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CHAPTER 17

Auctions and Bidding Strategies

A mechanism for selling things whose value is uncertain, and the art of bidding well in one.

What this chapter covers



17.2–17.3 Formats & bidding

- Four standard auctions
- Strategic equivalences
- Bidding with private values



17.4–17.5 Revenue & curse

- Revenue equivalence
- Common values
- The winner's curse



17.6–17.7 Evidence

- Case: spectrum & search ads
- Empirical: oil-lease bidding

THE BIG IDEA

When a seller does not know what buyers will pay, an auction lets competition among bidders reveal it. This chapter applies the game theory of Part V to auction design and bidding.

17.1

Introduction

- Selling the radio airwaves
- Choosing which ad to show
- Why winners regret oil leases

Three puzzles, one answer



Spectrum

How does a government sell radio waves worth tens of billions when it has no idea what they are worth to each company?



Search ads

How does an internet company decide, in a fraction of a second, which advertiser's link to show and what to charge?



Oil leases

Why do companies that win the rights to a drilling tract so often regret it?

THE COMMON THREAD

The answer to all three is an auction, a mechanism for selling things whose value is uncertain or known only to the bidders.

Why auctions?

■ An auction

A mechanism for selling things whose value is uncertain or known only to the bidders. It solves a problem posted prices cannot: when a seller does not know what buyers will pay, competition among bidders reveals it.

THE PLAN

We begin with the four standard formats, then study how to bid with private values, the surprising result that all four raise the same revenue, and the trap of the winner's curse when value is uncertain and shared.

17.2

Four Standard Auctions

- English (ascending)
- Dutch (descending)
- First-price sealed-bid
- Second-price (Vickrey)

17.2 FOUR STANDARD AUCTIONS

The two open formats

■ English (ascending) auction

The price rises until only one bidder remains. The familiar auction of art houses like Sotheby's, and of eBay.

■ Dutch (descending) auction

The price starts high and falls until a bidder accepts, as in the Dutch flower markets that give it its name.

The two sealed formats

■ First-price sealed-bid auction

Each bidder submits one secret bid. The highest bidder wins and pays her own bid.

■ Second-price sealed-bid (Vickrey) auction

The highest bidder wins but pays only the second-highest bid.

17.2 FOUR STANDARD AUCTIONS

The four formats side by side

Format	Bids	How the price is set	Winner pays
English (ascending)	Open	Rises until one bidder remains	$\approx$ second-highest value
Dutch (descending)	Open	Starts high, falls until accepted	the price she accepts
First-price sealed-bid	Sealed	Highest secret bid wins	her own bid
Second-price (Vickrey)	Sealed	Highest secret bid wins	the second-highest bid

The four standard auction formats, by whether bids are public or sealed.

17.2 FOUR STANDARD AUCTIONS

Public or sealed, a 2×2 map

Open (bids public)	Sealed (bids secret)
English (ascending) price rises until one bidder remains	First-price highest secret bid wins, pays its own bid
Dutch (descending) price falls until a bidder accepts	Second-price (Vickrey) highest bid wins, pays the 2nd-highest bid

- Open (English, Dutch): bidders see the price move and react.
- Sealed (first- and second-price): one private bid, no chance to react.

Figure 17.1 The four standard auction formats, by whether bids are public or sealed.

Two pairs behave the same way

■ English $\approx$ second-price sealed-bid

Under independent private values (each bidder knows her own value and it does not depend on what others learn): you stay in until the price reaches your value, then drop out. The auction ends when the second-to-last bidder quits, so the winner pays roughly the second-highest value, exactly the second-price rule.

■ Dutch $\approx$ first-price sealed-bid

You must decide in advance the price at which you will jump in, and you pay it, just as in a first-price auction you submit one bid and pay it, with no chance to react to others.

Why this ties the chapter together

ONE SIMPLIFICATION

These equivalences let us reason about all four formats by analyzing just two bidding problems: the second-price logic, where truthful bidding is a dominant strategy, and the first-price logic, where you must shade your bid.

17.3

Bidding with Private Values

- Each bidder knows her own value
- Second-price: bid your true value
- First-price: shade your bid

17.3 BIDDING WITH PRIVATE VALUES

What is a private value?

■ Private values

Each bidder knows her own value for the object, what it is worth to her, and these values differ from person to person. How should she bid?

The answer depends on the format. Two cases, very different logic.

Second-price: bid exactly your true value

THE CLEAN ANSWER

Bidding your value is a dominant strategy, best no matter what others do.

