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# FINM3407 – Behavioral Finance

**Topic 2:**

Chapter 3: Prospect Theory, Framing and Mental Accounting

*Reference: AckertDeaves Chapters 3*

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# What we do this week

**[Part One – Prospect Theory]**

- **Overview about Prospect Theory**

(1) Risk Aversion vs. Risk Seeking

(2) Development of Prospect Theory

- **Prospect Theory Value Function**
- **The Weighting Function**

**[Part Two – Mental Accounting]**

- **Mental Accounting**

(1) Integration vs. Segregation

(2) Theater Ticker Problems

(3) Opening and Closing Accounts

# Introduction to Prospect theory

- Prospect theory was developed by two psychologists, **Kahneman and Tversky (1979)** based on observing actual behaviour (aka. Positive model).
- Experimental evidence suggests that individuals frequently deviate from the behavioural predictions of expected utility theory (Normative model)**.**
- Prospect theory has a solid mathematical basis.
- Unlike expected utility theory which concerns itself with how decisions under uncertainty **should** be made (a ***prescriptive*** approach), prospect theory concerns itself with how decisions are actually made (a ***descriptive*** approach)

## Recap: Expected Utility Theory

- Expected utility can be defined as:

$$\textbf{E(U)} = \sum_{i=1}^{N} \boldsymbol{P_i}\ \boldsymbol{U(w_i)},$$

where $\boldsymbol{P_i}$ = probability of each outcome,

$\boldsymbol{U(w_i)}$ is the utility derived from each outcome ($w_i$ = wealth)

- Example:

  If you face this gambling opportunity: 50% win $105, 50% lose $100. Take it?

  If you are an expected utility maximizer with wealth W, you should take the gamble if

  current utility < expected utility

  U(W) < 0.5*U(+$105) + 0.5*U(-$100).

- Von Neumann and Morgenstern
  - ➢ if you follow certain axioms, you must maximize "**expected utility**."
- *Note: Expected utility is linear in probabilities.*

# Risk Aversion vs. Risk Seeking vs. Loss Aversion

- Prospect pair 1 -- choose between:
  - **A: (0.8, 4,000)**
  - **B: (3,000)**
- ***Note: with certainty, which is =1, there is no need to show a probability***

- Prospect pair 2 -- choose between:
  - **A: (0.8, -4,000)**
  - **B: (-3,000)**

- Prospect pair 3 -- choose between:
  - **A: no prospect**
  - **B: (0.5, 50, -50)**

# Loss Aversion vs. Risk Aversion

## Loss Aversion

- Strong preference to avoid losses rather than acquiring equivalent gains.
- Feelings of loss are psychologically about twice as powerful as feelings of gain.
- May lead to taking bigger risks to avoid losses.

## Risk Aversion

- Preference for lower levels of risk and uncertainty.
- Choice of guaranteed outcomes, even if less profitable.
- Drives decisions towards certainty over uncertainty.

