  
## Zero Net Hiring 0.195 3.815 48,224  
## Stations 17.942 8.246 44,997  
## Zero Net Investment 0.893 0.309 38,188  
## Net Investment -0.111 2.208 48,224  
## Septic Infection Rate 11.311 5.975 46,870  
## Excess Mortality 1.005 0.391 45,985  
## For Profit 0.837 0.369 48,224  
## ---------------------------------------------

### Table 2: Potential Quality Drivers

Data Processing: Use the center year, 2010

# For time since last inspection  
dialysis$time.since.inspection <- dialysis$days.since.inspection / 365  
  
# For state inspection rate  
dialysis.center <- dialysis[dialysis$year==2010,]  
dialysis.state <- data.frame(data = dialysis.center$time.since.inspection [(!is.na(dialysis.center$time.since.inspection))] < 1 ,group=dialysis.center$state[!is.na(dialysis.center$time.since.inspection) ])  
  
state.inspection.rate <- ddply(dialysis.state,~group,summarize, mean = mean(data,na.rm=TRUE), N = length(data), sd = sd(data,na.rm=TRUE))  
map = setNames(as.vector(state.inspection.rate$mean),as.vector(state.inspection.rate$group))  
dialysis.center$inspect.rate.state <- map[dialysis.center$state]  
  
  
# For city level competitors  
dialysis.city <- data.frame(data = dialysis.center$patient.months,group = dialysis.center$city)  
  
city.competitors <- ddply(dialysis.city,~group,summarize, mean = mean(data,na.rm=TRUE), N = length(data), sd = sd(data,na.rm=TRUE))  
  
map = setNames(as.vector(city.competitors$N),as.vector(city.competitors$group))  
dialysis.center$city.compititors <- map[dialysis.center$city]

I am not able to find % Patients Referred by Nephrologist, because the data set didn't indicate the resource of the patients. In addition, cannot find the number of competitors in each HSA, use the number of competitors in each city instead.

var.names <- c("inspect.rate.state", "time.since.inspection","city.compititors","for.profit")  
tab2 <- t( apply(dialysis.center [, var.names ], 2,descriptive.statistic))  
colnames( tab2) <- c(" Mean ", "St. Dev .", "N")  
rownames(tab2) <- c("State Inspection Rate","Time since inspection", "Compititors","For Profit")  
stargazer (tab2 , type ="text")

##   
## ===========================================  
## Mean St. Dev . N   
## -------------------------------------------  
## State Inspection Rate 0.399 0.139 5,387  
## Time since inspection 1.892 2.109 5,371  
## Compititors 7.106 10.835 5,387  
## For Profit 0.832 0.374 5,387  
## -------------------------------------------

### Table 3: Patient Characteristics Summary Statis-tics

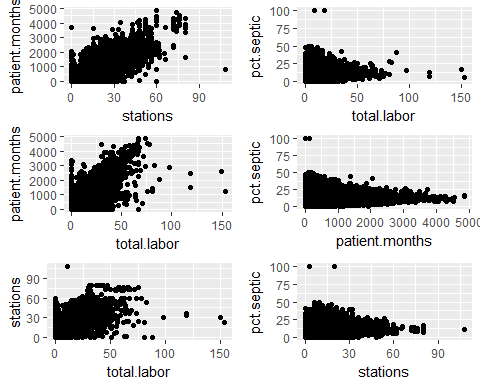
var.names <- c("patient.age", "pct.female", "pct.fistula","comorbidities", "patient.esrd.years", "hemoglobin" )  
tab3 <- t( apply(dialysis.center [, var.names ], 2,descriptive.statistic))  
colnames( tab3) <- c(" Mean ", "St. Dev .", "N")  
rownames(tab3) <- c( "Patient Age", "Percentage Female", "Pct. AV Fistula ","Avg. Comorbid Conditions ","Avg. Duration of ESRD", "Avg. Hemoglobin Level " )  
stargazer (tab3 , type ="text")

##   
## ===============================================  
## Mean St. Dev . N   
## -----------------------------------------------  
## Patient Age 61.409 5.982 5,369  
## Percentage Female 44.721 8.635 5,369  
## Pct. AV Fistula 55.898 11.788 5,253  
## Avg. Comorbid Conditions 4.938 0.854 5,265  
## Avg. Duration of ESRD 4.361 1.053 5,369  
## Avg. Hemoglobin Level 9.828 0.629 5,256  
## -----------------------------------------------

