PROSPECT THEORY

Episode 1

EE 434 Behavioral Finance, SEM1/2022

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From comparing expected value to comparing Prospect theory value

Suppose you have initial wealth w, Consider two lotteries

$X = (x_1, p; x_2, 1-p)$ vs. $Y = (y_1, q; y_2, 1-q)$

You will prefer lottery X over lottery Y IF….

x ≻ Y

From comparing expected value to comparing Prospect theory value

- Expected Value Theory

$$w + px_1 + (1-p)x_2 > w + qy_1 + (1-q)y_2$$

- Expected Utility Theory

$$pU(w + x_1) + (1-p)U(w + x_2) > qU(w + y_1) + (1-q)U(w + y_2)$$

- Prospect theory

$V(x_1, p; x_2, 1-p) > V(y_1, q; y_2, 1-q)$

$$\pi(p)v(x_1) + \pi(1-p)v(x_2) > \pi(q)v(y_1) + \pi(1-q)v(y_2)$$

Prospect Theory: Stages

In order to consider prospects, individuals go through two stages:

(1.) Editing stage

(2.) Evaluation stage

Prospect Theory: Editing Stage

This is the stage of organizing & reformulating the problem.

Taking an objective prospect $(\hat{x}_1, \hat{p}_1; \ldots; \hat{x}_m, \hat{p}_m)$and

transforming it into an object for evaluation $(x_1, p_1; \ldots; x_n, p_n)$

by:

Prospect Theory: Editing Stage

- **Coding:** code outcomes as gains & losses relative to reference point.
- **Combination:** e.g., (100, .5; 100, .5) replaced with (100, 1).
- Segregation: e.g., (100, .5; 200, .5) replaced with 100 for sure plus (0, .5; 100, .5).

- Cancellation: discard shared components.
- Simplification: rounding of probabilities. $(100, 0.5190321) \Rightarrow (100, 0.5)$
- Eliminating dominated alternatives

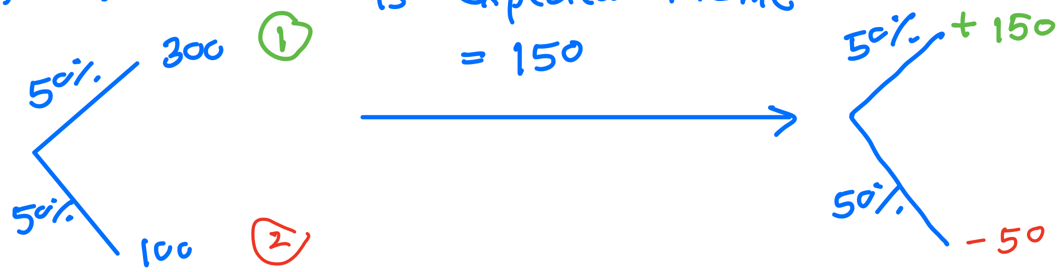
Coding

e.g.

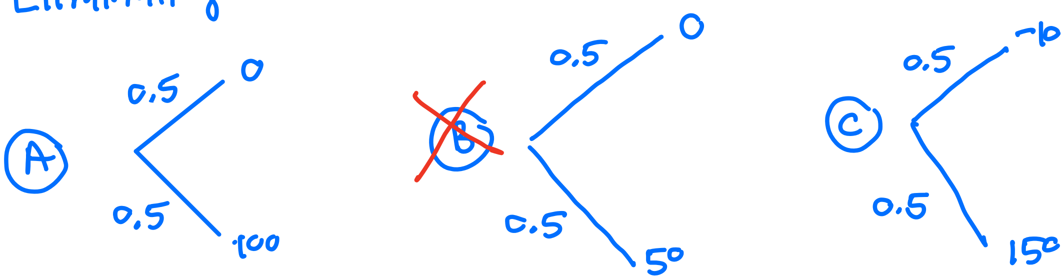
$(\hat{x}_1, \hat{p}_1 ; \hat{x}_2, \hat{p}_2)$

Coding

if reference point is expected income = 150



Eliminating



Prospect theory: Evaluation stage

A prospect can be written as $(x, p; y, q)$ with $p + q \leq 1$.
Note: $p + q < 1$ implies prospect yields 0 with probability $1 - p - q$.