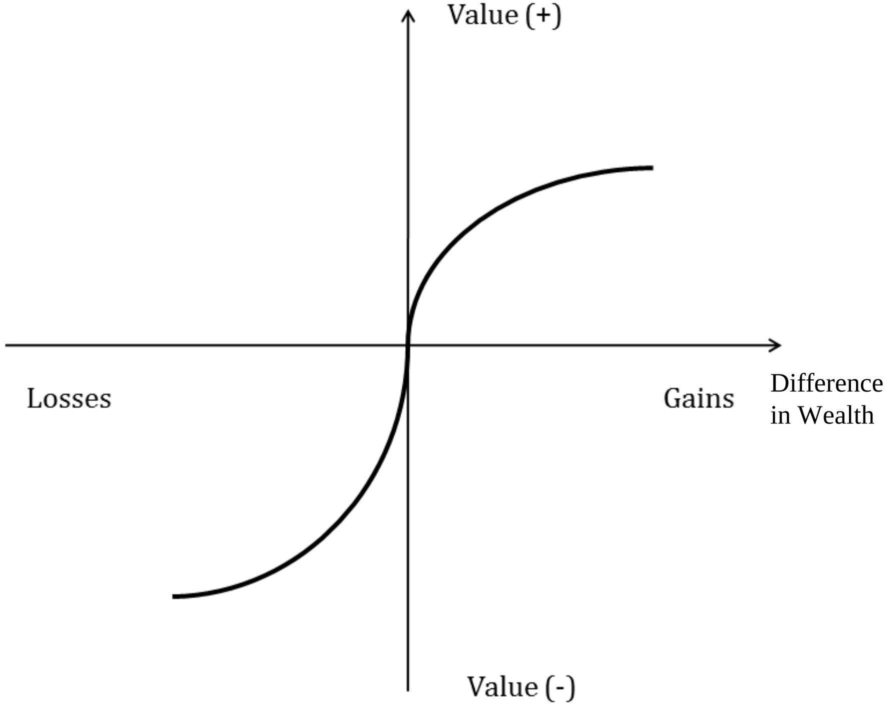
# Development of prospect theory

- The prospect theory was proposed in 1979 to address certain empirical observations that Expected Utility Theory failed to explain.
  - ➢Value vs. Utility & Difference in Wealth vs. Total Wealth

- **<u>Three Key characteristics of the value function include:</u>**
  - **Reference Dependence:** Value perception is relative to a specific reference point, typically the status quo.
  - **Loss Aversion:** Losses impact utility more than equivalent gains.

    $$v(x) < -v(-x)$$

  - **Diminishing Sensitivity:** Sensitivity to wealth changes decreases as the magnitude of gain or loss increases.




- These 3 aspects make Prospect Theory more fitting than Expected Utility Theory in high-risk and uncertain situations.

# Common value functional form of Prospect Theory

Positive Domain

$v(z) = z^{\alpha}$ **for** $z \geq 0,\ 0<\alpha<1$

- z is change in wealth (horizontal line)
- Value function (not utility) so **v** is used.

Negative Domain

$v(z) = -\lambda(-z)^{\beta}$ **for** $z<0,\ \lambda>1,\ 0<\beta<1$

- The factor **λ**, which is greater than 1, introduces loss aversion
- The parameter **β** (0<β<1) controls the **curvature** of the function on the loss side, similar to **α** on the gain side (see Appendix).
- Kink at origin.

# Common ratio effect

**Prospect pair 4 – choose between:**

- A: (.9, $2000)
- B: (.45, $4000)

Most people opt for?

**Prospect pair 5 – choose between:**

- A: (.002, $2000)
- B: (.001, $4000)

Most people opt for?

This discrepancy is explained by prospect theory, which takes into account the **fact that people's perceptions of probabilities and outcomes can be skewed by factors like the possibility of a large gain.**

# Common ratio effect

**Invoke linear transformation rule:**

**Prospect pair 4**

$$0.9u(\$2000) > 0.45u(\$4000)$$
$$\div\, 0.45 \qquad\qquad \div\, 0.45$$
$$2u(\$2000) > u(\$4000)$$

➔ This reflects the fact that individuals prioritize the high probability of winning a smaller amount ($2000) over the lower probability of winning a larger amount ($4000).

**Prospect pair 5**

$$0.001u(\$4000) > 0.002u(\$2000)$$
$$\div\, 0.001 \qquad\qquad \div\, 0.001$$
$$u(\$4000) > 2u(\$2000)$$

