Heuristics and Reference Dependence

ADEC781001: Empirical Behavioral Economics

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Outline

Heuristics

How good was the service?

- In 1922, Emily Post, an American author known for writing about etiquette advised travelers "You will not get good service unless you tip generously... The rule is ten per cent, beginning with a meal costing about three or four dollars."[1]
- This has somewhat kept up with inflation (median tip is around 19.5%, though still pretty low)[2]
- Tipping is a problem in which you decide what percent of a bill to give to a server
  - The cut is continuous: could be any number between [0,100]
  - But most people only consider three discrete outcomes: 10, 15 and 20 percent
  - This is an example of a heuristic: a rule of thumb to help solve a problem

[1] She also wrote: "Tipping is undoubtedly a bad system, but it happens to be in force, and that being the case, travelers have to pay their share of it—if they like the way made smooth and comfortable."

[2] https://www.payscale.com/data-packages/restaurant-report/full-data

Other examples of heuristics

- Max out contributions to your 401(k)
- Split the restaurant bill 50-50
- Trust news from a source with a good reputation
- Tell someone you will be there in five minutes when you are running late
- Any stereotype
- What else?

Tradeoffs to heuristics

- We develop heuristics because they make it easier to solve complex problems
- But they come at at a cost
- Heuristics lead us to develop biases that can sometimes make it harder to make optimal decisions
- We will focus on a few

Anna in the cereal aisle

- We will use the book's example of a consumer choosing a cereal. You could also think about choosing an iPhone or a TV or a health insurance plan (or many other things)
- Suppose her utility function is $U(x, TQ, HQ) = 20\sqrt{x} + 2TQ + HQ$ where x is money, TQ is a cereal's taste quality and HQ is its health quality

Table 2.1 Cereals for sale, and their characteristics, where 1 = low, 2 = medium and 3 = high

Product	*Price*	*Taste quality*	*Health quality*
Budget	\$1	1	1
Nutty	\$3	2	2
Honey	\$4	3	2
Superior	\$6	3	3

Table 2.2 The utility of each cereal if initial wealth is \$100

Choice	*Wealth*	*TQ*	*HQ*	*Utility*
No cereal	\$100	0	0	200
Budget	\$99	1	1	202
Nutty	\$97	2	2	203
Honey	\$96	3	2	204
Superior	\$94	3	3	203

Optimizing utility and information search

- We know that *homo economicus* would write down the utility function then solve it
  - Algorithm: solve for first order condition
  - Answer: buy Honey
- But this assumes a) they know the functional form and b) they have perfect information. Both are unlikely.
- What if they have never tried certain cereals? What if manufacturer changed quality?
  - Algorithm: ?
  - Answer: ?
- Need to search for information – big step away from standard model
- How would *homo economicus* search for information?
  - Answer: until marginal benefit equals marginal cost
  - e.g. if x is information then $U(x) = \pi(x) - c(x)$ and optimum holds at $\pi' = c'$
- How would a real person search?

Search heuristics

- An obvious search heuristic is "try everything" but this is very costly
- Three candidates: satistificing, elimination by aspects and directed cognition
  - **satisficing**: choose a target (e.g. reasonable price and quality) and keep searching until you find something close
  - **elimination by aspects**: consider *aspects* of each choice against a target (e.g. find a cereal that is less than $5 but with good quality)
  - **directed cognition**: treat each chance to gather info as if last chance before choice (thus requires no forward planning and avoids costly permutations)
- The three heuristics are compliments:
  - satisficing: how long to search
  - elimination by aspects: what not to try
  - directed cognition: what to try next

Directed cognition: Gabaix et al (2006)

- How do people actually search for information? There could be many, many heuristics.
- Experiment: consider one (directed cognition or DC) against an optimal algorithm (Gittins-Weitzman or GW)[3]
- First experiment: subjects choose one of three uncorrelated "projects" X_i that are "winners" with probability p_i and paying V_i or "losers" with probability $1 - p_i$ paying 0
- Subjects sequentially investigate projects to get information about winning likelihood at cost c_i
  - When project X_i is "investigated" p_i collapses to zero or one

[3] Gabaix, Xavier, David Laibson, Guillermo Moloche, and Stephen Weinberg. "Costly information acquisition: Experimental analysis of a boundedly rational model." American Economic Review 96, no. 4 (2006): 1043-1068.