A person evaluates a prospect $(x, p; y, q)$ according to the functional

$$V(x, p; y, q) = \pi(p)v(x) + \pi(q)v(y)$$

Note: Nowadays, it might be best to take Prospect theory as a theory for simple prospects with at most two non-zero outcomes.

Prospect Theory's Value Function

Prospect Theory: Value Function

Three key features of the value function $v(.)$:

positive change in wealth from referent pt. ⇒ gain
(negative) (loss)

- The carriers of value are changes in wealth ($v(0) = 0$).

- Diminishing sensitivity to the magnitude of changes:

concave over gain   convex over loss

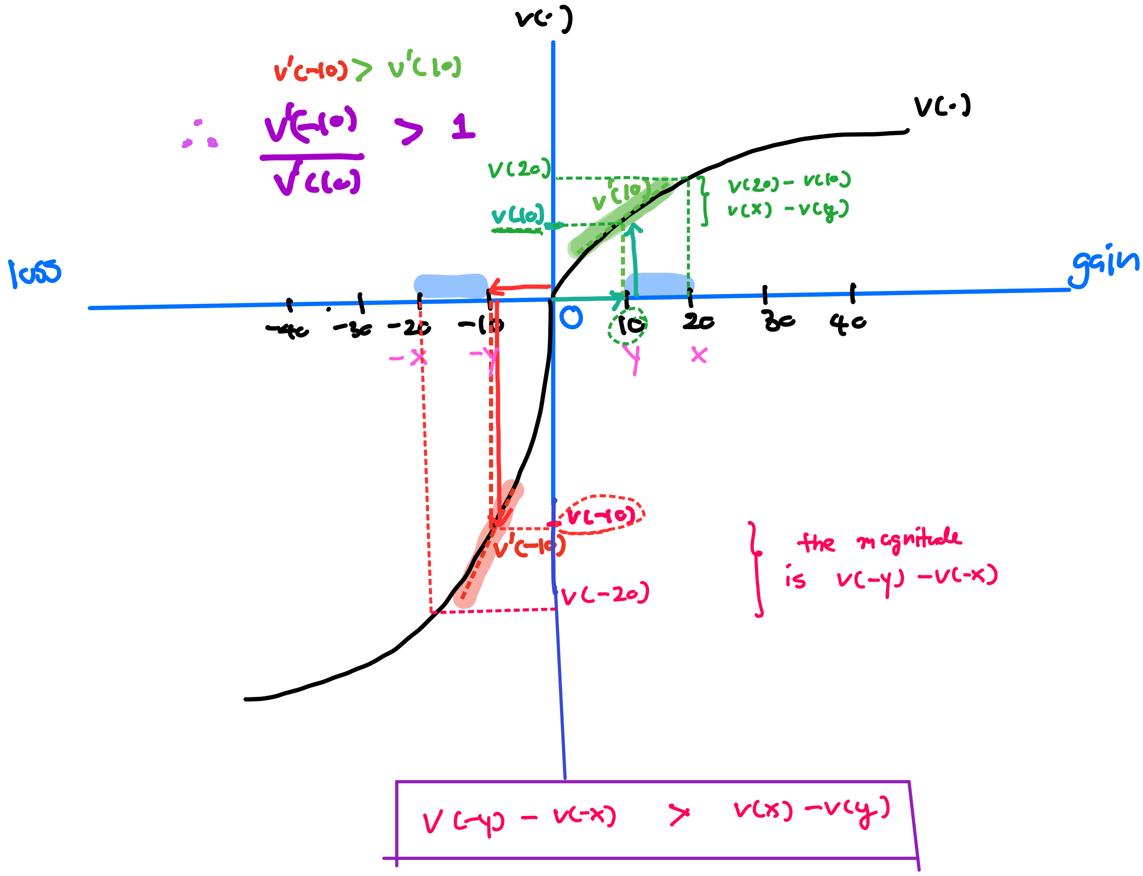
$v''(x) < 0$ for $x > 0$, $v''(x) > 0$ for $x < 0$.

- Loss aversion: losses loom larger than gains.

