### 1 BLOCKING PROBABILITY P\_k

lm <- 75

mu <- 20

c <- 5

k<-15

rho\_0\_1 <- 0.77

rho\_0\_2 <- 0.79

rho\_0\_3 <- 0.81

n1 <- c(30, 50, 100, 150)

n2 <- c(30, 50, 100, 150)

matmse\_pk <- matrix(0, nrow = 4, ncol = 4)

matmse\_pk\_1 <- matrix(0, nrow = 4, ncol = 4)

matmse\_pk\_2 <- matrix(0, nrow = 4, ncol = 4)

matmse\_pk\_3 <- matrix(0, nrow = 4, ncol = 4)

matmape\_pk <- matrix(0, nrow = 4, ncol = 4)

matmape\_pk\_1 <- matrix(0, nrow = 4, ncol = 4)

matmape\_pk\_2 <- matrix(0, nrow = 4, ncol = 4)

matmape\_pk\_3 <- matrix(0, nrow = 4, ncol = 4)

matmae\_pk <- matrix(0, nrow = 4, ncol = 4)

matmae\_pk\_1 <- matrix(0, nrow = 4, ncol = 4)

matmae\_pk\_2 <- matrix(0, nrow = 4, ncol = 4)

matmae\_pk\_3 <- matrix(0, nrow = 4, ncol = 4)

matmedian\_pk <- matrix(0, nrow = 4, ncol = 4)

matmedian\_pk\_1 <- matrix(0, nrow = 4, ncol = 4)

matmedian\_pk\_2 <- matrix(0, nrow = 4, ncol = 4)

matmedian\_pk\_3 <- matrix(0, nrow = 4, ncol = 4)

matq90\_pk <- matrix(0, nrow = 4, ncol = 4)

matq90\_pk\_1 <- matrix(0, nrow = 4, ncol = 4)

matq90\_pk\_2 <- matrix(0, nrow = 4, ncol = 4)

matq90\_pk\_3 <- matrix(0, nrow = 4, ncol = 4)

matq25\_pk <- matrix(0, nrow = 4, ncol = 4)

matq25\_pk\_1 <- matrix(0, nrow = 4, ncol = 4)

matq25\_pk\_2 <- matrix(0, nrow = 4, ncol = 4)

matq25\_pk\_3 <- matrix(0, nrow = 4, ncol = 4)

for (a in 1:4) {

for (b in 1:4) {

mse\_pk <- 0

mse\_pk1 <- 0

mse\_pk2 <- 0

mse\_pk3 <- 0

mape\_pk <- 0

mape\_pk1 <- 0

mape\_pk2 <- 0

mape\_pk3 <- 0

mae\_pk <- 0

mae\_pk1 <- 0

mae\_pk2 <- 0

mae\_pk3 <- 0

e\_pk<-numeric(10000)

e\_pk1<-numeric(10000)

e\_pk2<-numeric(10000)

e\_pk3<-numeric(10000)

for (t in 1:10000) {

sx <- 0

sy <- 0

for (i in 1:n1[a]) {

random <- runif(1)

x <- log(1 - random) / (-lm)

sx <- sx + x

}

lambda <- n1[a] / sx

meanx <- sx / n1[a]

for (j in 1:n2[b]) {

random <- runif(1)

y <- log(1 - random) / (-mu)

sy <- sy + y

}

meu <- n2[b] / sy

meany <- sy / n2[b]

sum1<-0

for(n in 0:(c-1)){

fact1<-factorial(n)

x1<-((lm/mu)^n)/fact1

sum1<-sum1+x1

}

fact2<-factorial(c)

p0<-(((((lm/mu)^c)/fact2)\*((1-(lm/(c\*mu))^(k-c+1))/(1-(lm/(c\*mu)))))+sum1)^(-1)

pk\_1<-(((lm/mu)^k)/((c^(k-c))\*fact2))\*p0

sum2<-0

for(n in 0:(c-1)){

fact3<-factorial(n)

x2<-((meany/meanx)^n)/fact3

sum2<-sum2+x2

}

p0\_1<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum2)^(-1)

pk\_2<-(((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_1

e\_pk[t]<-abs(pk\_1-pk\_2)

p\_pk<-100\*(e\_pk[t]/pk\_1)

mse\_pk<-mse\_pk+e\_pk[t]^2

mape\_pk<-mape\_pk+abs(p\_pk)

mae\_pk<-mae\_pk+e\_pk[t]

if(meany<=rho\_0\_1\*meanx\*c){

sum3<-0

for(n in 0:(c-1)){

fact4<-factorial(n)

x3<-((meany/meanx)^n)/fact4

sum3<-sum3+x3

}

p0\_2<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum3)^(-1)

pk\_3<-(((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_2

} else{

sum4<-0

for(n in 0:(c-1)){

fact5<-factorial(n)

x4<-((c\*rho\_0\_1)^n)/fact5

sum4<-sum4+x4

}

p0\_3<-(((((c\*rho\_0\_1)^c)/fact2)\*((1-(rho\_0\_1)^(k-c+1))/(1-(rho\_0\_1))))+sum4)^(-1)

pk\_3<-(((c\*rho\_0\_1)^k)/((c^(k-c))\*fact2))\*p0\_3

}

e\_pk1[t]<-abs(pk\_1-pk\_3)

p\_pk1<-100\*(e\_pk1[t]/pk\_1)

mse\_pk1<-mse\_pk1+e\_pk1[t]^2

mape\_pk1<-mape\_pk1+abs(p\_pk1)

mae\_pk1<-mae\_pk1+e\_pk1[t]

if(meany<=rho\_0\_2\*meanx\*c){

sum5<-0

for(n in 0:(c-1)){

fact6<-factorial(n)

x5<-((meany/meanx)^n)/fact6

sum5<-sum5+x5

}

p0\_4<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum5)^(-1)

pk\_4<-(((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_4

} else{

sum6<-0

for(n in 0:(c-1)){

fact7<-factorial(n)

x6<-((c\*rho\_0\_2)^n)/fact7

sum6<-sum6+x6

}

p0\_5<-(((((c\*rho\_0\_2)^c)/fact2)\*((1-(rho\_0\_2)^(k-c+1))/(1-(rho\_0\_2))))+sum6)^(-1)

pk\_4<-(((c\*rho\_0\_2)^k)/((c^(k-c))\*fact2))\*p0\_5

}

e\_pk2[t]<-abs(pk\_1-pk\_4)

p\_pk2<-100\*(e\_pk2[t]/pk\_1)

mse\_pk2<-mse\_pk2+e\_pk2[t]^2

mape\_pk2<-mape\_pk2+abs(p\_pk2)

mae\_pk2<-mae\_pk2+e\_pk2[t]

if(meany<=rho\_0\_3\*meanx\*c){

sum7<-0

for(n in 0:(c-1)){

fact8<-factorial(n)

x7<-((meany/meanx)^n)/fact8

sum7<-sum7+x7

}

p0\_6<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum7)^(-1)

pk\_5<-(((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_6

} else{

sum8<-0

for(n in 0:(c-1)){

fact9<-factorial(n)

x8<-((c\*rho\_0\_3)^n)/fact9

sum8<-sum8+x8

}

p0\_7<-(((((c\*rho\_0\_3)^c)/fact2)\*((1-(rho\_0\_3)^(k-c+1))/(1-(rho\_0\_3))))+sum8)^(-1)

pk\_5<-(((c\*rho\_0\_3)^k)/((c^(k-c))\*fact2))\*p0\_7

}

e\_pk3[t]<-abs(pk\_1-pk\_5)

p\_pk3<-100\*(e\_pk3[t]/pk\_1)

mse\_pk3<-mse\_pk3+e\_pk3[t]^2

mape\_pk3<-mape\_pk3+abs(p\_pk3)

mae\_pk3<-mae\_pk3+e\_pk3[t]

}

e\_pk<-sort(e\_pk)

median\_pk<-(e\_pk[4999]+e\_pk[5000])/2

q90\_pk<-(e\_pk[8999]+e\_pk[9000])/2

q25\_pk<-(e\_pk[2499]+e\_pk[2500])/2

e\_pk1<-sort(e\_pk1)

median\_pk1<-(e\_pk1[4999]+e\_pk1[5000])/2

q90\_pk1<-(e\_pk1[8999]+e\_pk1[9000])/2

q25\_pk1<-(e\_pk1[2499]+e\_pk1[2500])/2

e\_pk2<-sort(e\_pk2)

median\_pk2<-(e\_pk2[4999]+e\_pk2[5000])/2

q90\_pk2<-(e\_pk2[8999]+e\_pk2[9000])/2

q25\_pk2<-(e\_pk2[2499]+e\_pk2[2500])/2

e\_pk3<-sort(e\_pk3)

median\_pk3<-(e\_pk3[4999]+e\_pk3[5000])/2

q90\_pk3<-(e\_pk3[8999]+e\_pk3[9000])/2

q25\_pk3<-(e\_pk3[2499]+e\_pk3[2500])/2

matmse\_pk[a,b]<-(mse\_pk/10000)

matmape\_pk[a,b]<-(mape\_pk/10000)

matmae\_pk[a,b]<-(mae\_pk/10000)

matmedian\_pk[a,b]<-median\_pk

matq90\_pk[a,b]<-q90\_pk

matq25\_pk[a,b]<-q25\_pk

matmse\_pk\_1[a,b]<-(mse\_pk1/10000)

matmape\_pk\_1[a,b]<-(mape\_pk1/10000)

matmae\_pk\_1[a,b]<-(mae\_pk1/10000)

matmedian\_pk\_1[a,b]<-median\_pk1

matq90\_pk\_1[a,b]<-q90\_pk1

matq25\_pk\_1[a,b]<-q25\_pk1

matmse\_pk\_2[a,b]<-(mse\_pk2/10000)

matmape\_pk\_2[a,b]<-(mape\_pk2/10000)

matmae\_pk\_2[a,b]<-(mae\_pk2/10000)

matmedian\_pk\_2[a,b]<-median\_pk2

matq90\_pk\_2[a,b]<-q90\_pk2

matq25\_pk\_2[a,b]<-q25\_pk2

matmse\_pk\_3[a,b]<-(mse\_pk3/10000)

matmape\_pk\_3[a,b]<-(mape\_pk3/10000)

matmae\_pk\_3[a,b]<-(mae\_pk3/10000)

matmedian\_pk\_3[a,b]<-median\_pk3

matq90\_pk\_3[a,b]<-q90\_pk3

matq25\_pk\_3[a,b]<-q25\_pk3

}

}

cat("\n\n estimates of pk for mse using substitution estimators")

cat("\t")

cat("\n\n the mse\_pk matrix is")

for(a in 0:4){

cat("\n\n")

for(b in 0:4){

cat("\t", matmse\_pk[a, b])

}

}

cat("\n\n estimates of pk for mse using alternative estimators using rho\_0\_1")

cat("\t")

cat("\n\n the mse\_pk\_1 matrix is")

for(a in 0:4){

cat("\n\n")

for(b in 0:4){

cat("\t", matmse\_pk\_1[a, b])

}

}

cat("\n\n estimates of pk for mse using alternative estimators using rho\_0\_2")

cat("\t")

cat("\n\n the mse\_pk\_2 matrix is")

for(a in 0:4){

cat("\n\n")

for(b in 0:4){

cat("\t", matmse\_pk\_2[a, b])

}

}

cat("\n\n estimates of pk for mse using alternative estimators using rho\_0\_3")

cat("\t")

cat("\n\n the mse\_pk\_3 matrix is")

for(a in 0:4){

cat("\n\n")

for(b in 0:4){

cat("\t", matmse\_pk\_3[a, b])

}

}

cat("\n\n estimates of pk for mape using substitution estimators")

cat("\t")

cat("\n\n the mape\_pk matrix is")

for(a in 0:4){

cat("\n\n")

for(b in 0:4){

cat("\t", matmape\_pk[a, b])

}

}

cat("\n\n estimates of pk for mape using alternative estimators using rho\_0\_1")

cat("\t")

cat("\n\n the mape\_pk\_1 matrix is")

for(a in 0:4){

cat("\n\n")

for(b in 0:4){

cat("\t", matmape\_pk\_1[a, b])

}

}

cat("\n\n estimates of pk for mape using alternative estimators using rho\_0\_2")

cat("\t")

cat("\n\n the mape\_pk\_2 matrix is")

for(a in 0:4){

cat("\n\n")

for(b in 0:4){

cat("\t", matmape\_pk\_2[a, b])

}

}

cat("\n\n estimates of pk for mape using alternative estimators using rho\_0\_3")

cat("\t")

cat("\n\n the mape\_pk\_3 matrix is")

for(a in 0:4){

cat("\n\n")

for(b in 0:4){

cat("\t", matmape\_pk\_3[a, b])

}

}

cat("\n\n estimates of pk for mae using substitution estimators")

cat("\t")

cat("\n\n the mae\_pk matrix is")

for(a in 0:4){

cat("\n\n")

for(b in 0:4){

cat("\t", matmae\_pk[a, b])

}

}

cat("\n\n estimates of pk for mae using alternative estimators using rho\_0\_1")

cat("\t")

cat("\n\n the mae\_pk\_1 matrix is")

for(a in 0:4){

cat("\n\n")

for(b in 0:4){

cat("\t", matmae\_pk\_1[a, b])

}

}

cat("\n\n estimates of pk for mae using alternative estimators using rho\_0\_2")

cat("\t")

cat("\n\n the mae\_pk\_2 matrix is")

for(a in 0:4){

cat("\n\n")

for(b in 0:4){

cat("\t", matmae\_pk\_2[a, b])

}

}

cat("\n\n estimates of pk for mae using alternative estimators using rho\_0\_3")

cat("\t")

cat("\n\n the mae\_pk\_3 matrix is")

for(a in 0:4){

cat("\n\n")

for(b in 0:4){

cat("\t", matmae\_pk\_3[a, b])

}

}

cat("\n\n estimates of pk for mdae using substitution estimators")

cat("\t")

cat("\n\n the median\_pk matrix is")

for(a in 0:4){

cat("\n\n")

for(b in 0:4){

cat("\t", matmedian\_pk[a, b])

}

}

cat("\n\n estimates of pk for mdae using alternative estimators using rho\_0\_1")

cat("\t")

cat("\n\n the median\_pk\_1 matrix is")

for(a in 0:4){

cat("\n\n")

for(b in 0:4){

cat("\t", matmedian\_pk\_1[a, b])

}

}

cat("\n\n estimates of pk for mdae using alternative estimators using rho\_0\_2")

cat("\t")

cat("\n\n the median\_pk\_2 matrix is")

for(a in 0:4){

cat("\n\n")

for(b in 0:4){

cat("\t", matmedian\_pk\_2[a, b])

}

}

cat("\n\n estimates of pk for mdae using alternative estimators using rho\_0\_3")

cat("\t")

cat("\n\n the median\_pk\_3 matrix is")

for(a in 0:4){

cat("\n\n")

for(b in 0:4){

cat("\t", matmedian\_pk\_3[a, b])

}

}

cat("\n\n estimates of pk for 90th percentile using substitution estimators")

cat("\t")

cat("\n\n the q90\_pk matrix is")

for(a in 0:4){

cat("\n\n")

for(b in 0:4){

cat("\t", matq90\_pk[a, b])

}

}

cat("\n\n estimates of pk for 90th percentile using alternative estimators using rho\_0\_1")

cat("\t")

cat("\n\n the q90\_pk\_1 matrix is")

for(a in 0:4){

cat("\n\n")

for(b in 0:4){

cat("\t", matq90\_pk\_1[a, b])

}

}

cat("\n\n estimates of pk for 90th percentile using alternative estimators using rho\_0\_2")

cat("\t")

cat("\n\n the q90\_pk\_2 matrix is")

for(a in 0:4){

cat("\n\n")

for(b in 0:4){

cat("\t", matq90\_pk\_2[a, b])

}

}

cat("\n\n estimates of pk for 90th percentile using alternative estimators using rho\_0\_3")

cat("\t")

cat("\n\n the q90\_pk\_3 matrix is")

for(a in 0:4){

cat("\n\n")

for(b in 0:4){

cat("\t", matq90\_pk\_3[a, b])

}

}

cat("\n\n estimates of pk for 25th percentile using substitution estimators")

cat("\t")

cat("\n\n the q25\_pk matrix is")

for(a in 0:4){

cat("\n\n")

for(b in 0:4){

cat("\t", matq25\_pk[a, b])