Gabaix et al (2006): Experiment

TABLE 1—INVESTMENT GAME A

	Payoff in winning state	Probability of winning state
Project 1	$V_1 = \$1$	$p_1 = 1.00$
Project 2	$V_2 = \$21$	$p_2 = 0.09$
Project 3	$V_3 = \$10$	$p_3 = 0.76$

Notes: A subject chooses among three uncorrelated projects. If project i is a "winner" (which happens with probability p_i), its payoff is V_i; otherwise, its payoff is 0. The subject can sequentially investigate projects that are not known winners, thereby revealing their state. Such information acquisition costs $1 per project. The subject may stop acquiring information at any time and choose one project among the *known* winners. Would a subject begin by taking project 1 (the only known winner at the moment), by paying $1 to investigate project 2, or by paying $1 to investigate project 3?

Gabaix et al (2006): Comparing algorithms

- GW: $\mathbb{E}[max(X_i, Z_i)] - Z_i = c_i \implies \frac{p_i V_i - c_i}{p_i}$
  - this is expected benefit from exploration (agent is just willing to pay c_i to reveal value of X_i rather than immediately take Z_i)
  - "If the highest value of Z_i corresponds to a project with an unknown payoff, then the agent should acquire information about that project"
  - "If the highest value of Z_i corresponds to a winning project, then the agent should take that investment project, thereby ending that game."
- DC: $G_i \equiv \mathbb{E}[(X_i - S_t)^+] - c_i \implies p_i(V_i - S_t) - c_i$ where S_t is value of the best known winning project at time t
  - myopic – does not realize chains of reasoning
    - e.g. it cannot do this: "Project 3 has a higher expected value than project 2, but project 2 has a small chance of a high payoff. If I investigate project 2 first, and it is not a winner, then I can proceed to investigate project 3"

Gabaix et al (2006): Comparing algorithms

Table 2—Algorithms for Investment Game A

	Gittins-Weitzman	Directed cognition
t	Investigate project 2	Investigate project 3
$t+1$	Take project 2 if winner	Take project 3 if winner
$t+2$	Else investigate project 3	Else investigate project 2
$t+3$	Take project 3 if winner	Take project 2 if winner
$t+4$	Else take project 1	Else take project 1

Results

- Subjects appeared to behave according to DC rather than GW

Table 3—Fraction of Subjects Who Play the First Move according to Gittins-Weitzman or according to Directed Cognition

	Percentage GW	Percentage DC	Difference	t-test	p-value
Game A	33	65	32	3.80	0.0001
Game B	35	63	28	3.30	0.0010
Game C	42	57	16	1.80	0.0726
Game D	28	70	42	5.30	0.0000
Game E	34	62	28	3.32	0.0009
A–E average	34	63	29	4.55	0.0000

A taxonomy of search heuristics

Table 2.3 Five search heuristics with a very brief statement of how they can help with search

Heuristic	*What it does well*	*What it does not do so well*
Try them all	Make the person well informed	Minimize the cost of search
Satisficing	Say when to stop search	Say what choice to try next
Directed cognition	Suggest what choice to try next	Give a forward looking plan of search
Elimination by aspects	Say what choices not to try	Say when to stop searching
Search for x minutes	Give certainty how long search will last	React to success or failure in search

Consequences of heuristics

- People often use choice heuristics like “pick the one in the middle” or “pick the one closest to me”
- Such heuristics are driven by *contrast* – comparing one good (or aspect of a good) to another
  - How we feel about the good (or aspect) then depends on what we are comparing it to
  - Technically the number of options should have an effect on choice, but they do, because they change the comparisons we can make

Consequences of heuristics

- These heuristics simplify choice but at a cost
  - **tradeoff contrast**: a good with a desirable quality appears "cheaper" if contrasted with a good where the desireable quality is more expensive (Simonson & Tversky 1992: the $10 coupon looks cheap, or expensive, compared to if the coupon once cost $15 or $5)
  - **extremeness aversion**: avoiding the "extreme" goods that have the most of one or multiple aspects
    - *with compromise*: buy the product "in the middle" because it strikes a compromise between two extremes (e.g. price and taste)
    - *with polarization*: buy the product "on the extreme" because it emphasizes the importance of a certain aspect
    - "Decoy products": if you have a middle product and you expect aversion with compromise, introduce a pricier option and a cheaper option (people pick the middle). If you expect aversion with polarization, introduce a cheaper option (people pick the pricier option)
  - **anchoring effect**: compare the good in front of you to some prior cue or anchor (e.g. your thoughts on the good are influenced by a prior event)

