Valuation of Life

- Read:
  - *The Life You Save May Be Your Own* [Schelling]
  - 《掌握價格就能操控世界》, 第二章, 遠流出版, 2011

- Value of life is implicitly calculated all all times

  E Traffic accident policing

  E Everyone takes risk in daily life for convenience (time/money)

- Inconsistency:

  E A "6-year-old cute girl" needs money for brain operation

  v. Donation for medical research foundation

  E A child trapped in a deep well[1]

  v. Potential victim in a future disaster

  E Sending a man to certain death[2]

  v. Low prob of returning[3]

  ▷ We care if we know the person !

- **Statistical life** (ex-ante, finite) v. **Certain life** (ex-post, infinite):

[1] 真實的案例是: 2012 年十月, 智利礦場 Mina San Jose 的礦坑倒塌, 共有 33 名礦工被困在 624 公尺深的坑道中。智利總統公開宣示「不計任何代價」要救人, 在經過六十九天的努力後, 全數礦工在鎂光燈焦點和全球媒體注視下步出坑道, 全部成爲英雄人物。這次救災行動臆測花費近六億台幣, 平均每人的營救成本將近兩千萬台幣, 但沒有人敢說一條智利礦工的生命不值得此數。

[2] 荆軻刺秦王, 神風特攻隊。

[3] 戰爭時深入敵營的情報員。

- Can only estimate statistical life

  [E] Death lottery: Russian roulette, box drawing (1/1000 killed)

- Moral dilemma:

  [?] What if govt knows who will die, but the public do not?

- Social benefits of life-saving: Jones-Lee (1976)
  - Labor productivity
  - Subjective desire to live, pains of relatives
  - Delayed expenditures: medical/funeral
  - Property damages in accidents

1. Human Capital Approach

- Valued as "discounted lifetime labor income" forgone due to premature death:

$$L = \sum_{t=\tau}^{T} \frac{p_t y_t}{[1+r]^{t-\tau}}$$

<u>where</u>:

$p_t \equiv$ survival probability

$y_t \equiv$ time-t labor earning

- "Net output" method:

$$L = \sum_{t=\tau}^{T} \frac{p_t [y_t - c_t]}{[1+r]^{t-\tau}}$$

<u>where</u>:

$c_t \equiv$ time-t consumption

- Problems:
  - Lack of theoretical foundation
  - Victim's desire to live is ignored
  - Prolonged life after retirement has no value

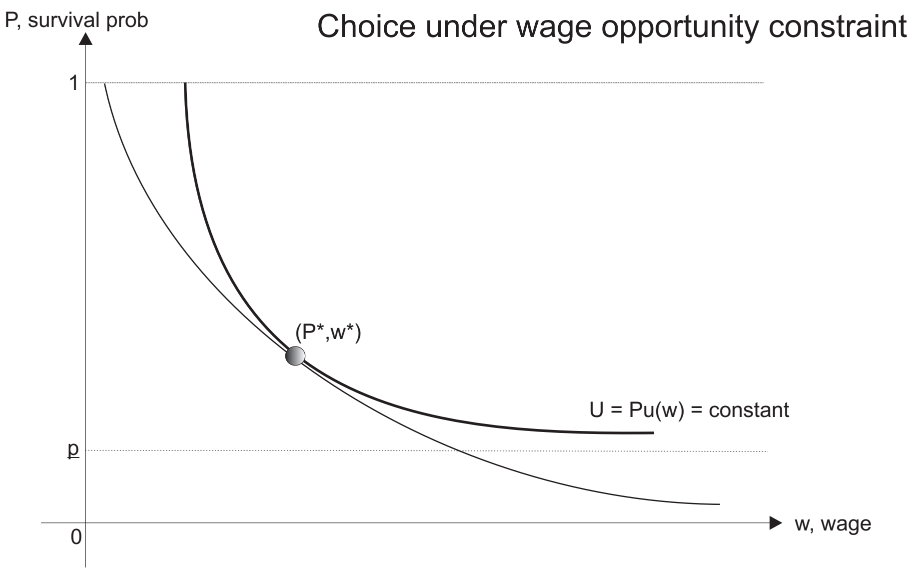
- Suggested as a lower bound for life value [Conley 1976]

2. WTP/WTA

- People's subjective desire to live recognized
- Based on welfare theory: *risk-accepting behaviors*
- Job choice: risky v. safe