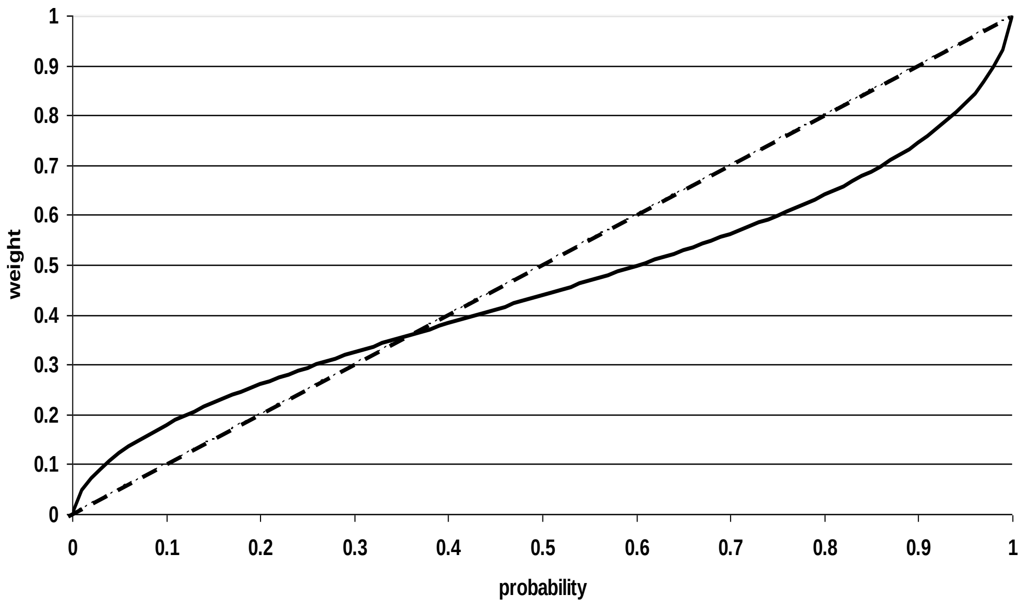
➔ This shows the contradiction where people are choosing a smaller expected utility when it comes to small probabilities, opting for the chance to win a larger amount ($4000) despite the lower likelihood.

# Common ratio effect cont.

**Reconciliation Through Prospect Theory:**

The answer lies in its nonlinear weighting function.

In Prospect Theory, probabilities are not treated linearly. **Small probabilities** are *overweighted*, which means they seem larger than they are, and **moderate to high probabilities** are *underweighted*, appearing smaller than they are.




This distortion of probabilities can make option B in Prospect Pair 5 seem more attractive than it would be under expected utility theory, thus reconciling the apparent contradiction.

## Lottery Effect

### Prospect pair 6 -- choose between:

- **A: (0.001, $5,000)**
- **B: ($5)**

**Most prefer A which is inconsistent with risk aversion.**

- People seem to overweight low-probability events (which is why people buy lottery tickets)

## Insurance

### Prospect pair 7 -- choose between:

- **A: (0.001, -$5,000)**
- **B: (-$5)**

**Most prefer B which is inconsistent with risk seeking.**

- Insurance need
- Once again, people seem to overweight low-probability events (which is why people buy insurance)

# Certainty effect

**Prospect pair 8 -- choose between:**

- **A: (0.2, $4000)**
- **B: (0.25, $3000)**

**Prospect pair 9 – choose between:**

- **A: (0.8, $4,000)**
- **B: ($3000)**

**Most choose 8A and 9B, but they shouldn't.**

- **Certainty is accorded high weight *relative to* near-certainty**

# Prospect Theory: More than two outcomes

Prospect theory assumes people maximize a "weighted sum of utilities," although the weights are not the same as the true probabilities, and the "utilities" are determined by a *value function* rather than a *utility function*:

$$\Rightarrow \textbf{Max: E(v)} = \sum \boldsymbol{\pi(p_i)} \times (\boldsymbol{x_i} - \boldsymbol{r})$$

- Where $\boldsymbol{\pi}$ is a non-linear weighting function,
- v($x_i$ - r) is the value function evaluated with respect to the reference point, r [Change in Wealth]

# Weighting function

- **The decision weighting function is non-linear with the probability p.**

- That is, decision weights are not probability.
- They do not obey the probability axioms.
- They should not be interpreted as measures of belief.

