Uncertainty

ECON 420: Game Theory

Spring 2018

Announcements

- ► Homework 3 on Canvas
- ► Due *Monday, May 21*
- ► Reading: Chapter 8

Uncertainty

- ► So far: Strategic uncertainty
 - Some players unaware of the actions of other players
 - ► Example: Simultaneous-move games
- ► Today: External uncertainty
 - ► "Nature" changes aspects of the game
 - Players cannot control external uncertainty, must take it into account when making decisions

Expected Utility Theory

- ► Events that happen according to some probability distribution are called gambles
- gambles▶ Agents are able to rank gambles by comparing the expected utility that they

would receive from the potential outcomes of the gamble

► The utility that we will use is *von Neumann-Morgenstern (VNM)* utility

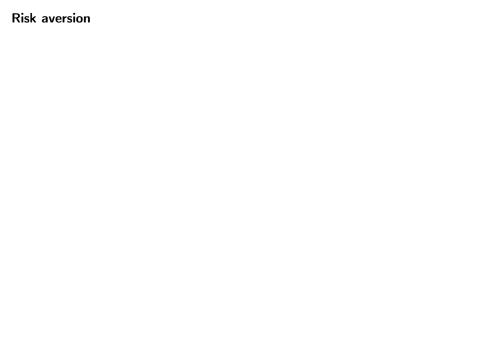
Risk preference		
▶ When there is uncertainty we can calculate the <i>expected</i> v	<i>value</i> of a	gamble

But people do not just consider expected value when making decisions
Some people might be willing to pay to avoid risk (risk aversion)

- ► Suppose I flip a coin. If heads, you get \$100. If tails, you get \$0.
 - ► What is the expected value?
 - ► How much would you pay to play this game?
- ► Suppose instead the payoffs are \$1 million for heads, \$0 for tails.

VNM Utility and Risk Preference

- ► Outcomes are denoted *D* (dollars)
- \blacktriangleright Agents in the model have preferences over outcomes represented by utility u=u(D)
- ► Agents with *diminishing marginal utility* are risk averse
 - ► Concave utility function





- ► A farmer's crop yield depends on weather
- ► Farmer gets good weather with 50%
- ► Yield with good weather is \$160,000, yield in bad weather is \$40,000
- Farmer has VNM utility $u(D) = \sqrt{D}$

Risk sharing

▶ Risk averse agents willing to pay to remove risk

you if you have a bad outcome

- ► Agents can therefore benefit from trading *state-contingent claims* with one
- another

► You agree to pay someone else if you have a good outcome, someone else pays

- ► Suppose there is another farmer that has the same weather probability and outcomes (weather probability is independent of first farmer)
- ► Farmers agree to a contract: If one farmer gets good luck and the other gets bad luck, lucky farmer pays \$60,000 to the unlucky farmer
- ► Are the farmers better off?

- ► Now suppose the other farmer faces no uncertainty and will earn \$100,000 with probability 1
 - ► The farmer with risk is willing to accept their certainty equivalence instead of the gamble
 - ► Is the riskless farmer willing to buy the risk in exchange for the certainty equivalence?

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- ▶ Now suppose the farmer without risk is *risk neutral*

▶ What is the maximum that this farmer is willing to pay for the gamble?

Insurance and risk

- ► Suppose there are thousands of farmers with identical risk/outcomes
- ► A single entity (insurance company) can buy the risk of all of the farmers and make them better off
- ► Law of large numbers says that the insurance company will earn the expected value of the gamble

Manipulating Risk

► This is why underdogs in sports often choose risky actions

- ► Sometimes agents have control over risk and can use it to their advantage
- ▶ By increasing risk, the probability of "tail events" increases

▶ How can this team maximize their chances of winning?

- ► A basketball team scores 60 points per game on average

- ▶ They are playing a better opponent and must score at least 80 points to win

Cheap Talk

- ► In coordination games, players may be able to costlessly communicate before

- - - ▶ This might allow players to better coordinate on preferred outcomes

the game begins

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