# Problem 3

In the graphs, I observe that there's no clear pattern between total capital and total labor.

p1 <- ggplot(dialysis,aes(x=stations,y=patient.months)) + geom\_point()  
  
p2 <- ggplot(dialysis,aes(x=total.labor,y=patient.months)) + geom\_point()  
  
p3 <- ggplot(dialysis,aes(x=total.labor,y=stations)) + geom\_point()  
  
p4 <- ggplot(dialysis,aes(x=total.labor,y=pct.septic)) + geom\_point()  
  
p5 <- ggplot(dialysis,aes(x=patient.months,y=pct.septic)) + geom\_point()  
  
p6 <- ggplot(dialysis,aes(x=stations,y=pct.septic)) + geom\_point()  
  
multiplot(p1,p2,p3,p4,p5,p6, cols=2)



# Problem 4

dialysis$inspected.this.year <- 0  
dialysis$inspected.this.year[dialysis$time.since.inspection <= 1] <- 1  
inspection.rate <- aggregate(inspected.this.year ~ state \* year, data = dialysis, FUN=mean)  
colnames(inspection.rate) <- c("state","year","state.year.inspection.rate")  
dialysis <- merge(x=dialysis,y=inspection.rate,by=c("year","state"))  
  
competitor.number <- aggregate(provfs ~ city \* year, data = dialysis, FUN=length)  
colnames(competitor.number) <- c("city","year","city.year.competitor.number")  
dialysis <- merge(x=dialysis,y=competitor.number,by=c("year","city"))  
dialysis$competitor.1 <- as.numeric(dialysis$city.year.competitor.number == 2)  
dialysis$competitor.2 <- as.numeric(dialysis$city.year.competitor.number == 3)  
dialysis$competitor.3 <- as.numeric(dialysis$city.year.competitor.number >= 4)  
  
dialysis$DaVita <- as.numeric(dialysis$chain.name == "DAVITA")  
dialysis$Fresenius <- as.numeric(dialysis$chain.name == "FRESENIUS MEDICAL CARE (FMC)")  
dialysis$Fresenius[dialysis$chain.name == "FRESENIUS MEDICAL CARE" ] = 1  
  
dialysis$non.profit <- 1 - dialysis$for.profit  
# ggplot(data = competitor.number, aes(x=city,y=city.year.competitor.number,color=year)) + geom\_point() + theme\_minimal()

Reproduce the result in table 4. There is no referral data available, so column 3 cannot be replicated. Also, I cannot find indicators for HSA. City seems to be a good approximation. I'll just use city instead.

In the second column, the effect of year since inspection seem to be relatively large than in the paper. I suspect there is endogeneity due to the control variables.

In the 7th and 8th columns, being non-profit has a smaller effect than the result in the paper. I think that's because we don't have the HSA characteristics as fixed effect.

tab4.col1 <- plm(pct.septic ~ I(days.since.inspection/365) + patient.age + pct.female + patient.esrd.years + pct.fistula + comorbidities + hemoglobin, data=dialysis,index="provfs")  
  
tab4.col2 <- plm(pct.septic ~ state.year.inspection.rate + patient.age + pct.female + patient.esrd.years + pct.fistula + comorbidities + hemoglobin, data=dialysis,index="provfs")  
  
tab4.col4 <- plm(pct.septic ~ competitor.1 + competitor.2 + competitor.3 + patient.age + pct.female + patient.esrd.years + pct.fistula + comorbidities + hemoglobin, data=dialysis,index="provfs")  
  
  
tab4.col5 <- plm(pct.septic ~ I(days.since.inspection/365) + state.year.inspection.rate + patient.age + pct.female + patient.esrd.years + pct.fistula + comorbidities + hemoglobin, data=dialysis,index="provfs")  
  
tab4.col6 <- plm(pct.septic ~ I(days.since.inspection/365) + state.year.inspection.rate + competitor.1 + competitor.2 + competitor.3 + patient.age + pct.female + patient.esrd.years + pct.fistula + comorbidities + hemoglobin, data=dialysis,index="provfs")  
  
  
tab4.col7 <- lm(pct.septic ~ non.profit + patient.age + pct.female + patient.esrd.years + pct.fistula + comorbidities + hemoglobin, data=dialysis )  
  
tab4.col8 <- lm(pct.septic ~ non.profit + DaVita + Fresenius + patient.age + pct.female + patient.esrd.years + pct.fistula + comorbidities + hemoglobin, data=dialysis )  
  
  
tab4.col9 <- lm(pct.septic ~ I(days.since.inspection/365) + state.year.inspection.rate + competitor.1 + competitor.2 + competitor.3 + non.profit + DaVita + Fresenius + patient.age + pct.female + patient.esrd.years + pct.fistula + comorbidities + hemoglobin, data=dialysis )  
  
stargazer(tab4.col1,tab4.col2, type="text",title="Results",align=TRUE)