}

}

cat("\n\n estimates of pk for 25th percentile using alternative estimators using rho\_0\_1")

cat("\t")

cat("\n\n the q25\_pk\_1 matrix is")

for(a in 0:4){

cat("\n\n")

for(b in 0:4){

cat("\t", matq25\_pk\_1[a, b])

}

}

cat("\n\n estimates of pk for 25th percentile using alternative estimators using rho\_0\_2")

cat("\t")

cat("\n\n the q25\_pk\_2 matrix is")

for(a in 0:4){

cat("\n\n")

for(b in 0:4){

cat("\t", matq25\_pk\_2[a, b])

}

}

cat("\n\n estimates of pk for 25th percentile using alternative estimators using rho\_0\_3")

cat("\t")

cat("\n\n the q25\_pk\_3 matrix is")

for(a in 0:4){

cat("\n\n")

for(b in 0:4){

cat("\t", matq25\_pk\_3[a, b])

}

}

##########

## 2 Expected Queue Length (lq)

lm <- 126

mu <- 20

c <- 7

k<-20

rho\_0\_1 <- 0.92

rho\_0\_2 <- 0.95

rho\_0\_3 <- 0.98

n1 <- c(30, 50, 100)

n2 <- c(30, 50, 100)

matmse\_lq <- matrix(0, nrow = 3, ncol = 3)

matmse\_lq\_1 <- matrix(0, nrow = 3, ncol = 3)

matmse\_lq\_2 <- matrix(0, nrow = 3, ncol = 3)

matmse\_lq\_3 <- matrix(0, nrow = 3, ncol = 3)

matmape\_lq <- matrix(0, nrow = 3, ncol = 3)

matmape\_lq\_1 <- matrix(0, nrow = 3, ncol = 3)

matmape\_lq\_2 <- matrix(0, nrow = 3, ncol = 3)

matmape\_lq\_3 <- matrix(0, nrow = 3, ncol = 3)

matmae\_lq <- matrix(0, nrow = 3, ncol = 3)

matmae\_lq\_1 <- matrix(0, nrow = 3, ncol = 3)

matmae\_lq\_2 <- matrix(0, nrow = 3, ncol = 3)

matmae\_lq\_3 <- matrix(0, nrow = 3, ncol = 3)

matmedian\_lq <- matrix(0, nrow = 3, ncol = 3)

matmedian\_lq\_1 <- matrix(0, nrow = 3, ncol = 3)

matmedian\_lq\_2 <- matrix(0, nrow = 3, ncol = 3)

matmedian\_lq\_3 <- matrix(0, nrow = 3, ncol = 3)

matq90\_lq <- matrix(0, nrow = 3, ncol = 3)

matq90\_lq\_1 <- matrix(0, nrow = 3, ncol = 3)

matq90\_lq\_2 <- matrix(0, nrow = 3, ncol = 3)

matq90\_lq\_3 <- matrix(0, nrow = 3, ncol = 3)

matq25\_lq <- matrix(0, nrow = 3, ncol = 3)

matq25\_lq\_1 <- matrix(0, nrow = 3, ncol = 3)

matq25\_lq\_2 <- matrix(0, nrow = 3, ncol = 3)

matq25\_lq\_3 <- matrix(0, nrow = 3, ncol = 3)

for (a in 1:3) {

for (b in 1:3) {

mse\_lq <- 0

mse\_lq1 <- 0

mse\_lq2 <- 0

mse\_lq3 <- 0

mape\_lq <- 0

mape\_lq1 <- 0

mape\_lq2 <- 0

mape\_lq3 <- 0

mae\_lq <- 0

mae\_lq1 <- 0

mae\_lq2 <- 0

mae\_lq3 <- 0

e\_lq<-numeric(10000)

e\_lq1<-numeric(10000)

e\_lq2<-numeric(10000)

e\_lq3<-numeric(10000)

for (t in 1:10000) {

sx <- 0

sy <- 0

for (i in 1:n1[a]) {

random <- runif(1)

x <- log(1 - random) / (-lm)

sx <- sx + x

}

lambda <- n1[a] / sx

meanx <- sx / n1[a]

for (j in 1:n2[b]) {

random <- runif(1)

y <- log(1 - random) / (-mu)

sy <- sy + y

}

meu <- n2[b] / sy

meany <- sy / n2[b]

sum1<-0

for(n in 0:(c-1)){

fact1<-factorial(n)

x1<-((lm/mu)^n)/fact1

sum1<-sum1+x1

}

fact2<-factorial(c)

p0<-(((((lm/mu)^c)/fact2)\*((1-(lm/(c\*mu))^(k-c+1))/(1-(lm/(c\*mu)))))+sum1)^(-1)

lq\_1<-((p0\*((lm/mu)^c)\*(lm/(c\*mu)))/(fact2\*(1-(lm/(c\*mu)))^2))\*(1-((lm/(c\*mu))^(k-c+1))-(1-(lm/(c\*mu)))\*(k-c+1)\*(lm/(c\*mu))^(k-c))

sum2<-0

for(n in 0:(c-1)){

fact3<-factorial(n)

x2<-((meany/meanx)^n)/fact3

sum2<-sum2+x2

}

p0\_1<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum2)^(-1)

lq\_2<-((p0\_1\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c))

e\_lq[t]<-abs(lq\_1-lq\_2)

p\_lq<-100\*(e\_lq[t]/lq\_1)

mse\_lq<-mse\_lq+e\_lq[t]^2

mape\_lq<-mape\_lq+abs(p\_lq)

mae\_lq<-mae\_lq+e\_lq[t]

if(meany<=rho\_0\_1\*meanx\*c){

sum3<-0

for(n in 0:(c-1)){

fact4<-factorial(n)

x3<-((meany/meanx)^n)/fact4

sum3<-sum3+x3

}

p0\_2<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum3)^(-1)

lq\_3<-((p0\_2\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c))

} else{

sum4<-0

for(n in 0:(c-1)){

fact5<-factorial(n)

x4<-((c\*rho\_0\_1)^n)/fact5

sum4<-sum4+x4

}

p0\_3<-(((((c\*rho\_0\_1)^c)/fact2)\*((1-(rho\_0\_1)^(k-c+1))/(1-(rho\_0\_1))))+sum4)^(-1)

lq\_3<-((p0\_3\*((c\*rho\_0\_1)^c)\*rho\_0\_1)/(fact2\*(1-(rho\_0\_1))^2))\*(1-((rho\_0\_1)^(k-c+1))-(1-(rho\_0\_1))\*(k-c+1)\*(rho\_0\_1)^(k-c))

}

e\_lq1[t]<-abs(lq\_1-lq\_3)

p\_lq1<-100\*(e\_lq1[t]/lq\_1)

mse\_lq1<-mse\_lq1+e\_lq1[t]^2

mape\_lq1<-mape\_lq1+abs(p\_lq1)

mae\_lq1<-mae\_lq1+e\_lq1[t]

if(meany<=rho\_0\_2\*meanx\*c){

sum5<-0

for(n in 0:(c-1)){

fact6<-factorial(n)

x5<-((meany/meanx)^n)/fact6

sum5<-sum5+x5

}

p0\_4<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum5)^(-1)

lq\_4<-((p0\_4\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c))

} else{

sum6<-0

for(n in 0:(c-1)){

fact7<-factorial(n)

x6<-((c\*rho\_0\_2)^n)/fact7

sum6<-sum6+x6

}

p0\_5<-(((((c\*rho\_0\_2)^c)/fact2)\*((1-(rho\_0\_2)^(k-c+1))/(1-(rho\_0\_2))))+sum6)^(-1)

lq\_4<-((p0\_5\*((c\*rho\_0\_2)^c)\*rho\_0\_2)/(fact2\*(1-(rho\_0\_2))^2))\*(1-((rho\_0\_2)^(k-c+1))-(1-(rho\_0\_2))\*(k-c+1)\*(rho\_0\_2)^(k-c))

}

e\_lq2[t]<-abs(lq\_1-lq\_4)

p\_lq2<-100\*(e\_lq2[t]/lq\_1)

mse\_lq2<-mse\_lq2+e\_lq2[t]^2

mape\_lq2<-mape\_lq2+abs(p\_lq2)

mae\_lq2<-mae\_lq2+e\_lq2[t]

if(meany<=rho\_0\_3\*meanx\*c){

sum7<-0

for(n in 0:(c-1)){

fact8<-factorial(n)

x7<-((meany/meanx)^n)/fact8

sum7<-sum7+x7

}

p0\_6<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum7)^(-1)

lq\_5<-((p0\_6\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c))

} else{

sum8<-0

for(n in 0:(c-1)){

fact9<-factorial(n)

x8<-((c\*rho\_0\_3)^n)/fact9

sum8<-sum8+x8

}

p0\_7<-(((((c\*rho\_0\_3)^c)/fact2)\*((1-(rho\_0\_3)^(k-c+1))/(1-(rho\_0\_3))))+sum8)^(-1)

lq\_5<-((p0\_7\*((c\*rho\_0\_3)^c)\*rho\_0\_3)/(fact2\*(1-(rho\_0\_3))^2))\*(1-((rho\_0\_3)^(k-c+1))-(1-(rho\_0\_3))\*(k-c+1)\*(rho\_0\_3)^(k-c))

}

e\_lq3[t]<-abs(lq\_1-lq\_5)

p\_lq3<-100\*(e\_lq3[t]/lq\_1)

mse\_lq3<-mse\_lq3+e\_lq3[t]^2

mape\_lq3<-mape\_lq3+abs(p\_lq3)

mae\_lq3<-mae\_lq3+e\_lq3[t]

}

e\_lq<-sort(e\_lq)

median\_lq<-(e\_lq[4999]+e\_lq[5000])/2

q90\_lq<-(e\_lq[8999]+e\_lq[9000])/2

q25\_lq<-(e\_lq[2499]+e\_lq[2500])/2

e\_lq1<-sort(e\_lq1)

median\_lq1<-(e\_lq1[4999]+e\_lq1[5000])/2

q90\_lq1<-(e\_lq1[8999]+e\_lq1[9000])/2

q25\_lq1<-(e\_lq1[2499]+e\_lq1[2500])/2

e\_lq2<-sort(e\_lq2)

median\_lq2<-(e\_lq2[4999]+e\_lq2[5000])/2

q90\_lq2<-(e\_lq2[8999]+e\_lq2[9000])/2

q25\_lq2<-(e\_lq2[2499]+e\_lq2[2500])/2

e\_lq3<-sort(e\_lq3)

median\_lq3<-(e\_lq3[4999]+e\_lq3[5000])/2

q90\_lq3<-(e\_lq3[8999]+e\_lq3[9000])/2

q25\_lq3<-(e\_lq3[2499]+e\_lq3[2500])/2

matmse\_lq[a,b]<-(mse\_lq/10000)

matmape\_lq[a,b]<-(mape\_lq/10000)

matmae\_lq[a,b]<-(mae\_lq/10000)

matmedian\_lq[a,b]<-median\_lq

matq90\_lq[a,b]<-q90\_lq

matq25\_lq[a,b]<-q25\_lq

matmse\_lq\_1[a,b]<-(mse\_lq1/10000)

matmape\_lq\_1[a,b]<-(mape\_lq1/10000)

matmae\_lq\_1[a,b]<-(mae\_lq1/10000)

matmedian\_lq\_1[a,b]<-median\_lq1

matq90\_lq\_1[a,b]<-q90\_lq1

matq25\_lq\_1[a,b]<-q25\_lq1

matmse\_lq\_2[a,b]<-(mse\_lq2/10000)

matmape\_lq\_2[a,b]<-(mape\_lq2/10000)

matmae\_lq\_2[a,b]<-(mae\_lq2/10000)

matmedian\_lq\_2[a,b]<-median\_lq2

matq90\_lq\_2[a,b]<-q90\_lq2

matq25\_lq\_2[a,b]<-q25\_lq2

matmse\_lq\_3[a,b]<-(mse\_lq3/10000)

matmape\_lq\_3[a,b]<-(mape\_lq3/10000)

matmae\_lq\_3[a,b]<-(mae\_lq3/10000)

matmedian\_lq\_3[a,b]<-median\_lq3

matq90\_lq\_3[a,b]<-q90\_lq3

matq25\_lq\_3[a,b]<-q25\_lq3

}

}

cat("\n\n estimates of lq for mse using substitution estimators")

cat("\t")

cat("\n\n the mse\_lq matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmse\_lq[a, b])

}

}

cat("\n\n estimates of lq for mse using alternative estimators using rho\_0\_1")

cat("\t")

cat("\n\n the mse\_lq\_1 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmse\_lq\_1[a, b])

}

}

cat("\n\n estimates of lq for mse using alternative estimators using rho\_0\_2")

cat("\t")

cat("\n\n the mse\_lq\_2 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmse\_lq\_2[a, b])

}

}

cat("\n\n estimates of lq for mse using alternative estimators using rho\_0\_3")

cat("\t")

cat("\n\n the mse\_lq\_3 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmse\_lq\_3[a, b])

}

}

cat("\n\n estimates of lq for mape using substitution estimators")

cat("\t")

cat("\n\n the mape\_lq matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmape\_lq[a, b])

}

}

cat("\n\n estimates of lq for mape using alternative estimators using rho\_0\_1")

cat("\t")

cat("\n\n the mape\_lq\_1 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmape\_lq\_1[a, b])

}

}

cat("\n\n estimates of lq for mape using alternative estimators using rho\_0\_2")

cat("\t")

cat("\n\n the mape\_lq\_2 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmape\_lq\_2[a, b])

}

}

cat("\n\n estimates of lq for mape using alternative estimators using rho\_0\_3")

cat("\t")

cat("\n\n the mape\_lq\_3 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmape\_lq\_3[a, b])

}

}

cat("\n\n estimates of lq for mae using substitution estimators")

cat("\t")

cat("\n\n the mae\_lq matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmae\_lq[a, b])

}

}

cat("\n\n estimates of lq for mae using alternative estimators using rho\_0\_1")

cat("\t")

cat("\n\n the mae\_lq\_1 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmae\_lq\_1[a, b])

}

}

cat("\n\n estimates of lq for mae using alternative estimators using rho\_0\_2")

cat("\t")

cat("\n\n the mae\_lq\_2 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmae\_lq\_2[a, b])

}

}

cat("\n\n estimates of lq for mae using alternative estimators using rho\_0\_3")

cat("\t")

cat("\n\n the mae\_lq\_3 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmae\_lq\_3[a, b])

}

}

cat("\n\n estimates of lq for mdae using substitution estimators")

cat("\t")

cat("\n\n the median\_lq matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmedian\_lq[a, b])

}

}

cat("\n\n estimates of lq for mdae using alternative estimators using rho\_0\_1")

cat("\t")

cat("\n\n the median\_lq\_1 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmedian\_lq\_1[a, b])

}

}

cat("\n\n estimates of lq for mdae using alternative estimators using rho\_0\_2")

cat("\t")

cat("\n\n the median\_lq\_2 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmedian\_lq\_2[a, b])

}

}

cat("\n\n estimates of lq for mdae using alternative estimators using rho\_0\_3")

cat("\t")

cat("\n\n the median\_lq\_3 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmedian\_lq\_3[a, b])

}

}

cat("\n\n estimates of lq for 90th percentile using substitution estimators")

cat("\t")

cat("\n\n the q90\_lq matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq90\_lq[a, b])

}

}

cat("\n\n estimates of lq for 90th percentile using alternative estimators using rho\_0\_1")

cat("\t")

cat("\n\n the q90\_lq\_1 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq90\_lq\_1[a, b])

}

}

cat("\n\n estimates of lq for 90th percentile using alternative estimators using rho\_0\_2")

cat("\t")

cat("\n\n the q90\_lq\_2 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq90\_lq\_2[a, b])

}

}

cat("\n\n estimates of lq for 90th percentile using alternative estimators using rho\_0\_3")

cat("\t")

cat("\n\n the q90\_lq\_3 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq90\_lq\_3[a, b])

}

}

cat("\n\n estimates of lq for 25th percentile using substitution estimators")

cat("\t")

cat("\n\n the q25\_lq matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq25\_lq[a, b])

}

}

cat("\n\n estimates of lq for 25th percentile using alternative estimators using rho\_0\_1")

cat("\t")

cat("\n\n the q25\_lq\_1 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq25\_lq\_1[a, b])

}

}

cat("\n\n estimates of lq for 25th percentile using alternative estimators using rho\_0\_2")

cat("\t")

cat("\n\n the q25\_lq\_2 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq25\_lq\_2[a, b])

