Appendix B

R Code Program Used in This Research

```
fix(thesis)
function (r,b,dun,mue0)
{
start<-proc.time()
a<-1000 #number of monte carlo#
alpha<-0.05 #significant level#
mue1<-100 #mean 1th group#
mue2<-100 #mean 2th group#
mue3<-100 #mean 3th group#
ss<-25 #variance of group treatments#
v<-4*(r-1) #degree of freedom#
#Define variables#
ddmax<-rep(0,a)
dmax<-rep(0,a)
raw<-rep(0,3)
rp<-rep(0,3)
y0<-rep(0,r)
y1<-rep(0,r)
y2<-rep(0,r)
y3<-rep(0,r)
y<-rep(0,4*r)
y0in<-rep(0,r)
y1in<-rep(0,r)
y2in<-rep(0,r)
y3in<-rep(0,r)
P1in<-rep(0,b)
P2in<-rep(0,b)
```

```
P3in<-rep(0,b)
Pallin<-array(0,dim=c(3,b))
in1<-rep(0,b)
in2<-rep(0,b)
in3<-rep(0,b)
din1<-rep(0,b)
din2<-rep(0,b)
din3<-rep(0,b)
adin<-rep(0,a)
dadin<-rep(0,a)
y0two<-rep(0,r)
y1two<-rep(0,r)
y2two<-rep(0,r)
y3two<-rep(0,r)
P1two<-rep(0,b)
P2two<-rep(0,b)
P3two<-rep(0,b)
Palltwo<-array(0,dim=c(3,b))
two1<-rep(0,b)
two2<-rep(0,b)
two3<-rep(0,b)
dtwo1<-rep(0,b)
dtwo2<-rep(0,b)
dtwo3<-rep(0,b)
adtwo<-rep(0,a)
dadtwo<-rep(0,a)
y0four<-rep(0,r)
y1four<-rep(0,r)
y2four<-rep(0,r)
y3four<-rep(0,r)
P1four<-rep(0,b)
P2four<-rep(0,b)
```

```
P3four<-rep(0,b)
Pallfour<-array(0,dim=c(3,b))
four1<-rep(0,b)
four2<-rep(0,b)
four3<-rep(0,b)
dfour1<-rep(0,b)
dfour2<-rep(0,b)
dfour3<-rep(0,b)
adfour<-rep(0,a)
dadfour<-rep(0,a)
u<-rep(0,4*r)
uu<-rep(0,4*r)

for(i in 1:a){
#Generate data, MSE and mean group treatments#
y0<-rnorm(r,mue0,ss)
y1<-rnorm(r,mue1,ss)
y2<-rnorm(r,mue2,ss)
y3<-rnorm(r,mue3,ss)
y<-c(y0,y1,y2,y3)
yc2<-c(y,y)
yc4<-c(yc2,yc2)
mse<-(var(y0)+var(y1)+var(y2)+var(y3))/4
m0<-mean(y0)
m1<-mean(y1)
m2<-mean(y2)
m3<-mean(y3)
de<-sqrt(mse*2/r)
```

```
#Dunnett two-sided#
d1<-abs(m0-m1)/de
d2<-abs(m0-m2)/de
d3<-abs(m0-m3)/de
ddmax[i]<-max(d1,d2,d3)
if(ddmax[i]>=dun) dmax[i]<-1 else dmax[i]<-0

#raw p-value#
rp[1]<-2*(1-pt(abs((m0-m1)/de),v))
rp[2]<-2*(1-pt(abs((m0-m2)/de),v))
rp[3]<-2*(1-pt(abs((m0-m3)/de),v))
raw<-sort(rp)
if(raw[1]-rp[1]==0) i1<-1
if(raw[1]-rp[2]==0) i1<-2
if(raw[1]-rp[3]==0) i1<-3

if(raw[2]-rp[1]==0) i2<-1
if(raw[2]-rp[2]==0) i2<-2
if(raw[2]-rp[3]==0) i2<-3

if(raw[3]-rp[1]==0) i3<-1
if(raw[3]-rp[2]==0) i3<-2
if(raw[3]-rp[3]==0) i3<-3

for(j in 1:b){
#step-down independent bootstrap#
y0in<-sample(y,r,replace=T)
y1in<-sample(y,r,replace=T)
y2in<-sample(y,r,replace=T)
y3in<-sample(y,r,replace=T)
```

```
m0in<-mean(y0in)
m1in<-mean(y1in)
m2in<-mean(y2in)
m3in<-mean(y3in)
msein<-(var(y0in)+var(y1in)+var(y2in)+var(y3in))/4
dein<-sqrt(msein*2/r)

P1in[j]<-2*(1-pt(abs((m0in-m1in)/dein),v))
P2in[j]<-2*(1-pt(abs((m0in-m2in)/dein),v))
P3in[j]<-2*(1-pt(abs((m0in-m3in)/dein),v))

if(i1==1) Pallin[1,j]<-P1in[j]
if(i1==2) Pallin[1,j]<-P2in[j]
if(i1==3) Pallin[1,j]<-P3in[j]

if(i2==1) Pallin[2,j]<-P1in[j]
if(i2==2) Pallin[2,j]<-P2in[j]
