Individual Decision Making: Risk and Time Preferences 個別決策：風險/時間偏好

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Lecture 2a, EE-BGT

Individual Decision Making (個別決策實驗)

- Study Personal Preferences (研究個人的偏好)
  - Risk Aversion, (風險趨避)
  - Time Discounting, (時間折現)
  - Ambiguity Aversion, etc. (未知趨避等等)
- Measured Characteristics
  - 可以用實驗來測量個人特質
- Do these correlate with other subject behavior?
  - 這些特質是否跟受試者其他行為相關?

Measuring Risk Preferences (測量風險偏好)

- Consider the following decision:
  - Originally from "Who wants to be a millionaire?"
- You have two choices, A and B: (你有兩個選擇，選項A和選項B)
  - One option gives you \$1 million (一個會給你新台幣一百萬元)
  - The other gives you \$10 million (另一個會給你新台幣一千萬元)
- Problem: Don't know which is which (但是不曉得哪個是A，哪個是B)
- Pick one of them, or fold for a sure \$5 million?
  - 如果「放棄」仍可獲得新台幣五百萬元，你會繼續賭下去、猜A,B選項當中的一個，還是比較保險地選擇「放棄」？

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You have two choices, A and B.
One option gives you \$1 million; the other gives you \$10 million.
You don't know which is which. Do you want to pick one of them, or fold for a sure \$5 million?

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Measuring Risk Preferences (測量風險偏好)

- What if the choices are:
  A. 0 or \$30 million w/ (½, ½) (0或三千萬機率一半一半)
  B. \$10 million for sure (確定拿一千萬元)
  - What would you choose? (你會選擇哪一個選項？)

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You have two choices, A and B. Which would you choose?

Choice A: 0 or $30 million with (½, ½)

Choice B: $10 million for sure

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Measuring Risk Preferences (測量風險偏好)

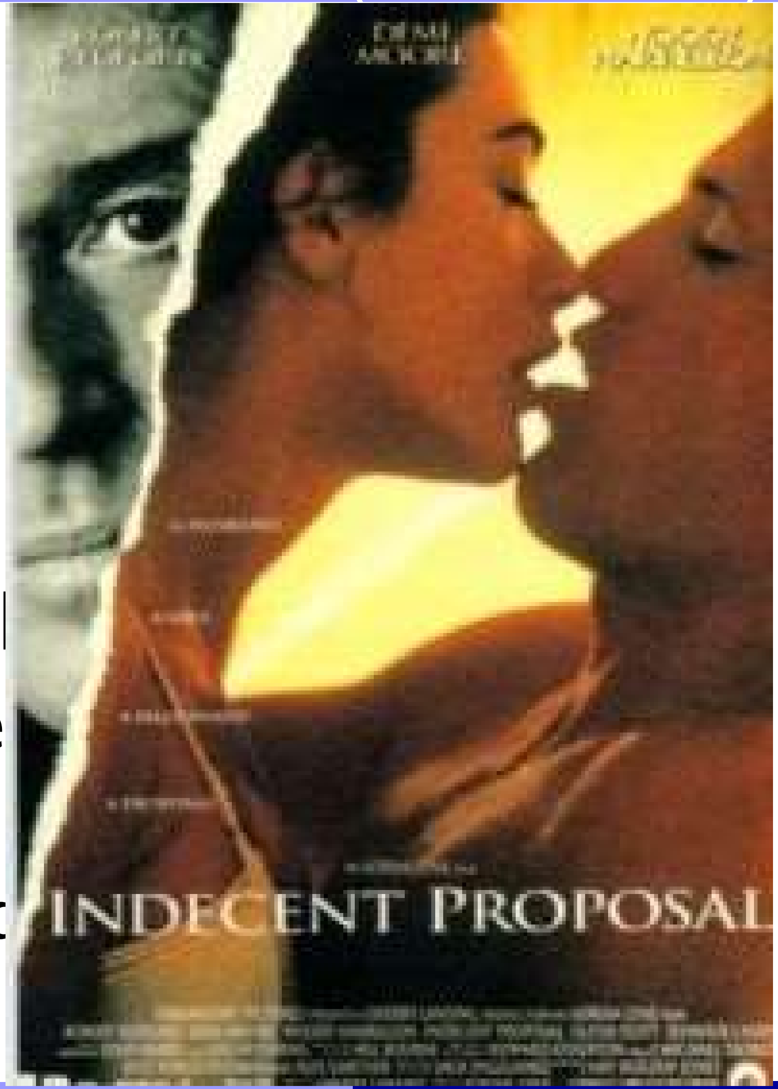
- What if the choices are:
  A. 0 or $30 million w/ (½, ½) (0或三千萬機率一半一半)
  B. $10 million for sure (確定拿一千萬元)
  - What would you choose? (你會選擇哪一個選項?)
- Why would one take Option B? (為什麼會有人選B呢?)
- $$U(x) = \sum_i p_i u(x_i), u(x) = x^{1-r} = x^{0.5}$$
  - Diminishing Marginal Utility (邊際效用遞減) $(\text{for } r = 0.5)$
- Are these too "hypothetical"? (假設性問題?)

