14.661 Recitation 4: Losses and Leases

Andrea Manera

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Roadmap

- Revise compensating variation
  - Analyze Taxi take-up
  - Loss aversion framework
- Estimate loss aversion on earnings

Excess expenditure function

- Recall that the expenditure function is defined as:

$$e(p, w, \bar{u}) \equiv \min_{x,l:u(x,l)=\bar{u}} px + wl$$

- Gives optimal consumption x^c, leisure l^c (Hicksian/compensated demand)
- Can be used to define a money-metric utility, the *excess expenditure*

$$s(w, \bar{u}) = e(p, w, \bar{u}) - wT,$$

  the amount of dollars I need transferred to achieve utility $\bar{u}$ on top of the value of my endowment.
- Note:

$$s(w, \bar{u}) = px^c - wh^c$$

  amount of dollars needed to achieve utility $\bar{u}$.

CV

- The more cash I need to achieve utility $\bar{u}$, the happier I am (non-satiation!)
- Compensating variation after a wage change:

$$\begin{aligned} CV &\equiv e(p, w', V(p, w')) - e(p, w', V(p, w)), \\ &= e(p, w, U) - e(p, w', U), \end{aligned}$$

  where $V(p, w) = U$ is the indirect utility at the initial allocation, second line duality
- This gives how much money I have to take from the agent after the change to make them indifferent to it!
- Note: *utility of new allocation is higher IFF CV is positive.* (I had to spend more/work more to achieve same U before)

CV with excess expenditure

Applying this to the Uber context note first that minimum expenditure with Taxi is (gotta pay the lease)

$$e(p, w, \bar{u}) \equiv \min_{x,l:u(x,l)=\bar{u}} px + wl + L.$$

Given this the CV for moving from Uber with fee t_0 to taxi without fee is:

$$CV = e\left(p, \underbrace{w\left(1 - t_0\right)}_{\equiv w_0}, u_0\right) - e\left(p, w, u_0\right) = s\left(w_0, u_0\right) - s\left(w, u_0\right) - L.$$

From above, I choose taxi IFF

$$s\left(w_0, u_0\right) - s\left(w, u_0\right) - L > 0$$

Writing the decision nicely

- Recall

$$s(w, u_0) = px^c - wh^c$$

- Second-order expansion of $s(w, u_0)$ around w_0 :

$$s(w, u_0) - s(w_0, u_0) \approx -h^c\left(w - (1 - t_0)w\right) - \frac{1}{2}\left(\frac{\partial h^c}{\partial w}\right)\left(w - (1 - t_0)w\right)^2$$

$$= -t_0 w h_0 - \frac{t_0^2 w^2}{2}\left(\frac{\partial h^c}{\partial w}\right)$$

$$= -t_0 w h_0 - \frac{1}{2}\left(\underbrace{\frac{\partial h^c}{\partial w}\frac{w\,(1 - t_0)}{h_0}}_{\equiv\delta}\right) t_0 w h_0 \frac{t_0}{1 - t_0}$$

- Here δ is the *Hicksian* labor supply elasticity (at fixed utility) around the Uber equilibrium

Breakeven and Take-up

- Back to the fundamental question: when does someone take taxi and what can we learn?
- From above, taxi is better when:

$$s\left(w_0, u_0\right) - s\left(w, u_0\right) - L > 0$$

$$wh_0 > \underbrace{\underbrace{\frac{L}{t_0}}_{\text{Taxi lease breakeven}} \left(1 + \frac{1}{2}\delta^f \frac{t_0}{1 - t_0}\right)^{-1}}_{\text{adjusted breakeven}}$$

- Estimated take-up is the share of workers making more than the adjusted breakeven.

Surprising Undersubscription?

Use the experiment to estimate the Frisch elasticity, δ^f, 2SLS regression:

$$\log h_{it} = \delta^f \log w_{it} + \beta X_{it} + \eta_{it},$$
$$\log w_{it} = \gamma Z_{it} + \lambda X_{it} + \upsilon_{it}.$$

Use $\hat{\delta}^f$ to compute adjusted breakeven and predicted take-up rate for j experimental strata:

$$q_{0,j}(L,t) = \frac{1}{N_j} \sum_{i=1}^{N_j} \mathbb{1} \left\{ \log wh_{0i} > \log \left[\frac{L}{t} \left(1 + \frac{1}{2} \hat{\delta}^f \frac{t}{1-t} \right)^{-1} \right] \right\}$$

Surprising Undersubscription?