Y fair gamble   X fair gamble   (expected value of gamble = 0)

100 −100 200 −200

$$\frac{v'(x) \text{ when } x<0}{v'(x) \text{ when } x>0} > 1, \text{ or } (y, 0.5; -y, 0.5) \succ (x, 0.5; -x, 0.5) \text{ if } 0 < y < x$$



Y fair gamble		X fair gamble	(expected value of gamble = 0)
100	-100	200	-200

r $(y, 0.5; -y, 0.5) \succ (x, 0.5; -x, 0.5)$ if $0 < y < x$

$V(y, 0.5; -y, 0.5) > V(x, 0.5; -x, 0.5)$

$\pi(0.5)v(y) + \pi(0.5)v(-y) > \pi(0.5)v(x) + \pi(0.5)v(-x)$

since $\pi(0.5) > 0$

$v(y) + v(-y) > v(x) + v(-x)$

$v(-y) - v(-x) > v(x) - v(y)$

The loss feeling > The gain feeling for equal-sized gain and loss

Prospect Theory: Value Function

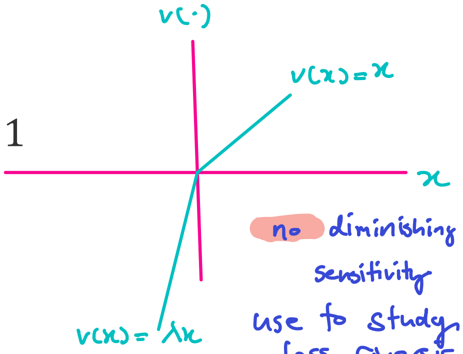
Two common functional forms for the value function:

Tversky & Kahneman (1992)

$$v(x) = \begin{cases} x^{\alpha} & \text{if } x > 0 \\ -\lambda(-x)^{\beta} & \text{if } x < 0 \end{cases}$$,where $\alpha, \beta \in (0,1]$ and $\lambda \geq 1$

Two-part linear

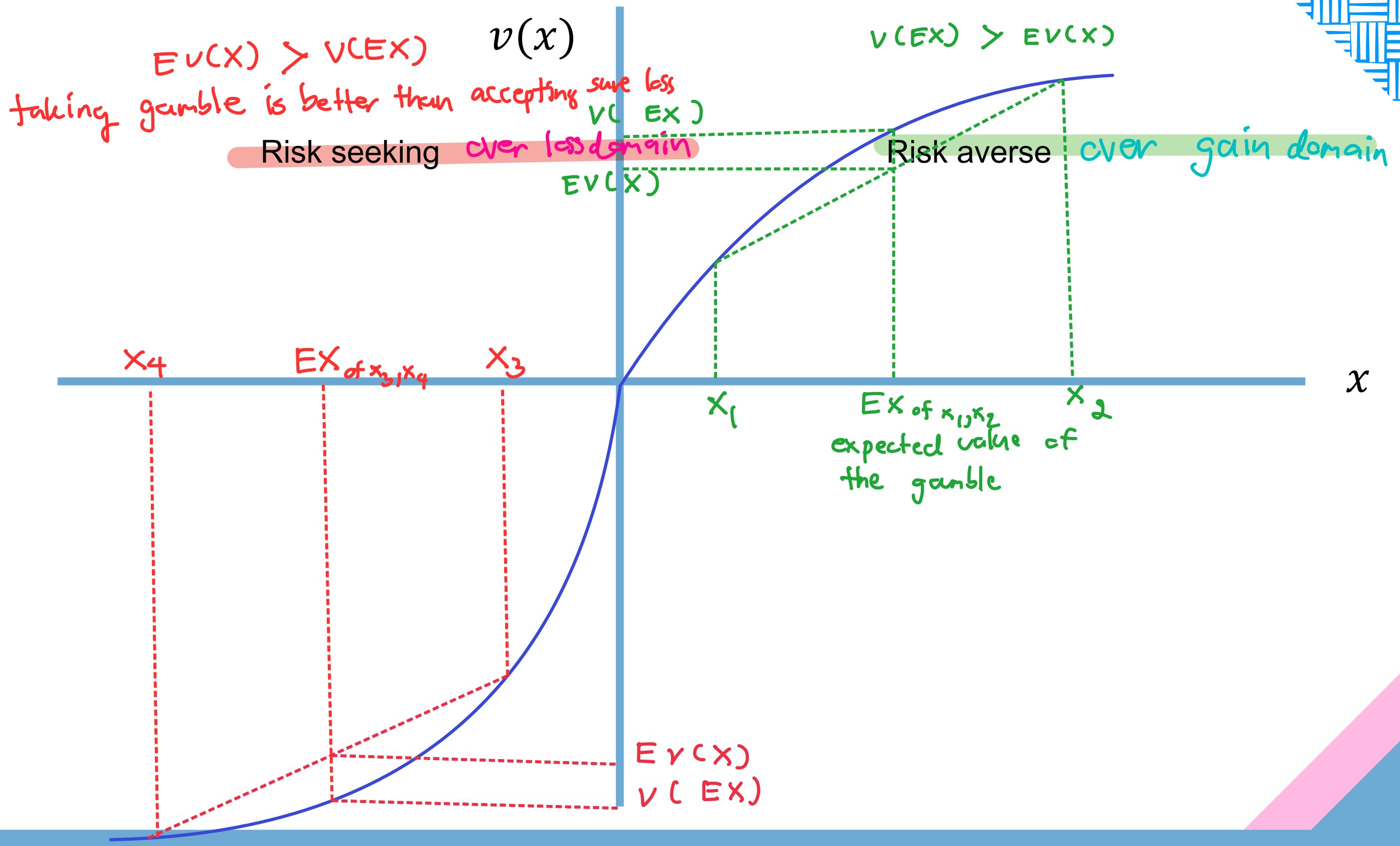
$$v(x) = \begin{cases} x & \text{if } x > 0 \\ \lambda x. & \text{if } x < 0 \end{cases}$$,where $\lambda \geq 1$



