

# The Economics of Cybersecurity — Lecture 2 Notes

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## Pre-Class

- Write title, course number, hours, on blackboard
- Write out sections of discussion

## 1 Homework Recap (6:10)

(Discuss agenda for the day. Write agenda on board)

### 1.1 Systems diagrams review (6:10)

(Depending on class size, pick on 2–3 to share their chosen problem and diagram)

Conclusion: It's kind of messy! Good segue...

### 1.2 “Wicked problem” paper review (6:25)

Don't want to spend too much time on this so let's briefly review.

Discussion:

- Initial thoughts?
- Applicable to security? Which points? Discuss
- What are our thoughts on this type of “science”? There's no hypothesis being tested here. Sort of like “here's something we intuited and came up with a name for it”. Is it science? How do we trust it? It may be the best we can do.

- Very different from other types of CS papers you may have read before.

This concludes our discussion of “systems-thinking” although the mindset is going to pervade much of the rest of the semester.

## 2 Big Ideas in Economics (6:30)

So far we’ve talked about security as a system and maybe talked about some open issues in security but up to this point we haven’t really talked about security as an *economics* problem.

This class doesn’t assume any economics knowledge. So we’re going to establish a basic foundation. You may have seen some of this stuff before if you’ve ever taken an economics class before. But we need to

### 2.1 Big Idea #1: Goods

Economics is fundamentally about the distribution of goods and services.

*Ask: What is a good?*

A **good** is an item that provides value or utility for someone. Something that someone wants. Something that someone is willing to sacrifice something to obtain. Example: A table, or a barrel of oil.

*Ask: What are some goods we deal with in security?* Hardware, obviously. Software can also be a good (even though it is sort of intangible).

*Ask: What about services? How are they different?*

A **service** is an act that someone performs because someone else values the act and is willing to pay for it. A good is transferrable. A service is not. Example: a haircut.

Different from goods in that they are always **intangible** (whereas goods can be tangible or intangible). Another difference is that services are **non-transferrable**: Once a service is performed, it can’t be transferred to someone else. If I can’t a haircut I can’t undo it and give it someone else. Different from a transferrable good like a chair.

*Ask: What are some services we deal with in security?* Penetration testing, incident response.

#### 2.1.1 Types of Goods

We can taxonomize goods in a few ways. Two main ones are used: rivalrousness and exclusivity.

	Excludable	Non-Excludable
Rivalrous	private goods	common-pool resources
Non-Rivalrous	club goods	public goods

(Write out 2x2 grid)

**Rivalrous:** Consumption by one person → cannot be consumed by another. Example: If I eat an apple, you can't also eat it.

**Excludable:** Consumption can be restricted to certain people only. Example: Concerts. You physically cannot get access without buying a ticket.

*Ask: What's an example of a non-excludable good?* Air. A lighthouse (everyone can take advantage of it).

I'm writing these as binary categories but in reality they exist more on spectrums. Example: this class! Supposed to be available to those who pay tuition. But if someone wanted to audit, I wouldn't physically prevent them from entering the classroom (could even enhance if they contribute to the discussion!). So this class is semi-excludable.

1. Private goods: rivalrous + excludable. Examples: GPUs, firewalls. As opposed to...
2. Public goods: non-rivalrous, non-excludable. Examples: Air. Cybersecurity itself?
3. Club goods: excludable, non-rivalrous. Examples: Antivirus software? Since it is intangible.
4. Common-pool resources: rivalrous but non-excludable. Example: Fish in the sea. Internet traffic?

## 2.2 Big Idea #2: Some goods are more valuable to some people than to others

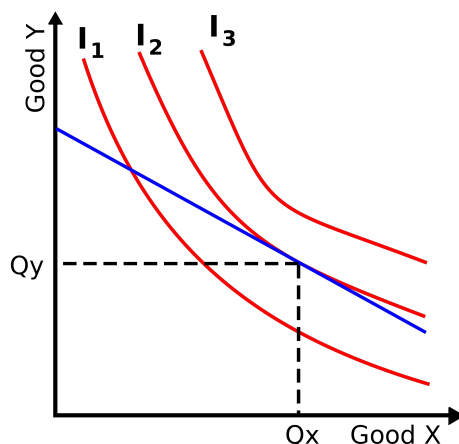
Some goods can even be more or less valuable to the same people depending on circumstances. E.g. if it's a sunny day, I might not care to have an umbrella; if it's raining really hard, I'm really going to want one.

Acquiring goods usually involves trading off something you want for something else you want more.

There are a few common methods that economists to capture how valuable things are to people.

### 2.2.1 Indifference curves

A typical way of expressing how much people value something is via indifference curves. This is a way of expressing how much someone values something in terms of something else.



- X: the good in question
- Y: could be another good. But typically is a composite of all other goods!

This is a 2D space of possible goods you can acquire. We're going to make some simplifying assumptions and say that we're dealing with "normal" goods (like e.g. more is better. May not be a realistic assumption! Economics can handle more advanced cases but take an econ class if you want to learn more about that).

We can draw the line of the

(Draw axes + 1 indifference line)

*Ask: I drew it convex. Why?* Diminishing marginal utility. Lets use a computer systems analogy. Let's say I have a system where X is my CPU clock frequency (it's something we want! It's a good!) and Y is all other system design constraints. If my goal is to make a fast system, and my clock frequency is very low, this could be the bottleneck in system performance

*Ask: What does it mean if I draw the indifference curve as a straight line?* It means that X and Y are perfect substitutes—I don't care if I have one or the other.

## 2.3 The Supply Curve (6:30)

## 2.4 The Demand Curve (6:40)

## 2.5 Pareto efficiency (6:50)

?

### 3 Market Failures in Security (7:00)

*Ask: What kinds of assumptions are needed to make markets efficient?*

This section is really the “why” this subject needs to exist. Markets are wonderful and they solve many problems of the allocation of goods and services. But let’s review some of the required assumptions needed for efficient markets.

*Ask: Which of the above requirements might be violated in the world of security?*

Some suggested answers:

1. Perfect information

### 4 Paper Discussion: Why Information Security is Hard (7:00)

Introductory discussion things to note:

1. This is a seminal paper. So where are the experiments? Where are the graphs and tables? There are none. How can this be? (If you’re looking for a technical rigor to this class, we will make sure we cover that too).
2. A big part of this class is going to be studying methods. This paper has no methods! But in future papers we will highlight methods used.

#### 4.1 Types of Market Failures in Security

#### 4.2 Conclusion

“In general, where the party who is in a position to protect a system is not the party who would suffer the results of security failure, then problems may be expected.”