Incomplete asymmetric information

“Asymmetric” in this case points at the fact that one party is less informed than the other.

The following analogy may be helpful:
A card game may be played under different rules:
- All cards are dealt face up – complete information
- Some (or all) cards are dealt face down – incomplete symmetric information.
- Some (or all) cards are dealt face down but player can look at some of his own cards – incomplete asymmetric information.
An example of asymmetric information: Sellers know product quality, buyers do not. The only way for buyers to find out the true value is to try the product. (**“Experience goods”**)

Under certainty, the rule for rational behavior is:

**Buy if** \( \text{Value} > P \),

where “value” (a.k.a. “utility”) stands for the subjective value the buyer gets from the product.

Under uncertainty, it becomes

**Buy if** \( \text{Exp. Value} > P \) (for a risk neutral consumer)

or

**Buy if** \( \text{Exp. Value} - \text{risk premium} > P \) (for a risk averse consumer)
Say the product has a value of $100 for a consumer if it works as expected/promised. The consumer believes that there is
- a 90% chance the product will deliver services;
- a 10% chance it will break down immediately (value = 0).

Up to what price will a risk neutral consumer pay for the product?

Max P = Exp Value = 0.9 \cdot 100 + 0.1 \cdot 0 = $90

What happens if the consumer is risk averse?

Max P = $90 – risk premium < $90

If buyers’ subjective valuations of the good are below the producer’s cost of making it, the market breaks down – nothing will be sold. Both buyers and sellers are hurt by that.
Example:

The market for “lemons” (Akerlof, 1973) analyzes the market for “lemons”, or cars with hidden defects.

Asymmetric information is reflected in the fact that the quality of cars in the market is known to sellers but not to buyers.

There are two types of used cars offered for sale in the market, 1,000 good cars and 1,000 “lemons”.
The number of potential buyers exceeds the number of cars available (a case of “sellers’ market”).

All buyers are identical – each of them will pay up to $1,000 for a lemon and $2,000 for a good car. (Those numbers are also called “reservation prices”.)

The sellers’ “reservation price” (the lowest price they would agree to sell for) is $800 for a lemon and $1600 for a good car.
Case 1. Symmetric complete information – the true quality of each car is known to both parties. We have two separate markets:

All cars are sold.
Case 2. Symmetric incomplete information – the true quality of a particular car is not known to anybody.

Each car is either a good one (with a 50% probability) or a lemon (with a 50% probability). Neither buyers nor sellers can tell one from another.

For simplicity, we are going to assume both sides are risk neutral. Therefore they base their reservation prices on expected values.

For sellers, \( EV = 0.5 \cdot 1600 + 0.5 \cdot 800 = $1,200 \)

For buyers, \( EV = 0.5 \cdot 2000 + 0.5 \cdot 1000 = $1,500 \)
Equilibrium price = $1500
Equilibrium quantity = 2000
Case 3. Asymmetric incomplete information – sellers know the quality, buyers don’t. For buyers, the situation is the same as in the previous case – they will pay $1500 for any car. Sellers, however, can tell good cars from lemons, and their reservation price is different for each category.
As a result, **only lemons are sold.** This is an example of **adverse selection**, or a situation when poor quality products drive high quality products out of the market. Adverse selection prevents markets from operating efficiently and is detrimental for both buyers and sellers. After buyers realize that no good cars are being traded, their EV drops to $1000.

What happens to the market price?

It also decreases to $1000.
Asymmetric information does not necessarily result in adverse selection. For instance, if sellers’ reservation price for a good car is $1200, then efficiency is restored. See below.
A similar example:

Adverse selection in the health insurance market.

• An individual knows his probability of accident, illness, etc. better than the insurance company.

• Insurance companies know only the composition of the population. If they offer a uniform insurance contract and price it based on the average degree of risk, then it is attractive only for the high-risk individuals. Low-risk individuals don’t buy insurance, and the average probability of accident/illness exceeds the initial estimate.
Ways to overcome the undesirable consequences of information asymmetry involved making the uninformed party better informed or reducing the amount at stake for them:

• laws protecting consumers;
• consumer reports;
• “screening”;  
• “signaling”.

The last two deserve some discussion.
1. **Screening** – the uninformed party does something that makes it better informed.

In the context of the lemons example, the (informed) seller may want to let (uninformed) buyers try the product out.

Insurance companies use a combination of tools to **screen** consumers and to better identify groups with different degree of risk:

- Questionnaires (age, marital status, smoking habits, etc.),
- A variety of contracts that differ in premiums, deductibles, and co-pay shares (a self-selection device).

Other examples: credit scores, asking for a second opinion when buying a car, etc.
2. **Signaling** – the informed party sends an observable indicator of his or her hidden characteristics to an uninformed party.

   In order to be effective, the signal must not be easily mimicked by other types.

   Examples: warranties as signals of quality, education as a signal of ability, etc.
Warranties

Forms of warranties:
• money refund (money-back guarantee);
• product replacement;
• product repair.