- You pay the second-highest bid, not your own, so your bid sets whether you win, not how much you pay.
- Raising your bid above your value risks winning at a price above what the object is worth.
- Lowering it below your value only risks losing an auction you would have been glad to win.

Truthful bidding cannot be beaten

A NOBEL RESULT

This result won William Vickrey a Nobel Prize, and it makes second-price auctions prized for their simplicity and honesty, the model for many online ad auctions.

First-price: shade your bid below your value

■ Bid shading

Because you pay your own bid, bidding your full value would guarantee zero profit even if you win. So you shade your bid below your value, sacrificing some chance of winning in exchange for a profit when you do.

HOW MUCH TO SHADE

How much to shade depends on how many rivals you face and how high you think they will bid. (The English works like the second-price; the Dutch like the first-price.)

A worked example: the object is worth \$100 to you

The Claim, Checked with Numbers

You value the object at \$100 in a second-price auction. Consider bidding your true value, \$100. Does any other bid do better? Check the cases.



Bid \$100, rival bids \$80

You win and pay \$80, for a \$20 gain, good.



Bid \$100, rival bids \$120

You lose, which is fine, since winning would mean paying \$120 for something worth \$100.

Neither deviation can help



Bid MORE, say \$130

Only changes the outcome when the top rival bid is between \$100 and \$130, you now win but pay more than the object is worth. A loss.



Bid LESS, say \$70

Only changes the outcome when the top rival bid is between \$70 and \$100, you now lose an auction you would have won at a price below \$100.

WHY BOTH FAIL

Your own bid sets WHETHER you win, but not HOW MUCH you pay. So bidding your true value is a dominant strategy, Vickrey's clean result.

17.3.1 WHY TRUTHFUL BIDDING WINS

Self-check

SELF-CHECK

In a second-price (Vickrey) auction you value an item at \$100. Why is bidding exactly \$100 your best strategy, no matter what others bid?

The winner pays the second-highest bid, not their own, so your bid only decides WHETHER you win, never how much you pay. Bidding your true \$100 wins exactly when the price is below your value and never overpays. Truthful bidding is a dominant strategy.

17.4

Revenue Equivalence

Which format makes the most money for the seller?

All four raise the same expected revenue

■ Revenue equivalence theorem

Under ideal conditions, symmetric bidders drawing independent private values from the same distribution, all risk neutral, all four formats raise the same expected revenue. The formats differ in who pays what in any single auction, but on average the higher prices of one are exactly offset by the bid shading of another.

WHEN IT BREAKS

It is a benchmark, not a law of nature. When the assumptions fail, bidders are risk averse, values are correlated, or some bidders are stronger, the formats diverge, and choosing the right one becomes the central problem of auction design.

17.5

Common Values and the Winner's Curse

- When the prize's value is shared but unknown
- Why winning is bad news
- How to avoid the curse

From private to common values

■ Common value

The object is worth the same to everyone, but its value is unknown at the time of bidding. An offshore oil tract holds a certain amount of oil; a company up for sale has a definite worth. Each bidder forms an estimate, but no one knows the true figure.

Estimates scatter around the true value, some too high, some too low.

17.5 THE WINNER'S CURSE

Why winning is bad news

■ The winner's curse

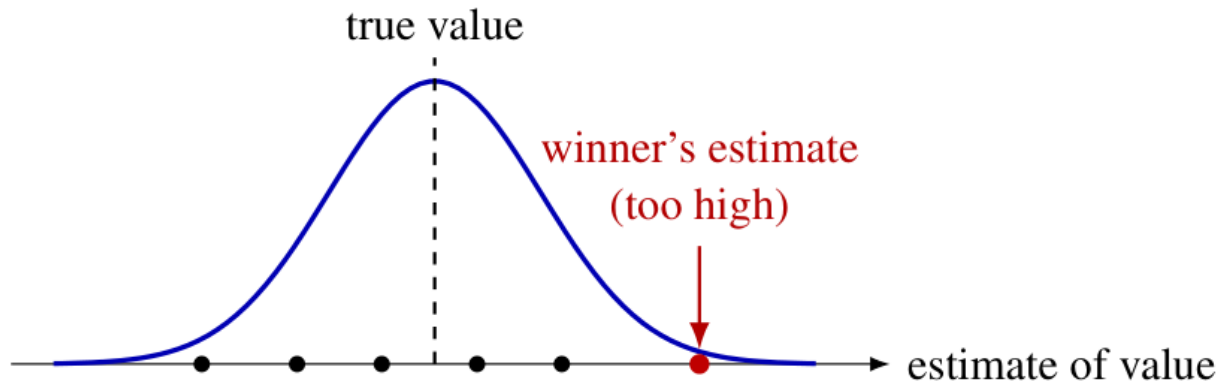
The winner is, by definition, the bidder with the highest estimate, and the highest estimate is very likely an overestimate. So the act of winning means you were probably the most optimistic, and have likely paid more than the object is worth.