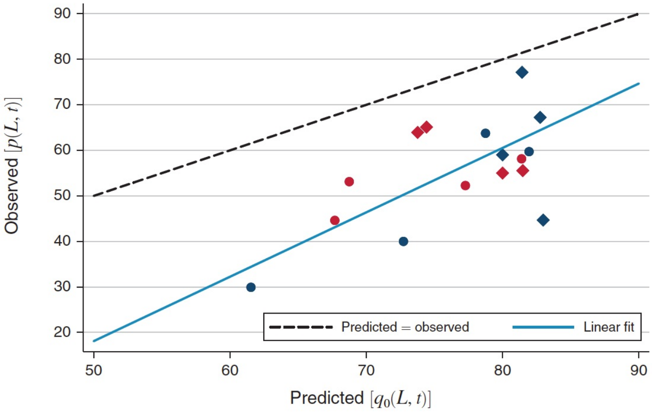

FIGURE 8. TAXI UNDERSUBSCRIPTION

A Loss-Aversion Framework

- Earnings are uncertain and drivers are taking a gamble
- Risk aversion to fix the facts with very low wealth is near 20 (mean of estimates is 2!)
- Idea: drivers are loss averse and reference average earnings
- We have to further adjust the breakeven!

Fehr and Goette (2007): Loss-Aversion

- Consider a utility function linear in earnings, with a reference point c:

$$u(x) = \begin{cases} x - c & x \geqslant c \\ \gamma\,(x - c) & x < c \end{cases}$$

  with $\gamma > 1$
- Every dollar earned below c lowers my utility by γ (loss aversion), dollars above c increase utility by just 1
- Assume:
  - Inelastic labor supply, hours fixed at $\bar{h}$
  - Wage can be high, w^H, with probability p or low, w^L
  - Reference point is potential rideshare earnings $w^H\bar{h}$, or $w^L\bar{h}$
  - In the low state I make more with Uber than taxi: $w^L\bar{h}\,(1 - t) > w^L\bar{h} - L$
- Note: if $c = 0$ I take Taxi as long as I am above breakeven

Take-up with loss-aversion

- Expected utility from Taxi with reference dependence is:

$$\begin{aligned}\left\{p\left[w^H\bar{h} - L - (1-t)w^H\bar{h}\right] + (1-p)\,\gamma\left[w^L\bar{h} - L - (1-t)w^L\bar{h}\right]\right\} &= \\ \left\{p\left[tw^H\bar{h}\right] + (1-p)\,\gamma\left[tw^L\bar{h}\right]\right\} &- (p + (1-p)\,\gamma)\,L\end{aligned}$$

- Note: expected utility of Uber normalized to 0 via reference-dependence
- We then have:

$$\left\{p\left[w^H\bar{h}\right] + (1-p)\,\gamma\left[w^L\bar{h}\right]\right\} \geqslant (p + (1-p)\,\gamma)\,\frac{L}{t},$$

Take-up with loss-aversion II

- Note:

$$
\begin{aligned}
\left\{p\left[w^{H}\bar{h}\right]+(1-p)\,\gamma\left[w^{L}\bar{h}\right]\right\} &= \mathbb{E}\left[w\bar{h}\right]+(1-p)\,(\gamma-1)\,\pi\frac{L}{t} \\
&= \mathbb{E}\left[w\bar{h}\right]+(1-p)\,(\gamma-1)\,\pi\frac{L}{t},
\end{aligned}
$$

with $\pi < 1$ the ratio between $w^{L}\bar{h}$ and the breakeven. Then the decision rule is:

$$
\mathbb{E}\left[w\bar{h}\right] \geqslant \underbrace{(p+(1-p)\,(\pi+(1-\pi)\,\gamma))}_{\equiv\kappa>1}\frac{L}{t} > \frac{L}{t}.
$$

Estimating κ

- We can use take-up decisions to estimate loss aversion, parametrized by κ
- Need to know expected earnings, as well as distribution of earnings
- Assume that earning forecasts are drawn from a log-normal, conditional on covariates X_i:

$$\ln y_{0i} \mid X_i \sim N\left(X_i'\beta, \tau_0^2\right),$$

  where τ_0^2 is the variance of forecasts errors

Estimating κ: Probit

- Take logs of breakeven earnings of individual i with loss aversion:

$$\kappa \frac{L_i}{t_i} \left(1 + \frac{1}{2} \delta^f \frac{t_i}{1 - t_i} \right)^{-1}$$

- Then by symmetry of normal distribution, the predicted take-up is the inverse normal CDF:

$$q_0 \left(L_i, t_i; X_i \right) = 1 - \Phi \left(\frac{\ln \kappa + \ln \frac{L_i}{t_i} - \ln \left(1 + \frac{1}{2} \delta^f \frac{t_i}{1 - t_i} \right) - X_i' \beta}{\tau_0} \right)$$

$$= \Phi \left(\frac{1}{\tau_0} \chi_i - \frac{1}{\tau_0} \kappa \right)$$

- Can use probit regression!