Context effects

- Those are examples of how choice is influenced by context
- **Framing effect**: what people choose depends on how question is asked or framed
  - a "carbon offset" is preferred to a "carbon tax" even though they are the same instrument
  - a policy that saves 90 out of 100 lives is preferred to a policy that loses 10 out of 100 lives
  - beef is advertised as 95% lean rather than 5% fat
  - students more likely to register for classes on time if facing a penalty rather than an equivalent discount
  - people offer to pay more for the same beer at a fancy resort versus a cheap bodega
- Framing effects occur because because not all human thinking is deliberate and reasoned ("slow"), it can also be impulsive ("fast")
- One of the most important ways context affects decisions is by creating reference points against which we compare the choice or outcome at hand
  - This is how context affects how we value things

Loss aversion and the endowment effect

- An important frame is gains versus losses relative to some reference point
  - gains: outcome is above some reference point
  - losses: outcome is below the reference point
- Lot of evidence that *losses* have a larger absolute effect on utility
- Loss aversion often leads to the endowment effect: people value more highly something they feel ownership over
- List (2004)[4]: sport card convention where subjects were given a coffee cup or chocolate bar (both worth $6) for completing a survey
  - Some were physically given a mug or chocolate and told they could immediately swap for one or the other
  - Others given nothing and asked to choose

[4] List, John A. "Neoclassical theory versus prospect theory: Evidence from the marketplace." Econometrica 72, no. 2 (2004): 615-625.

List (2004) results

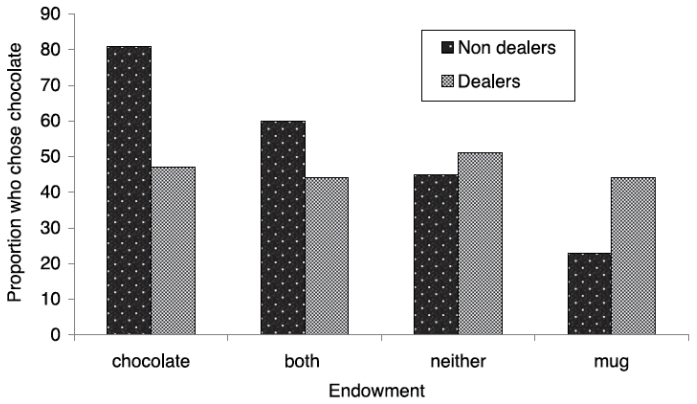


Figure 2.8 Whether subjects chose chocolate depended on the endowment. Those given chocolate were more likely to choose chocolate and those given a mug to choose the mug.

Source: List (2004).

Benefits to endowment effect?

- Conclusion from List (2004) is that endowment effect is counterproductive and we "unlearn it" through market experience
- But are there benefits from endowment effect?
  - Genesove and Mayer (2001): Boston housing price data 1990-1997
    - observed: price of home when bought and starting price of home when put on the market by owner
    - loss aversion: either sell home at price equal to or above buy price, or don't sell
    - finding: people ask for higher prices and wait a long time but eventually sell at higher prices
    - explains why sales volume falls during price slumps (should be the other way round!)
  - Apicella et al. (2014)[5]: possible evolutionary benefits to endowment effect in the face of scarcity and competition

[5] Apicella, Coren L., Eduardo M. Azevedo, Nicholas A. Christakis, and James H. Fowler. "Evolutionary origins of the endowment effect: Evidence from hunter-gatherers." American Economic Review 104, no. 6 (2014): 1793-1805.

Apicella et al. (2014): subject pool

- Test the endowment effect among Hadza, hunter-gatherers from Northern Tanzania
  - Egalitarian, collective society ("100% taxation and redistribution") with no markets or private property
- Hunter-gatherers commonly used to evolutionary hypotheses
  - best approximation to how our ancestors lived and almost all human anatomy –including the brain – evolved during hunter-gatherer epoch
- Exogenous randomization
  - some Hadza isolated from industrialized cultures (low exposure to outside markets/culture, LE)
  - others not (high exposure to outside markets/culture vis a vis tourists or going to villages, HE)
  - key point: "two genetically and largely culturally homogeneous groups from the same population"

Apicella et al. (2014): Exogenous randomization

Figure 1. Region Inhabited by the Hadza, around Lake Eyasi

Notes: High exposure (HE) camps are marked with circles, and low exposure (LE) camps with diamonds. The triangle marks the Mangola village center.