THE CURE, IN ONE LINE

The cure: bid as though you had already won, recognize that winning signals you overestimated, and shade your bid downward accordingly.

17.5 THE WINNER'S CURSE

Estimates scatter; the winner overestimates



- Bidders' estimates cluster around the true value, but spread out on both sides.
- The winner draws the highest estimate, most likely above the truth.
- Win, and you have probably overpaid.

Figure 17.2 The winner's curse: estimates scatter around the true value, so the highest bidder, the winner, has probably overestimated it.

17.5.1 HOW TO AVOID THE WINNER'S CURSE

Bid as though you have already won

Where the Trap Comes From

The trap comes from a failure of imagination: a bidder forms her estimate, bids close to it, and forgets that winning itself is information.

- Ask: “if my bid turns out to be the highest, what does that tell me about my estimate?” It was probably too optimistic.
- So shade your bid downward, below your raw estimate, by an amount that grows with the number of rivals.
- More bidders means the winner is more likely the single most over-optimistic, so the shading should be larger.

A reason to bid thoughtfully, not to stay away

THE TAKEAWAY

Experienced bidders in common-value auctions, oil companies, corporate acquirers, players in online ad markets, learn to do exactly this. The winner's curse is not a reason to avoid auctions; it is a reason to bid thoughtfully in them.

17.6

Case Study: Selling the Airwaves and the Search Page

Two of the largest auction markets, built directly on this theory.

17.6 CASE STUDY

Selling the airwaves: spectrum auctions

- Governments auction the rights to use frequency bands for mobile phones and the internet.
- The formats are designed by economists to handle bidders who want particular combinations of licenses.
- Milgrom and Wilson won the 2020 Nobel Prize for improving auction theory and inventing new formats for complex goods like spectrum.

\$81 bn

raised by the FCC's 2021 “C-band” auction, the highest-grossing spectrum auction ever

WORLDWIDE

These designs have raised hundreds of billions of dollars worldwide.

Selling the search page: ad auctions

An Auction in Every Search

Every time you search online, an auction runs in milliseconds to decide which ads appear and what each advertiser pays, using a design based on the second-price logic of Section 17.3.

- Advertisers are encouraged to bid their true value for a click, because what they pay depends on the next bidder's bid, not their own.
- Run billions of times a day, these tiny auctions generate the overwhelming majority of the revenue of the world's largest search companies.
- Auctions once confined to art houses now allocate the airwaves and the internet's attention.

17.7

Empirical Evidence: The Winner's Curse in Oil-Lease Bidding

Discovered in the oil fields, before theorists had formalized it.

Capen, Clapp & Campbell (1971)

- Three petroleum engineers published “Competitive Bidding in High-Risk Situations.”
- Oil companies bidding for offshore leases in the Gulf of Mexico earned disappointingly low returns “year after year”.
- And yet the auctions were fiercely competitive.

THE DIAGNOSIS

Their explanation was the winner's curse. The oil's value was roughly the same for every company but unknown; each firm bid on its own geologists' estimate. The winner was typically the firm whose geologists were most optimistic, so the winning bid routinely exceeded the oil's true worth.

A prediction found by practitioners first

- Companies that bid their raw estimate rather than shading it down systematically overpaid.
- The paper taught the industry to bid more cautiously, and the oil-lease losses shrank once the lesson was absorbed.
- It gave economists their first real-world documentation of a phenomenon later confirmed in dozens of lab experiments (people bidding for a jar of coins reliably overpay).
- A rare case where a subtle prediction of game theory was discovered by practitioners before theorists had fully formalized it.

Key takeaways

1

Four formats

English, Dutch, first-price sealed-bid, and second-price (Vickrey).

2

Two equivalences

English $\approx$ second-price; Dutch $\approx$ first-price, so two bidding problems cover all four.

3

Private values

Second-price: bid your true value (dominant). First-price: shade below it.

4

Revenue equivalence

Under ideal conditions all four raise the same expected revenue; a benchmark, not a law.

5

Winner's curse

With common values, winning is bad news; bid as if you had already won and shade down.

6

Evidence

Spectrum (\$81 bn) and search-ad auctions; oil-lease overbidding, Capen–Clapp–Campbell (1971).