A brief introduction to economics

Part IV

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Notes

Outline

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Reading reminder

- I have updated the economics lecture notes to discuss attitudes towards risk
- "Why information security is hard" linked to today's calendar
- Some people have requested more introductory economics reading
  - I've put two optional readings on Blackboard
  - Selected excerpts from *Intermediate Microeconomics*, Hal Varian
  - Selected exerpt from economics chapter, *Security Engineering*, Ross Anderson

Notes

Risk attitude example (take 3): antivirus software

- Suppose you have $5,000 in wealth. You have the option to buy antivirus software for $x.
- Outcomes available:

$$\mathcal{O} = \{\text{hacked (decreases wealth by \$2,000)}, \text{not hacked (no change in wealth)}\}$$

- Without AV software, probability of being hacked is 0.05 ($P(\text{hacked}|\text{no antivirus}) = 0.05$)
- With AV software, probability of being hacked is 0 ($P(\text{hacked}|\text{antivirus}) = 0$)
- Exercise 1a: How much would you pay for antivirus software if you were risk-neutral?
- Exercise 1b: How much would you pay for antivirus software if you were risk-averse and $U(o) = \sqrt{o}$?
- Exercise 1c: For what values of x will the risk-averse buy and the risk-neutral not buy?

Risk attitude example (take 2): antivirus software

- First question: what is the constraint that makes buying AV affordable?
- Recommended approach: draw out the table of outcomes and actions, along with probabilities
- Solve for x
- We'll go through it by hand; see the revised economics lecture notes for more information.

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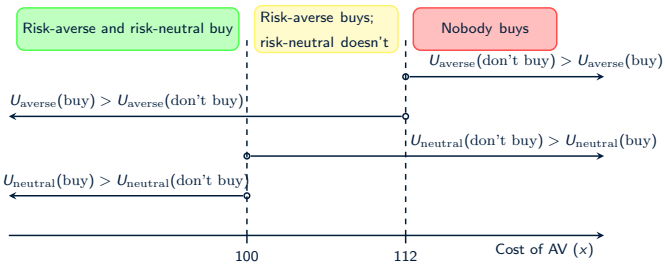
Visualizing constraints



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Another example

- Modeling real-world situations using rational choice theory is a fundamental skill
- There usually is no single "correct" model; instead you must justify your choices for approximating reality
- This includes a statement of the limitations of the model, so that we are clear on its shortcomings
- Let's practice together on a newsworthy topic

Notes

GoDaddy, world's largest web hosting provider, hacked?

Source: http://www.zdnet.com/anonymous-hacker-claims-godaddy-attack-outage-hits-millions-7000003925/

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Turns out GoDaddy experienced a non-malicious outage

Source: `http://www.cnn.com/2012/09/11/tech/mobile/godaddy-response-outage/index.html`

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Exercise 2: let's model a security investment decision

- Suppose GoDaddy is approached by a security firm *XYZSec* offering a "DDoS protection" product
- *XYZSec* claims to be able to eradicate DDoS threats using a shared-bandwidth pool, will sell for $100,000.
- Your task: model GoDaddy's security investment choice using rational choice theory
  1. What are the outcomes?
  2. What are the actions?

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Exercise 2: Actions-outcomes table

- o_1=no outage, o_2=outage
- a_1=buy DDoS service, a_2=don't buy

	outcome o_1		outcome o_2		
Action	$U(o_1)$	$P(o_1\|\text{action})$	$U(o_2)$	$P(o_2\|\text{action})$	$E[U(\text{action})]$
a_1	-$100,000	.99999	-$100,000+outage cost?	.00001	?
a_2	0	.99999 - $P(\text{DDoS})$?	outage cost?	.00001+$P(\text{DDoS})$	?

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Exercise 2: Calculate the effectiveness of DDoS prevention

- Suppose that GoDaddy expects an outage would cost them $10 million to deal with.
- How well must *XYZSecurity*'s DDoS prevention system work in order to be worth the cost? (Hint: use the action-outcome table from the last slide)
- State the assumptions that you must make for the model to work, and qualitatively assess whether or not they are reasonable

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Exercise 2: Calculate the effectiveness of DDoS prevention

- My answer: $P(\text{DDoS}) \geq .001$
- Solution details: see whiteboard
- My assumptions

- Exercise on your own: suppose that $P(\text{DDoS}) = .0005$. How expensive must an outage be in order to justify the \$100,000 investment?

Notes

First Fundamental Theorem of Welfare Economics

Definition

(First Fundamental Theorem of Welfare Economics) Any competitive equilibrium leads to a Pareto efficient allocation of resources.

- This definition begs the question: under what circumstances do we get competitive equilibrium?
  - Assume complete markets (perfect information, no transaction costs)
  - Assume price-taking behavior (infinite buyers and sellers, no barriers to entry)
- Now we will discuss *market failures*, and explain why information security suffers from many of them

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How monopolists behave

- In a market with a single supplier, the supplier isn't forced to sell at the point where $S(p*) = D(p*)$
- Monopolist can choose the price to sell at that maximizes expected revenue

$$\arg\max_{p^m} p^m \cdot D(p^m)$$

- Can also choose to restrict supply to maximize expected revenue
- Can you think of an example industry where there are few enough competitors to set the prices?

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Apple e-Book price fixing

Source: http://online.wsj.com/article/SB10001424052702304444604577337573054615152.html

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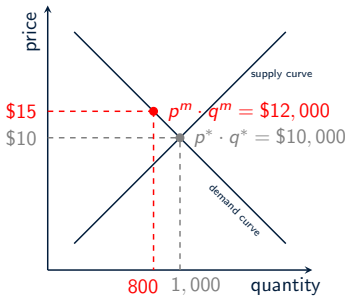
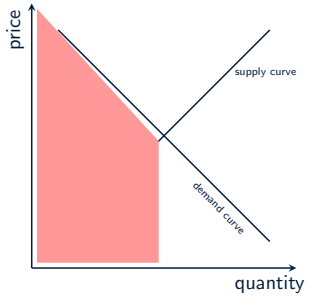
Monopolists can select prices to maximize revenue



Monopolists can select prices to maximize revenue

Price discrimination charges different prices to maximize revenue



- Most goods can be privately consumed (e.g., cars, food)
- But somethings can't be privately consumed (e.g., national defense, grazing commons)
- Public goods have two characteristics that make them hard to allocate efficiently
  - *Non-rivalrous*: individual consumption does not reduce what's available to others
  - *Non-excludable*: no practical way to exclude people from consuming
- Public goods tend to be delivered at less than what is socially optimal

The IT sector faces inherent impediments to competition

- Network effects tends toward dominant platforms
- Technology makes tracking (and price discrimination easier)
- Information goods have practically zero marginal cost
- Information goods are also non-rivalrous, firms use DRM to make them excludable

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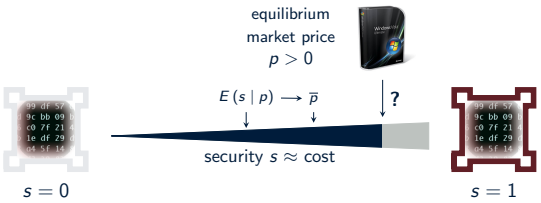
Information Asymmetries



willingness to pay: $p^* = \frac{3}{2}s$

unknown security: $\overline{p} = \frac{3}{2}E(s \mid p)$

uniform distribution: $\overline{p} = \frac{3}{2} \cdot \frac{p}{2} = \frac{3}{4}p \; < p$!

→ **The market for secure products collapses** Akerlof, 1970; Anderson, 2001

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