Apicella et al. (2014): Methods

- Similar to List (2004): give subjects one of two objects and give them a chance to trade
- Concerns that endowment effect might be driven by experimental procedures (Plott and Zeiler 2007), so multiple goods used
  - trial 1: subjects receive one of two food items (biscuits), or:
  - trial 2: subjects receive one of two non-food items (lighters)
  - each subject participates in both trials
- Two other concerns: endowment effect driven by 1) whether subjects understand endowed item is randomized and 2) whether subject can hold endowed item
  - two experiment conditions: 1) experimenter gives item to subject; 2) experimenter places item in front of subject and tells subject it now belongs to them
- Overal design: 2x2 (2 trials, 2 conditions)

Apicella et al. (2014): Results

- Endowment effect observed in HE population but not LE population (t-test significant, binomial test significant only for HE)

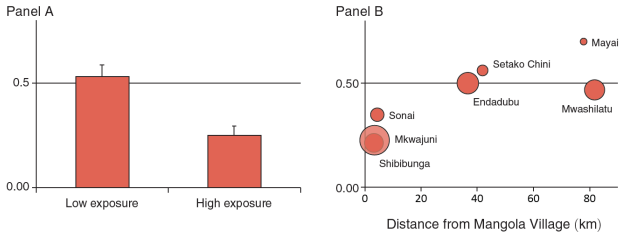


Figure 2. Fraction of Subjects Trading Endowed Item

Notes: Panel A: Fraction of subjects trading the endowed object, in low exposure and high exposure groups (M + SE of M). Rational behavior corresponds to 0.50. Panel B: Scatter plot of the fraction of subjects trading the endowed object within each camp and distance from Mangola village in km. Rational behavior corresponds to 0.50. Marker size is proportional to number of subjects.

Apicella et al. (2014): Sanity checks

- Unlikely results are driven by:
  - **selection**: Hadza who display bias more likely to migrate to HE region, so expect fewer subjects to migrate in the farthest camps
    - evidence: Figure 2b, Table 1 column 2 shows distance from village does not matter
  - **experimental artifacts**: effect depends on whether the item is a biscuit or a lighter
    - evidence: Table 1 Columns 3+4 shows experiment condition does not matter
  - **familiarity**: effect driven by Hadza familiarity with items; if so, frequency these items make it to LE should be correlated with distance
    - evidence: no positive relationship between trade and distance (Table 1, Column 2) and no relationship between durable good – the lighter, more likely to travel far– and distance (Table 1 Column 5)

Table 1—Impact of Exposure on Probability of Trading Endowed Item

Variable	(1)	(2)	(3)	(4)	(5)
High exposure region	−0.283*** (0.0457)	−0.286* (0.0818)	−0.315** (0.0656)	−0.210* (0.0477)	−0.286* (0.0822)
Distance to village (km)		−0.0000476 (0.00172)			0.00144 (0.00155)
Lighter					0.0790 (0.0859)
Lighter* distance (km)					−0.00297 (0.00162)
Constant	0.533*** (0.0357)	0.536*** (0.0818)	0.586*** (0.0409)	0.438* (0.0477)	0.497*** (0.0952)
Sample	Full	Full	Condition 1	Condition 2	Full
Observations	182	182	106	76	182
R^2	0.084	0.084	0.100	0.050	0.093

Notes: Results of regressions of dependent variable equal to 1 if the subject traded endowed item, 0 otherwise. The variable high exposure region is a dummy for whether subject was in the HE camps. Lighter is a dummy for whether experiment used lighters as the items. Standard

Apicella et al. (2014): Interpretation

- Punchline: no endowment effect among LE suggests early man did not display this bias
- Most likely that the effect is driven by culture (but paper cannot isolate exact mechanism)
  - endowment effect observed in small children in America – they are exposed to markets and private property very young (Vons et al. 2006)
  - broader point: exposure to markets influences individual preferences and valuations
- Endowment effect driven by loss aversion – but also by reluctance to trade on unfavorable terms compared to reference prices (Weaver and Frederick 2012)
  - implies knowledge of prices and therefore market experience, so these results support this notion (and contradict List 2004)

Reference Dependence

Keeping up with the Jones'

- Old saying: a happy man is he who makes more money than his brother-in-law
  - People care about *relative* earnings as much (if not more than) *absolute earnings*
- So far we have seen the importance of evaluating utility through *comparisons*
- Comparisons require a reference point r
- If utility depends on r we can write $u^r(x) = \eta u(x) + v(x - r)$
  - total utility is a weighted sum of utility from x and utility from a relative gain or loss in x (relative to r)