Hypothetical Bias (假設性偏誤)

- **John**: Suppose... I were to offer you one million dollars for one night with your wife.
- **David**: I'd assume you're kidding.
- **John**: Let's pretend I'm not. What would you say?
- **Diana**: He'd tell you to go to hell.
- **John**: I didn't hear him.
- **David**: I'd tell you to go to hell.
- **John**: That's a reflex answer because you view the question as hypothetical. But let's say that there was real money backing it up. I'm not kidding. A million dollars.
- The night would come and go but the money could last a lifetime. Think of it. A million dollars. A lifetime of security... for one night.
- Don't answer right away. Just consider it; seriously?

Hypothetical Bias (假設性偏誤)

- John: Sup
you one m
night with
- David: I'd
kidding.
- John: Let'
What woul
- Diana: He
hell.
- John: I dic
- David: I'd



- John: That's a reflex answer because you view the question as hypothetical. But let's say that there was real money backing it up. I'm not kidding. A million dollars.
- The night would come and go but the money could last a lifetime. Think of it. A million dollars. A lifetime of security... for one night.
- Don't answer right away. Just consider it; seriously?

桃色交易(1993)

Measuring Risk Preferences

- 10 Decisions of Holt and Laury (AER 2002)
  - What would you choose?
- Session 1: Real 1x (Baseline)
- Session 2: Hypothetical 20x (or 50x, 90x)
- Session 3: Real 20x (or 50x, 90x)
- Session 4: Real 1x
  - 請看實驗說明裡面的十個問題，你會選擇什麼？
  - 實驗一：玩真的，獎金1倍 (基準實驗)
  - 實驗二：假設性，獎金20倍(或 50倍, 90倍)
  - 實驗三：玩真的，獎金20倍(或 50倍, 90倍)
  - 實驗四：玩真的 ，獎金1倍 (基準實驗)

Risk Preferences (Holt-Laury Task)

Decision	Lottery A		Lottery B		Your choice (A or B)
Question 1	1: 2~10:	Gain NT$200 Gain NT$160	1: 2~10:	Gain NT$385 Gain NT$10	
Question 2	1~2 : 3~10:	Gain NT$200 Gain NT$160	1~2 : 3~10:	Gain NT$385 Gain NT$10	
Question 3	1~3 : 4~10:	Gain NT$200 Gain NT$160	1~3 : 4~10:	Gain NT$385 Gain NT$10	
Question 4	1~4 : 5~10:	Gain NT$200 Gain NT$160	1~4 : 5~10:	Gain NT$385 Gain NT$10	
Question 5	1~5 : 6~10:	Gain NT$200 Gain NT$160	1~5 : 6~10:	Gain NT$385 Gain NT$10	
Question 6	1~6 : 7~10:	Gain NT$200 Gain NT$160	1~6 : 7~10:	Gain NT$385 Gain NT$10	

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Which lottery would you choose in Question 1?

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Which lottery would you choose in Question 10?

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Which Question would you switch from Lottery A to Lottery B?

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Which Question would a risk neutral person switch from Lottery A to Lottery B?

