Mediation_analysis_question

2023-04-15

Continous outcome and continous mediator

Results for continuous outcome and continuous mediator look all right.

```
n = 1000
#C is the covariate
C = rnorm(n)
#X is the treatment variable
X = rnorm(n, mean = 0, sd = 1)
#M is the mediator
M = 0.3*X + 0.5* C  + rnorm(n)
#Y is the outcome
Y = M*0.2+0.1*X + 0.3* C
data = data.frame(Y, X, M, C)
#direct effect is 0.1
#indirect effect is 0.06
#total effect is 0.16
out_model = lm(Y ~ X + M + C, data = data)
med_model = lm(M~X + C, data = data)
total_model = lm(Y ~ X + C, data = data)
summary(out_model)
```

```
##
## Call:
## lm(formula = Y ~ X + M + C, data = data)
##
## Residuals:
##        Min         1Q     Median         3Q        Max
## -1.393e-14 -6.700e-18  2.730e-17  5.670e-17  3.154e-16
##
## Coefficients:
##               Estimate Std. Error    t value Pr(>|t|)
## (Intercept) -2.940e-17  1.570e-17 -1.872e+00   0.0614 .
## X            1.000e-01  1.629e-17  6.140e+15   <2e-16 ***
## M            2.000e-01  1.533e-17  1.305e+16   <2e-16 ***
## C            3.000e-01  1.757e-17  1.707e+16   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4.966e-16 on 996 degrees of freedom
## Multiple R-squared:      1,  Adjusted R-squared:      1
## F-statistic: 3.245e+32 on 3 and 996 DF,  p-value: < 2.2e-16
```

```
summary(med_model)
```

```
##
## Call:
```

```
## lm(formula = M ~ X + C, data = data)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3.2414 -0.7041  0.0172  0.7173  3.5097
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 0.001712   0.032450   0.053    0.958
## X           0.317472   0.032117   9.885   <2e-16 ***
## C           0.537496   0.032067  16.761   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.026 on 997 degrees of freedom
## Multiple R-squared:  0.2762, Adjusted R-squared:  0.2748
## F-statistic: 190.2 on 2 and 997 DF,  p-value: < 2.2e-16
```

```
summary(total_model)
```

```
##
## Call:
## lm(formula = Y ~ X + C, data = data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.64828 -0.14082  0.00344  0.14345  0.70194
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 0.0003425  0.0064900   0.053    0.958
## X           0.1634944  0.0064234  25.453   <2e-16 ***
## C           0.4074993  0.0064135  63.538   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.2052 on 997 degrees of freedom
## Multiple R-squared:  0.8251, Adjusted R-squared:  0.8247
## F-statistic:  2351 on 2 and 997 DF,  p-value: < 2.2e-16
```

```
library(mediation)
```

```
## Warning: package 'mediation' was built under R version 4.0.2
## Loading required package: MASS
## Warning: package 'MASS' was built under R version 4.0.2
## Loading required package: Matrix
## Warning: package 'Matrix' was built under R version 4.0.2
## Loading required package: mvtnorm
## Loading required package: sandwich
## Warning: package 'sandwich' was built under R version 4.0.2
## mediation: Causal Mediation Analysis
```

```
## Version: 4.5.0
```

```
fit_model = mediate(med_model, out_model, treat="X", mediator= "M", boot=T, boot.ci.type = "bca")
```

```
## Running nonparametric bootstrap
```

```
#result from mediation package looks right
summary(fit_model)
```

```
##
## Causal Mediation Analysis
##
## Nonparametric Bootstrap Confidence Intervals with the BCa Method
##
##                Estimate 95% CI Lower 95% CI Upper p-value
## ACME             0.0635       0.0504         0.08  <2e-16 ***
## ADE              0.1000       0.1000         0.10  <2e-16 ***
## Total Effect     0.1635       0.1504         0.18  <2e-16 ***
## Prop. Mediated   0.3884       0.3336         0.43  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Sample Size Used: 1000
##
##
## Simulations: 1000
```