- **Properties of the weighting function:**

- $\boldsymbol{\pi}'(\mathbf{p}) > \mathbf{0}$ is an increasing function of p
- $\boldsymbol{\pi}(0) = 0$: outcomes contingent on an impossible event are ignored
- $\boldsymbol{\pi}(1) = 1$: scale is *normalised* so the certainty event has a π value of 1.

For small p, $\boldsymbol{\pi}(r*p) > r\boldsymbol{\pi}(p)$ where $0<r<1$: $\boldsymbol{\pi}$ is subadditive

- Ex: $\boldsymbol{\pi}(0.001)/\boldsymbol{\pi}(0.002) > ½$

- Meaning: when winning is **possible but not probable** (i.e., small p), most people choose the prospect that offers **larger gain**: V(6,000, 0.001) > V(3,000, 0.002)

# Weighting function notes

**This (displayed) mathematical function is:**

$$\pi(pr) = pr^{\gamma} / [pr^{\gamma} + (1- pr)^{\gamma}]^{(1/\gamma)} \text{, where } \gamma = .65$$

- Weighting function for losses can vary from weighting function for gains.
- Low probabilities are given relatively higher weights than more probable events.
- And certainty is weighted highly vs. near-certainty.
- Using functions like this solves some earlier puzzles.

# Valuing prospects under prospect theory

$$V(P) = \pi(pr_A) * v(z_A) + \pi(1 - pr_A) * v(z_B)$$

**Steps:**

- Convert probabilities to decision weights
- Calculate values of wealth differences
- Use the above formula

## Exercise – Previous Prospect 8 & 9

**Prospect pair 8**

- A: (0.2, $4000)
- B: (0.25, $3000

**Prospect pair 9**

- A: (0.8, $4000)
- B: ($3000

Given $\pi(pr) = pr^{\gamma} / [pr^{\gamma} + (1- pr)^{\gamma}]^{(1/\gamma)}$ where $\gamma = .65$

$v(z) = z^{1/2}$

# Some more prospects

**You were given $1000, now choose between:**

- **A: (0.5, another $1000)**
- **B: ($500)**

**You were given $2000, now choose between:**

- **C: (0.5, -$1000)**
- **D: (-$500)**

**Problems are identical! People have chosen differently because of different frames.**

# Frames

Essential condition for a theory of choice is **principle of invariance**: Different representations of same problem should yield same preference.

**Unfortunately, this sometimes does not work out in practice:**

- People have different perspectives and come up with different decisions depending on how a problem is framed.

# Mental accounting

*Related to prospect theory and frames.*

- **Accounting is process of categorizing money, spending and financial events.**
- **Mental accounting is a description of way people intuitively do these things, and how it impacts financial decision-making.**
- **Often tendency to use mental accounting leads to odd and suboptimal decisions.**

**Mental Accounting:** This is a concept where people treat money differently depending on where it comes from, where it is kept, or how it is spent.