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Real vs. Hypothetical High Stakes (玩真的x1vs.假設x20)

效用	$u(x) = x$		$u(x) = x^{0.5}$	
Prob	Safe	Risky	Safe	Risky
0.3	34.40	24.50	5.86	3.62
0.4	35.20	32.00	5.92	4.36
0.5	36.00	39.50	5.99	5.09
0.6	36.80	47.00	6.06	5.83
0.7	37.60	54.50	6.12	6.57
0.8	38.40	62.00	6.19	7.30
0.9	39.20	69.50	6.26	8.04
1.0	40.00	77.00	6.32	8.77

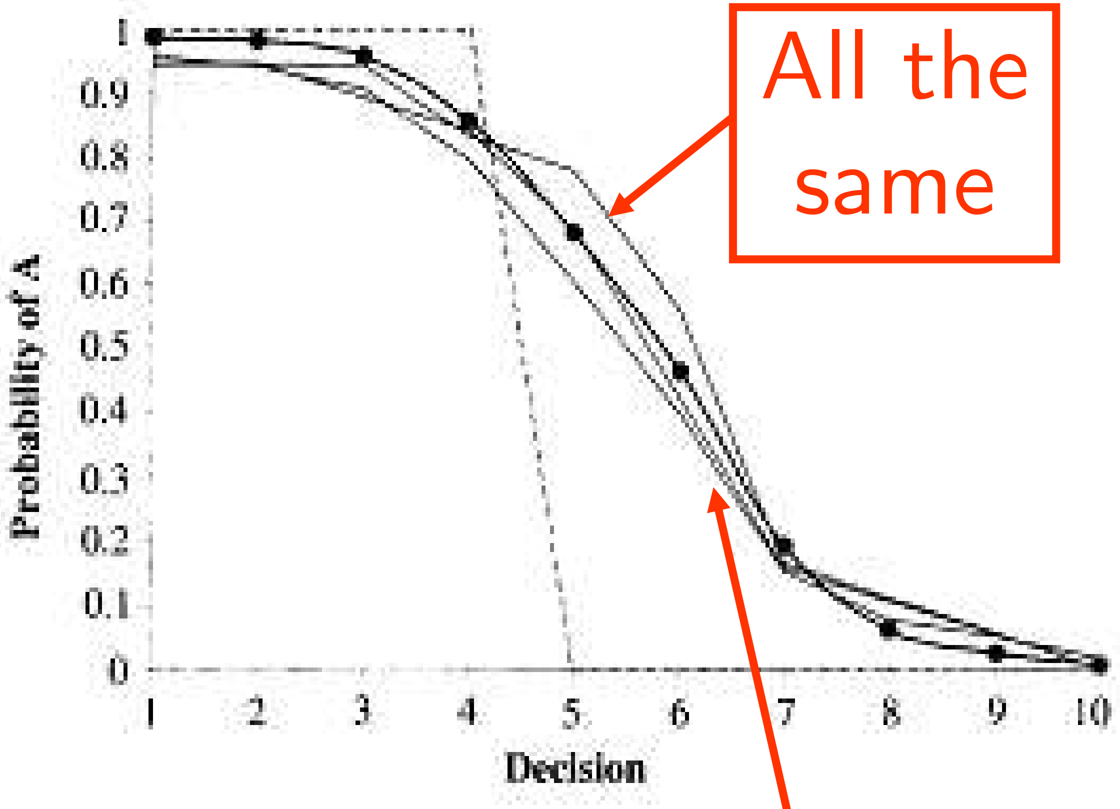

FIGURE 1. PROPORTION OF SAFE CHOICES IN EACH ...

... dots], 20x, 50x, and 90x hypothetical payoffs [thin lines], and risk-neutral prediction [dashed line].

Real vs. Hypothetical High Stakes (玩真的x1vs.假設x20)

