

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

$$\Pr(y_i = 1|\mathbf{x}_i) = \Phi(\tau_1 - \alpha - \mathbf{x}_i\beta)$$

$$\Pr(y_i = 2|\mathbf{x}_i) = \Phi(\tau_2 - \alpha - \mathbf{x}_i\beta) - \Phi(\tau_1 - \alpha - \mathbf{x}_i\beta)$$

$$\Pr(y_i = 3|\mathbf{x}_i) = \Phi(\tau_3 - \alpha - \mathbf{x}_i\beta) - \Phi(\tau_2 - \alpha - \mathbf{x}_i\beta)$$

$$\Pr(y_i = 4|\mathbf{x}_i) = 1 - \Phi(\tau_3 - \alpha - \mathbf{x}_i\beta)$$

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 $\hat{V}(\hat{\beta}, \hat{\tau})$
→ `optim()`, `polr()`
2. Simulate estimation uncertainty from a multivariate normal distribution:
Draw $\tilde{\beta}, \tilde{\tau} \sim MVN[(\hat{\beta}, \hat{\tau}), \hat{V}(\hat{\beta}, \hat{\tau})]$
→ `MASS::mvrnorm()`
3. Create hypothetical scenarios of your substantive interest:
Choose values of X: X_c
→ `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

$$\text{EV: } \mathbb{E}(y = j | X_{c1}, \tilde{\beta}, \tilde{\tau})$$

→ `simcf::oprobitsimev()` ...

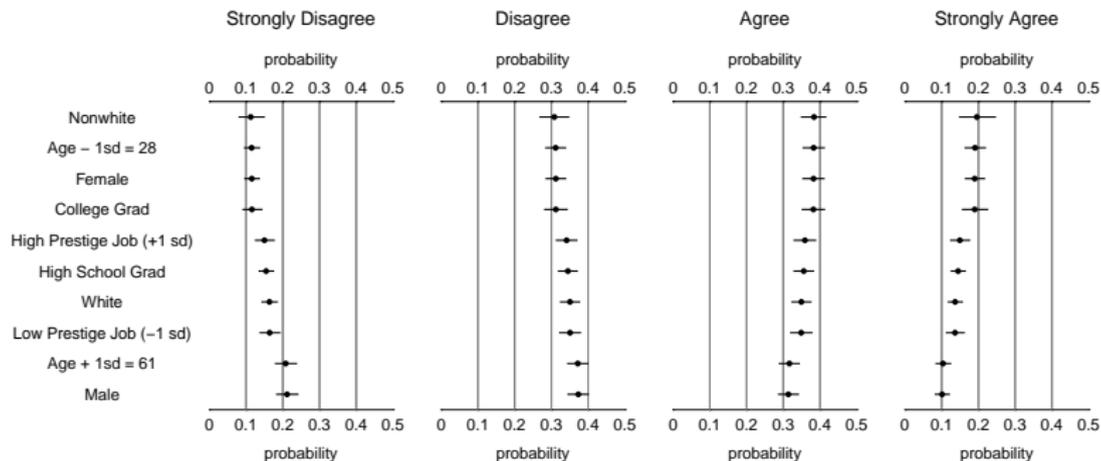
$$\text{FD: } \mathbb{E}(y = j | X_{c2}, \tilde{\beta}, \tilde{\tau}) - \mathbb{E}(y = j | X_{c1}, \tilde{\beta}, \tilde{\tau})$$

→ `simcf::oprobitsimfd()` ...

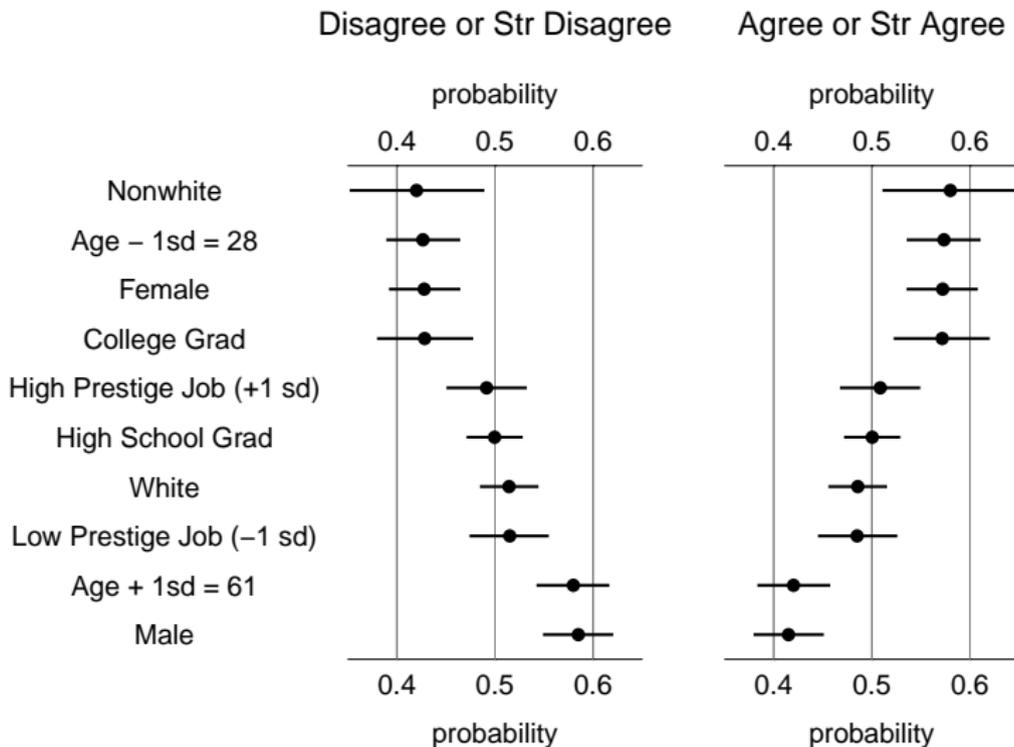
$$\text{RR: } \frac{\mathbb{E}(y=j|X_{c2},\tilde{\beta},\tilde{\tau})}{\mathbb{E}(y=j|X_{c1},\tilde{\beta},\tilde{\tau})}$$