no diminishing sensitivity

use to study the role of loss aversion

λ is the coefficient of loss aversion.



EV(X) > V(EX)
taking gamble is better than accepting sure loss
v(x)
V(EX) > EV(X)
V(EX)
Risk seeking over loss domain
Risk averse over gain domain
EV(X)
X4
EX of x3,x4
X3
x
X1
EX of x1,x2
expected value of the gamble
X2
Ev(X)
v(EX)

Risk aversion over gain & Risk seeking over loss

In a situation where a sure loss is compared to a gamble with probable larger loss, diminishing sensitivity cause risk seeking.

In a situation where a sure gain is compared to a gamble with probable larger gain, diminishing sensitivity cause risk aversion.

At the same level of wealth, an individual can both be risk averse and risk seeking.

Riskless Loss Aversion

Loss aversion can also be viewed in a riskless context.

Experiments have examined people's willingness to pay for a good, compared to their willingness to accept money in exchange for the same good.

Buy : Don't have it → have it : gain feeling

Sell : Have it → don't have it : loss feeling

WTP
The max price you are willing to pay

WTA
The minimum price you need to let go of what you have

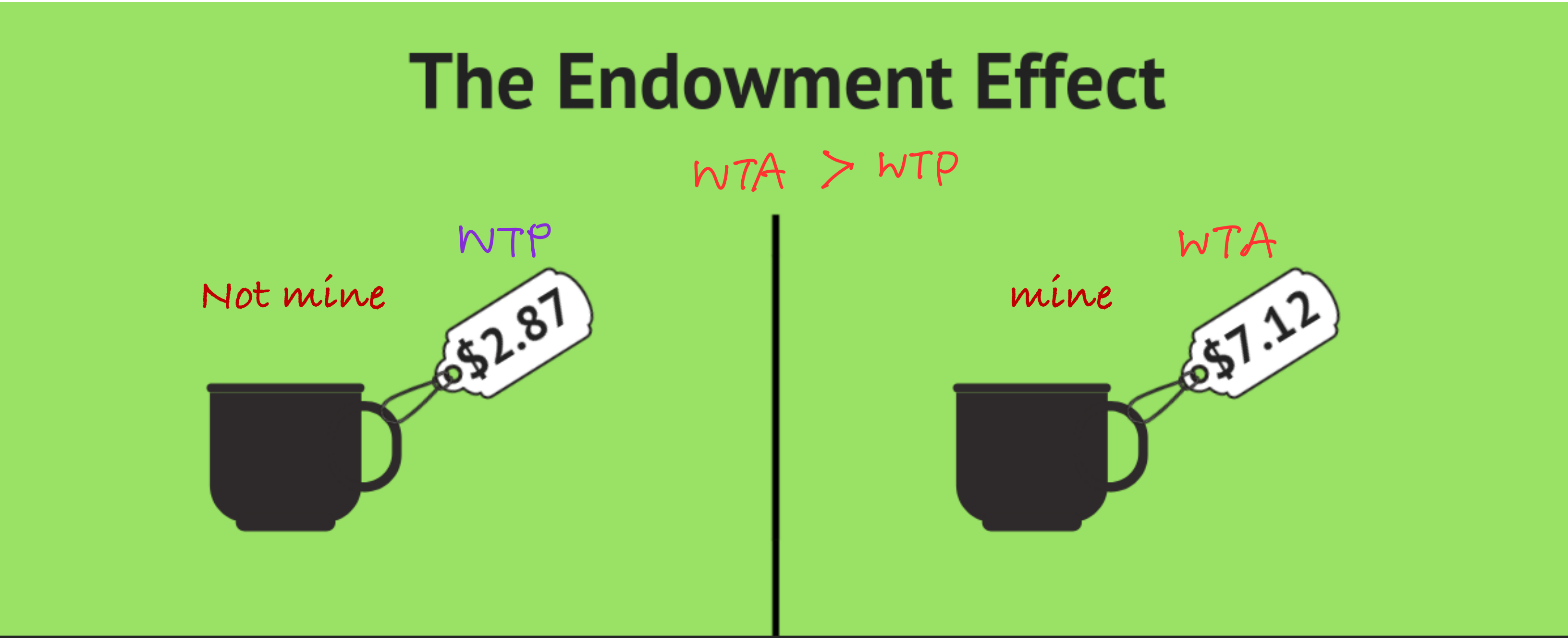
Willingness to Pay(WTP) vs. Willingness to Accept(WTA)

