# Class 3: Modeling and Optimization

Introduction to Public Policy

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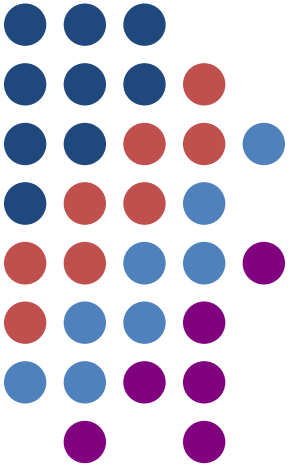
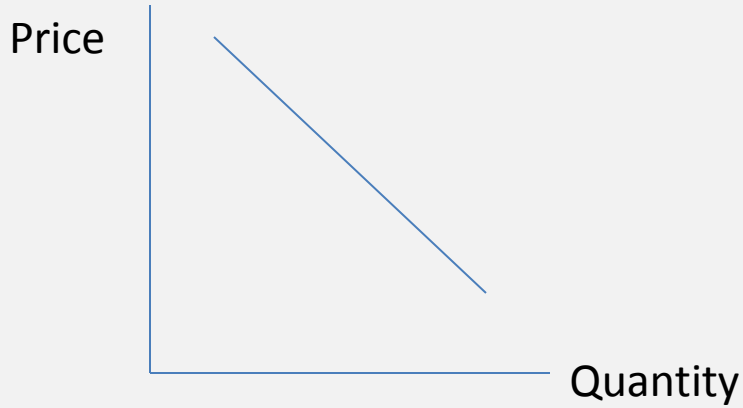


# What is a model?

- A model is a simplified representation of some aspect of the real world.
- Public policy analysts need to use models because they often confront public policy problems with a huge amount of messy information.
- Public policy analysts have to eliminate nonessential parts that can confound the public policy problems being analyzed, focus on the structural relationships among important variables, and predict the effects of a particular policy option.

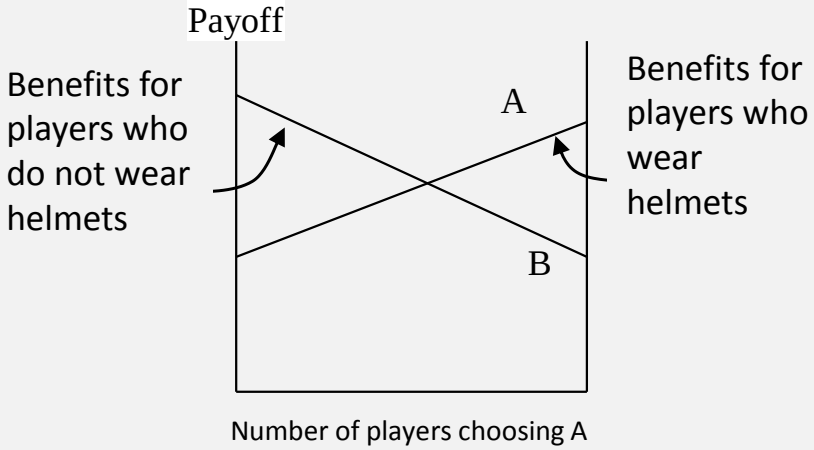
# The Art of Modeling: Simplification at an Appropriate Level

- Example 1: Demand curve



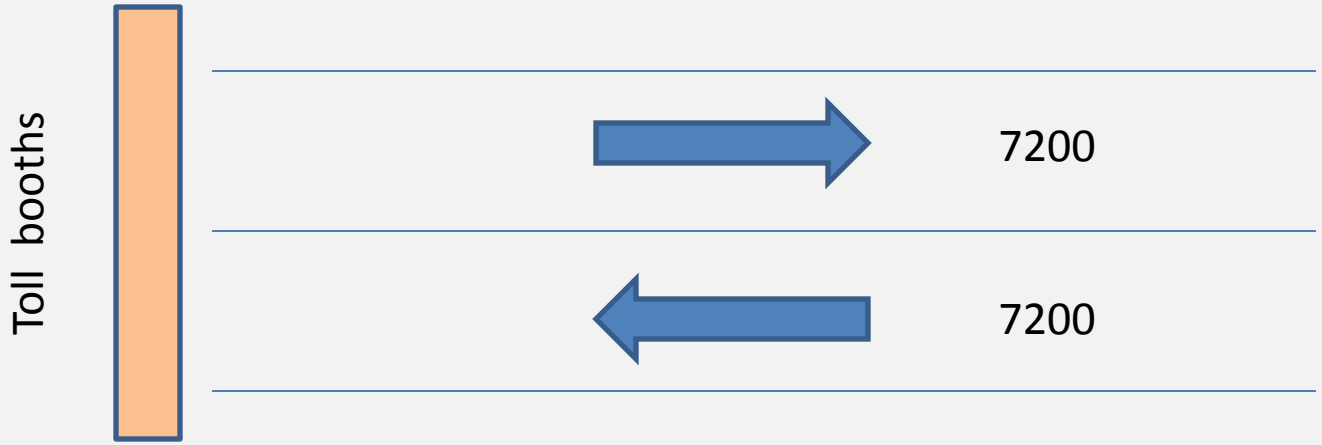

- Example 2: Thomas Schelling on Helmets

Choices facing hockey players:
A: wear helmets
B: don't wear helmets



# A Queuing Model (Stokey & Zeckhauser, Ch. 5)

- How many toll booths are needed at a toll bridge to ensure smooth traffic?
  - Toll bridge at the gateway of a city
  - 2 lanes (1 in, 1 out)
  - A toll booth can serve one car every 10 seconds
  - There are 7,200 cars going each way in a day (24 hours)



