Why Can't You Find a Taxi in the Rain?
The Behavioral Critique of Neoclassical Economics

Henry S. Farber

Princeton University

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The Behavioral Challenge to Neoclassical Economics

- Neoclassical economics has used a very simple "black-box" utility function to translate constraints into behavior.
- The utility function itself is not the focus of greatest interest.
    - "Most interesting questions in economics are about the effects of changes in the budget constraint. The utility function is merely a tool for analysis."
- The "behavioral revolution," building on the pathbreaking work of Amos Tversky and Daniel Kahneman, suggests that this approach systematically gets it wrong.
    - Indidivual behavior deviates from the predictions of the neoclassical model in systematic and predictable ways.

Homo Economicus – A Necessarily Simple View

- Individuals make choices to maximize a well-defined utility function subject to a budget constraint.
- The utility function itself is relatively unimportant.
- The power of economics is in the budget constraint.
- Interesting policy questions are centrally about the budget constraint. Examples:
  - What is the effect of the earned income tax credit on labor supply?
  - What would be the effect of an increase in the gasoline tax on the consumption of gasoline?
  - Should the merger of United and Continental have been allowed?

The Limits of Rationality: The Behavioral Critique

- The economists conception of the utility function is naive and does not take into account how individuals actually reason.
- Individuals are not perfect computers of optimal outcomes.
- People make mistakes (e.g., evaluating probabilities).
- People use short-cuts and rules of thumb to make decisions. => Heuristics.
- People process information in ways that depend on how that information is presented or framed.

Deviations from Simple Rationality – Being Human
Behavioral Decision Theory

How is man not "rational"? – Examples

- Status-quo bias
  - Opt-in vs. Opt-out in choices (pension enrollment, organ donation)
- Loss aversion
  - Reference dependence
  - Endowment effects
- Hyperbolic Discounting
  - Overweighting the presence and near future relative to the longer run.

Why Study Labor Supply?
How People Decide How Much to Work

- Most income comes from work. => labor supply affects household wellbeing.
- Work can be central to peoples' sense of self.
- Many public policies have important effects on hours of work. For example:
  - The income tax (by reducing the net wage).
  - The sales tax (by making goods more expensive).
  - The EITC (by providing additional income to low income workers).
  - Universal Health Insurance (by breaking link between work and health care).

The Neoclassical (Standard Economic) Labor Supply Decision

- Individuals trade off the utility of additional income (in buying goods) against the disutility of working (reduced consumption of leisure).
- On the margin, utility derived from an additional hour of work equals loss of utility from the lost hour of leisure.
- Generally the case that a transitory (temporary) increase in the wage leads to an increase in labor supply because an hour of work can now buy more goods.
- Upward sloping labor supply curve (positive relationship between the wage rate and hours of work).
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- Note: A permanent increase in the wage could reduce desired hours of work as individuals want to "consume more leisure".

Reference-Dependent Preferences and Labor Supply

- Loss Aversion => reference-dependent preferences.
- Individuals have a reference point in (daily) income.
- Suffer large utility loss if fail to earn that amount.
- Smaller utility gain if exceed that income.
- Kink in U(Y) at reference income level such that MU_Y is larger below the kink than above the kink.
    - => Bunching at the reference income level.
    - Work until reach reference income then quit.
    - Work less on high wage days.
    - Work more on low wage days.
    - Downward sloping labor supply curve.
- This is simplified overview. Model is more nuanced.
- Full model suggests reference dependent behavior in response to unanticipated wage changes, but neoclassical behavior in response to anticipated changes.

Constrasting the Two Models

- Neoclassical Model
  - Work more when wage is unexpectedly higher.
  - "Make hay while the sun shines."
- The Target Earnings / Reference Dependent Preferenes Model
  - Work less when wage is unexpectedly higher.
  - Reach target sooner.
  - Work at "getting blood from a stone"
- Interpretation
  - More efficient to behave neoclassically (earn more in less time).
  - Driving a taxi is a hard way to make a living.
  - Big payoff to taking advantage of high wages by working more.

Are Workers Free to Set Hours?

- In most settings, workers are not free to set their hours.
- Jobs offer a fixed package of wage and hours.
- Over half of all workers report that their weekly hours are exactly 40.
- => Evidence on the competing models must come from those settings where workers are free to set their hours.

NYC Taxi Drivers Can Set Their Own Hours

- Drivers rent cabs for the shift and pay fuel.
- Drivers keep all income.
- Free to drive or not drive.
- Early research (Camerer *et al*) finds a strong negative relationship between daily hours and the "hourly wage" (daily income divided by daily hours).
  - Concludes that taxi drivers are target earners.
  - But there are econometric problems with this analysis. (regress hours on a variable with hours in the denominator).
- Later research (mine) finds that taxi drivers are neoclassical in their behavior.
  - Accumulated income not important in stopping decision.
  - Stop when enough hours accumulate.