if(i2==3) Pallin[2,j]<-P3in[j]

if(i3==1) Pallin[3,j]<-P1in[j]
if(i3==2) Pallin[3,j]<-P2in[j]
if(i3==3) Pallin[3,j]<-P3in[j]

in1[j]<-min(Pallin[1,j],Pallin[2,j],Pallin[3,j])
in2[j]<-min(Pallin[2,j],Pallin[3,j])
in3[j]<-Pallin[3,j]

if(in1[j]<=raw[1])din1[j]<-1 else din1[j]<-0
if(in2[j]<=raw[2])din2[j]<-1 else din2[j]<-0
if(in3[j]<=raw[3])din3[j]<-1 else din3[j]<-0
```

```
#step-down dependent bootstrap with 2 copy#
u<-sample(1:(4*r*2),4*r,replace=F)
for(w in 1:r){
y0two[w]<-yc2[u[w]]
y1two[w]<-yc2[u[w+r]]
y2two[w]<-yc2[u[w+2*r]]
y3two[w]<-yc2[u[w+3*r]]}

m0two<-mean(y0two)
m1two<-mean(y1two)
m2two<-mean(y2two)
m3two<-mean(y3two)
msetwo<-(var(y0two)+var(y1two)+var(y2two)+var(y3two))/4
detwo<-sqrt(msetwo*2/r)

P1two[j]<-2*(1-pt(abs((m0two-m1two)/detwo),v))
P2two[j]<-2*(1-pt(abs((m0two-m2two)/detwo),v))
P3two[j]<-2*(1-pt(abs((m0two-m3two)/detwo),v))

if(i1==1) Palltwo[1,j]<-P1two[j]
if(i1==2) Palltwo[1,j]<-P2two[j]
if(i1==3) Palltwo[1,j]<-P3two[j]

if(i2==1) Palltwo[2,j]<-P1two[j]
if(i2==2) Palltwo[2,j]<-P2two[j]
if(i2==3) Palltwo[2,j]<-P3two[j]

if(i3==1) Palltwo[3,j]<-P1two[j]
if(i3==2) Palltwo[3,j]<-P2two[j]
if(i3==3) Palltwo[3,j]<-P3two[j]
```

```
two1[j]<-min(Palltwo[1,j],Palltwo[2,j],Palltwo[3,j])
two2[j]<-min(Palltwo[2,j],Palltwo[3,j])
two3[j]<-Palltwo[3,j]

if(two1[j]<=raw[1])dtwo1[j]<-1 else dtwo1[j]<-0
if(two2[j]<=raw[2])dtwo2[j]<-1 else dtwo2[j]<-0
if(two3[j]<=raw[3])dtwo3[j]<-1 else dtwo3[j]<-0

#step-down dependent bootstrap with 4 copy#
uu<-sample(1:(4*r*4),4*r,replace=F)
for(p in 1:r){
y0four[p]<-yc4[uu[p]]
y1four[p]<-yc4[uu[p+r]]
y2four[p]<-yc4[uu[p+2*r]]
y3four[p]<-yc4[uu[p+3*r]]}

m0four<-mean(y0four)
m1four<-mean(y1four)
m2four<-mean(y2four)
m3four<-mean(y3four)
msefour<-(var(y0four)+var(y1four)+var(y2four)+var(y3four))/4
defour<-sqrt(msefour*2/r)

P1four[j]<-2*(1-pt(abs((m0four-m1four)/defour),v))
P2four[j]<-2*(1-pt(abs((m0four-m2four)/defour),v))
P3four[j]<-2*(1-pt(abs((m0four-m3four)/defour),v))

if(i1==1) Pallfour[1,j]<-P1four[j]
if(i1==2) Pallfour[1,j]<-P2four[j]
if(i1==3) Pallfour[1,j]<-P3four[j]
```

```
if(i2==1) Pallfour[2,j]<-P1four[j]
if(i2==2) Pallfour[2,j]<-P2four[j]
if(i2==3) Pallfour[2,j]<-P3four[j]

if(i3==1) Pallfour[3,j]<-P1four[j]
if(i3==2) Pallfour[3,j]<-P2four[j]
if(i3==3) Pallfour[3,j]<-P3four[j]

four1[j]<-min(Pallfour[1,j],Pallfour[2,j],Pallfour[3,j])
four2[j]<-min(Pallfour[2,j],Pallfour[3,j])
four3[j]<-Pallfour[3,j]

if(four1[j]<=raw[1])dfour1[j]<-1 else dfour1[j]<-0
if(four2[j]<=raw[2])dfour2[j]<-1 else dfour2[j]<-0
if(four3[j]<=raw[3])dfour3[j]<-1 else dfour3[j]<-0

}

#adjusted p-value by step-down independent#
din1<-mean(din1)
din2<-mean(din2)
din3<-mean(din3)

adin1<-din1
adin2<-max(din1,din2)
adin3<-max(din1,din2,din3)

adin[i]<-min(adin1,adin2,adin3)