Consequences of reference dependence

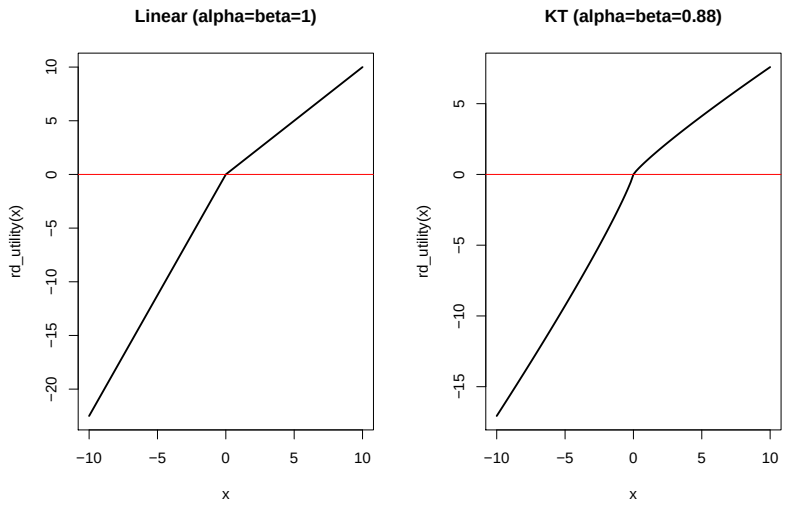
- Reference dependence influences how we value goods
  - e.g. loss aversion and endowment effect: for any $g > 0$, $v(-g) < -v(g)$
  - e.g. goal-setting and goal-targeting (framing progress towards a goal)
- Reference dependence also influences whether we buy goods/trade
  - acquisition vs transaction utility: feelings about bargains or overcharges (e.g. Thaler 2008: WTP for same beer at 'small, run-down grocery store' or 'fancy resort')
  - Relative vs absolute savings: Tversky and Kahneman (1981)
    - jacket for $125 ($15) and calculator for $15 ($125). Calculator $5 cheaper at store 20 mins away. Do you get it?
    - Constant $5 savings across conditions but frame differs (33% when calculator is $15 and 4% when $125)
    - Heuristic: 33% savings is better than 4% savings
- Reference dependence can also affect market efficiency
  - e.g. decision to engage in costly search for better prices a function of current price (reference point) and others
  - Genesove and Mayer (2001): sticky prices in the housing market
  - Chamberlain (1948): law of one price only holds on average in experimental markets

Reference dependence utility: functional form

$$u(x) = \begin{cases} u_+(x) = x^\alpha & \text{if } x \geq 0 \\ u_-(x) = -\lambda(-x)^\beta & \text{if } x < 0 \end{cases}$$

- Convexity over losses
- Concavity over gains
- Loss aversion implies:
  - $u(x) < -u(x) \quad \forall x > 0$
  - $u'_+(x) < u'_-(-x) \quad \forall x > 0$

Reference dependence utility: illustrated



Endowment effect revisited

- Contingent valuation: WTP vs WTA
  - WTP: starting from consumption level c, ask how much you are willing to spend to increase consumption to $c + 1$
  - WTA: starting from consumption level $c + 1$, ask how much you are willing to accept to decrease consumption to c
  - both measure value of $c + 1$ unit and should be equal according to standard model
  - endowment effect: WTA > WTP
  - Plot and Zeiler (2005)
    - Half of the subjects are given a mug and asked for WTA
    - Half of the subjects are shown a mug and asked for WTP
    - Finding: $WTA \approx 2 \times WTP$
    - However: endowment effect disappears with training

Mental Accounting and Narrow Framing

- Mental accounting: separating spending into different groups (e.g. "loose change", "going out", "necessities", etc.)
  - e.g. people unwilling to spend future but guaranteed income (e.g. tax rebates/returns)
  - Can lead to narrow framing: choice/outcome viewed in isolation rather than together with other choices/decisions
  - KT 1981: where losses come from matters
  - Problem with narrow framing: each account can have its own reference point, so more likely that reference points will be arbitrary

Hedonic editing

- But since people can choose their mental accounts and reference points, they can then overcome these biases by reframing gains and losses to themselves
  - Thaler: "Don't wrap all the Christmas presents in one box!"
  - Suppose you have two outcomes x and y
    - "segregated": evaluate each separately, so $v(x) + v(y)$
    - "integrated": $v(x + y)$
  - hedonic editing: re-coding gains and losses (e.g. segregate gains and integrate losses across)
    - "hedonic" because people code and re-code to maximize satisfaction with outcomes
    - so loss averse person more likely to take risks if losses are integrated (reduces the "sting" from each individual loss)
  - Marketing: exploit hedonic editing through price bundling (selling a group of related products for a combined price rather than pricing each item separately)

Where do reference points come from?