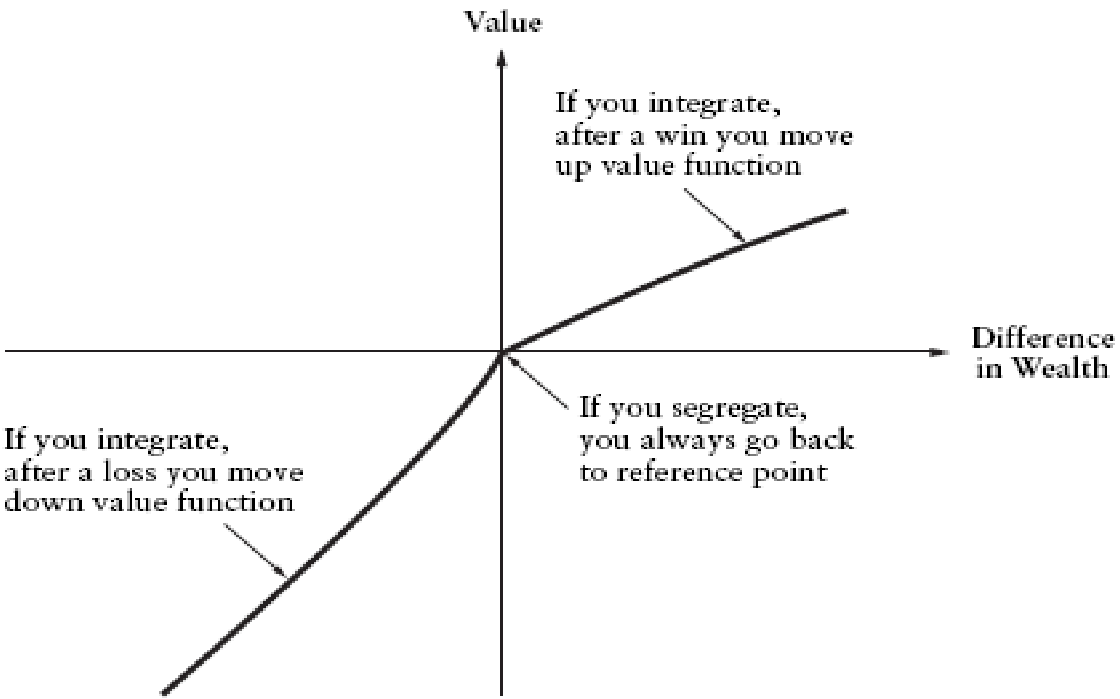
*For example, people may view a tax refund as a "bonus" or "windfall" and may be more inclined to spend it on a luxury or save it, rather than using it to pay off debts.*

# Prospect theory, mental accounting and prior outcomes

Problem with prospect theory is that it was set up to deal with one-shot gamble – but what if there have been prior gains or losses?

Do we go back to **zero (segregation)**, **or move along curve (integration)?**

## Segregation vs. Integration




**1.Segregation**: This refers to the idea that each new gamble is evaluated in isolation, starting from the reference point of zero (as if we "reset" after each gamble). The idea is that people have short memories, or they "start fresh" with each new gamble.

**2.Integration**: This suggests that people keep track of their gains and losses over time and use this cumulative total as their reference point. In this case, prior outcomes influence the valuation of current prospects.

# Prospect theory, mental accounting and prior outcomes

**Silver lining effect:**

- They tend to mentally combine wins but separate losses to make them feel less impactful.

**House money effect:**

- People tend to be more willing to gamble with money that they have won (house money) than with their initial stake or with money won in earlier rounds of betting.

Which of these approach individuals take can depend on the specific context and individual psychological factors

# Theater ticket problems

1. Imagine you have decided to see a play where admission is $10. As you enter theatre you discover that you have lost a $10 bill. Would you still pay $10 for a ticket to the play?

2. Imagine that you have decided to see a play and paid the admission price of $10 per ticket. As you enter the theatre you discover that you have lost the ticket. The seat was not marked, and the ticket cannot be recovered. Would you pay $10 for another ticket?

# Theater ticket problems cont.

Nothing is really different about the problems, however:

- Of respondents given **first question**, **88%** said they would **buy** a ticket.
- Of respondents given **second question**, **54%** said they would ***not* buy** a ticket.

• In 2nd question, integration is more likely because both lost ticket and new ticket **would be from same "account."**

- Integration might suggest that $20 is too much for the ticket.

• Example of how integration + mental accounting affect decision-making process

# Opening and closing accounts

Once an “account” is closed, you go back to zero.

Evidence that people avoid closing accounts at a loss:

- Selling a stock at a loss is painful: disposition effect (to be discussed).

Managers do the same thing as well.

- Companies rarely have low negative earnings but often have low positive earnings:
  - They manage earnings by either pushing things to a low positive,
  - Or they “take a bath” and move to a high negative.