Roles that can be performed by warranties:
• optimal risk sharing (transferring risk from risk averse buyers to a risk neutral seller; works even in the asymmetric incomplete information case)
• promotional tool (similar to low prices)
• signal of quality
A warranty may work as a quality signal because it is costlier for a low-quality firm to service a warranty than for a high-quality firm. A high-quality firm may separate itself by picking a warranty of a scope that will be hard for a low-quality firm to mimic.
Other forms of signaling:

Low introductory price offer (used mainly for goods purchased repeatedly). Later, as consumers become more confident about the quality of the product, the seller can return to the profit-maximizing price level.

An extreme case of such a practice: free samples.

(Note that in this case low prices don’t imply low quality! In fact, it’s the exact opposite – the firm is not afraid to let many consumers try their product out.)
Other forms of signaling:

For goods **purchased only a few times over a consumer’s lifetime** ("durable goods"), a seller can offer a free trial period – a practice that is getting more and more popular.
For **durable goods** (purchased very infrequently), quality can also be signaled by high prices:

- Pricing above the profit maximizing price results in revenue loss.
- This loss is more substantial for a low quality firm.
- Set the price at the level that would never be chosen by the low quality firm. This would make consumers believe you sell a product of high quality. They will revise their subjective valuation of your good.

A practice known as “**money burning advertising**” serves a similar purpose: “We are not afraid to “burn” all this money on expensive commercials to draw you in because we are confident in our product”.
Back to the earlier example: There is a 90% probability the product will deliver services, hence have a value of $100. There is also a 10% probability it will break down immediately, in which case its value is 0.

Now, the firm offers a warranty of some form. For concreteness, let’s say it’s a money-back guarantee: an unsatisfied customer can get a refund, no questions asked.

Up to what price will a risk neutral consumer pay for the product?

\[ E(x) = 0.9 \cdot 100 + 0.1 \cdot 100 = $100 \]

What happens if the consumer is risk averse? There is no risk, so the result is the same, “up to $100”.

Problem solved?
Auctions

A form of competition for scarce objects.

The attractiveness of this form of competition from the economics perspective is that in most cases the object goes to the person with the highest valuation – a sign of efficiency.

If a player with reservation value $v$ makes bid, $b$, and wins the auction, his payoff is $x = v - b$. A player who doesn’t win gets $x = 0$. 
Auctions differ in
• The order in which bids are made;
• What information bidders have about each other;
• Correlation of individual valuations for the object:
  - “private value” (value of the object is different for every bidder)
  vs.
  - “common value” (the value is the same no matter who wins it);
• What the winner is asked to pay.

Let’s consider several different types of auctions starting with private value auctions (individual valuations for the object are independent of each other).
The English (ascending-price) auction:

The initial price is set low, bidders outbid each other by announcing the prices they are prepared to pay until only one bidder is left.

The last bidder left pays the amount of his own last bid and gets the object.

This is called a “first-price auction”.

The optimal strategy in an English auction is to pay the amount that is incrementally larger than a competing bid but never more than the own valuation.
Example:

Your valuation is $207, the minimum allowed bidding increment is $20,

Last bid was $100  -  bid $120

Last bid was $140  -  bid $160

Last bid was $200  -  do not bid

(If you don’t bid, your payoff is 0; If you bid and someone bids higher, your payoff is 0; If you bid and win, your payoff is $207 – 220 = – $13.)
First-price, sealed-bid auction.

Each bidder submits only one bid without knowing the bids of others (so in a sense, simultaneously). Bids are revealed and the highest bidder pays his bid and gets the object.

Bidding principles:

• Never bid more than your true value;

• If you believe you are the highest bidder, bid below your true value and as close to the second-highest valuation as the bidding interval allows.
In general, in the presence of uncertainty about others’ valuations, shaving the bid makes sense no matter where you are on the valuation ladder.

For example, it can be shown that…

In a FPSB auction with \( n \) bidders whose independent private values are drawn from a uniform distribution between the lowest possible value \( L \) and the highest possible value \( H \), the optimal bid for a player whose valuation is \( v \) is

\[
b = v - \frac{v - L}{n} = \frac{L + (n - 1)v}{n}
\]
For an indirect proof this formula is valid, let’s consider the case of two bidders.

If valuations are distributed uniformly and players consistently use the same rule to determine their optimal bid, then the distribution of bids is also uniform.
Let’s say valuations are distributed uniformly over the [5,15] interval and my valuation is $11.

There is no point in b > 11.

If my \( b = $11 \),
I win w/prob 0.6 and earn 0
I lose w/prob 0.4 and earn 0 \( \text{E}(x) = 0 \)

If \( b = $10 \),
I win w/prob 0.5 and earn 1
I lose w/prob 0.5 and earn 0 \( \text{E}(x) = 0.5 \)

We already see shaving the bid makes sense!