if(adin[i]<alpha)dadin[i]<-1 else dadin[i]<-0
```

```
#adjusted p-value by step-down dependent bootstrap with 2 copy#
dtwo1<-mean(dtwo1)
dtwo2<-mean(dtwo2)
dtwo3<-mean(dtwo3)

adtwo1<-dtwo1
adtwo2<-max(dtwo1,dtwo2)
adtwo3<-max(dtwo1,dtwo2,dtwo3)

adtwo[i]<-min(adtwo1,adtwo2,adtwo3)
if(adtwo[i]<alpha)dadtwo[i]<-1 else dadtwo[i]<-0

#adjusted p-value by step-down dependent bootstrap with 4 copy#
dfour1<-mean(dfour1)
dfour2<-mean(dfour2)
dfour3<-mean(dfour3)

adfour1<-dfour1
adfour2<-max(dfour1,dfour2)
adfour3<-max(dfour1,dfour2,dfour3)

adfour[i]<-min(adfour1,adfour2,adfour3)
if(adfour[i]<alpha)dadfour[i]<-1 else dadfour[i]<-0
}

#Type one or Power of Dunnett's two-sided test at 0.05 level of significant#
max<-mean(dmax)
#Type one or Power of step-down independent#
din<-mean(dadin)
#Type one or Power of step-down dependent bootstrap with 2 copy#
dtwo<-mean(dadtwo)
```

```
#Type one or Power of step-down dependent bootstrap with 4 copy#
dfour<-mean(dadfour)

if(mue0-mue1==0) cat("Type I error rate \n") else cat("Power of the test \n")
cat("Dunnett",max,"\n")
cat("IN",din,"\n")
cat("DE2",dtwo,"\n")
cat("DE4",dfour,"\n")

end<-proc.time()
print(end[1]-start[1],2)
}
```

Refer to R code program, the command for all conditions in this research are shown in table 33;

Table 33: R Code Program for Each Condition

Sample size (r)	Number of resampling sample data (B)	Type I error rate	Power of the test
3	100	thesis(3,100,2.88,100)	thesis(3,100,2.88,60)
	1,000	thesis(3,1000,2.88,100)	thesis(3,1000,2.88,60)
	10,000	thesis(3,10000,2.88,100)	thesis(3,10000,2.88,60)
4	100	thesis(4,100,2.68,100)	thesis(4,100,2.68,60)
	1,000	thesis(4,1000,2.68,100)	thesis(4,1000,2.68,60)
	10,000	thesis(4,10000,2.68,100)	thesis(4,10000,2.68,60)
5	100	thesis(5,100,2.59,100)	thesis(5,100,2.59,60)
	1,000	thesis(5,1000,2.59,100)	thesis(5,1000,2.59,60)
	10,000	thesis(5,10000,2.59,100)	thesis(5,10000,2.59,60)
6	100	thesis(6,100,2.54,100)	thesis(6,100,2.54,60)
	1,000	thesis(6,1000,2.54,100)	thesis(6,1000,2.54,60)
	10,000	thesis(6,10000,2.54,100)	thesis(6,10000,2.54,60)
7	100	thesis(7,100,2.51,100)	thesis(7,100,2.51,60)
	1,000	thesis(7,1000,2.51,100)	thesis(7,1000,2.51,60)
	10,000	thesis(7,10000,2.51,100)	thesis(7,10000,2.51,60)
8	100	thesis(8,100,2.483,100)	thesis(8,100,2.483,60)
	1,000	thesis(8,1000,2.483,100)	thesis(8,1000,2.483,60)
	10,000	thesis(8,10000,2.483,100)	thesis(8,10000,2.483,60)
9	100	thesis(9,100,2.464,100)	thesis(9,100,2.464,60)
	1,000	thesis(9,1000,2.464,100)	thesis(9,1000,2.464,60)
	10,000	thesis(9,10000,2.464,100)	thesis(9,10000,2.464,60)
10	100	thesis(10,100,2.452,100)	thesis(10,100,2.452,60)
	1,000	thesis(10,1000,2.452,100)	thesis(10,1000,2.452,60)
	10,000	thesis(10,10000,2.452,100)	thesis(10,10000,2.452,60)