# Thank you!

# See you next week.

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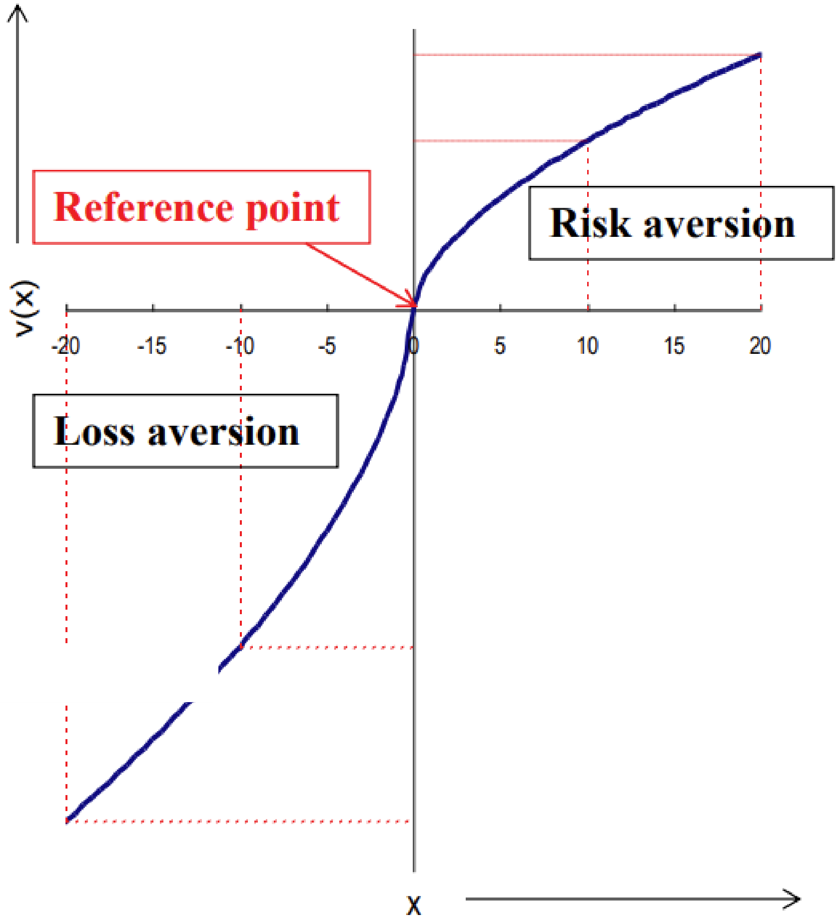
**Topic 2 Appendix:**

Extra Information

# Common value function functional form

**Properties:**

- Outcomes are *changes* with respect to reference point (often status quo)
- *Loss aversion* v(x)<-v(-x)
- *Diminishing sensitivity away* from reference point: function is concave for gains and convex for losses -- Weber-Fechner Law. Just noticeable difference proportional to magnitude.