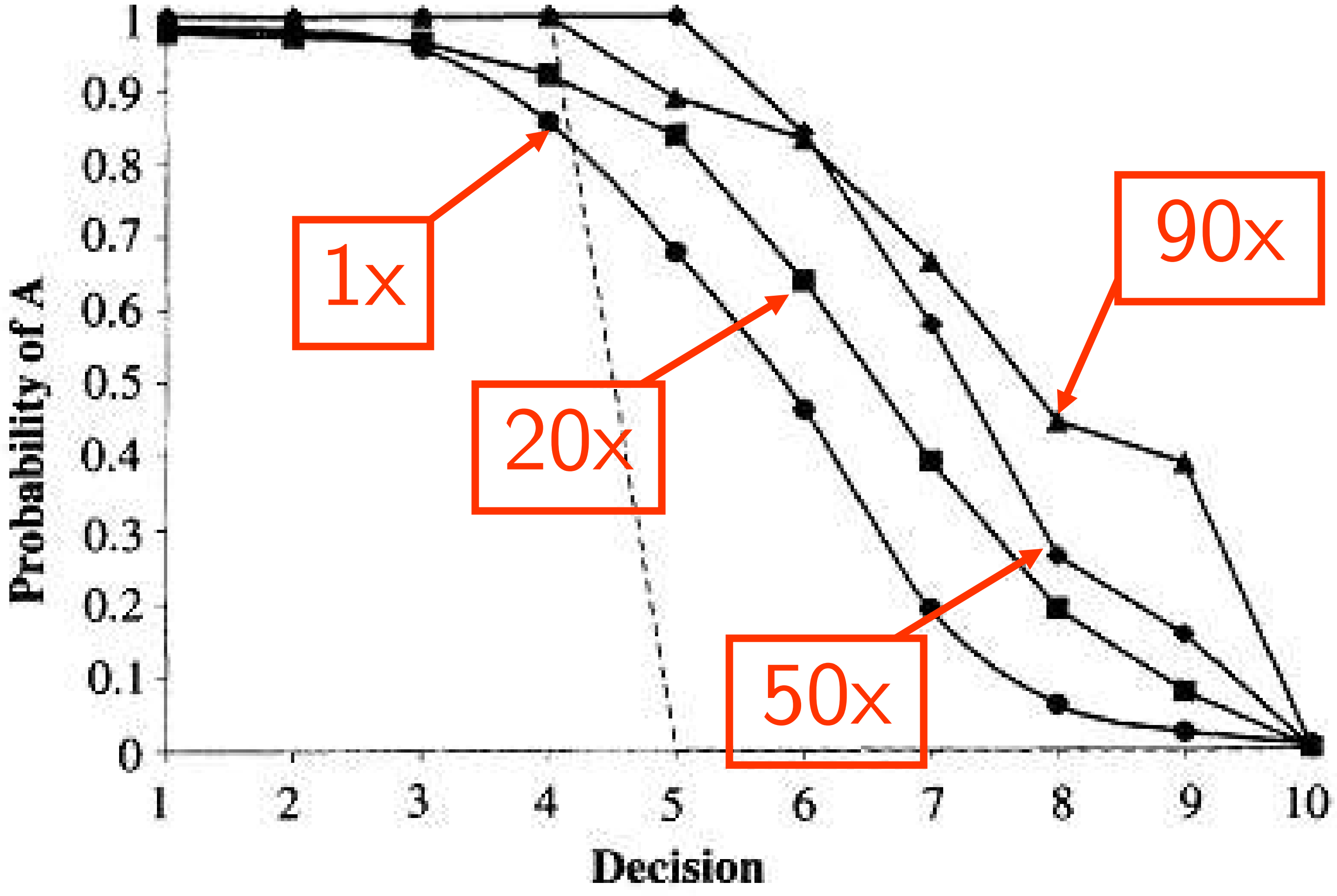

FIGURE 2. PROPORTION OF SAFE CHOICES IN EACH DECISION: DATA AVERAGES AND PREDICTIONS

Risk Aversion at Very High Stakes (高倍金額下的風險厭惡)

Lottery A 福袋	Lottery B 福袋
\$200 if throw of die is 1-9	\$336.5 if throw of die is 1-9
\$160 if throw of die is 10	\$9 if throw of die is 10
Chosen by 38%	Chosen by 62%

- Even though Lottery B gave \$100 more in expected value, 38% still chose Lottery A!
  - 即使樂透 B的期望值高出美金\$100，還是有38%的受試者選擇樂透 A!

of Safe Choices: Order/Incentive Effect

Experiment	Incentives	1x	10x	20x	50x	90x
Holt and Laury (2002) 208 subjects	Real	5.2		6.0	6.8	7.2
	Hypothetical	$\boxed{5.3}$		4.9	5.1	5.3
Harrison et al. (2005) 178 subjects	Real	5.3	6.4			
	Hypothetical		6.0			
Holt and Laury (2005) 168 subjects	Real	5.7		6.7		
	Hypothetical	5.6		5.7		

Between Subject
不同群受試者

Order/Incentive Effects (順序/誘因): Conclusion

- Participants are risk averse (受試者的確厭惡風險)
- Risk aversion increases with (real) higher payoffs
  - 而且厭惡程度會隨著玩真的倍數愈高上升
- High hypothetical payoffs are misleading
  - 高倍數的假設性報酬沒意義(跟低倍數一樣)
- Demographics? (人口特質如何影響風險偏好?)
  - High income people slightly less risk averse
  - 高所得人士稍微比較「不」厭惡風險
  - Women are more risk averse ONLY FOR 1x
  - 女生厭惡風險的程度只有在1倍金額(基準實驗)時比男生高

