II-7. Asymmetry
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Introduction
Lemons
EMH

Outline
Introduction
Market of lemons
The Efficient Market Hypothesis

Symmetric market
Based on trust

Symmetric market
supply
demand
Economics of information

Introduction
Lemons
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Economics of information

Asymmetric market

Based on influence

Moral hazard

Transferring risks: government-backed lending

Principal Agent Problem

Agent acts against the Principal: bankers’ bonuses
Rent Seeking

Profits on social expense: guilds, lobbying, advertising

Market of lemons

Profiting from lack of information

Phishing for phools

Creating lack of information: “Financial derivative”

Market sublimation

- security goal: equilibrium of supply and demand
- security protocol: free exchange
- "attacks above": advertising, information asymmetry
  - security protocol correctly executed
  - security goal shifted

Outline

Introduction

Market of lemons
  - Akerlof’s analysis
  - Expectations analysis
  - Signaling and authentication

The Efficient Market Hypothesis
Market of lemons

Market of lemons: Akerloff’s analysis

1. Symmetric information
   - Both sellers and buyers can tell which cars are good.
   - Each good car is sold for its true value.
   - The lemons are unsold or given for free.
   - Since \( \# \text{buyers} > \#\text{cars for sale} \), the market clears.

2. Asymmetric information: Naive buyers
   - Only sellers know which cars are good.
   - The buyers
     - expect the cars with \( w_i \in [0, \frac{2}{3}] \) uniformly distributed
     - offer the average price \( p_0 = \frac{1}{3} \)
   - The sellers
     - withdraw the cars with sellers’ values \( v \in (\frac{2}{3}, \frac{5}{8}] \) and
     - clear the \( \frac{2}{3} \) of the cars with sellers’ values \( v \in [0, \frac{2}{3}] \)
   - The buyers
     - get the average value \( w_i^* = \frac{4}{5} \cdot \frac{2}{3} = \frac{8}{15} \)
     - pay the average price \( p_0 = \frac{1}{3} \)

3. Asymmetric information: Rational buyers
   - Only sellers know which cars are good.
   - The buyers
     - expect the cars with \( w_i \in [0, \frac{2}{3}] \) uniformly distributed
     - offer the average price \( p_0 = \frac{1}{3} \)
   - The sellers
     - withdraw the cars with sellers’ values \( v \in (\frac{2}{3}, \frac{5}{8}] \) and
     - clear the \( \frac{2}{3} \) of the cars with sellers’ values \( v \in [0, \frac{2}{3}] \)
   - The buyers
     - know that the values are now \( w_i \in [0, \frac{2}{3}] - [0, \frac{2}{3}] \)
     - offer the average price \( p^*_0 = \frac{1}{6} \)
Market of lemons: Akerloff’s analysis

3. Asymmetric information: Rational buyers

- Only sellers know which cars are good.
- The buyers
  - expect the cars with \( w_2 \in \left[ 0, \frac{27}{64} \right] \) uniformly distributed
  - offer the average price \( p_1 = \frac{27}{64} \).
- The sellers
  - withdraw the cars with sellers’ values \( v \in \left( \frac{27}{64}, x \right) \)
  - clear the \( \frac{27}{64} \) of the cars with values \( v \in \left[ 0, \frac{27}{64} \right] \).
- The buyers
  - know that the values are \( w_3 \in \left[ 0, \frac{81}{256} \right] \)
  - offer the average price \( p_3 = \frac{81}{256} \).

Industry collapse:
- \( w, p \searrow 0 \)
- The market collapses!
Equilibria with asymmetric information

The cases

- belief e vs reality a
  - if \( e \in [a,1] \), then the buyers’ overpay the average value of the cars
  - if \( e \in [0,a] \), then the buyers don’t overpay

- offer \( 3e + 3 \) vs valuation intervals [2, 3] and [5, 6]
  - if \( e \in \left[ \frac{2}{3}, 1 \right] \), then \( p^* = 3e + 3 \in [5,6] \) clears all cars
  - if \( e \in (0, \frac{2}{3}) \), then \( p^* = 3e + 3 \in (3,5) \) overpays the bad cars and does not get the good cars,
  - if \( e = 0 \), then \( p^* = 3 \) clears the bad cars.

