Introduction to different types of auctions

CO@W Berlin

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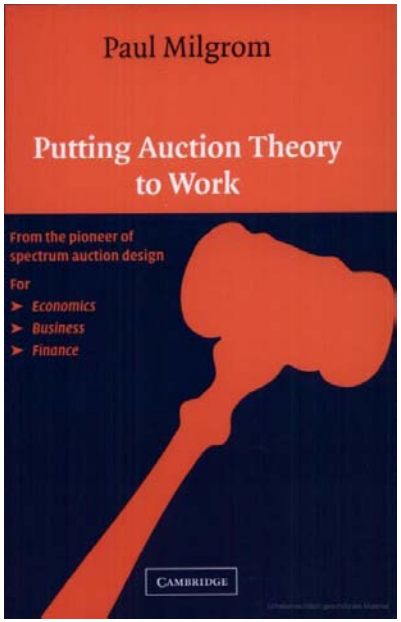
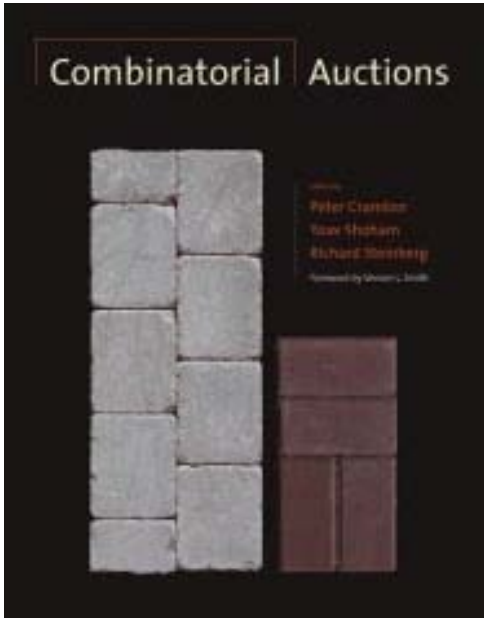
Good general references

- Paul Milgrom, *Putting Auction Theory to Work* Cambridge University Press, 2004 (Churchill Lectures in Economics)
- Peter Cramton, Yoav Shoham, and Richard Steinberg (editors), *Combinatorial Auctions*, MIT Press, 2006





What is an auction?

- An auction is a process of allocating goods among bidders; a little more detailed: a process of buying and selling goods or services by offering them up for bid, taking bids, and then selling the items.
- The general idea of an auction is to sell the items to the "highest bidder(s)". In which way the highest bidders are determined and what the price is they have to pay depends on the auction design, i.e., the particular rules that determine the auction mechanism.
- In economic theory, an auction may refer to any mechanism or set of trading rules for exchange.

What is an auction?

- The traditional auction that we usually think of when we hear the word auction is the auction of a single discrete item, say a painting at Christie's or Sotheby's.
- In this introduction and the experiments we will do in the classroom, we will focus on this type of single item auction.

What is an auction?

Auctions, however, may be employed to sell more complicated goods and services:

- homogeneous discrete items in larger quantities
- homogeneous continuous items in large quantities
- different discrete items on which simultaneous bids can be made
- combinations of discrete and continuous items on which simultaneous bids can be made.
- etc.

Things get complicated when bidders can choose several (arbitrary) combinations of items offered and bid on each combination. How should the auctioneer determine the “winners”, and what are the prices they have to pay? This will be discussed in “combinatorial auctions”.

Various Auction Rules

There are several variations on the basic auction form:

- There may be time limits or limits on the number of “rounds”.
- Minimum or maximum limits on bid prices or increments may apply.
- There are variations of the rules for determining the winning bidder(s) and sale price(s).
- Participants in an auction may or may not know the identities or actions of other participants.
- Bidders may participate in person or remotely, e.g., by telephone or the Internet.

The seller usually pays a commission to the auctioneer based on a percentage of the final sale price.

History

- There are reports about auctions as early as 500 B.C. According to Herodotus, in Babylon auctions of women for marriage were held annually. The auctions began with the woman the auctioneer considered to be the most beautiful and progressed to the least.
- One of the most significant historical auctions occurred in the year 193 A.D. when the entire Roman Empire was put on the auction block by the Praetorian Guard which first killed emperor Pertinax, then offered the empire to the highest bidder. Didius Julianus outbid everyone else for the price of 6,250 drachmas per Guard, an act that initiated a brief civil war. Didius was then beheaded two months later when Septimius Severus conquered Rome.