}

}

cat("\n\n estimates of lq for 25th percentile using alternative estimators using rho\_0\_3")

cat("\t")

cat("\n\n the q25\_lq\_3 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq25\_lq\_3[a, b])

}

}

########################################

#### 3 EXPECTED SYSTEM SIZE (L)

lm <- 126

mu <- 20

c <- 7

k<-20

rho\_0\_1 <- 0.92

rho\_0\_2 <- 0.95

rho\_0\_3 <- 0.98

n1 <- c(30, 50, 100)

n2 <- c(30, 50, 100)

matmse\_L <- matrix(0, nrow = 3, ncol = 3)

matmse\_L\_1 <- matrix(0, nrow = 3, ncol = 3)

matmse\_L\_2 <- matrix(0, nrow = 3, ncol = 3)

matmse\_L\_3 <- matrix(0, nrow = 3, ncol = 3)

matmape\_L <- matrix(0, nrow = 3, ncol = 3)

matmape\_L\_1 <- matrix(0, nrow = 3, ncol = 3)

matmape\_L\_2 <- matrix(0, nrow = 3, ncol = 3)

matmape\_L\_3 <- matrix(0, nrow = 3, ncol = 3)

matmae\_L <- matrix(0, nrow = 3, ncol = 3)

matmae\_L\_1 <- matrix(0, nrow = 3, ncol = 3)

matmae\_L\_2 <- matrix(0, nrow = 3, ncol = 3)

matmae\_L\_3 <- matrix(0, nrow = 3, ncol = 3)

matmedian\_L <- matrix(0, nrow = 3, ncol = 3)

matmedian\_L\_1 <- matrix(0, nrow = 3, ncol = 3)

matmedian\_L\_2 <- matrix(0, nrow = 3, ncol = 3)

matmedian\_L\_3 <- matrix(0, nrow = 3, ncol = 3)

matq90\_L <- matrix(0, nrow = 3, ncol = 3)

matq90\_L\_1 <- matrix(0, nrow = 3, ncol = 3)

matq90\_L\_2 <- matrix(0, nrow = 3, ncol = 3)

matq90\_L\_3 <- matrix(0, nrow = 3, ncol = 3)

matq25\_L <- matrix(0, nrow = 3, ncol = 3)

matq25\_L\_1 <- matrix(0, nrow = 3, ncol = 3)

matq25\_L\_2 <- matrix(0, nrow = 3, ncol = 3)

matq25\_L\_3 <- matrix(0, nrow = 3, ncol = 3)

for (a in 1:3) {

for (b in 1:3) {

mse\_L <- 0

mse\_L1 <- 0

mse\_L2 <- 0

mse\_L3 <- 0

mape\_L <- 0

mape\_L1 <- 0

mape\_L2 <- 0

mape\_L3 <- 0

mae\_L <- 0

mae\_L1 <- 0

mae\_L2 <- 0

mae\_L3 <- 0

e\_L<-numeric(10000)

e\_L1<-numeric(10000)

e\_L2<-numeric(10000)

e\_L3<-numeric(10000)

for (t in 1:10000) {

sx <- 0

sy <- 0

for (i in 1:n1[a]) {

random <- runif(1)

x <- log(1 - random) / (-lm)

sx <- sx + x

}

lambda <- n1[a] / sx

meanx <- sx / n1[a]

for (j in 1:n2[b]) {

random <- runif(1)

y <- log(1 - random) / (-mu)

sy <- sy + y

}

meu <- n2[b] / sy

meany <- sy / n2[b]

sum1<-0

for(n in 0:(c-1)){

fact1<-factorial(n)

x1<-((lm/mu)^n)/fact1

sum1<-sum1+x1

}

fact2<-factorial(c)

p0<-(((((lm/mu)^c)/fact2)\*((1-(lm/(c\*mu))^(k-c+1))/(1-(lm/(c\*mu)))))+sum1)^(-1)

L\_1<-(((p0\*((lm/mu)^c)\*(lm/(c\*mu)))/(fact2\*(1-(lm/(c\*mu)))^2))\*(1-((lm/(c\*mu))^(k-c+1))-(1-(lm/(c\*mu)))\*(k-c+1)\*(lm/(c\*mu))^(k-c)))+((lm/mu)\*(1-((((lm/mu)^k)/((c^(k-c))\*fact2))\*p0)))

sum2<-0

for(n in 0:(c-1)){

fact3<-factorial(n)

x2<-((meany/meanx)^n)/fact3

sum2<-sum2+x2

}

p0\_1<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum2)^(-1)

L\_2<-(((p0\_1\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c)))+((meany/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_1)))

e\_L[t]<-abs(L\_1-L\_2)

p\_L<-100\*(e\_L[t]/L\_1)

mse\_L<-mse\_L+e\_L[t]^2

mape\_L<-mape\_L+abs(p\_L)

mae\_L<-mae\_L+e\_L[t]

if(meany<=rho\_0\_1\*meanx\*c){

sum3<-0

for(n in 0:(c-1)){

fact4<-factorial(n)

x3<-((meany/meanx)^n)/fact4

sum3<-sum3+x3

}

p0\_2<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum3)^(-1)

L\_3<-(((p0\_2\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c)))+((meany/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_2)))

} else{

sum4<-0

for(n in 0:(c-1)){

fact5<-factorial(n)

x4<-((c\*rho\_0\_1)^n)/fact5

sum4<-sum4+x4

}

p0\_3<-(((((c\*rho\_0\_1)^c)/fact2)\*((1-(rho\_0\_1)^(k-c+1))/(1-(rho\_0\_1))))+sum4)^(-1)

L\_3<-(((p0\_3\*((c\*rho\_0\_1)^c)\*rho\_0\_1)/(fact2\*(1-(rho\_0\_1))^2))\*(1-((rho\_0\_1)^(k-c+1))-(1-(rho\_0\_1))\*(k-c+1)\*(rho\_0\_1)^(k-c)))+((c\*rho\_0\_1)\*(1-((((c\*rho\_0\_1)^k)/((c^(k-c))\*fact2))\*p0\_3)))

}

e\_L1[t]<-abs(L\_1-L\_3)

p\_L1<-100\*(e\_L1[t]/L\_1)

mse\_L1<-mse\_L1+e\_L1[t]^2

mape\_L1<-mape\_L1+abs(p\_L1)

mae\_L1<-mae\_L1+e\_L1[t]

if(meany<=rho\_0\_2\*meanx\*c){

sum5<-0

for(n in 0:(c-1)){

fact6<-factorial(n)

x5<-((meany/meanx)^n)/fact6

sum5<-sum5+x5

}

p0\_4<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum5)^(-1)

L\_4<-(((p0\_4\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c)))+((meany/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_4)))

} else{

sum6<-0

for(n in 0:(c-1)){

fact7<-factorial(n)

x6<-((c\*rho\_0\_2)^n)/fact7

sum6<-sum6+x6

}

p0\_5<-(((((c\*rho\_0\_2)^c)/fact2)\*((1-(rho\_0\_2)^(k-c+1))/(1-(rho\_0\_2))))+sum6)^(-1)

L\_4<-(((p0\_5\*((c\*rho\_0\_2)^c)\*rho\_0\_2)/(fact2\*(1-(rho\_0\_2))^2))\*(1-((rho\_0\_2)^(k-c+1))-(1-(rho\_0\_2))\*(k-c+1)\*(rho\_0\_2)^(k-c)))+((c\*rho\_0\_2)\*(1-((((c\*rho\_0\_2)^k)/((c^(k-c))\*fact2))\*p0\_5)))

}

e\_L2[t]<-abs(L\_1-L\_4)

p\_L2<-100\*(e\_L2[t]/L\_1)

mse\_L2<-mse\_L2+e\_L2[t]^2

mape\_L2<-mape\_L2+abs(p\_L2)

mae\_L2<-mae\_L2+e\_L2[t]

if(meany<=rho\_0\_3\*meanx\*c){

sum7<-0

for(n in 0:(c-1)){

fact8<-factorial(n)

x7<-((meany/meanx)^n)/fact8

sum7<-sum7+x7

}

p0\_6<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum7)^(-1)

L\_5<-(((p0\_6\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c)))+((meany/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_6)))

} else{

sum8<-0

for(n in 0:(c-1)){

fact9<-factorial(n)

x8<-((c\*rho\_0\_3)^n)/fact9

sum8<-sum8+x8

}

p0\_7<-(((((c\*rho\_0\_3)^c)/fact2)\*((1-(rho\_0\_3)^(k-c+1))/(1-(rho\_0\_3))))+sum8)^(-1)

L\_5<-(((p0\_7\*((c\*rho\_0\_3)^c)\*rho\_0\_3)/(fact2\*(1-(rho\_0\_3))^2))\*(1-((rho\_0\_3)^(k-c+1))-(1-(rho\_0\_3))\*(k-c+1)\*(rho\_0\_3)^(k-c)))+((c\*rho\_0\_3)\*(1-((((c\*rho\_0\_3)^k)/((c^(k-c))\*fact2))\*p0\_7)))

}

e\_L3[t]<-abs(L\_1-L\_5)

p\_L3<-100\*(e\_L3[t]/L\_1)

mse\_L3<-mse\_L3+e\_L3[t]^2

mape\_L3<-mape\_L3+abs(p\_L3)

mae\_L3<-mae\_L3+e\_L3[t]

}

e\_L<-sort(e\_L)

median\_L<-(e\_L[4999]+e\_L[5000])/2

q90\_L<-(e\_L[8999]+e\_L[9000])/2

q25\_L<-(e\_L[2499]+e\_L[2500])/2

e\_L1<-sort(e\_L1)

median\_L1<-(e\_L1[4999]+e\_L1[5000])/2

q90\_L1<-(e\_L1[8999]+e\_L1[9000])/2

q25\_L1<-(e\_L1[2499]+e\_L1[2500])/2

e\_L2<-sort(e\_L2)

median\_L2<-(e\_L2[4999]+e\_L2[5000])/2

q90\_L2<-(e\_L2[8999]+e\_L2[9000])/2

q25\_L2<-(e\_L2[2499]+e\_L2[2500])/2

e\_L3<-sort(e\_L3)

median\_L3<-(e\_L3[4999]+e\_L3[5000])/2

q90\_L3<-(e\_L3[8999]+e\_L3[9000])/2

q25\_L3<-(e\_L3[2499]+e\_L3[2500])/2

matmse\_L[a,b]<-(mse\_L/10000)

matmape\_L[a,b]<-(mape\_L/10000)

matmae\_L[a,b]<-(mae\_L/10000)

matmedian\_L[a,b]<-median\_L

matq90\_L[a,b]<-q90\_L

matq25\_L[a,b]<-q25\_L

matmse\_L\_1[a,b]<-(mse\_L1/10000)

matmape\_L\_1[a,b]<-(mape\_L1/10000)

matmae\_L\_1[a,b]<-(mae\_L1/10000)

matmedian\_L\_1[a,b]<-median\_L1

matq90\_L\_1[a,b]<-q90\_L1

matq25\_L\_1[a,b]<-q25\_L1

matmse\_L\_2[a,b]<-(mse\_L2/10000)

matmape\_L\_2[a,b]<-(mape\_L2/10000)

matmae\_L\_2[a,b]<-(mae\_L2/10000)

matmedian\_L\_2[a,b]<-median\_L2

matq90\_L\_2[a,b]<-q90\_L2

matq25\_L\_2[a,b]<-q25\_L2

matmse\_L\_3[a,b]<-(mse\_L3/10000)

matmape\_L\_3[a,b]<-(mape\_L3/10000)

matmae\_L\_3[a,b]<-(mae\_L3/10000)

matmedian\_L\_3[a,b]<-median\_L3

matq90\_L\_3[a,b]<-q90\_L3

matq25\_L\_3[a,b]<-q25\_L3

}

}

cat("\n\n estimates of l for mse using substitution estimators")

cat("\t")

cat("\n\n the mse\_L matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmse\_L[a, b])

}

}

cat("\n\n estimates of l for mse using alternative estimators using rho\_0\_1")

cat("\t")

cat("\n\n the mse\_L\_1 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmse\_L\_1[a, b])

}

}

cat("\n\n estimates of l for mse using alternative estimators using rho\_0\_2")

cat("\t")

cat("\n\n the mse\_L\_2 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmse\_L\_2[a, b])

}

}

cat("\n\n estimates of l for mse using alternative estimators using rho\_0\_3")

cat("\t")

cat("\n\n the mse\_L\_3 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmse\_L\_3[a, b])

}

}

cat("\n\n estimates of l for mape using substitution estimators")

cat("\t")

cat("\n\n the mape\_L matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmape\_L[a, b])

}

}

cat("\n\n estimates of l for mape using alternative estimators using rho\_0\_1")

cat("\t")

cat("\n\n the mape\_L\_1 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmape\_L\_1[a, b])

}

}

cat("\n\n estimates of l for mape using alternative estimators using rho\_0\_2")

cat("\t")

cat("\n\n the mape\_L\_2 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmape\_L\_2[a, b])

}

}

cat("\n\n estimates of l for mape using alternative estimators using rho\_0\_3")

cat("\t")

cat("\n\n the mape\_L\_3 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmape\_L\_3[a, b])

}

}

cat("\n\n estimates of l for mae using substitution estimators")

cat("\t")

cat("\n\n the mae\_L matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmae\_L[a, b])

}

}

cat("\n\n estimates of l for mae using alternative estimators using rho\_0\_1")

cat("\t")

cat("\n\n the mae\_L\_1 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmae\_L\_1[a, b])

}

}

cat("\n\n estimates of l for mae using alternative estimators using rho\_0\_2")

cat("\t")

cat("\n\n the mae\_L\_2 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmae\_L\_2[a, b])

}

}

cat("\n\n estimates of l for mae using alternative estimators using rho\_0\_3")

cat("\t")

cat("\n\n the mae\_L\_3 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmae\_L\_3[a, b])

}

}

cat("\n\n estimates of l for mdae using substitution estimators")

cat("\t")

cat("\n\n the median\_L matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmedian\_L[a, b])

}

}

cat("\n\n estimates of l for mdae using alternative estimators using rho\_0\_1")

cat("\t")

cat("\n\n the median\_L\_1 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmedian\_L\_1[a, b])

}

}

cat("\n\n estimates of l for mdae using alternative estimators using rho\_0\_2")

cat("\t")

cat("\n\n the median\_L\_2 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmedian\_L\_2[a, b])

}

}

cat("\n\n estimates of l for mdae using alternative estimators using rho\_0\_3")

cat("\t")

cat("\n\n the median\_L\_3 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmedian\_L\_3[a, b])

}

}

cat("\n\n estimates of l for 90th percentile using substitution estimators")

cat("\t")

cat("\n\n the q90\_L matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq90\_L[a, b])

}

}

cat("\n\n estimates of l for 90th percentile using alternative estimators using rho\_0\_1")

cat("\t")

cat("\n\n the q90\_L\_1 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq90\_L\_1[a, b])

}

}

cat("\n\n estimates of l for 90th percentile using alternative estimators using rho\_0\_2")

cat("\t")

cat("\n\n the q90\_L\_2 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq90\_L\_2[a, b])

}

}

cat("\n\n estimates of l for 90th percentile using alternative estimators using rho\_0\_3")

cat("\t")

cat("\n\n the q90\_L\_3 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq90\_L\_3[a, b])

}

}

cat("\n\n estimates of l for 25th percentile using substitution estimators")

cat("\t")

cat("\n\n the q25\_L matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq25\_L[a, b])

}

}

cat("\n\n estimates of l for 25th percentile using alternative estimators using rho\_0\_1")

cat("\t")

cat("\n\n the q25\_L\_1 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq25\_L\_1[a, b])

}

}

cat("\n\n estimates of l for 25th percentile using alternative estimators using rho\_0\_2")

cat("\t")

cat("\n\n the q25\_L\_2 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq25\_L\_2[a, b])

}

}

cat("\n\n estimates of l for 25th percentile using alternative estimators using rho\_0\_3")

cat("\t")

cat("\n\n the q25\_L\_3 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq25\_L\_3[a, b])