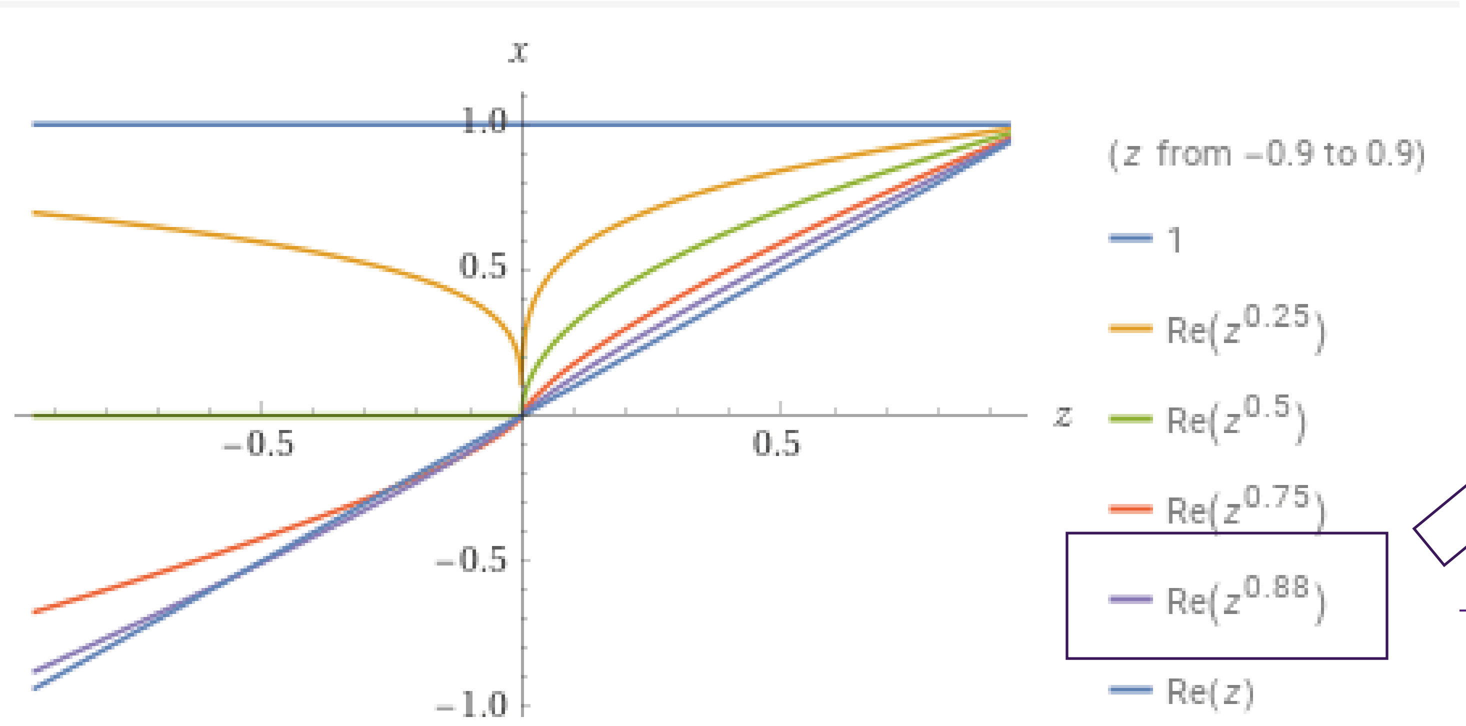


# Curvature of the function: $z^{\alpha}$ for $z \geq 0$, $0<\alpha<1$

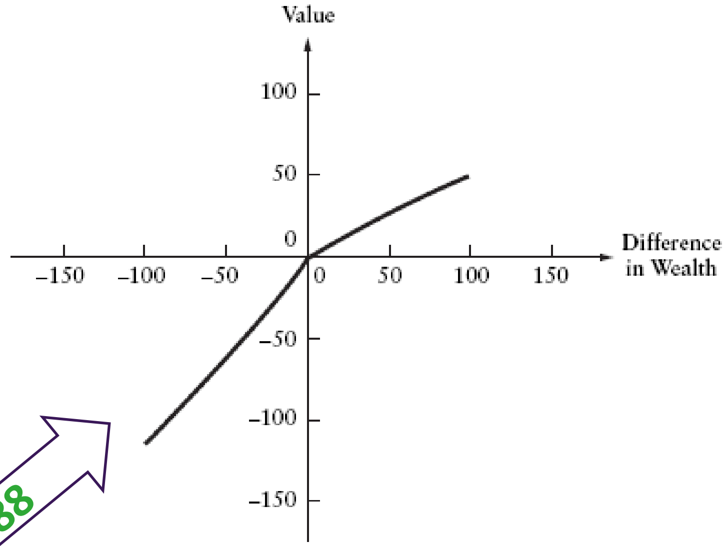
$$v(z) = z^{\alpha} \text{ for } z \geq 0,\ 0<\alpha<1$$

$$v(z) = -\lambda(-z)^{\beta} \text{ for } z<0,\ \lambda>1,\ 0<\beta<1$$

- The parameter $\beta$ ($0<\beta<1$) controls the curvature of the function on the loss side, similar to $\alpha$ on the gain side.




α, β =0.88




Source: WolframAlpha