Real Auctions Today

- Auctions have become very important in the last 10-15 years. Everybody has probably heard about auctions of telephone frequencies, transportation contracts, and the like.
- According to Paul Milgrom (*Putting Auction Theory to Work*, Cambridge University Press, 2004):

  "The era of putting auction theory to work began in 1993 – 1994 with the design and operation on the radio spectrum auctions in the United States. Although the economic theory of auctions had its beginnings in the 1960s, early research had little influence on practice. Since 1994 auction theorists have designed... . By the end of 2001,... , the theorists' s designs had powered worldwide sales totaling more than $100 billion".

Why auctions?

- Economists believe in the “invisible hand”, i.e., that individuals and firms, left to their own means of activity and operating in a sound legal framework (regulation), tend to implement efficient allocations.
- An auction is (hoped to be) a sales mechanism where all parties see what is required and have no problem negotiating how to divide the gains credited by the agreement. In other words, auctions must be designed in such a way that they provide the legal framework that leads to an efficient allocation of goods.
- In order to design a suitable auction one has to understand the demands of the sellers and bidders.

Why auctions? What is efficient?

- The term “efficient” is of course subject to debate. In mathematical terms, we need an objective function that quantifies the “value” of an allocation.
- Concerning the US spectrum auctions US Vice President Al Gore interpreted efficiency as “putting the licenses into the hands of those who value them most”.

Value

The “value” of an item is not a fixed quantity.

As an example, let us consider a spectrum auction. A license is the right to use a spectrum (an interval of frequencies) exclusively.

- Suppose only two licenses are for auction. It may be that a bidder acquiring one license is willing to pay more for the second (to become a monopolist) or less (because he thinks he can outperform the second winner). In the first case, the licenses are called complements, in the second substitutes.
- The situation becomes much more complicated if several licenses are for sale. The business strategy of a bidder needs to be evaluated in great detail.

Bidding Strategies

- Bid shading is placing a bid which is below the bidder's actual value for the item. Such a strategy risks losing the auction, but has the possibility of winning at a low price. Bid shading can also be a strategy to avoid the winner's curse (example).
- Chandelier Bidding, a practice, especially by high-end art auctioneers, of raising false bids at crucial times in the bidding process in order to create the appearance of greater demand or to extend bidding momentum.
- Collusion: Whenever bidders at an auction are aware of the identity of the other bidders there is a risk that they will form a "ring" and thus manipulate the auction result, a practice known as collusion. By agreeing to bid only against outsiders, never against members of the "ring", competition becomes weaker, which may dramatically affect the final price level. After the end of the official auction an unofficial auction will take place among the "ring" members. The difference in price between the two auctions will then be split among the members.

Real Auctions Today

- Economists and mathematicians are investigating auctions theoretically. We will give a glimpse of this.
- Among the problems in the real world are:
  - Participants do not understand/know the auction rules.
  - There are individual and global side constraints that are not well understood in theory or by auction participants.
  - People try to cheat or make “unintended use” of the rules.
  - Information is not symmetric.

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English Auction

- also known as an *open ascending price auction*, the most common form of auction in use today.
- Participants bid openly against one another, with each subsequent bid higher than the previous bid. An auctioneer may announce prices, bidders may call out their bids themselves (or have a proxy call out a bid on their behalf), or bids may be submitted electronically with the highest current bid publicly displayed.
- The auction ends when no participant is willing to bid further, at which point the highest bidder pays their bid. If the seller has set a minimum sale price in advance (the 'reserve' price) and the final bid does not reach that price the item remains unsold. Sometimes the auctioneer sets a minimum amount by which the next bid must exceed the current highest bid. The English auction is commonly used for selling goods, most prominently antiques and artwork, but also secondhand goods and real estate. At least two bidders are required.

Dutch Auction

- also known as an *open descending price auction*.
- The auctioneer begins with a high asking price which is lowered until some participant is willing to accept the auctioneer's price. The winning participant pays the last announced price.
- In addition to cut flower sales in the Netherlands, Dutch auctions have also been used for perishable commodities such as vegetables, fish and tobacco. In practice, however, the Dutch auction is not widely used.

Sealed First Price Auction

- also known as a *first-price sealed-bid auction* (FPSB).
- All bidders simultaneously submit sealed bids so that no bidder knows the bid of any other participant. The highest bidder pays the price they submitted.
- This type of auction is distinct from the English auction, in that bidders can only submit one bid each. Furthermore, as bidders cannot see the bids of other participants they cannot adjust their own bids accordingly.
- Sealed first-price auctions are used in tendering, particularly for government contracts and auctions for mining leases.