- In some cases reference points are easy to identify (e.g. buyer wants to sell for more than what they paid for, higher WTA than WTP for item that is owned, etc.)
- In other cases reference points are entirely context-dependent and can be arbitrary
- Famous example: New York taxi cab drivers (could also think about Uber/Lyft drivers, Postmates, Uber Eats, GrubHub, etc.)
  - driver chooses labor supply (how many hours to work) each day
  - wage varies day-to-day from idiosyncratic demand shocks (e.g. weather)
- Simple labor supply model due to DellaVigna (2009)[6]

[6] DellaVigna, Stefano. "Psychology and economics: Evidence from the field." Journal of Economic literature 47, no. 2 (2009): 315-72.i

Labor supply: standard model

- Let h be effort (hours), w be hourly wage, $Y = wh$ returns to effort, $U(Y) = Y$ be utility, and $c(h) = \frac{\theta h^2}{2}$ be the cost of effort where θ is disutility of effort

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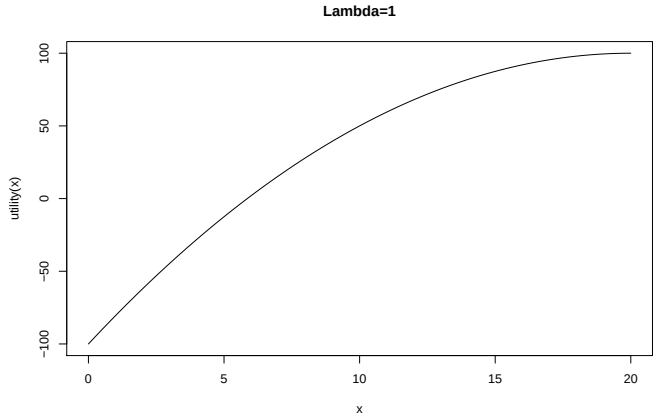

Labor supply: standard model

Optimization

- **Standard model**: driver maximizes $\max_h U(Y) - c(h) = wh - \frac{\theta h^2}{2}$
  - FOC: $w - \theta h = 0 \implies h^* = \frac{w}{\theta} = L^S$

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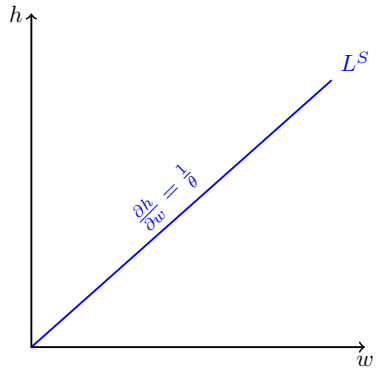

Labor supply: standard model

Equilibrium

- labor demand: $L^D = a - bw, a > 0, b > 0$
- Equilibrium: $L^S = L^D \implies \frac{w^*}{\theta} = a - bw^*$
  - $w^* = \frac{a}{1/\theta + b}$
  - $h^* = \frac{a}{1 + b\theta}$
- Comparative statics: $\frac{\partial w^*}{\partial a} > 0$ and $\frac{\partial h^*}{\partial a} > 0$ (labor demand shock)
  - work less on low demand days and work more on high demand days

Heuristics Reference Dependence

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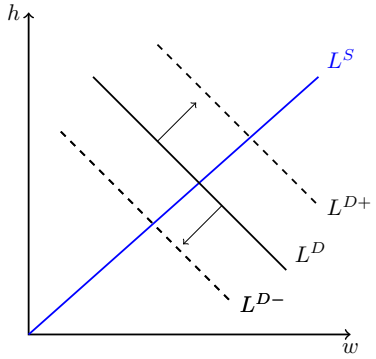

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Heuristics Reference Dependence

Labor supply: reference dependence

- Now suppose the driver has some threshold or reference-level of earnings r that want to achieve each day
  - driver is loss averse to earnings below r
  - let $\lambda > 1$ be the loss aversion coefficient
  - utility function "kinks" at r (i.e. it is discontinuous at the threshold)

$$u(Y) = \begin{cases} wh - r & \text{if } wh \geq r \\ \lambda(wh - r) & \text{if } wh < r \end{cases}$$

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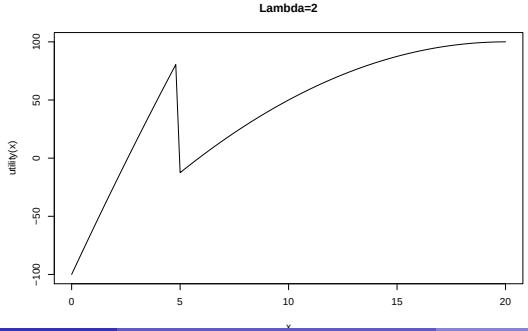