Standard economic theory says that an individual has a single value (i.e. some price p) that she associates with any good

- ✓ If she is given the opportunity to buy the good at (or below) that price, she will pay it. The price is her "willingness to pay(WTP).
- ✓ Similarly, if someone offers to buy the good from her at (or above) that price, she will accept it. The price is her "willingness to accept". (WTA)
- ✓ Standard economic theory says that WTP=WTA

RICHARD THALER

Around the same time Kahneman and Tversky were working on their model of Prospect Theory, economist Richard Thaler was noticing (and writing about) some of his own "anomalies". Thaler (1980) attributes gap between WTP and WTA to what he coined **the endowment effect.**

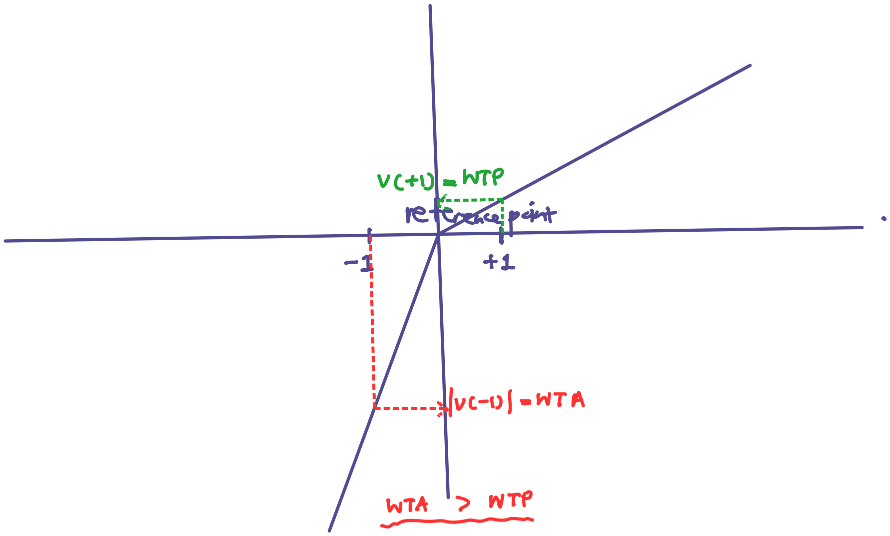


The Endowment effect

- The term endowment effect is used because the value of a good seems to increase once a person owns it.

- This is consistent with prospect theory because losses (i.e., giving up the good) are felt much more strongly than gains (receiving the good).

The Endowment effect



The absolute value of $v(-x)$ is more than the value of $v(x)$.

Endowment Effect: Mug Experiment

Kahneman, Knetsch, and Thaler (1990) test these ideas in their famous “mug experiments” at Cornell University.

Experiment: Class of 50 - 75 economics students.

After students sit down, half of them are given a coffee mug.