  E 領港人 v. 白領職員
- Expected utility maximization:

$$U = p \cdot u(w)$$



- Value is infinite for <u>certain life</u> (survival is essential)
- Finite value for <u>statistical life</u>: *slope at tangency*

$$\frac{dw}{dp}$$

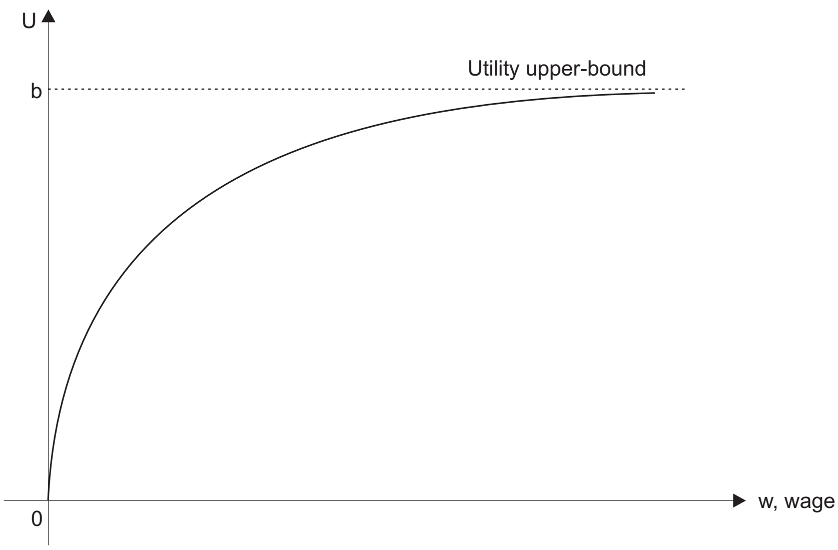
▷ Can pay total $[dw/dp]$ and claim 1 life among $[1/dp]$ volunteers

- If utility UB exists:

$$u(w) \;\leq\; b, \;\; \forall\, w$$

then risk LB also exists:

$$p \;=\; \frac{p^{*}u(w^{*})}{u(w)} \;\geq\; \frac{p^{*}u(w^{*})}{b}$$



- Problems:
  - People may not perceive risk accurately
  - Imperfect occupational mobility
  - Wage differential not reflecting risks
  - Tradeoff between wealth/risk not constant

3. Cook 1978

- Conley [1976] suggests using human capital as a LB for life WTP
- Cook [1978] shows this may not be true.[4]

3.1. The Model

- Consumer utility: with lifetime consumption C

$$U(C),\ \ U' > 0,\ \ U'' < 0$$

- Human capital: lifetime no-risk income

$$y$$

- Wage opportunity constraint:

$$w(p),\ w'(p) < 0$$

▷ Lower survival probability p for extra income w

- Insurance market:
  - Exogenous survival prob: p
  - Consumer pays premium w first
  - Dead consumer gets nothing
  - Surviving consumer gets benefits

$$\frac{w}{p}$$

[4] Cook, P.J., "The Value of Human Life in the Demand for Safety: Comment," *AER*, 68(4):710–11.

- Actuarially fair: insurance company earns zero expected profit

$$p \cdot \frac{w}{p} \;=\; w$$

- Risk-bearing consumer: pays premium w
  - Higher survival consumption:

$$y \;+\; \frac{w}{p}$$

  - Expected lifetime utility:

$$C \;=\; y \;+\; \frac{w}{p}$$

3.2. Consumer WTP for Life

- Consumer EU-max:

$$\max_p \ \text{EU} = pU(C) + [1-p]U_0$$
$$= pU(y+\frac{w}{p}) + [1-p]U_0$$

<u>where</u>:

$U_0 \equiv$ death utility

- Interior foc:

$$[U(C)-U_0] + U'(C)\left[\frac{dw}{dp} - \frac{w}{p}\right] = 0$$

- Consumer marginal WTP for life:

$$W \equiv -dw/dp$$

▷

$$W = -\frac{w}{p} + \frac{U-U_0}{U'} = [y-C] + \frac{U-U_0}{U'} = y + \left[\frac{U-U_0}{U'} - C\right]$$

- Let $U_0 = 0$:

$$W = y + \left[\frac{U}{U'} - C\right]$$

- Comparision: WTP (W) v. human capital (y)

$$W \gtrless y \ \rightleftharpoons \ \frac{U}{U'} - C \gtrless 0 \ \rightleftharpoons \ U \gtrless CU'$$