If \( b = $9 \),
I win w/prob 0.4 and earn 2
I lose w/prob 0.6 and earn 0 \( \text{E}(x) = 0.8 \)
If $b = $8,
I win w/prob 0.3 and earn 3
I lose w/prob 0.7 and earn 0  $E(x) = 0.9$

If $b = $7,
I win w/prob 0.2 and earn 4
I lose w/prob 0.8 and earn 0  $E(x) = 0.8$

In the more general form,
Given the interval of possible bids, $[L, H]$ and my bid $b$,
I win w/prob $\frac{b - L}{H - L}$ and get $x = v - b$
(and zero otherwise)
My expected payoff is

\[ E(x) = \frac{(b - L)(v - b)}{(H - L)} = \frac{bv - Lv - b^2 + Lb}{H - L} \]

There is only one variable of choice in this expression, \( b \).

To find \( b \) that maximizes \( E(x) \), we will use differentiation.

\[ \frac{dE(x)}{db} = \frac{v - 2b + L}{H - L} \]

, which we need to equal zero.
\[ v - 2b + L = 0 \]
\[ 2b = v + L \]
\[ b = (v + L) / 2 \]

In our example, \( b = (11 + 5) / 2 = \$8 \)

Interestingly, the upper limit of the uniform distribution affects the chances of winning but does not affect the optimal strategy!
**Caveat:** This formula is attractively simple due to the simplicity of the uniform distribution. However, in real life uniform distributions are not too common, and for a different distribution of valuations, the formula will be different as well. Deriving optimal bidding strategies for normal (bell-shaped), gamma, exponential, and other distributions requires more analytical work.

However, the above formula does capture the important principles:

The higher one’s valuation, the **higher** the optimal bid.

The more bidders there are, the **higher** the optimal bid and the **smaller** the spread between \( v \) and \( b \).

The smaller is one’s valuation (the closer it is to \( L \)), the **smaller** the spread between \( v \) and \( b \).
This was done for risk neutral bidders. What if bidders are risk averse?

Let’s go back to the previous example.
If $b = 11, \quad \text{Var} = 0$

If $b = 10,$
\[
\text{Var} = 0.5 \times (1 - 0.5)^2 + 0.5 \times (0 - 0.5)^2 = 0.25
\]

If $b = 9,$
\[
\text{Var} = 0.4 \times (2 - 0.8)^2 + 0.6 \times (0 - 0.8)^2 = 0.96
\]

If $b = 8,$
\[
\text{Var} = 0.3 \times (3 - 0.9)^2 + 0.7 \times (0 - 0.9)^2 = 1.89
\]

Risk averse consumers don’t like high variance!
Some of them will choose to bid $9$ instead of $8$
(slightly lower $E(x)$ but lower variance)
Conclusion: the more risk averse the bidders are, the less they will shave off their bids in a FPSB auction (the closer the bids will be to their true value).
Note that if the player with the highest valuation in a FPSB auction doesn’t know the second bid and guesses incorrectly, he may “shave” his bid too much and therefore lose, in which case the object will go NOT to the player with the highest valuation. This leads to market inefficiency.

This shortcoming can be mitigated by using

**Second-price, sealed-bid (SPSB) auction:**
(a.k.a. *Vickrey auction*)

Whoever places the highest bid, wins, but is asked to pay only the amount of the second highest bid.
Optimal bidding strategy in a SPSB auction:

Shaving the bid brings no benefit but reduces the probability of winning. Therefore the optimal strategy is to bid the true private valuation.

This scheme is often used when the auctioneer is concerned with efficiency and is confident in getting a large number of bidders.

It has also produced the largest number of disappointments regarding auction outcomes (mainly low revenues).

Sellers may establish the “reserve price” which is de facto the minimum bid accepted.

Example of SPSB: proxy bidding on eBay.
Dutch (descending-price) auction.

A seller begins by asking a very high price for the item. The price is gradually lowered until one buyer indicates a willingness to buy the item at that price.

The winning bidder pays that price and gets the item.

What is the optimal bidding strategy?

Since bidders don’t know each others’ valuations, and since the winning bidder has to pay his own bid, the Dutch auction is equivalent to…. a FPSB auction

Therefore so is the optimal strategy – shaving a bid to some extent.
Common-value auctions

In this type of auctions, the true value of the item is not known. It will end up being the same no matter who wins it.
(Example: the commercial value of gas/oil deposits)
The situation looks something like this:

Probabilistic distribution of “signals” bidders receive

“True” expected value of the item, $350
If everyone would bid according to the value of their signals, then the winner will be the bidder with the most optimistic estimate of the object value (therefore likely above the true value) – the “winner’s curse”.

Therefore the **optimal strategy** in common value auctions is to **bid less than the perceived value**, in order to avoid the winner’s curse.

The winner’s curse is partially mitigated in an English auction, where bidders can gain additional information about the distribution of “signals” by observing others’ bids.
Questions for discussion:

Is shopping a private-value or common-value situation?

What are we trying to achieve when we compare prices at different retailers?