Binary outcome and continous mediator

Results for binary outcome and continuous mediator are not on the right magnitude. The estimated total effect is only 0.01 where the true total effect is 0.16.

```
n = 1000
#C is the covariate
C = rnorm(n)
#X is the treatment variable
X = rnorm(n, mean = 0, sd = 1)
#M is the mediator
M = 0.3*X + 0.5* C  + rnorm(n)
score = -3+M*0.2+0.1*X + 0.3* C
P = exp(score)/(1+exp(score))
#Y is the outcome
Y = rbinom(P,size = 1,prob = P)
sum(Y)
```

```
## [1] 52
```

```
#direct effect is 0.1
#indirect effect is 0.06
#total effect is 0.16
data = data.frame(Y, X, M, C)
out_model = glm(Y ~ X + M + C, data = data, family = binomial(link = 'logit'))
med_model = lm(M~X + C, data = data)
total_model = glm(Y ~ X + C, data = data, family = binomial(link = 'logit'))
summary(out_model)
```

```
##
```

```
## Call:
## glm(formula = Y ~ X + M + C, family = binomial(link = "logit"),
##     data = data)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.9215  -0.3663  -0.2807  -0.2130   2.9947
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept) -3.14178    0.17324 -18.136  < 2e-16 ***
## X            0.06142    0.14893   0.412    0.680
## M            0.17276    0.14738   1.172    0.241
## C            0.64572    0.16569   3.897 9.74e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 408.73  on 999  degrees of freedom
## Residual deviance: 383.39  on 996  degrees of freedom
## AIC: 391.39
##
## Number of Fisher Scoring iterations: 6
```

```
summary(med_model)
```

```
##
## Call:
## lm(formula = M ~ X + C, data = data)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -2.6010 -0.6304 -0.0154  0.6435  3.6997
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.02902    0.03074  -0.944    0.345
## X            0.30238    0.03015  10.028   <2e-16 ***
## C            0.48442    0.03080  15.729   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.972 on 997 degrees of freedom
## Multiple R-squared:  0.2629, Adjusted R-squared:  0.2614
## F-statistic: 177.8 on 2 and 997 DF,  p-value: < 2.2e-16
```

```
summary(total_model)
```

```
##
## Call:
## glm(formula = Y ~ X + C, family = binomial(link = "logit"), data = data)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
```

```
## -0.8803  -0.3624  -0.2856  -0.2205   2.9068
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  -3.1299     0.1714 -18.264  < 2e-16 ***
## X             0.1102     0.1421   0.776    0.438
## C             0.7169     0.1534   4.673 2.97e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 408.73  on 999  degrees of freedom
## Residual deviance: 384.76  on 997  degrees of freedom
## AIC: 390.76
##
## Number of Fisher Scoring iterations: 6
```

```
library(mediation)
fit_model = mediate(med_model, out_model, treat="X", mediator= "M", boot=T, boot.ci.type = "bca")
```

```
## Running nonparametric bootstrap
```

```
#result from mediation package is not on the right magnitude.
summary(fit_model)
```

```
##
## Causal Mediation Analysis
##
## Nonparametric Bootstrap Confidence Intervals with the BCa Method
##
##                          Estimate 95% CI Lower 95% CI Upper p-value
## ACME (control)            0.00256     -0.00180         0.01    0.22
## ACME (treated)            0.00269     -0.00173         0.01    0.22
## ADE (control)             0.00302     -0.01112         0.02    0.69
## ADE (treated)             0.00315     -0.01212         0.02    0.69
## Total Effect              0.00571     -0.01003         0.02    0.51
## Prop. Mediated (control)  0.44776      4.84618      4081.85    0.58
## Prop. Mediated (treated)  0.47146      4.48338      3848.42    0.58
## ACME (average)            0.00263     -0.00180         0.01    0.22
## ADE (average)             0.00309     -0.01160         0.02    0.69
## Prop. Mediated (average)  0.45961      4.65026      3965.13    0.58
##
## Sample Size Used: 1000
##
##
## Simulations: 1000
```