##   
## Results  
## ==================================================================================  
## Dependent variable:   
## -----------------------------------------------------  
## pct.septic   
## (1) (2)   
## ----------------------------------------------------------------------------------  
## I(days.since.inspection/365) 0.100\*\*\*   
## (0.017)   
##   
## state.year.inspection.rate -0.521\*\*   
## (0.249)   
##   
## patient.age -0.140\*\*\* -0.137\*\*\*   
## (0.015) (0.015)   
##   
## pct.female 0.009\* 0.009\*   
## (0.005) (0.005)   
##   
## patient.esrd.years -0.142\*\*\* -0.139\*\*\*   
## (0.046) (0.045)   
##   
## pct.fistula -0.091\*\*\* -0.089\*\*\*   
## (0.003) (0.003)   
##   
## comorbidities 0.894\*\*\* 0.897\*\*\*   
## (0.045) (0.045)   
##   
## hemoglobin 0.179\*\*\* 0.181\*\*\*   
## (0.045) (0.045)   
##   
## ----------------------------------------------------------------------------------  
## Observations 38,180 38,405   
## R2 0.034 0.032   
## Adjusted R2 -0.157 -0.159   
## F Statistic 159.318\*\*\* (df = 7; 31881) 151.059\*\*\* (df = 7; 32081)  
## ==================================================================================  
## Note: \*p<0.1; \*\*p<0.05; \*\*\*p<0.01

stargazer(tab4.col4, tab4.col5, tab4.col6, type="text",title="Results",align=TRUE)

##   
## Results  
## ==============================================================================================================  
## Dependent variable:   
## ---------------------------------------------------------------------------------  
## pct.septic   
## (1) (2) (3)   
## --------------------------------------------------------------------------------------------------------------  
## competitor.1 -0.336\* -0.365\*\*   
## (0.179) (0.179)   
##   
## competitor.2 -0.594\*\* -0.618\*\*\*   
## (0.233) (0.233)   
##   
## competitor.3 -0.864\*\*\* -0.939\*\*\*   
## (0.269) (0.269)   
##   
## I(days.since.inspection/365) 0.095\*\*\* 0.097\*\*\*   
## (0.017) (0.017)   
##   
## state.year.inspection.rate -0.347 -0.352   
## (0.255) (0.255)   
##   
## patient.age -0.136\*\*\* -0.140\*\*\* -0.140\*\*\*   
## (0.015) (0.015) (0.015)   
##   
## pct.female 0.009\* 0.009\* 0.009\*   
## (0.005) (0.005) (0.005)   
##   
## patient.esrd.years -0.129\*\*\* -0.143\*\*\* -0.134\*\*\*   
## (0.046) (0.046) (0.046)   
##   
## pct.fistula -0.087\*\*\* -0.091\*\*\* -0.090\*\*\*   
## (0.003) (0.003) (0.003)   
##   
## comorbidities 0.901\*\*\* 0.896\*\*\* 0.905\*\*\*   
## (0.045) (0.045) (0.045)   
##   
## hemoglobin 0.174\*\*\* 0.181\*\*\* 0.176\*\*\*   
## (0.045) (0.045) (0.045)   
##   
## --------------------------------------------------------------------------------------------------------------  
## Observations 38,405 38,180 38,180   
## R2 0.032 0.034 0.034   
## Adjusted R2 -0.159 -0.157 -0.157   
## F Statistic 118.188\*\*\* (df = 9; 32079) 139.639\*\*\* (df = 8; 31880) 102.706\*\*\* (df = 11; 31877)  
## ==============================================================================================================  
## Note: \*p<0.1; \*\*p<0.05; \*\*\*p<0.01

stargazer(tab4.col7, tab4.col8,tab4.col9,type="text",title="Results",align=TRUE)