}

}

#############################

### 4 EXPECTED WAITING TIMES IN SYSTEM (W)

lm <- 126

mu <- 20

c <- 7

k<-20

rho\_0\_1 <- 0.92

rho\_0\_2 <- 0.95

rho\_0\_3 <- 0.98

n1 <- c(30, 50, 100)

n2 <- c(30, 50, 100)

matmse\_W <- matrix(0, nrow = 3, ncol = 3)

matmse\_W\_1 <- matrix(0, nrow = 3, ncol = 3)

matmse\_W\_2 <- matrix(0, nrow = 3, ncol = 3)

matmse\_W\_3 <- matrix(0, nrow = 3, ncol = 3)

matmape\_W <- matrix(0, nrow = 3, ncol = 3)

matmape\_W\_1 <- matrix(0, nrow = 3, ncol = 3)

matmape\_W\_2 <- matrix(0, nrow = 3, ncol = 3)

matmape\_W\_3 <- matrix(0, nrow = 3, ncol = 3)

matmae\_W <- matrix(0, nrow = 3, ncol = 3)

matmae\_W\_1 <- matrix(0, nrow = 3, ncol = 3)

matmae\_W\_2 <- matrix(0, nrow = 3, ncol = 3)

matmae\_W\_3 <- matrix(0, nrow = 3, ncol = 3)

matmedian\_W <- matrix(0, nrow = 3, ncol = 3)

matmedian\_W\_1 <- matrix(0, nrow = 3, ncol = 3)

matmedian\_W\_2 <- matrix(0, nrow = 3, ncol = 3)

matmedian\_W\_3 <- matrix(0, nrow = 3, ncol = 3)

matq90\_W <- matrix(0, nrow = 3, ncol = 3)

matq90\_W\_1 <- matrix(0, nrow = 3, ncol = 3)

matq90\_W\_2 <- matrix(0, nrow = 3, ncol = 3)

matq90\_W\_3 <- matrix(0, nrow = 3, ncol = 3)

matq25\_W <- matrix(0, nrow = 3, ncol = 3)

matq25\_W\_1 <- matrix(0, nrow = 3, ncol = 3)

matq25\_W\_2 <- matrix(0, nrow = 3, ncol = 3)

matq25\_W\_3 <- matrix(0, nrow = 3, ncol = 3)

for (a in 1:3) {

for (b in 1:3) {

mse\_W <- 0

mse\_W1 <- 0

mse\_W2 <- 0

mse\_W3 <- 0

mape\_W <- 0

mape\_W1 <- 0

mape\_W2 <- 0

mape\_W3 <- 0

mae\_W <- 0

mae\_W1 <- 0

mae\_W2 <- 0

mae\_W3 <- 0

e\_W<-numeric(10000)

e\_W1<-numeric(10000)

e\_W2<-numeric(10000)

e\_W3<-numeric(10000)

for (t in 1:10000) {

sx <- 0

sy <- 0

for (i in 1:n1[a]) {

random <- runif(1)

x <- log(1 - random) / (-lm)

sx <- sx + x

}

lambda <- n1[a] / sx

meanx <- sx / n1[a]

for (j in 1:n2[b]) {

random <- runif(1)

y <- log(1 - random) / (-mu)

sy <- sy + y

}

meu <- n2[b] / sy

meany <- sy / n2[b]

sum1<-0

for(n in 0:(c-1)){

fact1<-factorial(n)

x1<-((lm/mu)^n)/fact1

sum1<-sum1+x1

}

fact2<-factorial(c)

p0<-(((((lm/mu)^c)/fact2)\*((1-(lm/(c\*mu))^(k-c+1))/(1-(lm/(c\*mu)))))+sum1)^(-1)

W\_1<-((((p0\*((lm/mu)^c)\*(lm/(c\*mu)))/(fact2\*(1-(lm/(c\*mu)))^2))\*(1-((lm/(c\*mu))^(k-c+1))-(1-(lm/(c\*mu)))\*(k-c+1)\*(lm/(c\*mu))^(k-c)))+((lm/mu)\*(1-((((lm/mu)^k)/((c^(k-c))\*fact2))\*p0))))/(lm\*(1-((((lm/mu)^k)/((c^(k-c))\*fact2))\*p0)))

sum2<-0

for(n in 0:(c-1)){

fact3<-factorial(n)

x2<-((meany/meanx)^n)/fact3

sum2<-sum2+x2

}

p0\_1<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum2)^(-1)

W\_2<-((((p0\_1\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c)))+((meany/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_1))))/((1/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_1)))

e\_W[t]<-abs(W\_1-W\_2)

p\_W<-100\*(e\_W[t]/W\_1)

mse\_W<-mse\_W+e\_W[t]^2

mape\_W<-mape\_W+abs(p\_W)

mae\_W<-mae\_W+e\_W[t]

if(meany<=rho\_0\_1\*meanx\*c){

sum3<-0

for(n in 0:(c-1)){

fact4<-factorial(n)

x3<-((meany/meanx)^n)/fact4

sum3<-sum3+x3

}

p0\_2<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum3)^(-1)

W\_3<-((((p0\_2\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c)))+((meany/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_2))))/((1/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_2)))

} else{

sum4<-0

for(n in 0:(c-1)){

fact5<-factorial(n)

x4<-((c\*rho\_0\_1)^n)/fact5

sum4<-sum4+x4

}

p0\_3<-(((((c\*rho\_0\_1)^c)/fact2)\*((1-(rho\_0\_1)^(k-c+1))/(1-(rho\_0\_1))))+sum4)^(-1)

W\_3<-((((p0\_3\*((c\*rho\_0\_1)^c)\*rho\_0\_1)/(fact2\*(1-(rho\_0\_1))^2))\*(1-((rho\_0\_1)^(k-c+1))-(1-(rho\_0\_1))\*(k-c+1)\*(rho\_0\_1)^(k-c)))+((c\*rho\_0\_1)\*(1-((((c\*rho\_0\_1)^k)/((c^(k-c))\*fact2))\*p0\_3))))/(((c\*rho\_0\_1)/meany)\*(1-((((c\*rho\_0\_1)^k)/((c^(k-c))\*fact2))\*p0\_3)))

}

e\_W1[t]<-abs(W\_1-W\_3)

p\_W1<-100\*(e\_W1[t]/W\_1)

mse\_W1<-mse\_W1+e\_W1[t]^2

mape\_W1<-mape\_W1+abs(p\_W1)

mae\_W1<-mae\_W1+e\_W1[t]

if(meany<=rho\_0\_2\*meanx\*c){

sum5<-0

for(n in 0:(c-1)){

fact6<-factorial(n)

x5<-((meany/meanx)^n)/fact6

sum5<-sum5+x5

}

p0\_4<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum5)^(-1)

W\_4<-((((p0\_4\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c)))+((meany/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_4))))/((1/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_4)))

} else{

sum6<-0

for(n in 0:(c-1)){

fact7<-factorial(n)

x6<-((c\*rho\_0\_2)^n)/fact7

sum6<-sum6+x6

}

p0\_5<-(((((c\*rho\_0\_2)^c)/fact2)\*((1-(rho\_0\_2)^(k-c+1))/(1-(rho\_0\_2))))+sum6)^(-1)

W\_4<-((((p0\_5\*((c\*rho\_0\_2)^c)\*rho\_0\_2)/(fact2\*(1-(rho\_0\_2))^2))\*(1-((rho\_0\_2)^(k-c+1))-(1-(rho\_0\_2))\*(k-c+1)\*(rho\_0\_2)^(k-c)))+((c\*rho\_0\_2)\*(1-((((c\*rho\_0\_2)^k)/((c^(k-c))\*fact2))\*p0\_5))))/(((c\*rho\_0\_2)/meany)\*(1-((((c\*rho\_0\_2)^k)/((c^(k-c))\*fact2))\*p0\_5)))

}

e\_W2[t]<-abs(W\_1-W\_4)

p\_W2<-100\*(e\_W2[t]/W\_1)

mse\_W2<-mse\_W2+e\_W2[t]^2

mape\_W2<-mape\_W2+abs(p\_W2)

mae\_W2<-mae\_W2+e\_W2[t]

if(meany<=rho\_0\_3\*meanx\*c){

sum7<-0

for(n in 0:(c-1)){

fact8<-factorial(n)

x7<-((meany/meanx)^n)/fact8

sum7<-sum7+x7

}

p0\_6<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum7)^(-1)

W\_5<-((((p0\_6\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c)))+((meany/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_6))))/((1/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_6)))

} else{

sum8<-0

for(n in 0:(c-1)){

fact9<-factorial(n)

x8<-((c\*rho\_0\_3)^n)/fact9

sum8<-sum8+x8

}

p0\_7<-(((((c\*rho\_0\_3)^c)/fact2)\*((1-(rho\_0\_3)^(k-c+1))/(1-(rho\_0\_3))))+sum8)^(-1)

W\_5<-((((p0\_7\*((c\*rho\_0\_3)^c)\*rho\_0\_3)/(fact2\*(1-(rho\_0\_3))^2))\*(1-((rho\_0\_3)^(k-c+1))-(1-(rho\_0\_3))\*(k-c+1)\*(rho\_0\_3)^(k-c)))+((c\*rho\_0\_3)\*(1-((((c\*rho\_0\_3)^k)/((c^(k-c))\*fact2))\*p0\_7))))/(((c\*rho\_0\_3)/meany)\*(1-((((c\*rho\_0\_3)^k)/((c^(k-c))\*fact2))\*p0\_7)))

}

e\_W3[t]<-abs(W\_1-W\_5)

p\_W3<-100\*(e\_W3[t]/W\_1)

mse\_W3<-mse\_W3+e\_W3[t]^2

mape\_W3<-mape\_W3+abs(p\_W3)

mae\_W3<-mae\_W3+e\_W3[t]

}

e\_W<-sort(e\_W)

median\_W<-(e\_W[4999]+e\_W[5000])/2

q90\_W<-(e\_W[8999]+e\_W[9000])/2

q25\_W<-(e\_W[2499]+e\_W[2500])/2

e\_W1<-sort(e\_W1)

median\_W1<-(e\_W1[4999]+e\_W1[5000])/2

q90\_W1<-(e\_W1[8999]+e\_W1[9000])/2

q25\_W1<-(e\_W1[2499]+e\_W1[2500])/2

e\_W2<-sort(e\_W2)

median\_W2<-(e\_W2[4999]+e\_W2[5000])/2

q90\_W2<-(e\_W2[8999]+e\_W2[9000])/2

q25\_W2<-(e\_W2[2499]+e\_W2[2500])/2

e\_W3<-sort(e\_W3)

median\_W3<-(e\_W3[4999]+e\_W3[5000])/2

q90\_W3<-(e\_W3[8999]+e\_W3[9000])/2

q25\_W3<-(e\_W3[2499]+e\_W3[2500])/2

matmse\_W[a,b]<-(mse\_W/10000)

matmape\_W[a,b]<-(mape\_W/10000)

matmae\_W[a,b]<-(mae\_W/10000)

matmedian\_W[a,b]<-median\_W

matq90\_W[a,b]<-q90\_W

matq25\_W[a,b]<-q25\_W

matmse\_W\_1[a,b]<-(mse\_W1/10000)

matmape\_W\_1[a,b]<-(mape\_W1/10000)

matmae\_W\_1[a,b]<-(mae\_W1/10000)

matmedian\_W\_1[a,b]<-median\_W1

matq90\_W\_1[a,b]<-q90\_W1

matq25\_W\_1[a,b]<-q25\_W1

matmse\_W\_2[a,b]<-(mse\_W2/10000)

matmape\_W\_2[a,b]<-(mape\_W2/10000)

matmae\_W\_2[a,b]<-(mae\_W2/10000)

matmedian\_W\_2[a,b]<-median\_W2

matq90\_W\_2[a,b]<-q90\_W2

matq25\_W\_2[a,b]<-q25\_W2

matmse\_W\_3[a,b]<-(mse\_W3/10000)

matmape\_W\_3[a,b]<-(mape\_W3/10000)

matmae\_W\_3[a,b]<-(mae\_W3/10000)

matmedian\_W\_3[a,b]<-median\_W3

matq90\_W\_3[a,b]<-q90\_W3

matq25\_W\_3[a,b]<-q25\_W3

}

}

cat("\n\n estimates of w for mse using substitution estimators")

cat("\t")

cat("\n\n the mse\_W matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmse\_W[a, b])

}

}

cat("\n\n estimates of w for mse using alternative estimators using rho\_0\_1")

cat("\t")

cat("\n\n the mse\_W\_1 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmse\_W\_1[a, b])

}

}

cat("\n\n estimates of w for mse using alternative estimators using rho\_0\_2")

cat("\t")

cat("\n\n the mse\_W\_2 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmse\_W\_2[a, b])

}

}

cat("\n\n estimates of w for mse using alternative estimators using rho\_0\_3")

cat("\t")

cat("\n\n the mse\_W\_3 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmse\_W\_3[a, b])

}

}

cat("\n\n estimates of w for mape using substitution estimators")

cat("\t")

cat("\n\n the mape\_W matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmape\_W[a, b])

}

}

cat("\n\n estimates of w for mape using alternative estimators using rho\_0\_1")

cat("\t")

cat("\n\n the mape\_W\_1 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmape\_W\_1[a, b])

}

}

cat("\n\n estimates of w for mape using alternative estimators using rho\_0\_2")

cat("\t")

cat("\n\n the mape\_W\_2 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmape\_W\_2[a, b])

}

}

cat("\n\n estimates of w for mape using alternative estimators using rho\_0\_3")

cat("\t")

cat("\n\n the mape\_W\_3 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmape\_W\_3[a, b])

}

}

cat("\n\n estimates of w for mae using substitution estimators")

cat("\t")

cat("\n\n the mae\_W matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmae\_W[a, b])

}

}

cat("\n\n estimates of w for mae using alternative estimators using rho\_0\_1")

cat("\t")

cat("\n\n the mae\_W\_1 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmae\_W\_1[a, b])

}

}

cat("\n\n estimates of w for mae using alternative estimators using rho\_0\_2")

cat("\t")

cat("\n\n the mae\_W\_2 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmae\_W\_2[a, b])

}

}

cat("\n\n estimates of w for mae using alternative estimators using rho\_0\_3")

cat("\t")

cat("\n\n the mae\_W\_3 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmae\_W\_3[a, b])

}

}

cat("\n\n estimates of w for mdae using substitution estimators")

cat("\t")

cat("\n\n the median\_W matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmedian\_W[a, b])

}

}

cat("\n\n estimates of w for mdae using alternative estimators using rho\_0\_1")

cat("\t")

cat("\n\n the median\_W\_1 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmedian\_W\_1[a, b])

}

}

cat("\n\n estimates of w for mdae using alternative estimators using rho\_0\_2")

cat("\t")

cat("\n\n the median\_W\_2 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmedian\_W\_2[a, b])

}

}

cat("\n\n estimates of w for mdae using alternative estimators using rho\_0\_3")

cat("\t")

cat("\n\n the median\_W\_3 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmedian\_W\_3[a, b])

}

}

cat("\n\n estimates of w for 90th percentile using substitution estimators")

cat("\t")

cat("\n\n the q90\_W matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq90\_W[a, b])

}

}

cat("\n\n estimates of w for 90th percentile using alternative estimators using rho\_0\_1")

cat("\t")

cat("\n\n the q90\_W\_1 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq90\_W\_1[a, b])

}

}

cat("\n\n estimates of w for 90th percentile using alternative estimators using rho\_0\_2")

cat("\t")

cat("\n\n the q90\_W\_2 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq90\_W\_2[a, b])

}

}

cat("\n\n estimates of w for 90th percentile using alternative estimators using rho\_0\_3")

cat("\t")

cat("\n\n the q90\_W\_3 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq90\_W\_3[a, b])

}

}

cat("\n\n estimates of w for 25th percentile using substitution estimators")

cat("\t")

cat("\n\n the q25\_W matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq25\_W[a, b])

}

}

cat("\n\n estimates of w for 25th percentile using alternative estimators using rho\_0\_1")

cat("\t")

cat("\n\n the q25\_W\_1 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq25\_W\_1[a, b])

}

}

cat("\n\n estimates of w for 25th percentile using alternative estimators using rho\_0\_2")

cat("\t")

cat("\n\n the q25\_W\_2 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq25\_W\_2[a, b])

}

}

cat("\n\n estimates of w for 25th percentile using alternative estimators using rho\_0\_3")

cat("\t")

cat("\n\n the q25\_W\_3 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq25\_W\_3[a, b])