# When is simplification not appropriate?

- Example: Allocation of resources to take in patients in a hospital

# Types of Models – Box Diagram

| | Deterministic model | Probabilistic model |
|---|---|---|
| **Descriptive model** | | |
| **Prescriptive model** | | |

# Deterministic vs. Probabilistic Models

- Deterministic model:
  - Input parameters, relationships and consequences are certain.
  - In the real word, most things are uncertain, particularly in public policy. However, in many situations, there may be randomness in the input parameters, we use average estimates and get good approximation in results.
- Probabilistic model:
  - Model variables assume different values based on different situations/scenarios (uncertainty).
  - Variables follow certain probability distributions (risk)

# Descriptive vs. Prescriptive Models

- Descriptive Model:
  - Describe how the world works.
  - Predict how some variables will respond to changes in other parts of a system
  - Describe choices and conditions behind those choices
  - Show what outcomes will result from what actions
- Prescriptive Model:
  - Descriptive Model + Preferences of decision makers
  - Setup procedures and constraints for optimization
  - From the choices resulted from the descriptive model and preferences of the decision makers, the prescriptive model ranks choices and points out the best option.

# A Deterministic & Descriptive Model

**Example: Long Thanh or Tan Son Nhat Airports?**

| | Option A | Option B | Option C | Option D | Option E |
|---|---|---|---|---|---|
| Expand TSN in 2021 | no | no | no | no | yes |
| Close TSN | | | | | |
| In 2021 | | | | yes | |
| In 2031 | yes | | yes | | |
| In 2036 | | no | | | yes |
| Investor in Long Thanh | private | private | state | state | state |

# A Deterministic & Prescriptive Model

## Example: Long Thanh or Tan Son Nhat Airports?

| | Option A | Option B | Option C | Option D | Option E |
|---|---|---|---|---|---|
| Economic NPV | 5,288.6 | -329.4 | 5,288.6 | **10,287.7** | 7,751.2 |
| Economic IRR (real) | 10.1% | 5.8% | 10.1% | **23.8%** | 19.7% |

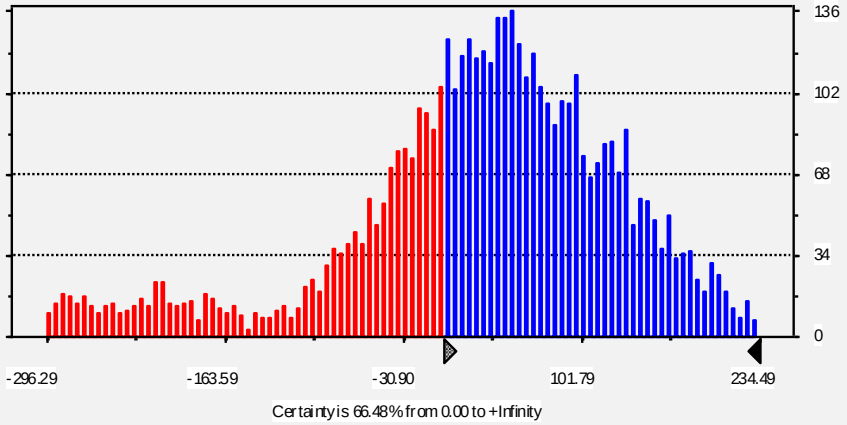
# A Probabilistic & Prescriptive Model

## Example: Long Thanh or Tan Son Nhat Airports?

**NPV kinh tế theo tốc độ tăng trưởng hành khách (PA C)**

| Kịch bản | 1 | 4 | 6 |
|---|---|---|---|
| Tốc độ tăng trưởng hành khách giảm so với kịch bản cơ sở | 0,0% | -2,0% | -3,0% |
| Kết quả | | | |
| NPV kinh tế (triệu USD) | 5.289 | 1.864 | 498 |
| EIRR thực | 10,1% | 7,9% | 6,6% |

**Probability Distribution of NPV**



# Normative Model

Descriptive Model

+

Individual Preferences

+

Social Welfare Function

# Critical Thinking in Modeling

- Use the “right” model
  - How good it describe the real world?
  - How well it predicts consequences of policy actions
  - How appropriate it reflects individual/social preferences?
- Limits of modeling
  - Note that models are simplified representations of the real world
  - But, a model too big, too complex that no one can understand will not be effective.