##   
## Results  
## ==============================================================================================================  
## Dependent variable:   
## ---------------------------------------------------------------------------------  
## pct.septic   
## (1) (2) (3)   
## --------------------------------------------------------------------------------------------------------------  
## I(days.since.inspection/365) 0.068\*\*\*   
## (0.016)   
##   
## state.year.inspection.rate -0.236   
## (0.231)   
##   
## competitor.1 0.200\*\*   
## (0.084)   
##   
## competitor.2 -0.017   
## (0.103)   
##   
## competitor.3 0.120\*   
## (0.069)   
##   
## non.profit -0.773\*\*\* -0.929\*\*\* -0.909\*\*\*   
## (0.079) (0.088) (0.088)   
##   
## DaVita -0.034 -0.040   
## (0.074) (0.074)   
##   
## Fresenius -0.459\*\*\* -0.446\*\*\*   
## (0.073) (0.073)   
##   
## patient.age -0.057\*\*\* -0.056\*\*\* -0.055\*\*\*   
## (0.006) (0.006) (0.006)   
##   
## pct.female 0.020\*\*\* 0.021\*\*\* 0.020\*\*\*   
## (0.003) (0.003) (0.003)   
##   
## patient.esrd.years -0.086\*\*\* -0.074\*\*\* -0.095\*\*\*   
## (0.028) (0.029) (0.029)   
##   
## pct.fistula -0.103\*\*\* -0.104\*\*\* -0.106\*\*\*   
## (0.002) (0.002) (0.002)   
##   
## comorbidities 1.885\*\*\* 1.894\*\*\* 1.908\*\*\*   
## (0.033) (0.033) (0.034)   
##   
## hemoglobin 0.322\*\*\* 0.315\*\*\* 0.317\*\*\*   
## (0.043) (0.043) (0.043)   
##   
## Constant 8.096\*\*\* 8.211\*\*\* 8.161\*\*\*   
## (0.621) (0.622) (0.641)   
##   
## --------------------------------------------------------------------------------------------------------------  
## Observations 38,405 38,405 38,180   
## R2 0.131 0.132 0.134   
## Adjusted R2 0.131 0.132 0.134   
## Residual Std. Error 5.489 (df = 38397) 5.485 (df = 38395) 5.470 (df = 38165)   
## F Statistic 828.589\*\*\* (df = 7; 38397) 650.560\*\*\* (df = 9; 38395) 423.196\*\*\* (df = 14; 38165)  
## ==============================================================================================================  
## Note: \*p<0.1; \*\*p<0.05; \*\*\*p<0.01

# Question 5

### Table 5: Transformation and Production Estimates

The quality seems to have a negative impact on revenue. Since the regression coefficient for pct.septic is positive, higher infection rate is associated with higher output.

tmp <- dialysis[which(dialysis$total.labor > 0 & dialysis$stations > 0 & dialysis$patient.years > 0 & dialysis$pct.septic > 0),]  
tab5.col5 <- lm(log(patient.years) ~ log(stations) + log(total.labor) , data=tmp)  
tab5.col6 <- plm(log(patient.years) ~ log(stations) + log(total.labor) , data=tmp,index="provfs" )  
  
tab5.col2 <- lm(log(patient.years) ~ log(pct.septic) + log(stations) + log(total.labor), data=tmp)  
tab5.col3 <- plm(log(patient.years) ~ log(pct.septic) + log(stations) + log(total.labor), data=tmp,index="provfs" )  
  
  
stargazer(tab5.col2,tab5.col3, type="text",title="Results With Quality",align=TRUE)

##   
## Results With Quality  
## ==============================================================================  
## Dependent variable:   
## ----------------------------------------------------------  
## log(patient.years)   
## OLS panel   
## linear   
## (1) (2)   
## ------------------------------------------------------------------------------  
## log(pct.septic) 0.046\*\*\* 0.033\*\*\*   
## (0.004) (0.003)   
##   
## log(stations) 0.428\*\*\* 0.075\*\*\*   
## (0.005) (0.010)   
##   
## log(total.labor) 0.733\*\*\* 0.421\*\*\*   
## (0.004) (0.006)   
##   
## Constant 1.005\*\*\*   
## (0.014)   
##   
## ------------------------------------------------------------------------------  
## Observations 39,640 39,640   
## R2 0.719 0.151   
## Adjusted R2 0.719 -0.008   
## Residual Std. Error 0.362 (df = 39636)   
## F Statistic 33,857.320\*\*\* (df = 3; 39636) 1,982.941\*\*\* (df = 3; 33373)  
## ==============================================================================  
## Note: \*p<0.1; \*\*p<0.05; \*\*\*p<0.01

stargazer(tab5.col5,tab5.col6, type="text",title="Results Without Quality",align=TRUE)