}

}

###################################

### 5 EXPECTED WAITING TIME IN QUEUE (Wq)

lm <- 126

mu <- 20

c <- 7

k<-20

rho\_0\_1 <- 0.92

rho\_0\_2 <- 0.95

rho\_0\_3 <- 0.98

n1 <- c(30, 50, 100)

n2 <- c(30, 50, 100)

matmse\_wq <- matrix(0, nrow = 3, ncol = 3)

matmse\_wq\_1 <- matrix(0, nrow = 3, ncol = 3)

matmse\_wq\_2 <- matrix(0, nrow = 3, ncol = 3)

matmse\_wq\_3 <- matrix(0, nrow = 3, ncol = 3)

matmape\_wq <- matrix(0, nrow = 3, ncol = 3)

matmape\_wq\_1 <- matrix(0, nrow = 3, ncol = 3)

matmape\_wq\_2 <- matrix(0, nrow = 3, ncol = 3)

matmape\_wq\_3 <- matrix(0, nrow = 3, ncol = 3)

matmae\_wq <- matrix(0, nrow = 3, ncol = 3)

matmae\_wq\_1 <- matrix(0, nrow = 3, ncol = 3)

matmae\_wq\_2 <- matrix(0, nrow = 3, ncol = 3)

matmae\_wq\_3 <- matrix(0, nrow = 3, ncol = 3)

matmedian\_wq <- matrix(0, nrow = 3, ncol = 3)

matmedian\_wq\_1 <- matrix(0, nrow = 3, ncol = 3)

matmedian\_wq\_2 <- matrix(0, nrow = 3, ncol = 3)

matmedian\_wq\_3 <- matrix(0, nrow = 3, ncol = 3)

matq90\_wq <- matrix(0, nrow = 3, ncol = 3)

matq90\_wq\_1 <- matrix(0, nrow = 3, ncol = 3)

matq90\_wq\_2 <- matrix(0, nrow = 3, ncol = 3)

matq90\_wq\_3 <- matrix(0, nrow = 3, ncol = 3)

matq25\_wq <- matrix(0, nrow = 3, ncol = 3)

matq25\_wq\_1 <- matrix(0, nrow = 3, ncol = 3)

matq25\_wq\_2 <- matrix(0, nrow = 3, ncol = 3)

matq25\_wq\_3 <- matrix(0, nrow = 3, ncol = 3)

for (a in 1:3) {

for (b in 1:3) {

mse\_wq <- 0

mse\_wq1 <- 0

mse\_wq2 <- 0

mse\_wq3 <- 0

mape\_wq <- 0

mape\_wq1 <- 0

mape\_wq2 <- 0

mape\_wq3 <- 0

mae\_wq <- 0

mae\_wq1 <- 0

mae\_wq2 <- 0

mae\_wq3 <- 0

e\_wq<-numeric(10000)

e\_wq1<-numeric(10000)

e\_wq2<-numeric(10000)

e\_wq3<-numeric(10000)

for (t in 1:10000) {

sx <- 0

sy <- 0

for (i in 1:n1[a]) {

random <- runif(1)

x <- log(1 - random) / (-lm)

sx <- sx + x

}

lambda <- n1[a] / sx

meanx <- sx / n1[a]

for (j in 1:n2[b]) {

random <- runif(1)

y <- log(1 - random) / (-mu)

sy <- sy + y

}

meu <- n2[b] / sy

meany <- sy / n2[b]

sum1<-0

for(n in 0:(c-1)){

fact1<-factorial(n)

x1<-((lm/mu)^n)/fact1

sum1<-sum1+x1

}

fact2<-factorial(c)

p0<-(((((lm/mu)^c)/fact2)\*((1-(lm/(c\*mu))^(k-c+1))/(1-(lm/(c\*mu)))))+sum1)^(-1)

wq\_1<-(((p0\*((lm/mu)^c)\*(lm/(c\*mu)))/(fact2\*(1-(lm/(c\*mu)))^2))\*(1-((lm/(c\*mu))^(k-c+1))-(1-(lm/(c\*mu)))\*(k-c+1)\*(lm/(c\*mu))^(k-c)))/(lm\*(1-((((lm/mu)^k)/((c^(k-c))\*fact2))\*p0)))

sum2<-0

for(n in 0:(c-1)){

fact3<-factorial(n)

x2<-((meany/meanx)^n)/fact3

sum2<-sum2+x2

}

p0\_1<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum2)^(-1)

wq\_2<-(((p0\_1\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c)))/((1/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_1)))

e\_wq[t]<-abs(wq\_1-wq\_2)

p\_wq<-100\*(e\_wq[t]/wq\_1)

mse\_wq<-mse\_wq+e\_wq[t]^2

mape\_wq<-mape\_wq+abs(p\_wq)

mae\_wq<-mae\_wq+e\_wq[t]

if(meany<=rho\_0\_1\*meanx\*c){

sum3<-0

for(n in 0:(c-1)){

fact4<-factorial(n)

x3<-((meany/meanx)^n)/fact4

sum3<-sum3+x3

}

p0\_2<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum3)^(-1)

wq\_3<-(((p0\_2\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c)))/((1/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_2)))

} else{

sum4<-0

for(n in 0:(c-1)){

fact5<-factorial(n)

x4<-((c\*rho\_0\_1)^n)/fact5

sum4<-sum4+x4

}

p0\_3<-(((((c\*rho\_0\_1)^c)/fact2)\*((1-(rho\_0\_1)^(k-c+1))/(1-(rho\_0\_1))))+sum4)^(-1)

wq\_3<-(((p0\_3\*((c\*rho\_0\_1)^c)\*rho\_0\_1)/(fact2\*(1-(rho\_0\_1))^2))\*(1-((rho\_0\_1)^(k-c+1))-(1-(rho\_0\_1))\*(k-c+1)\*(rho\_0\_1)^(k-c)))/(((c\*rho\_0\_1)/meany)\*(1-((((c\*rho\_0\_1)^k)/((c^(k-c))\*fact2))\*p0\_3)))

}

e\_wq1[t]<-abs(wq\_1-wq\_3)

p\_wq1<-100\*(e\_wq1[t]/wq\_1)

mse\_wq1<-mse\_wq1+e\_wq1[t]^2

mape\_wq1<-mape\_wq1+abs(p\_wq1)

mae\_wq1<-mae\_wq1+e\_wq1[t]

if(meany<=rho\_0\_2\*meanx\*c){

sum5<-0

for(n in 0:(c-1)){

fact6<-factorial(n)

x5<-((meany/meanx)^n)/fact6

sum5<-sum5+x5

}

p0\_4<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum5)^(-1)

wq\_4<-(((p0\_4\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c)))/((1/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_4)))

} else{

sum6<-0

for(n in 0:(c-1)){

fact7<-factorial(n)

x6<-((c\*rho\_0\_2)^n)/fact7

sum6<-sum6+x6

}

p0\_5<-(((((c\*rho\_0\_2)^c)/fact2)\*((1-(rho\_0\_2)^(k-c+1))/(1-(rho\_0\_2))))+sum6)^(-1)

wq\_4<-(((p0\_5\*((c\*rho\_0\_2)^c)\*rho\_0\_2)/(fact2\*(1-(rho\_0\_2))^2))\*(1-((rho\_0\_2)^(k-c+1))-(1-(rho\_0\_2))\*(k-c+1)\*(rho\_0\_2)^(k-c)))/(((c\*rho\_0\_2)/meany)\*(1-((((c\*rho\_0\_2)^k)/((c^(k-c))\*fact2))\*p0\_5)))

}

e\_wq2[t]<-abs(wq\_1-wq\_4)

p\_wq2<-100\*(e\_wq2[t]/wq\_1)

mse\_wq2<-mse\_wq2+e\_wq2[t]^2

mape\_wq2<-mape\_wq2+abs(p\_wq2)

mae\_wq2<-mae\_wq2+e\_wq2[t]

if(meany<=rho\_0\_3\*meanx\*c){

sum7<-0

for(n in 0:(c-1)){

fact8<-factorial(n)

x7<-((meany/meanx)^n)/fact8

sum7<-sum7+x7

}

p0\_6<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum7)^(-1)

wq\_5<-(((p0\_6\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c)))/((1/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_6)))

} else{

sum8<-0

for(n in 0:(c-1)){

fact9<-factorial(n)

x8<-((c\*rho\_0\_3)^n)/fact9

sum8<-sum8+x8

}

p0\_7<-(((((c\*rho\_0\_3)^c)/fact2)\*((1-(rho\_0\_3)^(k-c+1))/(1-(rho\_0\_3))))+sum8)^(-1)

wq\_5<-(((p0\_7\*((c\*rho\_0\_3)^c)\*rho\_0\_3)/(fact2\*(1-(rho\_0\_3))^2))\*(1-((rho\_0\_3)^(k-c+1))-(1-(rho\_0\_3))\*(k-c+1)\*(rho\_0\_3)^(k-c)))/(((c\*rho\_0\_3)/meany)\*(1-((((c\*rho\_0\_3)^k)/((c^(k-c))\*fact2))\*p0\_7)))

}

e\_wq3[t]<-abs(wq\_1-wq\_5)

p\_wq3<-100\*(e\_wq3[t]/wq\_1)

mse\_wq3<-mse\_wq3+e\_wq3[t]^2

mape\_wq3<-mape\_wq3+abs(p\_wq3)

mae\_wq3<-mae\_wq3+e\_wq3[t]

}

e\_wq<-sort(e\_wq)

median\_wq<-(e\_wq[4999]+e\_wq[5000])/2

q90\_wq<-(e\_wq[8999]+e\_wq[9000])/2

q25\_wq<-(e\_wq[2499]+e\_wq[2500])/2

e\_wq1<-sort(e\_wq1)

median\_wq1<-(e\_wq1[4999]+e\_wq1[5000])/2

q90\_wq1<-(e\_wq1[8999]+e\_wq1[9000])/2

q25\_wq1<-(e\_wq1[2499]+e\_wq1[2500])/2

e\_wq2<-sort(e\_wq2)

median\_wq2<-(e\_wq2[4999]+e\_wq2[5000])/2

q90\_wq2<-(e\_wq2[8999]+e\_wq2[9000])/2

q25\_wq2<-(e\_wq2[2499]+e\_wq2[2500])/2

e\_wq3<-sort(e\_wq3)

median\_wq3<-(e\_wq3[4999]+e\_wq3[5000])/2

q90\_wq3<-(e\_wq3[8999]+e\_wq3[9000])/2

q25\_wq3<-(e\_wq3[2499]+e\_wq3[2500])/2

matmse\_wq[a,b]<-(mse\_wq/10000)

matmape\_wq[a,b]<-(mape\_wq/10000)

matmae\_wq[a,b]<-(mae\_wq/10000)

matmedian\_wq[a,b]<-median\_wq

matq90\_wq[a,b]<-q90\_wq

matq25\_wq[a,b]<-q25\_wq

matmse\_wq\_1[a,b]<-(mse\_wq1/10000)

matmape\_wq\_1[a,b]<-(mape\_wq1/10000)

matmae\_wq\_1[a,b]<-(mae\_wq1/10000)

matmedian\_wq\_1[a,b]<-median\_wq1

matq90\_wq\_1[a,b]<-q90\_wq1

matq25\_wq\_1[a,b]<-q25\_wq1

matmse\_wq\_2[a,b]<-(mse\_wq2/10000)

matmape\_wq\_2[a,b]<-(mape\_wq2/10000)

matmae\_wq\_2[a,b]<-(mae\_wq2/10000)

matmedian\_wq\_2[a,b]<-median\_wq2

matq90\_wq\_2[a,b]<-q90\_wq2

matq25\_wq\_2[a,b]<-q25\_wq2

matmse\_wq\_3[a,b]<-(mse\_wq3/10000)

matmape\_wq\_3[a,b]<-(mape\_wq3/10000)

matmae\_wq\_3[a,b]<-(mae\_wq3/10000)

matmedian\_wq\_3[a,b]<-median\_wq3

matq90\_wq\_3[a,b]<-q90\_wq3

matq25\_wq\_3[a,b]<-q25\_wq3

}

}

cat("\n\n estimates of wq for mse using substitution estimators")

cat("\t")

cat("\n\n the mse\_wq matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmse\_wq[a, b])

}

}

cat("\n\n estimates of wq for mse using alternative estimators using rho\_0\_1")

cat("\t")

cat("\n\n the mse\_wq\_1 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmse\_wq\_1[a, b])

}

}

cat("\n\n estimates of wq for mse using alternative estimators using rho\_0\_2")

cat("\t")

cat("\n\n the mse\_wq\_2 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmse\_wq\_2[a, b])

}

}

cat("\n\n estimates of wq for mse using alternative estimators using rho\_0\_3")

cat("\t")

cat("\n\n the mse\_wq\_3 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmse\_wq\_3[a, b])

}

}

cat("\n\n estimates of wq for mape using substitution estimators")

cat("\t")

cat("\n\n the mape\_wq matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmape\_wq[a, b])

}

}

cat("\n\n estimates of wq for mape using alternative estimators using rho\_0\_1")

cat("\t")

cat("\n\n the mape\_wq\_1 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmape\_wq\_1[a, b])

}

}

cat("\n\n estimates of wq for mape using alternative estimators using rho\_0\_2")

cat("\t")

cat("\n\n the mape\_wq\_2 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmape\_wq\_2[a, b])

}

}

cat("\n\n estimates of wq for mape using alternative estimators using rho\_0\_3")

cat("\t")

cat("\n\n the mape\_wq\_3 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmape\_wq\_3[a, b])

}

}

cat("\n\n estimates of wq for mae using substitution estimators")

cat("\t")

cat("\n\n the mae\_wq matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmae\_wq[a, b])

}

}

cat("\n\n estimates of wq for mae using alternative estimators using rho\_0\_1")

cat("\t")

cat("\n\n the mae\_wq\_1 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmae\_wq\_1[a, b])

}

}

cat("\n\n estimates of wq for mae using alternative estimators using rho\_0\_2")

cat("\t")

cat("\n\n the mae\_wq\_2 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmae\_wq\_2[a, b])

}

}

cat("\n\n estimates of wq for mae using alternative estimators using rho\_0\_3")

cat("\t")

cat("\n\n the mae\_wq\_3 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmae\_wq\_3[a, b])

}

}

cat("\n\n estimates of wq for mdae using substitution estimators")

cat("\t")

cat("\n\n the median\_wq matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmedian\_wq[a, b])

}

}

cat("\n\n estimates of wq for mdae using alternative estimators using rho\_0\_1")

cat("\t")

cat("\n\n the median\_wq\_1 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmedian\_wq\_1[a, b])

}

}

cat("\n\n estimates of wq for mdae using alternative estimators using rho\_0\_2")

cat("\t")

cat("\n\n the median\_wq\_2 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmedian\_wq\_2[a, b])

}

}

cat("\n\n estimates of wq for mdae using alternative estimators using rho\_0\_3")

cat("\t")

cat("\n\n the median\_wq\_3 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matmedian\_wq\_3[a, b])

}

}

cat("\n\n estimates of wq for 90th percentile using substitution estimators")

cat("\t")

cat("\n\n the q90\_wq matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq90\_wq[a, b])

}

}

cat("\n\n estimates of wq for 90th percentile using alternative estimators using rho\_0\_1")

cat("\t")

cat("\n\n the q90\_wq\_1 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq90\_wq\_1[a, b])

}

}

cat("\n\n estimates of wq for 90th percentile using alternative estimators using rho\_0\_2")

cat("\t")

cat("\n\n the q90\_wq\_2 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq90\_wq\_2[a, b])

}

}

cat("\n\n estimates of wq for 90th percentile using alternative estimators using rho\_0\_3")

cat("\t")

cat("\n\n the q90\_wq\_3 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq90\_wq\_3[a, b])

}

}

cat("\n\n estimates of wq for 25th percentile using substitution estimators")

cat("\t")

cat("\n\n the q25\_wq matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq25\_wq[a, b])

}

}

cat("\n\n estimates of wq for 25th percentile using alternative estimators using rho\_0\_1")

cat("\t")

cat("\n\n the q25\_wq\_1 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq25\_wq\_1[a, b])

}

}

cat("\n\n estimates of wq for 25th percentile using alternative estimators using rho\_0\_2")

cat("\t")

cat("\n\n the q25\_wq\_2 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq25\_wq\_2[a, b])

}

}

cat("\n\n estimates of wq for 25th percentile using alternative estimators using rho\_0\_3")

cat("\t")

cat("\n\n the q25\_wq\_3 matrix is")

for(a in 0:3){

cat("\n\n")

for(b in 0:3){

cat("\t", matq25\_wq\_3[a, b])

