CSSS/POLS 510 MLE Lab

Lab 7. Ordered Categories

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Preview

- Ordered probit.
  - Simulation
  - Estimation: `optim` and `polr`
  - Visualization: `ggplot` and `tile`

Ordered Probit model

Probabilities we want to estimate in four category case

$$\Pr(y_i = 1|\boldsymbol{x_i}) = \Phi(\tau_1 - \alpha - \boldsymbol{x_i}\beta)$$
$$\Pr(y_i = 2|\boldsymbol{x_i}) = \Phi(\tau_2 - \alpha - \boldsymbol{x_i}\beta) - \Phi(\tau_1 - \alpha - \boldsymbol{x_i}\beta)$$
$$\Pr(y_i = 3|\boldsymbol{x_i}) = \Phi(\tau_3 - \alpha - \boldsymbol{x_i}\beta) - \Phi(\tau_2 - \alpha - \boldsymbol{x_i}\beta)$$
$$\Pr(y_i = 4|\boldsymbol{x_i}) = 1 - \Phi(\tau_3 - \alpha - \boldsymbol{x_i}\beta)$$

To identify the model, we commonly make one of two assumptions:

1. Assume that $\tau_1 = 0$. This is also the identifying assumption of logit and probit. `optim()` uses this.
2. Assume that $\alpha = 0$. `polr()` uses this.
   - 2.1. In `simcf::oprobitsimev()` set argument `constant=NA`.

The likelihood function for ordered probit finds the β and τ that make the observed data most likely.

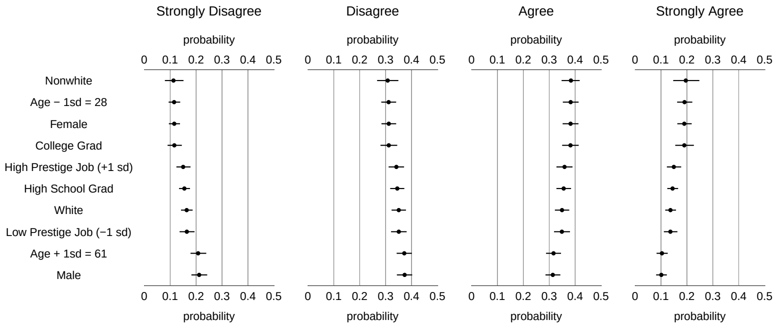
Simulating QoI: ordinal probit

1. Estimate: MLE $\hat{\beta}, \hat{\tau}$ and its variance $\hat{V}(\hat{\beta}, \hat{\tau})$
   $\rightarrow$ `optim(), polr()`
2. Simulate estimation uncertainty from a multivariate normal distribution:
   Draw $\tilde{\beta}, \tilde{\tau} \sim MVN\big[(\hat{\beta}, \hat{\tau}), \hat{V}(\hat{\beta}, \hat{\tau})\big]$
   $\rightarrow$ `MASS::mvrnorm()`
3. Create hypothetical scenarios of your substantive interest:
   Choose valuese of X: X_c
   $\rightarrow$ `simcf::cfmake(), cfchange()...`