3.3. Case 1: $U(0) = U_0$

- Any consumption is better than death

  ▷ Strong desire to live

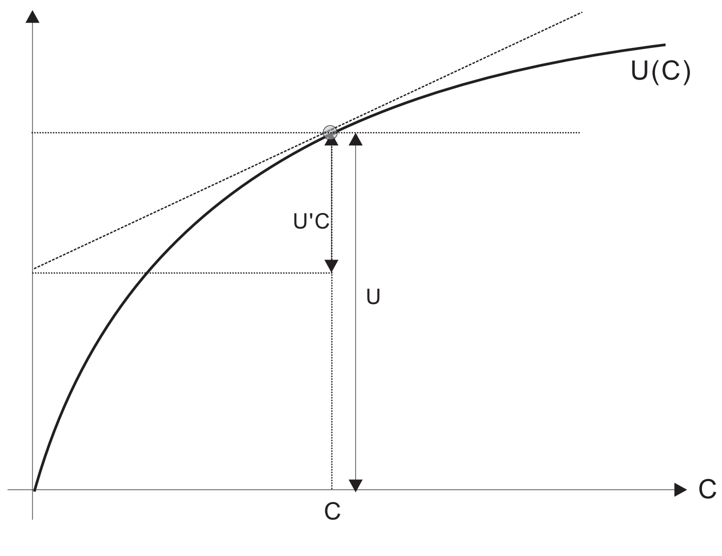
- By concavity of U, we know:

$$U > U'C$$

▷

$$\frac{U}{U'} > C$$

- Consumer WTP > human capital y



3.4. Case 2: $U(0) < U_0$

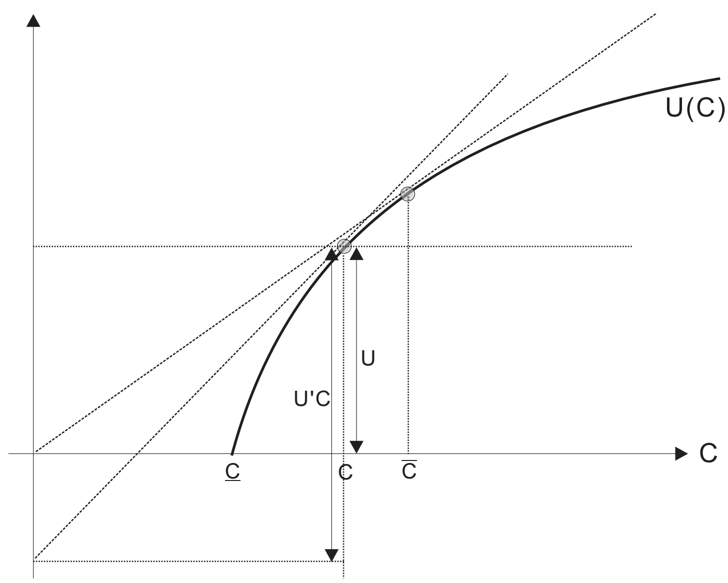
- Low consumption ($C < \underline{C}$) is as bad as death
- Consumer feels worse than death when $C < \underline{C}$
- $\forall\, C \in [\underline{C}, \bar{C}]$:

$$U \;<\; U'C$$

▷

$$\frac{U}{U'} \;<\; C$$

- Consumer WTP < human capital y



3.5. Extension: Monkeys in Paradise

- The Model:
  - Population: m (monkeys)
  - Fixed total resources: W (bananas)
  - Risk survivors: n ($< m$)
- Survival rate:

$$\frac{n}{m}$$

- Survival consumption:

$$C = \frac{W}{n}$$

- Is "life-saving" a good thing?
  - Expected utility:

$$\text{EU} = \frac{n}{m} \cdot U(\frac{W}{n})$$

  - Value of life-saving device:

$$\frac{d\text{EU}}{dn} = \frac{U}{m} - \frac{n}{m} U' \frac{W}{n^2} = \frac{1}{m} [U - U'C]$$

    ▷ Worthwhile only when (at initial $C = W/n$):

$$U - U'C > 0$$

- For poor society:
  ▷ $C < \bar{C}$ initially, survival is not first priority ($W/n \downarrow$)
  ▷ Should raise W first
- For wealthy society: life-saving is desirable