}

}

$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

lm <- 6

mu <- 3

c <- 3

k<-200

rho\_0\_1 <- 0.72

rho\_0\_2 <- 0.70

rho\_0\_3 <- 0.72

n1 <- 100

n2 <- 100

matmse\_lq <- matrix(0, nrow = 3, ncol = 3)

matmse\_lq\_1 <- matrix(0, nrow = 3, ncol = 3)

matmse\_lq\_2 <- matrix(0, nrow = 3, ncol = 3)

matmse\_lq\_3 <- matrix(0, nrow = 3, ncol = 3)

matmape\_lq <- matrix(0, nrow = 3, ncol = 3)

matmape\_lq\_1 <- matrix(0, nrow = 3, ncol = 3)

matmape\_lq\_2 <- matrix(0, nrow = 3, ncol = 3)

matmape\_lq\_3 <- matrix(0, nrow = 3, ncol = 3)

matmae\_lq <- matrix(0, nrow = 3, ncol = 3)

matmae\_lq\_1 <- matrix(0, nrow = 3, ncol = 3)

matmae\_lq\_2 <- matrix(0, nrow = 3, ncol = 3)

matmae\_lq\_3 <- matrix(0, nrow = 3, ncol = 3)

matmedian\_lq <- matrix(0, nrow = 3, ncol = 3)

matmedian\_lq\_1 <- matrix(0, nrow = 3, ncol = 3)

matmedian\_lq\_2 <- matrix(0, nrow = 3, ncol = 3)

matmedian\_lq\_3 <- matrix(0, nrow = 3, ncol = 3)

matq90\_lq <- matrix(0, nrow = 3, ncol = 3)

matq90\_lq\_1 <- matrix(0, nrow = 3, ncol = 3)

matq90\_lq\_2 <- matrix(0, nrow = 3, ncol = 3)

matq90\_lq\_3 <- matrix(0, nrow = 3, ncol = 3)

matq25\_lq <- matrix(0, nrow = 3, ncol = 3)

matq25\_lq\_1 <- matrix(0, nrow = 3, ncol = 3)

matq25\_lq\_2 <- matrix(0, nrow = 3, ncol = 3)

matq25\_lq\_3 <- matrix(0, nrow = 3, ncol = 3)

mean\_lq\_2<-0

mean\_lq\_1<-0

mean\_lq\_3<-0

mean\_pk\_1<-0

mean\_pk\_2<-0

mean\_pk\_3<-0

mean\_L\_1<-0

mean\_L\_2<-0

mean\_L\_3<-0

mean\_W\_1<-0

mean\_W\_2<-0

mean\_W\_3<-0

mean\_wq\_1<-0

mean\_wq\_2<-0

mean\_wq\_3<-0

mse\_lq <- 0

mse\_lq1 <- 0

mse\_lq2 <- 0

mse\_lq3 <- 0

mape\_lq <- 0

mape\_lq1 <- 0

mape\_lq2 <- 0

mape\_lq3 <- 0

mae\_lq <- 0

mae\_lq1 <- 0

mae\_lq2 <- 0

mae\_lq3 <- 0

mean\_act<- numeric(10000)

mean\_sub<-numeric(10000)

mean\_alt<-numeric(10000)

mean\_pk\_act<-numeric(10000)

mean\_pk\_sub<-numeric(10000)

mean\_pk\_alt<-numeric(10000)

mean\_L\_act<-numeric(10000)

mean\_L\_sub<-numeric(10000)

mean\_L\_alt<-numeric(10000)

mean\_W\_act<-numeric(10000)

mean\_W\_sub<-numeric(10000)

mean\_W\_alt<-numeric(10000)

mean\_wq\_act<-numeric(10000)

mean\_wq\_sub<-numeric(10000)

mean\_wq\_alt<-numeric(10000)

e\_lq<-numeric(10000)

e\_lq1<-numeric(10000)

e\_lq2<-numeric(10000)

e\_lq3<-numeric(10000)

for (t in 1:10000) {

sx <- 0

sy <- 0

for (i in 1:n1) {

random <- runif(1)

x <- log(1 - random) / (-lm)

sx <- sx + x

}

lambda <- n1/ sx

meanx <- sx / n1

for (j in 1:n2) {

random <- runif(1)

y <- log(1 - random) / (-mu)

sy <- sy + y

}

meu <- n2 / sy

meany <- sy / n2

sum1<-0

for(n in 0:(c-1)){

fact1<-factorial(n)

x1<-((lm/mu)^n)/fact1

sum1<-sum1+x1

}

fact2<-factorial(c)

p0<-(((((lm/mu)^c)/fact2)\*((1-(lm/(c\*mu))^(k-c+1))/(1-(lm/(c\*mu)))))+sum1)^(-1)

lq\_1<-((p0\*((lm/mu)^c)\*(lm/(c\*mu)))/(fact2\*(1-(lm/(c\*mu)))^2))\*(1-((lm/(c\*mu))^(k-c+1))-(1-(lm/(c\*mu)))\*(k-c+1)\*(lm/(c\*mu))^(k-c))

sum2<-0

for(n in 0:(c-1)){

fact3<-factorial(n)

x2<-((meany/meanx)^n)/fact3

sum2<-sum2+x2

}

p0\_1<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum2)^(-1)

lq\_2<-((p0\_1\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c))

e\_lq[t]<-abs(lq\_1-lq\_2)

p\_lq<-100\*(e\_lq[t]/lq\_1)

mean\_act[t]<-lq\_1

mean\_sub[t]<-lq\_2

mean\_lq\_1<- mean\_lq\_1+mean\_act[t]

mean\_lq\_2<-mean\_lq\_2+ mean\_sub[t]

mse\_lq<-mse\_lq+e\_lq[t]^2

mape\_lq<-mape\_lq+abs(p\_lq)

mae\_lq<-mae\_lq+e\_lq[t]

if(meany<=rho\_0\_1\*meanx\*c){

sum3<-0

for(n in 0:(c-1)){

fact4<-factorial(n)

x3<-((meany/meanx)^n)/fact4

sum3<-sum3+x3

}

p0\_2<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum3)^(-1)

lq\_3<-((p0\_2\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c))

} else{

sum4<-0

for(n in 0:(c-1)){

fact5<-factorial(n)

x4<-((c\*rho\_0\_1)^n)/fact5

sum4<-sum4+x4

}

p0\_3<-(((((c\*rho\_0\_1)^c)/fact2)\*((1-(rho\_0\_1)^(k-c+1))/(1-(rho\_0\_1))))+sum4)^(-1)

lq\_3<-((p0\_3\*((c\*rho\_0\_1)^c)\*rho\_0\_1)/(fact2\*(1-(rho\_0\_1))^2))\*(1-((rho\_0\_1)^(k-c+1))-(1-(rho\_0\_1))\*(k-c+1)\*(rho\_0\_1)^(k-c))

}

e\_lq1[t]<-abs(lq\_1-lq\_3)

p\_lq1<-100\*(e\_lq1[t]/lq\_1)

mean\_alt[t]<-lq\_3

mean\_lq\_3<-mean\_lq\_3+ mean\_alt[t]

mse\_lq1<-mse\_lq1+e\_lq1[t]^2

mape\_lq1<-mape\_lq1+abs(p\_lq1)

mae\_lq1<-mae\_lq1+e\_lq1[t]

if(meany<=rho\_0\_2\*meanx\*c){

sum5<-0

for(n in 0:(c-1)){

fact6<-factorial(n)

x5<-((meany/meanx)^n)/fact6

sum5<-sum5+x5

}

p0\_4<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum5)^(-1)

lq\_4<-((p0\_4\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c))

} else{

sum6<-0

for(n in 0:(c-1)){

fact7<-factorial(n)

x6<-((c\*rho\_0\_2)^n)/fact7

sum6<-sum6+x6

}

p0\_5<-(((((c\*rho\_0\_2)^c)/fact2)\*((1-(rho\_0\_2)^(k-c+1))/(1-(rho\_0\_2))))+sum6)^(-1)

lq\_4<-((p0\_5\*((c\*rho\_0\_2)^c)\*rho\_0\_2)/(fact2\*(1-(rho\_0\_2))^2))\*(1-((rho\_0\_2)^(k-c+1))-(1-(rho\_0\_2))\*(k-c+1)\*(rho\_0\_2)^(k-c))

}

e\_lq2[t]<-abs(lq\_1-lq\_4)

p\_lq2<-100\*(e\_lq2[t]/lq\_1)

mse\_lq2<-mse\_lq2+e\_lq2[t]^2

mape\_lq2<-mape\_lq2+abs(p\_lq2)

mae\_lq2<-mae\_lq2+e\_lq2[t]

if(meany<=rho\_0\_3\*meanx\*c){

sum7<-0

for(n in 0:(c-1)){

fact8<-factorial(n)

x7<-((meany/meanx)^n)/fact8

sum7<-sum7+x7

}

p0\_6<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum7)^(-1)

lq\_5<-((p0\_6\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c))

} else{

sum8<-0

for(n in 0:(c-1)){

fact9<-factorial(n)

x8<-((c\*rho\_0\_3)^n)/fact9

sum8<-sum8+x8

}

p0\_7<-(((((c\*rho\_0\_3)^c)/fact2)\*((1-(rho\_0\_3)^(k-c+1))/(1-(rho\_0\_3))))+sum8)^(-1)

lq\_5<-((p0\_7\*((c\*rho\_0\_3)^c)\*rho\_0\_3)/(fact2\*(1-(rho\_0\_3))^2))\*(1-((rho\_0\_3)^(k-c+1))-(1-(rho\_0\_3))\*(k-c+1)\*(rho\_0\_3)^(k-c))

}

e\_lq3[t]<-abs(lq\_1-lq\_5)

p\_lq3<-100\*(e\_lq3[t]/lq\_1)

mse\_lq3<-mse\_lq3+e\_lq3[t]^2

mape\_lq3<-mape\_lq3+abs(p\_lq3)

mae\_lq3<-mae\_lq3+e\_lq3[t]

#pk

sum1<-0

for(n in 0:(c-1)){

fact1<-factorial(n)

x1<-((lm/mu)^n)/fact1

sum1<-sum1+x1

}

fact2<-factorial(c)

p0<-(((((lm/mu)^c)/fact2)\*((1-(lm/(c\*mu))^(k-c+1))/(1-(lm/(c\*mu)))))+sum1)^(-1)

pk\_1<-(((lm/mu)^k)/((c^(k-c))\*fact2))\*p0

sum2<-0

for(n in 0:(c-1)){

fact3<-factorial(n)

x2<-((meany/meanx)^n)/fact3

sum2<-sum2+x2

}

p0\_1<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum2)^(-1)

pk\_2<-(((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_1

e\_pk[t]<-abs(pk\_1-pk\_2)

p\_pk<-100\*(e\_pk[t]/pk\_1)

mean\_pk\_act[t]<-pk\_1

mean\_pk\_sub[t]<-pk\_2

mean\_pk\_1<-mean\_pk\_1+ mean\_pk\_act[t]

mean\_pk\_2<-mean\_pk\_2+ mean\_pk\_sub[t]

mse\_pk<-mse\_pk+e\_pk[t]^2

mape\_pk<-mape\_pk+abs(p\_pk)

mae\_pk<-mae\_pk+e\_pk[t]

if(meany<=rho\_0\_1\*meanx\*c){

sum3<-0

for(n in 0:(c-1)){

fact4<-factorial(n)

x3<-((meany/meanx)^n)/fact4

sum3<-sum3+x3

}

p0\_2<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum3)^(-1)

pk\_3<-(((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_2

} else{

sum4<-0

for(n in 0:(c-1)){

fact5<-factorial(n)

x4<-((c\*rho\_0\_1)^n)/fact5

sum4<-sum4+x4

}

p0\_3<-(((((c\*rho\_0\_1)^c)/fact2)\*((1-(rho\_0\_1)^(k-c+1))/(1-(rho\_0\_1))))+sum4)^(-1)

pk\_3<-(((c\*rho\_0\_1)^k)/((c^(k-c))\*fact2))\*p0\_3

}

e\_pk1[t]<-abs(pk\_1-pk\_3)

p\_pk1<-100\*(e\_pk1[t]/pk\_1)

mean\_pk\_alt[t]<-pk\_3

mean\_pk\_3<-mean\_pk\_3+ mean\_pk\_alt[t]

mse\_pk1<-mse\_pk1+e\_pk1[t]^2

mape\_pk1<-mape\_pk1+abs(p\_pk1)

mae\_pk1<-mae\_pk1+e\_pk1[t]

if(meany<=rho\_0\_2\*meanx\*c){

sum5<-0

for(n in 0:(c-1)){

fact6<-factorial(n)

x5<-((meany/meanx)^n)/fact6

sum5<-sum5+x5

}

p0\_4<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum5)^(-1)

pk\_4<-(((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_4

} else{

sum6<-0

for(n in 0:(c-1)){

fact7<-factorial(n)

x6<-((c\*rho\_0\_2)^n)/fact7

sum6<-sum6+x6

}

p0\_5<-(((((c\*rho\_0\_2)^c)/fact2)\*((1-(rho\_0\_2)^(k-c+1))/(1-(rho\_0\_2))))+sum6)^(-1)

pk\_4<-(((c\*rho\_0\_2)^k)/((c^(k-c))\*fact2))\*p0\_5

}

e\_pk2[t]<-abs(pk\_1-pk\_4)

p\_pk2<-100\*(e\_pk2[t]/pk\_1)

mse\_pk2<-mse\_pk2+e\_pk2[t]^2

mape\_pk2<-mape\_pk2+abs(p\_pk2)

mae\_pk2<-mae\_pk2+e\_pk2[t]

if(meany<=rho\_0\_3\*meanx\*c){

sum7<-0

for(n in 0:(c-1)){

fact8<-factorial(n)

x7<-((meany/meanx)^n)/fact8

sum7<-sum7+x7

}

p0\_6<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum7)^(-1)

pk\_5<-(((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_6

} else{

sum8<-0

for(n in 0:(c-1)){

fact9<-factorial(n)

x8<-((c\*rho\_0\_3)^n)/fact9

sum8<-sum8+x8

}

p0\_7<-(((((c\*rho\_0\_3)^c)/fact2)\*((1-(rho\_0\_3)^(k-c+1))/(1-(rho\_0\_3))))+sum8)^(-1)

pk\_5<-(((c\*rho\_0\_3)^k)/((c^(k-c))\*fact2))\*p0\_7

}

e\_pk3[t]<-abs(pk\_1-pk\_5)

p\_pk3<-100\*(e\_pk3[t]/pk\_1)

mse\_pk3<-mse\_pk3+e\_pk3[t]^2

mape\_pk3<-mape\_pk3+abs(p\_pk3)

mae\_pk3<-mae\_pk3+e\_pk3[t]

#L

sum1<-0

for(n in 0:(c-1)){

fact1<-factorial(n)

x1<-((lm/mu)^n)/fact1

sum1<-sum1+x1

}

fact2<-factorial(c)

p0<-(((((lm/mu)^c)/fact2)\*((1-(lm/(c\*mu))^(k-c+1))/(1-(lm/(c\*mu)))))+sum1)^(-1)

L\_1<-(((p0\*((lm/mu)^c)\*(lm/(c\*mu)))/(fact2\*(1-(lm/(c\*mu)))^2))\*(1-((lm/(c\*mu))^(k-c+1))-(1-(lm/(c\*mu)))\*(k-c+1)\*(lm/(c\*mu))^(k-c)))+((lm/mu)\*(1-((((lm/mu)^k)/((c^(k-c))\*fact2))\*p0)))

sum2<-0

for(n in 0:(c-1)){

fact3<-factorial(n)

x2<-((meany/meanx)^n)/fact3

sum2<-sum2+x2

}

p0\_1<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum2)^(-1)

L\_2<-(((p0\_1\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c)))+((meany/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_1)))

e\_L[t]<-abs(L\_1-L\_2)

p\_L<-100\*(e\_L[t]/L\_1)

mean\_L\_act[t]<-L\_1

mean\_L\_sub[t]<-L\_2

mean\_L\_1<- mean\_L\_1+ mean\_L\_act[t]

mean\_L\_2<- mean\_L\_2+ mean\_L\_sub[t]

mse\_L<-mse\_L+e\_L[t]^2

mape\_L<-mape\_L+abs(p\_L)

mae\_L<-mae\_L+e\_L[t]

if(meany<=rho\_0\_1\*meanx\*c){

sum3<-0

for(n in 0:(c-1)){

fact4<-factorial(n)

x3<-((meany/meanx)^n)/fact4

sum3<-sum3+x3

}

p0\_2<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum3)^(-1)

L\_3<-(((p0\_2\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c)))+((meany/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_2)))

