# Ordered regression in R

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# Example in R

Data **“WVS”** from package **carData**:

- poverty – “Do you think that what the government is doing for people in poverty in this country is about the right amount, too much, or too little?”: Too Little, About Right, Too Much.
- religion – Member of a religion: no or yes.
- degree – Held a university degree: no or yes.
- country – Australia, Norway, Sweden, or USA.
- age – in years.
- gender – male or female.

```
> data(WVS)
> summary(WVS)
```

```
          poverty     religion   degree          country          age           gender
 Too Little :2708   no : 786   no :4238   Australia:1874   Min.   :18.00   female:2725
 About Right:1862   yes:4595   yes:1143   Norway   :1127   1st Qu.:31.00   male  :2656
 Too Much   : 811                         Sweden   :1003   Median :43.00
                                          USA      :1377   Mean   :45.04
                                                           3rd Qu.:58.00
                                                           Max.   :92.00
```

Predict evaluation of government efforts to help the poor by other variables

```
> library(MASS)
> m1 = polr(poverty ~ religion + degree + age + gender + country, data = WVS, Hess=T)
> summary(m1)
Call:
polr(formula = poverty ~ religion + degree + age + gender + country,
    data = WVS, Hess = T)

Coefficients:
                 Value Std. Error t value
religionyes    0.17973   0.077346   2.324
degreeyes      0.14092   0.066193   2.129
age            0.01114   0.001561   7.139
gendermale     0.17637   0.052972   3.329
countryNorway -0.32235   0.073766  -4.370
countrySweden -0.60330   0.079494  -7.589
countryUSA     0.61777   0.070665   8.742

Intercepts:
                       Value   Std. Error t value
Too Little|About Right  0.7298  0.1041     7.0128
About Right|Too Much    2.5325  0.1103    22.9496

Residual Deviance: 10402.59
AIC: 10420.59
```

```
> exp(coef(m1))
  religionyes     degreeyes           age    gendermale
    1.1968965     1.1513296     1.0112032     1.1928777
  countryNorway countrySweden    countryUSA
      0.7244420     0.5470047     1.8547921
```

```
#Marginal effects
> library(erer)
> ocME(m1)
```

| | effect.Too Little | effect.About Right | effect.Too Much |
|---|---|---|---|
| religionyes | -0.045 | 0.024 | 0.021 |
| degreeyes | -0.035 | 0.017 | 0.018 |
| age | -0.003 | 0.001 | 0.001 |
| gendermale | -0.044 | 0.022 | 0.022 |
| countryNorway | 0.080 | -0.043 | -0.037 |
| countrySweden | 0.149 | -0.084 | -0.065 |
| countryUSA | -0.152 | 0.067 | 0.085 |

# Interpretation of log odds ratio

Religion: for religious people the log odds of more positive evaluation of government efforts is 0.18 higher compared to non-religious.

Degree: for people with university degree the log odds of more positive evaluation of government efforts is 0.14 higher compared to people without tertiary education.

Age: each year the log odds of more positive evaluation of government efforts increases by 0.01.

Gender: for men the log odds of more positive evaluation of government efforts is 0.18 higher compared to women.

Country:

In Norway the log odds of more positive evaluation of government efforts is 0.32 lower compared to Australia.

In Sweden the log odds of more positive evaluation of government efforts is 0.60 lower compared to Australia.

In USA the log odds of more positive evaluation of government efforts is 0.63 higher compared to Australia.

# Interpretation of odds ratio

Religion: for religious people the odds of more positive evaluation of government efforts are 1.2 times higher compared to non-religious.

Degree: for people with university degree the odds of more positive evaluation of government efforts are 1.15 times higher compared to people without tertiary education.

Age: each year the odds of more positive evaluation of government efforts increases by 1.01 times.

Gender: for men the odds of more positive evaluation of government efforts are 1.19 times higher compared to women.

Country:

In Norway the odds of more positive evaluation of government efforts are 1.39 times lower compared to Australia.

In Sweden the odds of more positive evaluation of government efforts are 1.85 lower compared to Australia.

In USA the odds of more positive evaluation of government efforts are 1.85 higher compared to Australia.

# Interpretation of marginal effects

Example:

Age: each year the probability of thinking that government does ‘too little’ for people in poverty compared to ‘about right’ and ‘too much’ decreases by 0.3%; the probability of thinking that government does ‘too little’ or ‘about right’ for people in poverty compared to ‘too much’ increases by 0.1%; the probability of thinking that government does ‘too much’ for people in poverty compared to ‘too little’ or ‘about right’ increases by 0.1%.

Gender: for men the probability of thinking that government does ‘too little’ for people in poverty compared to ‘about right’ and ‘too much’ is 4.4% higher than for women; the probability of thinking that government does ‘too little’ or ‘about right’ for people in poverty compared to ‘too much’ is 2.2% higher than for women; the probability of thinking that government does ‘too much’ for people in poverty compared to ‘too little’ or ‘about right’ is 2.2% higher than for women.

```
> library(pscl)
> pR2(m1)
fitting null model for pseudo-r2
          llh       llhNull            G2      McFadden          r2ML          r2CU
-5.201296e+03 -5.370188e+03  3.377841e+02  3.144993e-02  6.084382e-02  7.041132e-02



> hitmiss(m1)
Table of Actual (y) Against Predicted (p)
Classification rule: outcome with highest probability.
              p=Too Little p=About Right p=Too Much Row PCP
y=Too Little          2190           518          0   80.87
y=About Right         1483           379          0   20.35
y=Too Much             377           434          0    0.00

Percent Correctly Predicted, Fitted Model: 47.74%
Percent Correctly Predicted, Null Model  : 50.33% #Feel the pain
```

```
> m2 = polr(poverty~religion+degree+age+gender+country, data = WVS, method = "probit")
> summary(m2) #doing probit

Re-fitting to get Hessian

Call:
polr(formula = poverty ~ religion + degree + age + gender + country,
    data = WVS, method = "probit")

Coefficients:
                  Value Std. Error t value
religionyes    0.113539  0.0459340   2.472
degreeyes      0.080645  0.0400074   2.016
age            0.006658  0.0009365   7.110
gendermale     0.099132  0.0317828   3.119
countryNorway -0.245617  0.0450304  -5.454
countrySweden -0.413537  0.0482523  -8.570
countryUSA     0.374512  0.0414241   9.041

Intercepts:
                       Value   Std. Error t value
Too Little|About Right  0.4280  0.0625     6.8518
About Right|Too Much    1.5126  0.0648    23.3500

Residual Deviance: 10352.25
AIC: 10370.25
```

```
> ocME(m2) # marginal effects are similar

Re-fitting to get Hessian

              effect.Too Little effect.About Right effect.Too Much
religionyes              -0.045              0.021           0.024
degreeyes                -0.032              0.014           0.018
age                      -0.003              0.001           0.001
gendermale               -0.040              0.017           0.022
countryNorway             0.098             -0.047          -0.050
countrySweden             0.163             -0.083          -0.079
countryUSA               -0.148              0.056           0.091
```

```
> library(sjPlot)
> plot_model(m1, type = "emm", terms = "age", title = 'Logit')
> plot_model(m2, type = "emm", terms = "age", title = 'Probit')
```