- From "Goals Gone Wild: The Systematic Side Effects of Over-Prescribing Goal Setting," by Ordóñez, Schweitzer, Galinsky, and Bazerman, Harvard Business School WP 09-083, 2009.
  - "On rainy days, cabbies make money more quickly than on sunny days (because demand is indeed higher), hit their daily goal sooner, and then they go home. . . ."
- There is more demand for taxi's in the rain, so hourly income is higher.
- Drivers reach their daily target earlier and quit for the day.
- => More demand, less supply.

- There is more demand for taxi's in the rain, so hourly income is higher.
- This tends to make it harder to find a taxi.
- What happens to supply?
  - Supply may increase due to increase in demand, if increase in demand raises wage.
  - Supply may decrease if it is harder or less pleasant to drive in the rain.

What Does Rain Do?

- Increases demand.
  - => easier to find passengers.
  - => higher hourly income.
- May decrease speed (congestion, conditions).
  - => reduces hourly income.
- May make driving less pleasant.
  - => Fewer cabs on road.
- If hourly income higher and target earner
  - => Fewer cabs on the road after it has been raining for a several hours.

The Data are Massive

- My earlier research and the early work by Camerer *et al* used information from relatively few shifts (hand coded from scrawled trip sheets).
- I now have data on every trip taken in every taxi cab in NYC for five years (2009-2013).
- I have complete histories for (all) individual drivers.
- Approximate Quantities:
  - 180 million trips per year.
  - 8 million shifts per year.
  - 62,000 drivers at some point from 2009 to 2013.
  - 40,000 drivers in a given year.
  - 25,000 drivers drive all five years.
- In fact, this is more data than I need or can use efficiently.
- Most of what I will show you is based on analyses of 2/15 (about 13 percent) of the data.

Empirics

- Data on all trips taken by 2/15 of the driver NYC between 2009 and 2013.
    - 116,177,329 trips, 8,802 drivers.
- Convert to hourly data
    - 5 years including 1 leap day = 48,824 hours.
- Hourly weather data from Central Park to get rain info.
- Use to data to measure the effect of rain on:
    1. Hourly income
    2. Fraction of time spent with a fare in cab
    3. Miles travelled
    4. Number of taxis on street
- Are results consistent with one theory or the other?

Effect of Rain on Hourly Taxi Market Outcomes, OLS

Outcome	(A)	R^2	(B)	R^2
1) Log Hourly Earnings	-0.0047	0.000	-0.0003	0.879
	(0.0054)		(0.0021)	
2) Log Time w/Passenger	0.0508	0.002	0.0475	0.904
	(0.0077)		(0.0028)	
3) Log Miles w/Passenger	-0.0306	0.002	-0.0241	0.792
	(0.0046)		(0.0026)	
4) Log Number of Hacks	-0.0671	0.001	-0.0711	0.878
	(0.0149)		(0.0089)	
Includes Other Controls?	No		Yes	

Note: Estimated using data for each of 43,824 hours in the years 2009-2013 derived from trip-level data for the 2/15 sample of all drivers of NYC taxi cabs. *Precipitation* is an indicator for hours where there is positive precipitation in Central Park. Other controls include indicators for hour of day by day of week (167), week of year (51), year (4), the period subsequent to the September 4, 2012 fare increase (1), and major holiday (1). HAC standard errors are in parentheses.

So Why is it Harder to Find a Taxi in the Rain?

- More demand and less supply.
- Increase in demand and reduction in supply make it difficult to find a taxi in the rain.
- But wage is no higher when it rains.
- Lower supply is *not* the result of drivers stopping after having reached their target.
- Lower supply is result of less pleasant driving in the rain.

- Supply $\downarrow$ 7.1%, utilization (time with passenger) $\uparrow$ 4.8%.
- => On net, about 2.3% fewer passengers served.
- Suggests that a rain surcharge (a la Uber) could help (if supply response rapid enough).
  - If labor supply elasticity 0.5 => 14.2 percent price “surge” could get supply back to “dry weather” level.
  - Might want larger surge to meet higher demand and slower driving.

Estimation of Labor Supply Function

- Analysis uses the new data (2009-2013) for 8,800 NYC taxi drivers on 5 million shifts.
- Regression of log hours on shift with average hourly earnings on shift.
- Instrument for AHE with average AHE on same date of other drivers (different 2/15 subsample).
- Estimated Elasticities are strongly positive => no evidence for reference dependence.
- Consistent with neoclassical model.