} else{

sum4<-0

for(n in 0:(c-1)){

fact5<-factorial(n)

x4<-((c\*rho\_0\_1)^n)/fact5

sum4<-sum4+x4

}

p0\_3<-(((((c\*rho\_0\_1)^c)/fact2)\*((1-(rho\_0\_1)^(k-c+1))/(1-(rho\_0\_1))))+sum4)^(-1)

L\_3<-(((p0\_3\*((c\*rho\_0\_1)^c)\*rho\_0\_1)/(fact2\*(1-(rho\_0\_1))^2))\*(1-((rho\_0\_1)^(k-c+1))-(1-(rho\_0\_1))\*(k-c+1)\*(rho\_0\_1)^(k-c)))+((c\*rho\_0\_1)\*(1-((((c\*rho\_0\_1)^k)/((c^(k-c))\*fact2))\*p0\_3)))

}

e\_L1[t]<-abs(L\_1-L\_3)

p\_L1<-100\*(e\_L1[t]/L\_1)

mean\_L\_alt[t]<-L\_3

mean\_L\_3<- mean\_L\_3+ mean\_L\_alt[t]

mse\_L1<-mse\_L1+e\_L1[t]^2

mape\_L1<-mape\_L1+abs(p\_L1)

mae\_L1<-mae\_L1+e\_L1[t]

if(meany<=rho\_0\_2\*meanx\*c){

sum5<-0

for(n in 0:(c-1)){

fact6<-factorial(n)

x5<-((meany/meanx)^n)/fact6

sum5<-sum5+x5

}

p0\_4<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum5)^(-1)

L\_4<-(((p0\_4\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c)))+((meany/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_4)))

} else{

sum6<-0

for(n in 0:(c-1)){

fact7<-factorial(n)

x6<-((c\*rho\_0\_2)^n)/fact7

sum6<-sum6+x6

}

p0\_5<-(((((c\*rho\_0\_2)^c)/fact2)\*((1-(rho\_0\_2)^(k-c+1))/(1-(rho\_0\_2))))+sum6)^(-1)

L\_4<-(((p0\_5\*((c\*rho\_0\_2)^c)\*rho\_0\_2)/(fact2\*(1-(rho\_0\_2))^2))\*(1-((rho\_0\_2)^(k-c+1))-(1-(rho\_0\_2))\*(k-c+1)\*(rho\_0\_2)^(k-c)))+((c\*rho\_0\_2)\*(1-((((c\*rho\_0\_2)^k)/((c^(k-c))\*fact2))\*p0\_5)))

}

e\_L2[t]<-abs(L\_1-L\_4)

p\_L2<-100\*(e\_L2[t]/L\_1)

mse\_L2<-mse\_L2+e\_L2[t]^2

mape\_L2<-mape\_L2+abs(p\_L2)

mae\_L2<-mae\_L2+e\_L2[t]

if(meany<=rho\_0\_3\*meanx\*c){

sum7<-0

for(n in 0:(c-1)){

fact8<-factorial(n)

x7<-((meany/meanx)^n)/fact8

sum7<-sum7+x7

}

p0\_6<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum7)^(-1)

L\_5<-(((p0\_6\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c)))+((meany/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_6)))

} else{

sum8<-0

for(n in 0:(c-1)){

fact9<-factorial(n)

x8<-((c\*rho\_0\_3)^n)/fact9

sum8<-sum8+x8

}

p0\_7<-(((((c\*rho\_0\_3)^c)/fact2)\*((1-(rho\_0\_3)^(k-c+1))/(1-(rho\_0\_3))))+sum8)^(-1)

L\_5<-(((p0\_7\*((c\*rho\_0\_3)^c)\*rho\_0\_3)/(fact2\*(1-(rho\_0\_3))^2))\*(1-((rho\_0\_3)^(k-c+1))-(1-(rho\_0\_3))\*(k-c+1)\*(rho\_0\_3)^(k-c)))+((c\*rho\_0\_3)\*(1-((((c\*rho\_0\_3)^k)/((c^(k-c))\*fact2))\*p0\_7)))

}

e\_L3[t]<-abs(L\_1-L\_5)

p\_L3<-100\*(e\_L3[t]/L\_1)

mse\_L3<-mse\_L3+e\_L3[t]^2

mape\_L3<-mape\_L3+abs(p\_L3)

mae\_L3<-mae\_L3+e\_L3[t]

#W

sum1<-0

for(n in 0:(c-1)){

fact1<-factorial(n)

x1<-((lm/mu)^n)/fact1

sum1<-sum1+x1

}

fact2<-factorial(c)

p0<-(((((lm/mu)^c)/fact2)\*((1-(lm/(c\*mu))^(k-c+1))/(1-(lm/(c\*mu)))))+sum1)^(-1)

W\_1<-((((p0\*((lm/mu)^c)\*(lm/(c\*mu)))/(fact2\*(1-(lm/(c\*mu)))^2))\*(1-((lm/(c\*mu))^(k-c+1))-(1-(lm/(c\*mu)))\*(k-c+1)\*(lm/(c\*mu))^(k-c)))+((lm/mu)\*(1-((((lm/mu)^k)/((c^(k-c))\*fact2))\*p0))))/(lm\*(1-((((lm/mu)^k)/((c^(k-c))\*fact2))\*p0)))

sum2<-0

for(n in 0:(c-1)){

fact3<-factorial(n)

x2<-((meany/meanx)^n)/fact3

sum2<-sum2+x2

}

p0\_1<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum2)^(-1)

W\_2<-((((p0\_1\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c)))+((meany/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_1))))/((1/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_1)))

e\_W[t]<-abs(W\_1-W\_2)

p\_W<-100\*(e\_W[t]/W\_1)

mean\_W\_act[t]<-W\_1

mean\_W\_sub[t]<-W\_2

mean\_W\_1<- mean\_W\_1+ mean\_W\_act[t]

mean\_W\_2<- mean\_W\_2+ mean\_W\_sub[t]

mse\_W<-mse\_W+e\_W[t]^2

mape\_W<-mape\_W+abs(p\_W)

mae\_W<-mae\_W+e\_W[t]

if(meany<=rho\_0\_1\*meanx\*c){

sum3<-0

for(n in 0:(c-1)){

fact4<-factorial(n)

x3<-((meany/meanx)^n)/fact4

sum3<-sum3+x3

}

p0\_2<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum3)^(-1)

W\_3<-((((p0\_2\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c)))+((meany/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_2))))/((1/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_2)))

} else{

sum4<-0

for(n in 0:(c-1)){

fact5<-factorial(n)

x4<-((c\*rho\_0\_1)^n)/fact5

sum4<-sum4+x4

}

p0\_3<-(((((c\*rho\_0\_1)^c)/fact2)\*((1-(rho\_0\_1)^(k-c+1))/(1-(rho\_0\_1))))+sum4)^(-1)

W\_3<-((((p0\_3\*((c\*rho\_0\_1)^c)\*rho\_0\_1)/(fact2\*(1-(rho\_0\_1))^2))\*(1-((rho\_0\_1)^(k-c+1))-(1-(rho\_0\_1))\*(k-c+1)\*(rho\_0\_1)^(k-c)))+((c\*rho\_0\_1)\*(1-((((c\*rho\_0\_1)^k)/((c^(k-c))\*fact2))\*p0\_3))))/(((c\*rho\_0\_1)/meany)\*(1-((((c\*rho\_0\_1)^k)/((c^(k-c))\*fact2))\*p0\_3)))

}

e\_W1[t]<-abs(W\_1-W\_3)

p\_W1<-100\*(e\_W1[t]/W\_1)

mean\_W\_alt[t]<-W\_3

mean\_W\_3<- mean\_W\_3+ mean\_W\_alt[t]

mse\_W1<-mse\_W1+e\_W1[t]^2

mape\_W1<-mape\_W1+abs(p\_W1)

mae\_W1<-mae\_W1+e\_W1[t]

if(meany<=rho\_0\_2\*meanx\*c){

sum5<-0

for(n in 0:(c-1)){

fact6<-factorial(n)

x5<-((meany/meanx)^n)/fact6

sum5<-sum5+x5

}

p0\_4<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum5)^(-1)

W\_4<-((((p0\_4\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c)))+((meany/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_4))))/((1/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_4)))

} else{

sum6<-0

for(n in 0:(c-1)){

fact7<-factorial(n)

x6<-((c\*rho\_0\_2)^n)/fact7

sum6<-sum6+x6

}

p0\_5<-(((((c\*rho\_0\_2)^c)/fact2)\*((1-(rho\_0\_2)^(k-c+1))/(1-(rho\_0\_2))))+sum6)^(-1)

W\_4<-((((p0\_5\*((c\*rho\_0\_2)^c)\*rho\_0\_2)/(fact2\*(1-(rho\_0\_2))^2))\*(1-((rho\_0\_2)^(k-c+1))-(1-(rho\_0\_2))\*(k-c+1)\*(rho\_0\_2)^(k-c)))+((c\*rho\_0\_2)\*(1-((((c\*rho\_0\_2)^k)/((c^(k-c))\*fact2))\*p0\_5))))/(((c\*rho\_0\_2)/meany)\*(1-((((c\*rho\_0\_2)^k)/((c^(k-c))\*fact2))\*p0\_5)))

}

e\_W2[t]<-abs(W\_1-W\_4)

p\_W2<-100\*(e\_W2[t]/W\_1)

mse\_W2<-mse\_W2+e\_W2[t]^2

mape\_W2<-mape\_W2+abs(p\_W2)

mae\_W2<-mae\_W2+e\_W2[t]

if(meany<=rho\_0\_3\*meanx\*c){

sum7<-0

for(n in 0:(c-1)){

fact8<-factorial(n)

x7<-((meany/meanx)^n)/fact8

sum7<-sum7+x7

}

p0\_6<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum7)^(-1)

W\_5<-((((p0\_6\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c)))+((meany/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_6))))/((1/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_6)))

} else{

sum8<-0

for(n in 0:(c-1)){

fact9<-factorial(n)

x8<-((c\*rho\_0\_3)^n)/fact9

sum8<-sum8+x8

}

p0\_7<-(((((c\*rho\_0\_3)^c)/fact2)\*((1-(rho\_0\_3)^(k-c+1))/(1-(rho\_0\_3))))+sum8)^(-1)

W\_5<-((((p0\_7\*((c\*rho\_0\_3)^c)\*rho\_0\_3)/(fact2\*(1-(rho\_0\_3))^2))\*(1-((rho\_0\_3)^(k-c+1))-(1-(rho\_0\_3))\*(k-c+1)\*(rho\_0\_3)^(k-c)))+((c\*rho\_0\_3)\*(1-((((c\*rho\_0\_3)^k)/((c^(k-c))\*fact2))\*p0\_7))))/(((c\*rho\_0\_3)/meany)\*(1-((((c\*rho\_0\_3)^k)/((c^(k-c))\*fact2))\*p0\_7)))

}

e\_W3[t]<-abs(W\_1-W\_5)

p\_W3<-100\*(e\_W3[t]/W\_1)

mse\_W3<-mse\_W3+e\_W3[t]^2

mape\_W3<-mape\_W3+abs(p\_W3)

mae\_W3<-mae\_W3+e\_W3[t]

#Wq

sum1<-0

for(n in 0:(c-1)){

fact1<-factorial(n)

x1<-((lm/mu)^n)/fact1

sum1<-sum1+x1

}

fact2<-factorial(c)

p0<-(((((lm/mu)^c)/fact2)\*((1-(lm/(c\*mu))^(k-c+1))/(1-(lm/(c\*mu)))))+sum1)^(-1)

wq\_1<-(((p0\*((lm/mu)^c)\*(lm/(c\*mu)))/(fact2\*(1-(lm/(c\*mu)))^2))\*(1-((lm/(c\*mu))^(k-c+1))-(1-(lm/(c\*mu)))\*(k-c+1)\*(lm/(c\*mu))^(k-c)))/(lm\*(1-((((lm/mu)^k)/((c^(k-c))\*fact2))\*p0)))

sum2<-0

for(n in 0:(c-1)){

fact3<-factorial(n)

x2<-((meany/meanx)^n)/fact3

sum2<-sum2+x2

}

p0\_1<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum2)^(-1)

wq\_2<-(((p0\_1\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c)))/((1/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_1)))

e\_wq[t]<-abs(wq\_1-wq\_2)

p\_wq<-100\*(e\_wq[t]/wq\_1)

mean\_wq\_act[t]<-wq\_1

mean\_wq\_sub[t]<-wq\_2

mean\_wq\_1<- mean\_wq\_1+ mean\_wq\_act[t]

mean\_wq\_2<- mean\_wq\_2+ mean\_wq\_sub[t]

mse\_wq<-mse\_wq+e\_wq[t]^2

mape\_wq<-mape\_wq+abs(p\_wq)

mae\_wq<-mae\_wq+e\_wq[t]

if(meany<=rho\_0\_1\*meanx\*c){

sum3<-0

for(n in 0:(c-1)){

fact4<-factorial(n)

x3<-((meany/meanx)^n)/fact4

sum3<-sum3+x3

}

p0\_2<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum3)^(-1)

wq\_3<-(((p0\_2\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c)))/((1/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_2)))

} else{

sum4<-0

for(n in 0:(c-1)){

fact5<-factorial(n)

x4<-((c\*rho\_0\_1)^n)/fact5

sum4<-sum4+x4

}

p0\_3<-(((((c\*rho\_0\_1)^c)/fact2)\*((1-(rho\_0\_1)^(k-c+1))/(1-(rho\_0\_1))))+sum4)^(-1)

wq\_3<-(((p0\_3\*((c\*rho\_0\_1)^c)\*rho\_0\_1)/(fact2\*(1-(rho\_0\_1))^2))\*(1-((rho\_0\_1)^(k-c+1))-(1-(rho\_0\_1))\*(k-c+1)\*(rho\_0\_1)^(k-c)))/(((c\*rho\_0\_1)/meany)\*(1-((((c\*rho\_0\_1)^k)/((c^(k-c))\*fact2))\*p0\_3)))

}

e\_wq1[t]<-abs(wq\_1-wq\_3)

p\_wq1<-100\*(e\_wq1[t]/wq\_1)

mean\_wq\_alt[t]<-wq\_3

mean\_wq\_3<- mean\_wq\_3+ mean\_wq\_alt[t]

mse\_wq1<-mse\_wq1+e\_wq1[t]^2

mape\_wq1<-mape\_wq1+abs(p\_wq1)

mae\_wq1<-mae\_wq1+e\_wq1[t]

if(meany<=rho\_0\_2\*meanx\*c){

sum5<-0

for(n in 0:(c-1)){

fact6<-factorial(n)

x5<-((meany/meanx)^n)/fact6

sum5<-sum5+x5

}

p0\_4<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum5)^(-1)

wq\_4<-(((p0\_4\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c)))/((1/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_4)))

} else{

sum6<-0

for(n in 0:(c-1)){

fact7<-factorial(n)

x6<-((c\*rho\_0\_2)^n)/fact7

sum6<-sum6+x6

}

p0\_5<-(((((c\*rho\_0\_2)^c)/fact2)\*((1-(rho\_0\_2)^(k-c+1))/(1-(rho\_0\_2))))+sum6)^(-1)

wq\_4<-(((p0\_5\*((c\*rho\_0\_2)^c)\*rho\_0\_2)/(fact2\*(1-(rho\_0\_2))^2))\*(1-((rho\_0\_2)^(k-c+1))-(1-(rho\_0\_2))\*(k-c+1)\*(rho\_0\_2)^(k-c)))/(((c\*rho\_0\_2)/meany)\*(1-((((c\*rho\_0\_2)^k)/((c^(k-c))\*fact2))\*p0\_5)))

}

e\_wq2[t]<-abs(wq\_1-wq\_4)

p\_wq2<-100\*(e\_wq2[t]/wq\_1)

mse\_wq2<-mse\_wq2+e\_wq2[t]^2

mape\_wq2<-mape\_wq2+abs(p\_wq2)

mae\_wq2<-mae\_wq2+e\_wq2[t]

if(meany<=rho\_0\_3\*meanx\*c){

sum7<-0

for(n in 0:(c-1)){

fact8<-factorial(n)

x7<-((meany/meanx)^n)/fact8

sum7<-sum7+x7

}

p0\_6<-(((((meany/meanx)^c)/fact2)\*((1-(meany/(c\*meanx))^(k-c+1))/(1-(meany/(c\*meanx)))))+sum7)^(-1)

wq\_5<-(((p0\_6\*((meany/meanx)^c)\*(meany/(c\*meanx)))/(fact2\*(1-(meany/(c\*meanx)))^2))\*(1-((meany/(c\*meanx))^(k-c+1))-(1-(meany/(c\*meanx)))\*(k-c+1)\*(meany/(c\*meanx))^(k-c)))/((1/meanx)\*(1-((((meany/meanx)^k)/((c^(k-c))\*fact2))\*p0\_6)))