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Labor supply: reference dependence

Optimization

- Agent maximizes

$$\max_h U(Y) = \begin{cases} wh - r - \frac{\theta h^2}{2} & \text{if } wh \geq r \\ \lambda(wh - r) - \frac{\theta h^2}{2} & \text{if } wh < r \end{cases}$$

- First order conditions:

$$\frac{\partial U(Y)}{\partial h} = \begin{cases} w - \theta h & \text{if } wh \geq r \\ \lambda w - \theta h \text{if } wh < r \end{cases}$$

- Three cases to consider

Labor supply: reference dependence

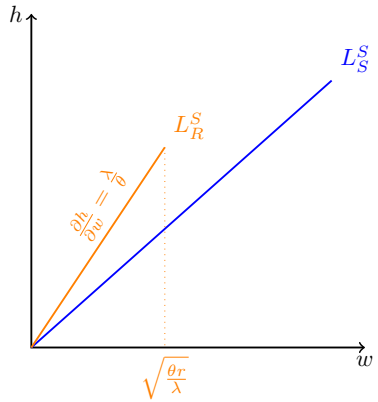
Optimization: Case 1

- **Case 1**: $\lambda w - \theta h < 0$
  - $\implies h^* = \frac{\lambda w}{\theta}$
  - $\frac{\partial h}{\partial w} = \frac{\lambda}{\theta} > 0$
  - over what domain of wage does this hold?
    - $\lambda w - \theta \frac{r}{w} < 0 \implies w < \sqrt{\frac{\theta r}{\lambda}}$

Labor supply: reference dependence

Optimization: Case 1

- **Case 1**: $\lambda w - \theta h < 0$
  - $\implies h^* = \frac{\lambda w}{\theta}$
  - $\frac{\partial h}{\partial w} = \frac{\lambda}{\theta} > 0$
  - over what domain of wage does this hold?
    - $\lambda w - \theta \frac{r}{w} < 0 \implies w < \sqrt{\frac{\theta r}{\lambda}}$



Labor supply: reference dependence

Optimization: Case 3

- **Case 3**:
  - $w - \theta h > 0$
  - $\implies h^* = \frac{w}{\theta}$ (same as standard model)
  - $\frac{\partial h}{\partial w} = \frac{1}{\theta} > 0$
  - over what domain of wage does this hold?
    - $w - \theta \frac{r}{w} < 0 \implies w > \sqrt{\theta r}$

Labor supply: reference dependence

Optimization: Case 3

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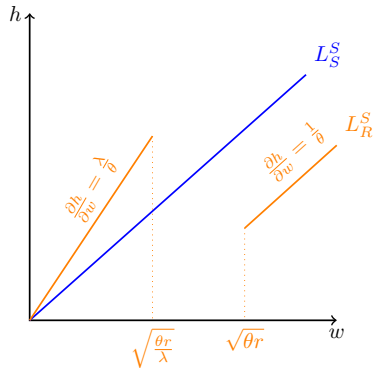

Labor supply: reference dependence

Optimization: Case 2

- What is slope of labor supply for $\sqrt{\frac{\theta r}{\lambda}} < w < \sqrt{\theta r}$?
- **Case 2**: $\lambda w - \theta h > 0 > w - \theta h$
  - Driver is content to simply reach the target r
  - $\implies h^* = \frac{r}{w}$ (i.e. the constraint)
  - $\frac{\partial h}{\partial w} = -\frac{r}{w^2} < 0$

Labor supply: reference dependence

Optimization: Case 2

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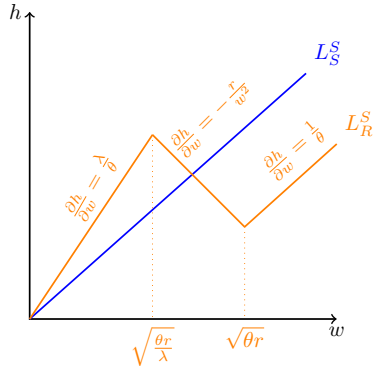

Labor supply: reference dependence

Equilibrium: Case 2

- $L^S = \frac{r}{w^*} = a - bw^* = L^D$
  - $w^* = \frac{a + \sqrt{a^2 - 4rb}}{2b}$, $h^* = \frac{2br}{a + \sqrt{a^2 - 4rb}}$
- Comparative statics (labor demand shock): $\frac{\partial h^*}{\partial a} < 0$
  - work *more* on low demand days to achieve target but work *less* on high demand days