IV Estimates of Wage Elasticity, by Shift

Cntrls	Driver F.E's	Elasticity All	Elasticity Day	Elasticity Night	Elasticity Other
No	No	0.2288	0.0202	0.3484	0.2913
		(0.0101)	(0.0134)	(0.0117)	(0.0306)
Yes	No	0.5709	0.3683	0.6182	0.9383
		(0.0100)	(0.0119)	(0.0132)	(0.0329)
Yes	Yes	0.5890	0.3672	0.6344	0.8751
		(0.0099)	(0.0112)	(0.0124)	(0.0281)

Note: Each estimated elasticity is from a separate IV regression. The instrument for average hourly earnings is the average of average hourly earnings for a non-overlapping sample of drivers on the same day. "Controls" include indicators for day of week (6), calendar month (11), year (4), the period subsequent to the September 4, 2012 fare increase (1), and major holiday (1). Robust standard errors clustered by driver are in parentheses.

- Elasticities significantly positive and substantial.
- Elasticities larger on night shift than day shift.

(Results Not Shown Here)

- There is variation across drivers in how they behave, but large majority work more when the wage is high.
- Drivers learn to be more responsive to earnings opportunities. (be more efficient) as they gain experience.
- Least efficient new drivers (smallest/negative elasticities) tend to quit driving.
- Bottom Line: Taxi drivers tend to (and learn to) behave as the standard neoclassical model suggests. Otherwise, it is just too hard to earn a living.

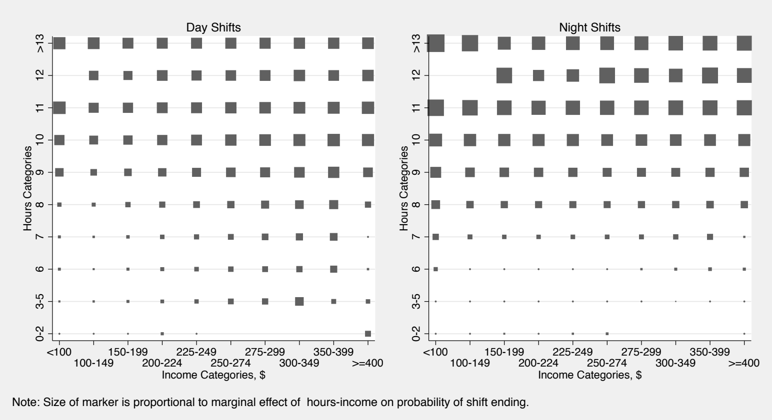
Discrete Choice Stoppiong Model – Follows Farber (2005)

- Alternative way of thinking about the daily labor supply of taxi drivers is as a sequence of decisions made to stop or continue driving after each trip.
- The neoclassical model:
    - Stopping decision a function of hours worked, expectations about earnings opportunities, and a set of variables measuring variation in the opportunity cost of time.
    - Daily income effects with regard to transitory changes in earnings unlikely to be important.
- The reference-dependent preferences model:
    - Like neoclassical model with respect to anticipated variation in earnings opportunities.
    - Daily income effects are likely to be important as unexpectedly high income at any point in a shift will increase the likelihood that the income reference point is reached.

Specification of the Model and Sample

- $h_\tau \cdot y_\iota$ – Interactions of 10 income x 10 hours categories.
- X_{it} includes indicators for: –
  - Hour-of-day by day-of-week (168)
  - Week of the year (52)
  - Year (5)
  - The period subsequent to the September 4, 2012 fare increase
  - Major holiday.
- Estimated separately for day shifts and night shifts:
  - 51,021,936 trips for 6312 drivers on 2,201,443 day shifts.
    - Averages: 23 trips, 8.8 hours, $244
  - 49,661,892 trips for 6380 drivers on 2,116,675 night shifts.
    - Averages: 23 trips, 8.2 hours, $261
- Estimated using a linear probability model due to computational burden introduced by thousands of driver fixed effects.

Marginal Effects of Hours and Income on Stopping
Unconstrained Hours x Income Effects



- Reading horizontally => effect of income at given hours.
- Reading vertically => effect of hours at given income.
- Not much income effect income but large hours effect.

What Have We Learned?

- Behaving rationally (neoclassically) is efficient in the sense of generating output / income.
- My view: When the stakes are high and there is pressure (competitive or survival), individuals learn to behave "rationally" and avoid cognitive biases.
- But there are plenty of important situations where folks make cognitive errors. No short-run pressure to correct.
- For example:
  - Loss aversion / endowment effect in some settings (selling home?).
  - Hyperbolic discounting (discount next month too lightly relative to tomorrow).
  - Status quo bias (default rules / organ donation).
  - And others.