Market with lemons: Expectations

Summary

The equilibria are

- buying all cars with \( e = a \) and \( p^* = 3a + 3 \in [5,6] \), provided that \( a \in \left[ \frac{2}{3}, 1 \right] \)
- buying only bad cars with \( e = 0 \) and \( p^* = 3 \)

Asymmetric information

- Only the sellers can tell the cars apart.
- Like before, the buyers settle on the expectation
  \[
  \text{cars for sale} = \frac{1}{3} \cdot \text{good} + \frac{1}{3} \cdot \text{bad} + \frac{1}{3} \cdot \text{lemons}
  \]
  and they are willing to pay per car
  \[
  p^*_1 = \frac{1}{3} \cdot 6 + \frac{1}{3} \cdot 3 = 3
  \]
  - Since \( p^*_1 < 5 \), the good cars are withdrawn.
Market with lemons: Expectations

Asymmetric information
- Only the sellers can tell the cars apart.
- Like before, the buyers settle on the expectation
  \[ \text{cars for sale} = \frac{1}{2} \cdot \text{bad} + \frac{1}{2} \cdot \text{lemons} \]
  so that the buyers are willing to pay per car
  \[ \rho^*_2 = \frac{1}{2} \cdot 3 = \frac{3}{2} \]
- Since \( \rho^*_2 < 2 \), the bad cars are withdrawn.

Example

Collateralized debt obligations (CDOs)
- Let a CDO, \( A \), consist of
  - 100 mortgages
  - each worth 1M
  - default probability 10%
  - expected value of \( A \) is 90M

Example

Collateralized debt obligations (CDOs)
- Let a CDO, \( A \), consist of
  - 100 mortgages
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  - default probability 10% \( \longrightarrow \) lemons
  - expected value of \( A \) is 90M

Solutions of information asymmetry

Information is provided in authenticated signals:
- certificates
- warranties
- reputation and feedback systems
- risk sharing
- ...
Example

Collateralized debt obligations (CDOs)

- Let a CDO $A$ consist of
  - 100 mortgages
  - each worth 1M
  - default probability 10% —— lemons
  - expected value of $A$ is 90M

- Problem: assure the buyer that the risk is $\leq 10\%$

- Solution: seller keeps the risky part of $A$
  - sell senior tranche: 85%
  - keep junior tranche: 15%
  - all defaults up to 15% go into the junior tranche

Market information security

- Market is an information processing plant
  - input: behaviors and utilities
  - output: prices

Security requirements on the market

- confidentiality: conceal private data (valuations, …)
- authenticity: prove public data (CDOs, …)

Attacks on the market

- against confidentiality and privacy: tracking, differential pricing, …
- against integrity and authenticity: spam, phishing, maladvertizing, booby-trapped CDOs, …
- moral hazard, principal-agent problem, rent-seeking, …
- fraud: pyramid schemes, Libor rigging, malicious short selling, …

Efficient Market Hypothesis

“Prices fully reflect all available information.”

Eugene Fama
Efficient Market Hypothesis

**Question**
What is "all available information"?

**Answer**
- strong EMH: past prices
- semi-strong EMH: public information (past prices, news...)
- weak EMH: public and private information (valuations, strategies, inside information...)

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Efficient Market Hypothesis

**Question**
What does it mean that "Prices reflect all available information"?

**Answer (P. Samuelson)**
It means that there are no arbitrage opportunities on the market, i.e. that the random variable

\[ X = \text{expected return} - \text{predicted return} \]

- is unpredictable
- has the mean value 0

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Efficient Market Hypothesis

**Question**
Why do prices reflect available information?

**Answer**
Otherwise, there would be arbitrage opportunities

- i.e., there would be successful gambles on \( X \), based on additional information

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Efficient Market Hypothesis

**EMH on street**
Eugene Fama is walking down the street with a friend. They come upon a $100 bill lying on the ground. The companion reaches down to pick it up, but Fama says: "Don’t bother. If it were a genuine $100 bill, someone would have already picked it up".