Probit Regression

- First compute:

$$\hat{\chi}_i = \ln\left(1 + \frac{1}{2}\hat{\delta}^f \frac{t_i}{1 - t_i}\right) + X_i'\hat{\beta} - \ln\frac{L_i}{t_i},$$

  where $\hat{\beta}$ is estimated in control group regressing log earnings on covariates
- Then estimate probit via maximum likelihood:

$$P\left[D_i = 1 \mid L_i, t_i, X_i\right] = \Phi\left(\frac{1}{\tau_0}\hat{\chi}_i - \frac{1}{\tau_0}\kappa\right)$$

Results

TABLE 7—MODELING TAXI TAKE-UP

	Parametric				Inattention	
	(1)	(2)	(3)	(4)	(5)	(6)
Slope	0.69	0.73	0.81	0.79	0.69	0.68
	(0.10)	(0.09)	(0.09)	(0.09)	(0.10)	(0.10)
Intercept	−0.24	−0.25	−0.28	−0.27	−0.24	−0.17
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.09)
Implied Kappa	1.41	1.40	1.41	1.41	1.41	1.27
	(0.11)	(0.10)	(0.10)	(0.10)	(0.11)	(0.15)
Implied Tau	1.46	1.36	1.24	1.26	1.46	1.47
	(0.22)	(0.18)	(0.15)	(0.16)	(0.22)	(0.23)
Forecasting regression RMSE	0.71	0.82	0.80	0.79	0.71	0.71
Attentive					1.00	
					(0.00)	
Attentive × low hours						0.91
						(0.06)
Attentive × high hours						1.00
						(0.01)
Number of drivers	954	938	938	938	954	954
Earnings distribution	Predicted offer week	Predicted treatment week	Predicted treatment week	Predicted treatment week	Predicted offer week	Predicted offer week
Number of earnings lags	1	1	2	3	1	1

Notes: Parametric models are fit to micro data on take-up using equation (18) in the text. Standard errors are bootstrapped as described in the online Appendix.

Non-Parametric

No need to assume that forecasts are log-normal, use quantile regression:

$$F^{-1}\left(1 - p_{L,t}\right) = \ln \kappa + \ln \frac{L}{t} - \sigma(t),$$

where:

- $\sigma(t)$ is the log of the breakeven correction factor
- $p_{L,t}$ is the fraction of drivers that take up give a taxi contract $[L, t]$,
- that is, with wages above corrected take-up
- In each stratum, $F^{-1}\left(1 - p_{L,t}\right)$ the weekly earnings such that a proportion $p_{L,t}$ of drivers accept taxi

Non-Parametric Results

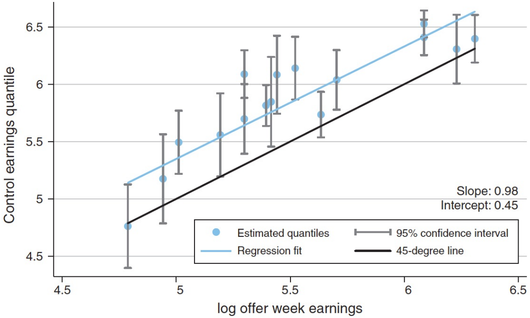

FIGURE 9. COMPARING EMPIRICAL AND THEORETICAL PARTICIPATION QUANTILES

Notes: For each of 16 strata defined by pre-experimental hours driven, treatment week, and Taxi treatment offered, this figure plots the quantile of offer week earnings for the control group against the log of theoretical offer week earnings, defined as breakeven minus a labor supply adjustment. Control earnings quantiles are calculated from the sample of drivers who drove during offer week. Whiskers indicate 95 percent confidence intervals for each quantile. A weighted regression line fit to the plotted points appears in blue. A 45-degree line is plotted in black.

Black line: predicted non-take-up quantiles with $\kappa = 0$

Light blue: actual non take-up quantiles, difference in intercept is $\log \kappa, \kappa \approx 1.6$