Follow-up Studies (後續研究)

- Harrison, Johnson, McInnes, Rutstrom (AER05)
- Harrison, Lau and Rutstrom (SJE 2005)
  - Representative sample of Denmark (16x) (使用丹麥的代表性樣本/16倍)
  - Danes are risk averse (r =0.67) (普通的丹麥人厭惡風險/ $r = 0.67$)
  - Middle-age and educated are less risk averse
    - 中年人和教育程度高的人比較不厭惡風險
- Dohmen, Falk, Huffman, Sunde, Schupp, Wagner (JEEA 2011) (Large German survey)
  - Men, youth, tall, educated are less risk aversion
    - 德國大型調查：身高和教育程度較高的年輕男性較不厭惡風險

Prospect Theory (展望理論)

- Risk/Loss Aversion (風險厭惡、損失厭惡)
- Overweighting Low Probabilities (過度杞人憂天、高估很小的機率)

- 1-Parameter Example (Prelec ECMA 1998):

$$
\begin{aligned}
U(x,p;y,q) &= v(y) + \pi(p)(v(x) - v(y)) \text{ if } xy > 0 \\
&= \pi(p)v(x) + \pi(q)v(y) \text{ if } xy < 0
\end{aligned}
$$

$$
\begin{aligned}
v(x) &= x^\alpha \text{ for } x > 0 \\
&= -\lambda(-x^\alpha) \text{ for } x < 0
\end{aligned}
\qquad
\pi(p) = e^{-(-\ln p)^\alpha}
$$

Prospect Theory Experiments (展望理論實驗)

- The following 7 set of decisions are from: (下列七組決策取自)
  - Liu, Meng and Wang (2014), "Confucianism and Preferences: Evidence from Lab Experiments in Taiwan and China," *Journal of Economic Behavior and Organization*, 104, 106–122.
- Taken from: (他們則是參考)
  - Tanaka, Camerer and Nguyen (2010), "Risk and time preferences: Experimental and household data from Vietnam," *American Economic Review*, 100(1), 557-71.

Loss Aversion (like Tanaka et al., 2010)

Decision	Lottery A	Lottery B	Your choice (A or B)
Question 11	1～5: Gain $60 6～10: Lose $35	1～5: Gain $75 6～10: Lose $65	
Question 12	1～5: Gain $55 6～10: Lose $35	1～5: Gain $75 6～10: Lose $65	
Question 13	1～5: Gain $50 6～10: Lose $35	1～5: Gain $75 6～10: Lose $65	
Question 14	1～5: Gain $45 6～10: Lose $35	1～5: Gain $75 6～10: Lose $65	
Question 15	1～5: Gain $40 6～10: Lose $35	1～5: Gain $75 6～10: Lose $50	
Question 16	1～5: Gain $40 6～10: Lose $35	1～5: Gain $75 6～10: Lose $45	
Question 17	1～5: Gain $35 6～10: Lose $35	1～5: Gain $75 6～10: Lose $40	

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Which lottery would you choose in Question 11?

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Which lottery would you choose in Question 17?

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How many Questions would you choose Lottery A?

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Preference Reversals

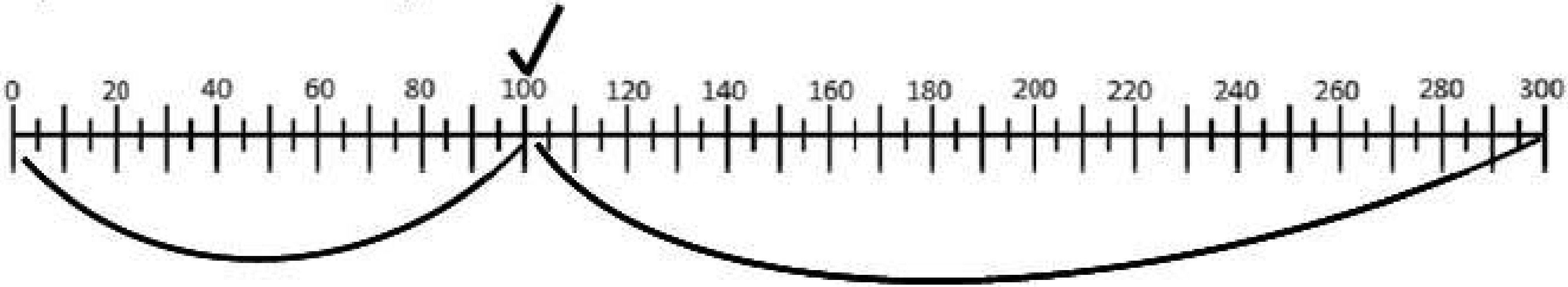
- A: When will you quit smoking? (哪天戒煙呀?)
- B: Tomorrow! (明天!)
  - The next day, (過了一天)
- A: When will you quit smoking? (哪天戒煙呀?)
- B: Tomorrow! (明天!)
- A: But you said that yesterday... (可是你昨天也是這麼說的呀...)
- Tomorrow Never Dies (明日復明日，明日何其多)

