$$\ln h_{it} = \gamma_0 + \underset{\text{ISE}}{\delta} \underbrace{\ln w_{it}}_{\text{time-varying wage}} + \delta(\rho - r)t + \delta \ln \lambda_i + \underbrace{\gamma_i}_{\text{extra fixed effect}} + \underbrace{u_{it}}_{\text{random stuff in prefs or other supply shifters}}$$

λ_i: i's MU of wealth (lifetime wealth)

- δ is the largest theoretical elasticity (gives an upper bound on elasticities of labor supply)
- good for policy analysis where wealth effects are second-order
  - are they ever really second-order?
- macroeconomists care about this

$h_{i1}, \ldots, h_{iT}$ $\frac{y_{it}}{h_{it}} = w_{it}$ $w_{i1}, \ldots, w_{iT}$ } data

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$\text{cov}(w_{it}, \lambda_i) < 0$ wage $\uparrow \Rightarrow MU_{\text{wealth}} \downarrow$

Can kill off λ by differencing

$$\Delta \ln h_{it} = \delta \Delta \ln w_{it} + \delta(\rho - r) + \bar{X} + \Delta u_{it}$$

Can use fixed effects: put a dummy for each guy.

o inconsistent for fixed T.

$\overline{(\ln h_{it})}_i = \gamma_0 + \delta\overline{(\ln w_{it})}_i + \delta(\rho - r)\bar{t} + \delta\ln\lambda_i + \bar{u}_i$

subtract person means:

$\ln h_{it} - \overline{(\ln h_{it})}_i = \delta(\ln w_{it} - \overline{(\ln w_{it})}_i) + \delta(\rho - r)(t - \bar{t}) + u_i - \bar{u}_i$

o differences and deviations from means are a second-order issue.

Solutions for OVB from unknown λ_i

- diffs
- deviations from person means
- deviations from time means

$\overline{(\ln h_{it})}_t = \gamma_0 + \delta\overline{(\ln w_{it})}_t + (\beta - r)t + \underbrace{\overline{(\delta\ln\lambda_i)}_t}_{\text{constant}}$

ashenfelter: $\dfrac{\overline{\ln h_t} - \overline{\ln h_{t-1}}}{\overline{\ln w_t} - \overline{\ln w_{t-1}}} = \hat{\delta}$

o in a world with stable labor supply, we can trace out the supply by varying wages.

$$\overline{(\ln h_{it})_t} = \eta_0 + \delta \overline{(\ln w_{it})_t}$$

$$w_{it} = \frac{y_{it}}{h_{it}} = \underset{\text{average hourly earnings}}{\underline{AHE}}$$

$$\ln h_{it} = \eta_0 + \delta \underbrace{\ln w_{it}}_{(\ln y_{it} - \ln h_{it})}$$

division bias.

$$\ln h_{it} = \ln h_{it}^* + \nu_{it}$$

$$\Rightarrow \ln w_{it} = \ln y_{it} - \ln h_{it} = \ln y_{it} - \ln h_{it}^* - \nu_{it}$$

$$= \ln w_{it}^* - \nu_{it}$$

- noise in hours is highly correlated with noise in wages in a negative direction $\Rightarrow$ will lead to $\delta < 0$.

$\Delta \ln h_{it} = \delta \Delta \ln w_{it}$. Division bias is worse when you take differences.

MaCurdy uses education and age as instruments for $\Delta \ln w_{it}$

$\ln h_{it} = \ln h_{it}^* + v_{it}$

Including ~~time~~ fixed effects allows for different instrumenting strategies

1] Macordy uses age/educ. as instruments for $\Delta \ln w_{it}$

2] angrist (1991)/ashenfelter (1984) uses year effects

(o using dummies as instruments recovers averages up to the group