Various Review Slides

Review

Last time:

- Risk:
  - Probabilities (objective, subjective)
  - Random variable - e.g. lottery payoff ***R***
  - Expected payoff - $\mathbf{E}\,\boldsymbol{R}$
  - Expected utility - $\mathbf{E}\,\boldsymbol{U}(\boldsymbol{R})$
  - Certainty equivalent - $\mathrm{E}\,U(M+R)=U(M+CE)$
  - Risk premium - $\pi=\mathrm{E}\,R-CE$
  - 'Arrow-Pratt measure of relative risk aversion' - $RRA=-\frac{U''(M)}{U'(M)}M$

Review

Economic literature distinguishes:

- *Risk*
- *Ambiguity/Knightian uncertainty*/deep uncertainty
- *Unforeseen contingencies*:

Also IPCC distinguishes types of uncertainty:

- Unpredictability
- Structural uncertainty
- Value uncertainty
- Confidence of experts
- Probabilities or probability ranges based on data

And even the former secretary of defense makes distinctions… (2nd try)

http://www.youtube.com/watch?v=_RpSv3HjpEw

Review

- First lecture on risk:

  Risk Premium: Money you are willing to pay in order to get the

  - expected value of a lottery with certainty
  - rather than taking the risky lottery itself
- Last time: **Willingness to Pay for a Risk Reduction**
  - Binary lottery (a good and a bad outcome)
  - You can reduce the probability of the bad outcome by Δp
  - How much consumption/money ΔM are you willing to pay (at most) for the risk reduction?

Two differences: In "Willingness to Pay for a Risk Reduction" we

- only reduce the risk rather than eliminate it
- change the expected value of the lottery

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  - Binary lottery (a good and a bad outcome)
  - You can reduce the probability of the bad outcome by $\boldsymbol{\Delta p}$
  - How much consumption/money $\boldsymbol{\Delta M}$ are you willing to pay (at most) for the risk reduction?

$$\frac{\Delta M}{\Delta p} \approx \frac{U(M) - U(M-d)}{\mathrm{E}_p\, U'(M-D)}$$

Willingness to Pay for a Risk Reduction

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Interpretation:

The willingness to pay for a risk reduction

- Increases in the utility loss caused by the damage
- Decreases in the expected value of money (which agent has to give up)

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In our example we found:

Risk neutral agent ***U(M)=M*** : $\frac{\Delta M}{\Delta p} \approx 5$

Risk averse agent ***U(M)***= $M^{\frac{1}{2}}$: $\frac{\Delta M}{\Delta p} \approx \frac{24}{5} < 5$

Review

- **Risk Premium**: Money you are willing to pay in order to get the
  - expected value of a lottery with certainty
  - rather than taking the risky lottery itself
- **Willingness to Pay for a Risk Reduction**
  - Willingness to pay ΔM to reduce probability of bad outcome by Δp
- **Option value**
  - Combine CBA/NPV analysis with risk
  - Can be valuable to wait for uncertainty to resolve before investing
- **Optimal Mitigation level & Learning**
  - Certain benefits and uncertain damages from GHG emissions
  - Risk neutral agent