→ `simcf::oprobitsimrr()` ...

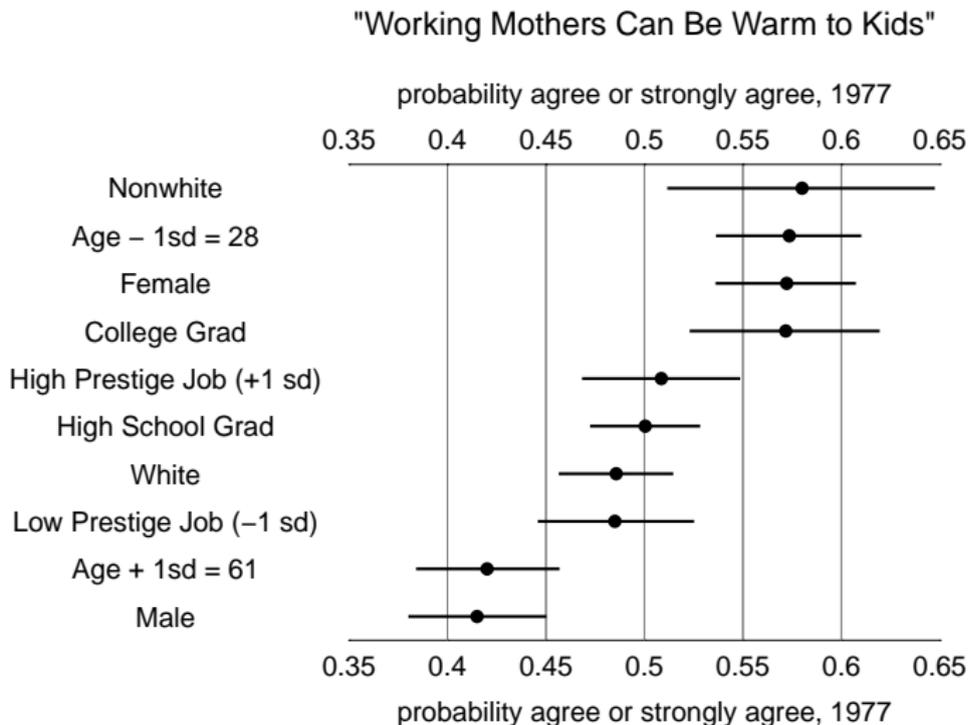
Preview: ropeladder plots - 4 category



Preview: ropeladder plots - 2 category



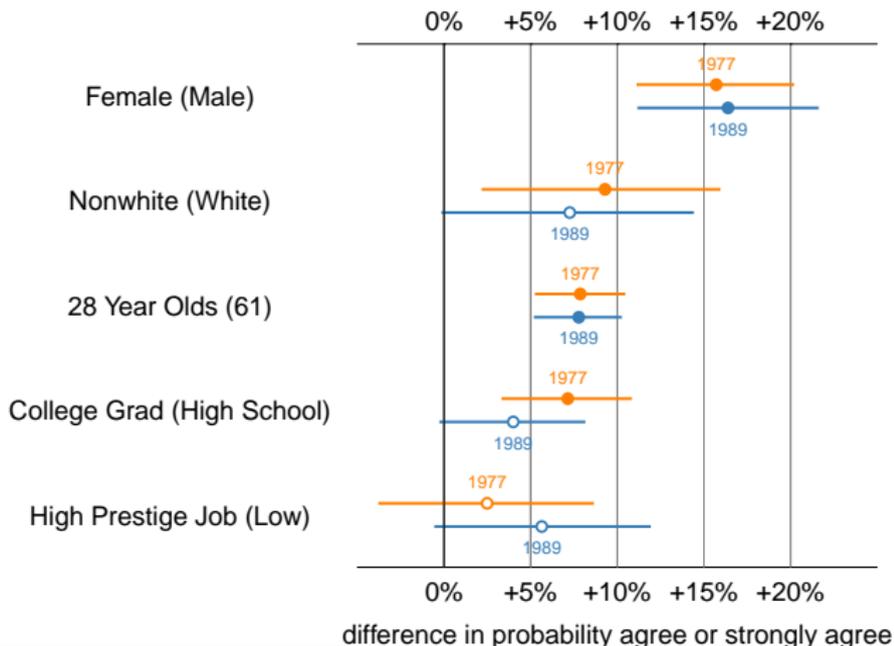
Preview: ropeladder plots - 1 category



Preview: ropeladder plots - first differences

"Working Mothers Can Be Warm to Kids"

difference in probability agree or strongly agree



Ordinal Probit Lab class

- ▶ Let's open RStudio and the file [Lab7_script.R](#).

FIN