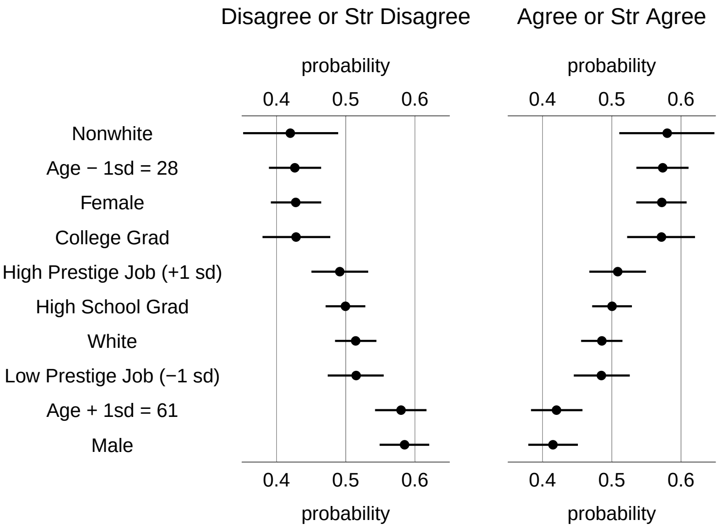
Simulating QoI: ordinal probit

4. Calculate expected values:
   $\tilde{\pi_c} = g(X_c, \tilde{\beta}, \tilde{\tau})$
5. Compute EVs, First Differences or Relative Risks
   EV: $\mathbb{E}(y = j | X_{c1}, \tilde{\beta}, \tilde{\tau})$
   $\rightarrow$ `simcf::oprobitsimev()...`
   FD: $\mathbb{E}(y = j | X_{c2}, \tilde{\beta}, \tilde{\tau}) - \mathbb{E}(y = j | X_{c1}, \tilde{\beta}, \tilde{\tau})$
   $\rightarrow$ `simcf::oprobitsimfd()...`
   RR: $\frac{\mathbb{E}(y=j|X_{c2},\tilde{\beta},\tilde{\tau})}{\mathbb{E}(y=j|X_{c1},\tilde{\beta},\tilde{\tau})}$
   $\rightarrow$ `simcf::oprobitsimrr()...`

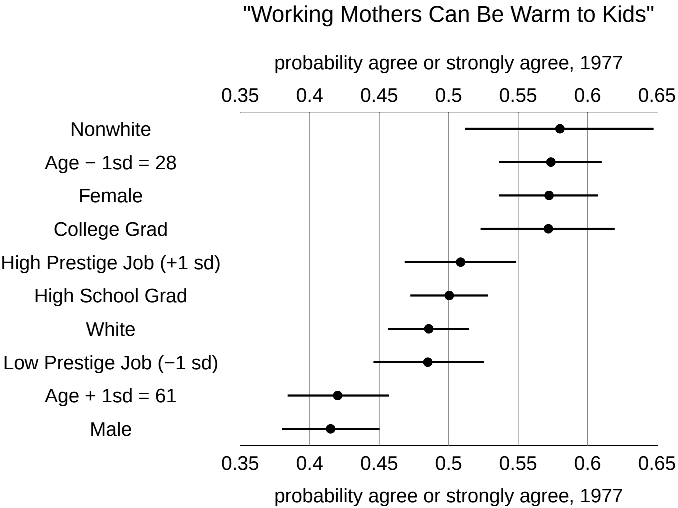
Preview: ropeladder plots - 4 category



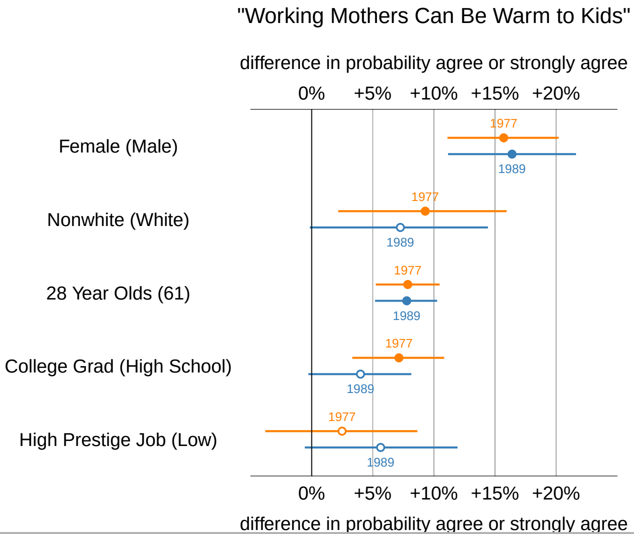
Preview: ropeladder plots - 2 category



Preview: ropeladder plots - 1 category



Preview: ropeladder plots - first differences



Ordinal Probit Lab class

- Let's open `RStudio` and the Lab7 file.

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