##   
## Results Without Quality  
## ==============================================================================  
## Dependent variable:   
## ----------------------------------------------------------  
## log(patient.years)   
## OLS panel   
## linear   
## (1) (2)   
## ------------------------------------------------------------------------------  
## log(stations) 0.430\*\*\* 0.075\*\*\*   
## (0.005) (0.010)   
##   
## log(total.labor) 0.733\*\*\* 0.420\*\*\*   
## (0.004) (0.006)   
##   
## Constant 1.107\*\*\*   
## (0.012)   
##   
## ------------------------------------------------------------------------------  
## Observations 39,640 39,640   
## R2 0.718 0.148   
## Adjusted R2 0.718 -0.012   
## Residual Std. Error 0.362 (df = 39637)   
## F Statistic 50,487.290\*\*\* (df = 2; 39637) 2,903.462\*\*\* (df = 2; 33374)  
## ==============================================================================  
## Note: \*p<0.1; \*\*p<0.05; \*\*\*p<0.01

# Question 6

dialysis$quality <- - residuals(lm(pct.septic ~ pct.fistula + pct.female + patient.age + patient.esrd.years + hemoglobin + comorbidities, data = dialysis, na.action = na.exclude))  
  
inc <- with(dialysis, stations > 0 & total.labor > 0 & net.hiring != 0 & !is.na(stations) & ! is.na(total.labor) & !is.na(net.hiring) & (net.investment == 0) & ! is.na(std.mortality))  
  
iv1 <- ivreg(log(patient.months) ~ quality + poly(log(stations), log(total.labor),net.hiring,degree=2)\*I(net.hiring > 0) | log(std.mortality + .01) + poly(log(stations), log(total.labor),net.hiring,degree=2)\*I(net.hiring > 0), data=subset(dialysis,inc),na.action="na.exclude")  
  
alpha <- coef(iv1)["quality"]  
Phi.step1 <- predict(iv1) - alpha\*subset(dialysis,inc)$quality  
dialysis$Phi <- NA  
dialysis[names(Phi.step1),"Phi"] <- Phi.step1  
print(alpha)

## quality   
## 0.003289409

# Question 7

dialysis <- dialysis[order(dialysis$provfs,dialysis$year),]  
  
obj <- function(b){  
 bx <- with(dialysis,log(stations)\*b[1] + log(total.labor)\*b[2])  
 omega <- dialysis$Phi - bx  
 omega.lag <- panel.lag(omega, i = dialysis$provfs,t=dialysis$year)  
 yhat <- with(dialysis,log(patient.months) - alpha \* quality - bx)  
   
 tmp <- subset(cbind(dialysis,yhat,omega.lag), is.finite(omega.lag) & is.finite(yhat))  
 eta <- residuals(lm(yhat ~ poly(omega.lag,degree=4),na.action="na.exclude",data=tmp))  
 nobs <- length(eta)  
 l <- tmp$total.labor  
 k <- tmp$stations  
 eta\_k <- eta \* k  
 eta\_l <- eta \* l  
 G <- rbind(eta\_k,eta\_l)  
 W <- solve(G %\*% t(G))  
 M <- apply(G,1,sum)  
 return(M %\*% W %\*% M)  
}  
  
nloptr(x0=c(0.2,0.2),eval\_f = obj , opts=list(algorithm="NLOPT\_LN\_BOBYQA",print\_level=3))

## Warning in nloptr.add.default.options(opts.user = opts, x0 = x0,  
## num\_constraints\_ineq = num\_constraints\_ineq, : No termination criterium  
## specified, using default (relative x-tolerance = 1e-04)

##   
## Call:  
##   
## nloptr(x0 = c(0.2, 0.2), eval\_f = obj, opts = list(algorithm = "NLOPT\_LN\_BOBYQA",   
## print\_level = 3))  
##   
##   
## Minimization using NLopt version 2.4.0   
##   
## NLopt solver status: 4 ( NLOPT\_XTOL\_REACHED: Optimization stopped because   
## xtol\_rel or xtol\_abs (above) was reached. )  
##   
## Number of Iterations....: 37   
## Termination conditions: relative x-tolerance = 1e-04 (DEFAULT)   
## Number of inequality constraints: 0   
## Number of equality constraints: 0   
## Optimal value of objective function: 4.34891482694947   
## Optimal value of controls: 0.2045935 0.5010596