Time Preferences (CTB)

Please allocate 300 ESC to the following: 11/12 (four weeks from now) and 12/24 (ten weeks from now)

Please indicate your allocation on the line below. Check the amount you want to **allocate to the early date.** Each segment indicates 5 ESC. The amount allocated to 12/24 can earn a bonus of 2.5%. NOTE: **The bonus could differ** across questions.

If your desired allocation is "Earn 100 ESC on 11/12 (four weeks from now) and earn 200 ESC plus a 5 ESC bonus on 12/24 (after another six weeks)," please check 100 on the line as shown below.
On 11/12 (four weeks from now), I want to earn:



Receive 100 ESC on 11/12

Receive 200 ESC plus a 5 ESC bonus on 12/24

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How many ESC (out of 300) would you allocate to the earlier date? The rest would go to the later date (to earn bonus).

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Time Preferences (CTB)

Table 3: Choices for Convex Time Budget Task

Game	Interest Rate (r)	Sooner Date (t)	Later Date (t+h)
1	0.50%	today	4 weeks
2	1%	today	4 weeks
3	1.50%	today	4 weeks
4	2%	today	4 weeks
5	2.50%	today	4 weeks
6	0.50%	6 weeks	10 weeks
7	1%	6 weeks	10 weeks
8	1.50%	6 weeks	10 weeks
9	2%	6 weeks	10 weeks
10	2.50%	6 weeks	10 weeks

Bonus = 0.5-2.5%

4 Weeks

6 Weeks

4 Weeks

Note: Subjects decide how much (of the 300 tokens) to receive earlier rather than later for each of the 10 games. The amount allocated at the later date would earn interest at the corresponding interesting rate.

Time Preferences (時間偏好)

- Discounting the Future (將未來折現)
  - Exponential: (指數型折現)
  - Dynamic Programming (可用動態規劃求解)

$$U(c_0, c_1, \ldots, c_n, \ldots) = u(c_0) + \sum_{k=1}^{\infty} \delta^k \cdot u(c_k)$$

- Quasi-Hyperbolic Discounting (半雙曲型折現)

$$U(c_0, c_1, \ldots, c_n, \ldots) = u(c_0) + \boxed{\beta} \sum_{k=1}^{\infty} \delta^k \cdot u(c_k)$$

Hyperbolic Discounting (雙曲型折現)

- Has neuroscience evidence!
  - 有神經科學上的證據!

- McClure, Laibson, Loewenstein and Cohen (2004), "Separate Neural Systems Value Immediate and Delayed Monetary Rewards", *Science* 306, October 15 2004.

Follow-up Study (後續研究)

- McClure, Ericson, Laibson, Loewenstein, and Cohen (2007) "Time Discounting for Primary Rewards." *Journal of Neuroscience*, 27: 5796–5804.
- Now vs. 10-30min later (現在或10-30分鐘後)

- Immediate "Juice" reward in the scanner (在fMRI裡立即給「果汁」)
- How does results change? (結果如何改變?)
- At what age do children develop into non-hyperbolic discounting? (小孩子何時學會不再用雙曲型折現?)

Conclusion (結論)

- Individual Decisions Reflect Preferences
  - 個別決策反應人們的(風險/時間)偏好
- Estimate parameterized models
  - 可用來估計決策模型參數來預測人們的行為
- Reflection Questions: (思考問題)
  - Did your decisions follow model predictions?
    - 你的選擇是否遵循模型預測?
  - Would you change your decision after seeing the models? Why or why not? (看到模型後你行為會改變嗎?)

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Audience Q&A Session

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