} else{

sum8<-0

for(n in 0:(c-1)){

fact9<-factorial(n)

x8<-((c\*rho\_0\_3)^n)/fact9

sum8<-sum8+x8

}

p0\_7<-(((((c\*rho\_0\_3)^c)/fact2)\*((1-(rho\_0\_3)^(k-c+1))/(1-(rho\_0\_3))))+sum8)^(-1)

wq\_5<-(((p0\_7\*((c\*rho\_0\_3)^c)\*rho\_0\_3)/(fact2\*(1-(rho\_0\_3))^2))\*(1-((rho\_0\_3)^(k-c+1))-(1-(rho\_0\_3))\*(k-c+1)\*(rho\_0\_3)^(k-c)))/(((c\*rho\_0\_3)/meany)\*(1-((((c\*rho\_0\_3)^k)/((c^(k-c))\*fact2))\*p0\_7)))

}

e\_wq3[t]<-abs(wq\_1-wq\_5)

p\_wq3<-100\*(e\_wq3[t]/wq\_1)

mse\_wq3<-mse\_wq3+e\_wq3[t]^2

mape\_wq3<-mape\_wq3+abs(p\_wq3)

mae\_wq3<-mae\_wq3+e\_wq3[t]

}

e\_lq<-sort(e\_lq)

median\_lq<-(e\_lq[4999]+e\_lq[5000])/2

q90\_lq<-(e\_lq[8999]+e\_lq[9000])/2

q25\_lq<-(e\_lq[2499]+e\_lq[2500])/2

e\_lq1<-sort(e\_lq1)

median\_lq1<-(e\_lq1[4999]+e\_lq1[5000])/2

q90\_lq1<-(e\_lq1[8999]+e\_lq1[9000])/2

q25\_lq1<-(e\_lq1[2499]+e\_lq1[2500])/2

e\_lq2<-sort(e\_lq2)

median\_lq2<-(e\_lq2[4999]+e\_lq2[5000])/2

q90\_lq2<-(e\_lq2[8999]+e\_lq2[9000])/2

q25\_lq2<-(e\_lq2[2499]+e\_lq2[2500])/2

e\_lq3<-sort(e\_lq3)

median\_lq3<-(e\_lq3[4999]+e\_lq3[5000])/2

q90\_lq3<-(e\_lq3[8999]+e\_lq3[9000])/2

q25\_lq3<-(e\_lq3[2499]+e\_lq3[2500])/2

matmean\_lq\_act<-(mean\_lq\_1/10000)

matmean\_lq\_sub<- (mean\_lq\_2/10000)

matmean\_lq\_alt<-(mean\_lq\_3/10000)

matmse\_lq[a,b]<-(mse\_lq/10000)

matmape\_lq[a,b]<-(mape\_lq/10000)

matmae\_lq[a,b]<-(mae\_lq/10000)

matmedian\_lq[a,b]<-median\_lq

matq90\_lq[a,b]<-q90\_lq

matq25\_lq[a,b]<-q25\_lq

matmse\_lq\_1[a,b]<-(mse\_lq1/10000)

matmape\_lq\_1[a,b]<-(mape\_lq1/10000)

matmae\_lq\_1[a,b]<-(mae\_lq1/10000)

matmedian\_lq\_1[a,b]<-median\_lq1

matq90\_lq\_1[a,b]<-q90\_lq1

matq25\_lq\_1[a,b]<-q25\_lq1

matmse\_lq\_2[a,b]<-(mse\_lq2/10000)

matmape\_lq\_2[a,b]<-(mape\_lq2/10000)

matmae\_lq\_2[a,b]<-(mae\_lq2/10000)

matmedian\_lq\_2[a,b]<-median\_lq2

matq90\_lq\_2[a,b]<-q90\_lq2

matq25\_lq\_2[a,b]<-q25\_lq2

matmse\_lq\_3[a,b]<-(mse\_lq3/10000)

matmape\_lq\_3[a,b]<-(mape\_lq3/10000)

matmae\_lq\_3[a,b]<-(mae\_lq3/10000)

matmedian\_lq\_3[a,b]<-median\_lq3

matq90\_lq\_3[a,b]<-q90\_lq3

matq25\_lq\_3[a,b]<-q25\_lq3

meanx

meany

lq\_1

lq\_2

lq\_3

matmean\_lq\_act

matmean\_lq\_sub

matmean\_lq\_alt

matmse\_lq[a,b]

matmse\_lq\_1[a,b]

e\_pk<-sort(e\_pk)

median\_pk<-(e\_pk[4999]+e\_pk[5000])/2

q90\_pk<-(e\_pk[8999]+e\_pk[9000])/2

q25\_pk<-(e\_pk[2499]+e\_pk[2500])/2

e\_pk1<-sort(e\_pk1)

median\_pk1<-(e\_pk1[4999]+e\_pk1[5000])/2

q90\_pk1<-(e\_pk1[8999]+e\_pk1[9000])/2

q25\_pk1<-(e\_pk1[2499]+e\_pk1[2500])/2

e\_pk2<-sort(e\_pk2)

median\_pk2<-(e\_pk2[4999]+e\_pk2[5000])/2

q90\_pk2<-(e\_pk2[8999]+e\_pk2[9000])/2

q25\_pk2<-(e\_pk2[2499]+e\_pk2[2500])/2

e\_pk3<-sort(e\_pk3)

median\_pk3<-(e\_pk3[4999]+e\_pk3[5000])/2

q90\_pk3<-(e\_pk3[8999]+e\_pk3[9000])/2

q25\_pk3<-(e\_pk3[2499]+e\_pk3[2500])/2

matmean\_pk\_act<-(mean\_pk\_1/10000)

matmean\_pk\_sub<-(mean\_pk\_2/10000)

matmean\_pk\_alt<-(mean\_pk\_3/10000)

matmse\_pk[a,b]<-(mse\_pk/10000)

matmape\_pk[a,b]<-(mape\_pk/10000)

matmae\_pk[a,b]<-(mae\_pk/10000)

matmedian\_pk[a,b]<-median\_pk

matq90\_pk[a,b]<-q90\_pk

matq25\_pk[a,b]<-q25\_pk

matmse\_pk\_1[a,b]<-(mse\_pk1/10000)

matmape\_pk\_1[a,b]<-(mape\_pk1/10000)

matmae\_pk\_1[a,b]<-(mae\_pk1/10000)

matmedian\_pk\_1[a,b]<-median\_pk1

matq90\_pk\_1[a,b]<-q90\_pk1

matq25\_pk\_1[a,b]<-q25\_pk1

matmse\_pk\_2[a,b]<-(mse\_pk2/10000)

matmape\_pk\_2[a,b]<-(mape\_pk2/10000)

matmae\_pk\_2[a,b]<-(mae\_pk2/10000)

matmedian\_pk\_2[a,b]<-median\_pk2

matq90\_pk\_2[a,b]<-q90\_pk2

matq25\_pk\_2[a,b]<-q25\_pk2

matmse\_pk\_3[a,b]<-(mse\_pk3/10000)

matmape\_pk\_3[a,b]<-(mape\_pk3/10000)

matmae\_pk\_3[a,b]<-(mae\_pk3/10000)

matmedian\_pk\_3[a,b]<-median\_pk3

matq90\_pk\_3[a,b]<-q90\_pk3

matq25\_pk\_3[a,b]<-q25\_pk3

pk\_1

pk\_2

pk\_3

matmean\_pk\_act

matmean\_pk\_sub

matmean\_pk\_alt

matmse\_pk[a,b]

matmse\_pk\_1[a,b]

e\_L<-sort(e\_L)

median\_L<-(e\_L[4999]+e\_L[5000])/2

q90\_L<-(e\_L[8999]+e\_L[9000])/2

q25\_L<-(e\_L[2499]+e\_L[2500])/2

e\_L1<-sort(e\_L1)

median\_L1<-(e\_L1[4999]+e\_L1[5000])/2

q90\_L1<-(e\_L1[8999]+e\_L1[9000])/2

q25\_L1<-(e\_L1[2499]+e\_L1[2500])/2

e\_L2<-sort(e\_L2)

median\_L2<-(e\_L2[4999]+e\_L2[5000])/2

q90\_L2<-(e\_L2[8999]+e\_L2[9000])/2

q25\_L2<-(e\_L2[2499]+e\_L2[2500])/2

e\_L3<-sort(e\_L3)

median\_L3<-(e\_L3[4999]+e\_L3[5000])/2

q90\_L3<-(e\_L3[8999]+e\_L3[9000])/2

q25\_L3<-(e\_L3[2499]+e\_L3[2500])/2

matmean\_L\_act<-(mean\_L\_1/10000)

matmean\_L\_sub<-(mean\_L\_2/10000)

matmean\_L\_alt<-(mean\_L\_3/10000)

matmse\_L[a,b]<-(mse\_L/10000)

matmape\_L[a,b]<-(mape\_L/10000)

matmae\_L[a,b]<-(mae\_L/10000)

matmedian\_L[a,b]<-median\_L

matq90\_L[a,b]<-q90\_L

matq25\_L[a,b]<-q25\_L

matmse\_L\_1[a,b]<-(mse\_L1/10000)

matmape\_L\_1[a,b]<-(mape\_L1/10000)

matmae\_L\_1[a,b]<-(mae\_L1/10000)

matmedian\_L\_1[a,b]<-median\_L1

matq90\_L\_1[a,b]<-q90\_L1

matq25\_L\_1[a,b]<-q25\_L1

matmse\_L\_2[a,b]<-(mse\_L2/10000)

matmape\_L\_2[a,b]<-(mape\_L2/10000)

matmae\_L\_2[a,b]<-(mae\_L2/10000)

matmedian\_L\_2[a,b]<-median\_L2

matq90\_L\_2[a,b]<-q90\_L2

matq25\_L\_2[a,b]<-q25\_L2

matmse\_L\_3[a,b]<-(mse\_L3/10000)

matmape\_L\_3[a,b]<-(mape\_L3/10000)

matmae\_L\_3[a,b]<-(mae\_L3/10000)

matmedian\_L\_3[a,b]<-median\_L3

matq90\_L\_3[a,b]<-q90\_L3

matq25\_L\_3[a,b]<-q25\_L3

L\_1

L\_2

L\_3

matmean\_L\_act

matmean\_L\_sub

matmean\_L\_alt

matmse\_L[a,b]

matmse\_L\_1[a,b]

e\_W<-sort(e\_W)

median\_W<-(e\_W[4999]+e\_W[5000])/2

q90\_W<-(e\_W[8999]+e\_W[9000])/2

q25\_W<-(e\_W[2499]+e\_W[2500])/2

e\_W1<-sort(e\_W1)

median\_W1<-(e\_W1[4999]+e\_W1[5000])/2

q90\_W1<-(e\_W1[8999]+e\_W1[9000])/2

q25\_W1<-(e\_W1[2499]+e\_W1[2500])/2

e\_W2<-sort(e\_W2)

median\_W2<-(e\_W2[4999]+e\_W2[5000])/2

q90\_W2<-(e\_W2[8999]+e\_W2[9000])/2

q25\_W2<-(e\_W2[2499]+e\_W2[2500])/2

e\_W3<-sort(e\_W3)

median\_W3<-(e\_W3[4999]+e\_W3[5000])/2

q90\_W3<-(e\_W3[8999]+e\_W3[9000])/2

q25\_W3<-(e\_W3[2499]+e\_W3[2500])/2

matmean\_W\_act<-(mean\_W\_1/10000)

matmean\_W\_sub<-(mean\_W\_2/10000)

matmean\_W\_alt<-(mean\_W\_3/10000)

matmse\_W[a,b]<-(mse\_W/10000)

matmape\_W[a,b]<-(mape\_W/10000)

matmae\_W[a,b]<-(mae\_W/10000)

matmedian\_W[a,b]<-median\_W

matq90\_W[a,b]<-q90\_W

matq25\_W[a,b]<-q25\_W

matmse\_W\_1[a,b]<-(mse\_W1/10000)

matmape\_W\_1[a,b]<-(mape\_W1/10000)

matmae\_W\_1[a,b]<-(mae\_W1/10000)

matmedian\_W\_1[a,b]<-median\_W1

matq90\_W\_1[a,b]<-q90\_W1

matq25\_W\_1[a,b]<-q25\_W1

matmse\_W\_2[a,b]<-(mse\_W2/10000)

matmape\_W\_2[a,b]<-(mape\_W2/10000)

matmae\_W\_2[a,b]<-(mae\_W2/10000)

matmedian\_W\_2[a,b]<-median\_W2

matq90\_W\_2[a,b]<-q90\_W2

matq25\_W\_2[a,b]<-q25\_W2

matmse\_W\_3[a,b]<-(mse\_W3/10000)

matmape\_W\_3[a,b]<-(mape\_W3/10000)

matmae\_W\_3[a,b]<-(mae\_W3/10000)

matmedian\_W\_3[a,b]<-median\_W3

matq90\_W\_3[a,b]<-q90\_W3

matq25\_W\_3[a,b]<-q25\_W3

W\_1

W\_2

W\_3

matmean\_W\_act

matmean\_W\_sub

matmean\_W\_alt

matmse\_W[a,b]

matmse\_W\_1[a,b]

e\_wq<-sort(e\_wq)

median\_wq<-(e\_wq[4999]+e\_wq[5000])/2

q90\_wq<-(e\_wq[8999]+e\_wq[9000])/2

q25\_wq<-(e\_wq[2499]+e\_wq[2500])/2

e\_wq1<-sort(e\_wq1)

median\_wq1<-(e\_wq1[4999]+e\_wq1[5000])/2

q90\_wq1<-(e\_wq1[8999]+e\_wq1[9000])/2

q25\_wq1<-(e\_wq1[2499]+e\_wq1[2500])/2

e\_wq2<-sort(e\_wq2)

median\_wq2<-(e\_wq2[4999]+e\_wq2[5000])/2

q90\_wq2<-(e\_wq2[8999]+e\_wq2[9000])/2

q25\_wq2<-(e\_wq2[2499]+e\_wq2[2500])/2

e\_wq3<-sort(e\_wq3)

median\_wq3<-(e\_wq3[4999]+e\_wq3[5000])/2

q90\_wq3<-(e\_wq3[8999]+e\_wq3[9000])/2

q25\_wq3<-(e\_wq3[2499]+e\_wq3[2500])/2

matmean\_wq\_act<-(mean\_wq\_1/10000)

matmean\_wq\_sub<-(mean\_wq\_2/10000)

matmean\_wq\_alt<-(mean\_wq\_3/10000)

matmse\_wq[a,b]<-(mse\_wq/10000)

matmape\_wq[a,b]<-(mape\_wq/10000)

matmae\_wq[a,b]<-(mae\_wq/10000)

matmedian\_wq[a,b]<-median\_wq

matq90\_wq[a,b]<-q90\_wq

matq25\_wq[a,b]<-q25\_wq

matmse\_wq\_1[a,b]<-(mse\_wq1/10000)

matmape\_wq\_1[a,b]<-(mape\_wq1/10000)

matmae\_wq\_1[a,b]<-(mae\_wq1/10000)

matmedian\_wq\_1[a,b]<-median\_wq1

matq90\_wq\_1[a,b]<-q90\_wq1

matq25\_wq\_1[a,b]<-q25\_wq1

matmse\_wq\_2[a,b]<-(mse\_wq2/10000)

matmape\_wq\_2[a,b]<-(mape\_wq2/10000)

matmae\_wq\_2[a,b]<-(mae\_wq2/10000)

matmedian\_wq\_2[a,b]<-median\_wq2

matq90\_wq\_2[a,b]<-q90\_wq2

matq25\_wq\_2[a,b]<-q25\_wq2

matmse\_wq\_3[a,b]<-(mse\_wq3/10000)

matmape\_wq\_3[a,b]<-(mape\_wq3/10000)

matmae\_wq\_3[a,b]<-(mae\_wq3/10000)

matmedian\_wq\_3[a,b]<-median\_wq3

matq90\_wq\_3[a,b]<-q90\_wq3

matq25\_wq\_3[a,b]<-q25\_wq3

wq\_1

wq\_2

wq\_3

matmean\_wq\_act

matmean\_wq\_sub

matmean\_wq\_alt

matmse\_wq[a,b]

matmse\_wq\_1[a,b]