Endowment Effect: Mug Experiment

Potential "Sellers"	Potential Buyers
How much willing to accept for the mug?	How much willing to pay for the mug?

Each seller were given a coffee mug.

Each buyer were shown a coffee mug.

Endowment Effect: Mug Experiment

Students are given cash and asked how much they would be willing to pay for a mug with the university's emblem.

Then another group of students is given mugs and asked how much they would accept in return.

In one session the students were willing to pay only $1.34 for a mug, yet others would not accept less than $8.83 for the exact same mug.

Measuring Loss Aversion

Would you accept the following bet? A coin toss where:

If tails, lose $100, heads win $150? reject accept
If tails, lose $100, heads win $160? reject
If tails, lose $100, heads win $170?
If tails, lose $100, heads win $180?
If tails, lose $100, heads win $190?
If tails, lose $100, heads win $200?
If tails, lose $100, heads win $210?
If tails, lose $100, heads win $220? reject
If tails, lose $100, heads win $230? accept
If tails, lose $100, heads win $240? accept
If tails, lose $100, heads win $250? accept
If tails, lose $100, heads win $260? accept accept

"Multiple price list"

⇒ to get "indifferent point"

How loss averse is the average person?

accept the risk $\sim$ reject the risk

lose \$100 wp 0.5 $\sim$ 0
gain \$230 wp 0.5

if $v(x) = \begin{cases} x & , x > 0 \\ \lambda x & , x < 0 \end{cases}$

$$\pi(0.5)\,v(-\$100) + \pi(0.5)\,v(\$230) = \pi(1)\,v(0) \to 0$$

$$v(-\$100) + v(\$230) = 0$$

$$\lambda(-100) + 230 = 0$$

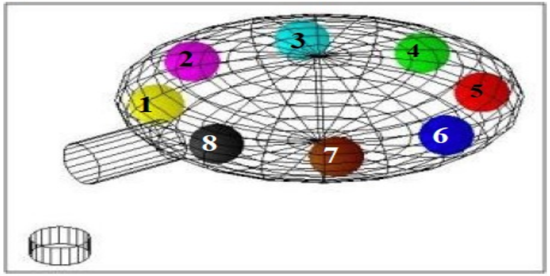
$$\lambda = \frac{230}{100} = 2.3 \; \#$$

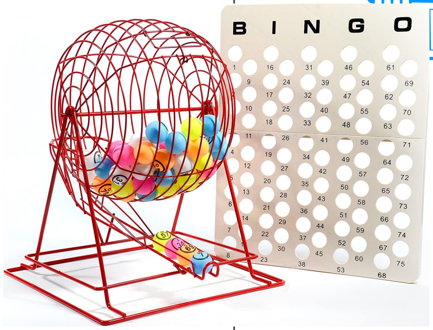
Measuring Loss Aversion 💔

For coin toss above, typical response is to be indifferent at gain = $200

The ratio of the amount you'd need to win (to accept the bet) and the amount you could potentially lose is generally found in range 1.5 to 2.5.

People are reluctant to expose themselves to fair gambles because they are loss averse. Typically, for a 50/50 bet, the gain has to be at least twice as great as the loss.





Win € 20 if one of the following balls is extracted:

1 2 3 4

If one of the following balls is extracted, then:

5 6 7 8

Lose € 20	O	O	€ 0 for sure
Lose € 19	O	O	€ 0 for sure
Lose € 18	O	O	€ 0 for sure
Lose € 17	O	O	€ 0 for sure
Lose € 16	O	O	€ 0 for sure
Lose € 15	O	O	€ 0 for sure
Lose € 14	O	O	€ 0 for sure
Lose € 13	O	O	€ 0 for sure
Lose € 12	O	O	€ 0 for sure
Lose € 11	O	O	€ 0 for sure
Lose € 10	O	O	€ 0 for sure

Measuring Loss Aversion

- Earlier, we measured the coefficient of loss aversion from answers to whether you would accept a bet with a 50% chance to win X , and a 50% chance to lose Y , where:

Coefficient of Loss Aversion = $\frac{X}{Y}$ for the smallest X given a fixed Y, OR for the largest Y given a fixed X

- We can also measure the coefficient of loss aversion using the endowment effect experiment:

λ =

Coefficient of Loss Aversion = $\frac{WTA}{WTP}$

capture loss feeling (WTA)

capture gain feeling (WTP)

DANKE!

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