Labor supply: reference dependence

Evidence: Camerer, Babcock, Loewenstein, and Thaler (1997)

- three data sets of hours worked and daily earnings for New York cab drivers to test whether the labor supply function is upward-sloping, as the standard theory above implies, or downward-sloping
- Estimation: $log(h_{it}) = \alpha + \beta \log\left(\frac{Y_{it}}{h_{it}}\right) + \theta' \mathbf{X} + \varepsilon_{it}$
  - Y daily earnings, h hours, $\mathbf{X}$ controls
  - log-log model: interpret β as elasticity of labor supply (percentage change in hours from percentage change in wages)
  - standard model predicts $\beta > 0$
  - reference dependence predicts $\beta < 0$
  - Findings: $\hat{\beta} = -.186, -.618$ and $-.355$
- Problems with estimation
  1. $\hat{\beta} < 0$ expected if h sensitive to shifts in labor supply rather than demand (e.g. weather: less pleasant to drive in rain)
  2. Division bias: daily wage is $\frac{Y_{it}}{h_{it}}$ and outcome predicted is h_{it} so any measurement error in h_{it} induces downward bias in $\hat{\beta}$

Labor supply: reference dependence

Farber (2005) and Farber (2008)

- Different taxi data (584 trip sheets for 21 New York cab drivers)
- Farber (2005) Estimates probability of stopping shift early as function of earnings and hours
  - $P(\text{stop}_{it}) = \Phi(\alpha + \beta_Y Y_{it} + \beta_h h_{it} + \theta' \mathbf{X} + \varepsilon_{it})$
  - Φ is normal CDF (ensures $P(\hat{\text{stop}}_{it}) \in [0, 1]$)
  - no division bias
  - standard theory: $\beta_Y = 0$ (earnings uncorrelated throughout day)
  - reference dependence: $\beta_Y > 0$ (more likely to stop as earnings increase)
  - finding: $\hat{\beta_Y} = 0.015$ but insignificant
  - Still impressive: ten percent increase in earnings (about \$15) increases P(stop) by (\$15)(0.15) = 0.225 percent
  - However, paper does not test whether cab drivers have reference dependent
- Farber (2008): back out λ (loss aversion) and r (reference point/target) in labor supply using same data
  - Finding: $\hat{\lambda} > 0$ and significant
  - However: substantial variation in $\hat{r}$ mitigates effect of loss-aversion
  - Some extensions in Farber (2015): hours worked more important than income earned
  - Problem: wage endogenous
  - Promising extension for an experiment: exogenously control changes in wage

Labor supply: reference dependence

Fehr and Goette (2007)

- labor supply of bike messengers in Zurich
  - messengers deliver packages
  - paid commission rate w of their revenues R, so earnings are wR
  - messengers can freely choose the number of shifts and whether they want to do a delivery, when offered by the dispatcher
  - demand varies substantially between days
- Field experiment: randomly assign 44 messengers into two groups
  1. Control: w left alone
  2. Treatment: w increased by 25%
- Findings:
  - treatment messengers work 30% more shifts
    - consistent with reference dependence: sign up for days when easier to reach target
  - treatment messengers do 6% fewer deliveries within each shift (i.e. decrease in h)
    - consistent with reference dependence (standard model predicts increase in h)
- Confounder: drop in h in treatment group because messengers get tired
  - Lab experiment on risk-taking: messengers who display loss aversion in lab exhibit more negative response in h due to increase in w

Other evidence of reference dependence

- **Housing market** : reluctance to sell houses at a loss (Genesove and Mayer 2001)
- **Disposition effect** in finance: tendency to sell "winners" and hold on to "losers"
  - standard theory: capital gain taxation should see investors liquidate losers quickly
  - Odean (1998): investors tend to sell assets that increased in value while holding onto assets that dropped in value
  - explanation: investors dislike losing more than they like winning
- **Insurance**: Why do people buy insurance on telephone wiring when losses amount to at most \$50 (Cicchetti and Dubin, 1994)?
  - More spending on insurance against small risks than predicted by standard model
- **Golf**: Pope and Schweitzer (2011)
  - "Golf provides a natural setting to test for loss aversion because golfers are rewarded for the total number of strokes they take during a tournament, yet each individual hole has a salient reference point, par."
  - "We analyze over 2.5 million putts using precise laser measurements and find evidence that even the best golfers—including Tiger Woods—show evidence of loss aversion"
- Caveat: still an open literature because difficult to observe r without changing it