Vickrey Auction

- also known as a *sealed-bid second-price auction*.
- This is identical to the sealed first-price auction except that the winning bidder pays the second highest bid rather than their own.
- This is very similar to the proxy bidding system used by eBay, where the winner pays the second highest bid plus a bidding increment (e.g., 10%). Although extremely important in auction theory, in practice Vickrey auctions are rarely used.
- William Spencer Vickrey (1914 –1996), a Canadian professor of economics. Vickrey was awarded the Nobel Memorial Prize in Economics for research into the economic theory of incentives under asymmetric information. The announcement of the prize was made just three days prior to his death.

Which auction is the best?

- The question is: What kind of auction leads to the highest prices for the sellers?
- Answer: There is (in principle) no systematic advantage of any of the standard auctions over the other. This is called the payoff equivalence theorem.




The theoretical optimality of the Vickrey Auction

- Willingness to pay
- private values
- True value – truthfull bidding
- Self-revelation/Incentive compatibility
- In a Vickrey auction with independent private values (IPV) each bidder maximizes his or her expected utility by bidding (revealing) his or her true valuation.
- http://en.wikipedia.org/wiki/Vickrey_auction

Paul Milgrom, *Putting Auction Theory to Work*, Cambridge UP, 2004

Arguing about auctions

1.3 Comparing Seller Revenues

The question most frequently asked of auction designers is: What kind of auction leads to the highest prices for the seller? The answer, of course, depends on the particular circumstances, but even the thrust of the answer surprises many people: There is no systematic advantage of either sealed bid over open bid auctions, or the reverse.




Paul Milgrom, *Putting Auction Theory to Work*, Cambridge UP, 2004

Arguing about auctions

A particular formal statement of this conclusion is known as the *payoff equivalence theorem*. It holds that for an important class of auctions and environments, the average revenues and the average payoffs of bidders are exactly the same for every auction in the class. To illustrate the logic of the idea, suppose you are selling an item that is worth $10 to bidder A and $15 to bidder B. If you sell the item using an ascending bid auction with both bidders in attendance, then bidder A will stop bidding at a price close to $10 and B will acquire the item for that price. If you use sealed bids instead and sell the item to the highest bidder, then the outcome will depend on what the bidders know when they bid. If they know all the values, then in theory B will bid just enough to ensure that it wins – around $10 or $10.01 – and A will likely bid close to $10. If they behave that way, the price will be just the same as in the ascending auction.

Paul Milgrom, *Putting Auction Theory to Work*, Cambridge UP, 2004

Arguing about auctions

Similar arguments among practitioners arise quite frequently, sometimes with variations. In the United States, the staff of the Treasury Department have periodically argued the relative merits of two alternative auction schemes for selling bills. In one scheme, each bidder pays the amount of its own bid for each bill it buys; in the other, all bidders pay the same *market-clearing price,* identified by the lowest accepted bid. Advocates of the first ("each pays its own bid") scheme say that the government will get more money from the auction, because winning bidders are by definition people who have bid more than the lowest acceptable bid. Advocates of the second ("uniform price") scheme counter that bidders who know they must pay their own bid when they win will naturally bid less, reducing the market-clearing price and leading to lower revenues.

Paul Milgrom, *Putting Auction Theory to Work*, Cambridge UP, 2004

Arguing about auctions

Experienced auctioneers often contest this irrelevance conclusion. Those who advocate ascending auctions argue that they generate more excitement and more competition than sealed bids. After all, they claim, no bidder is willing to bid close to its value unless pushed to do so by the open competition of the ascending auction design. Those who favor sealed bids counter by arguing that ascending auctions never result in more being paid than is absolutely necessary to win the auction; there is no money "left on the table." Sealed bids frequently result in lots of money left on the table. For instance, in the December 1997 auction for licenses to provide wireless telephone services in Brazil, an international consortium including Bellsouth and Splice do Brazil bid $2.45 billion in that auction to win the license covering the Sao Paulo concession. This bid was about 60% higher than the second highest bid, so 40%, or about $1 billion, was left on the table.[18]

Paul Milgrom, *Putting Auction Theory to Work*, Cambridge UP, 2004

Arguing about auctions

In the present state of the art, academic mechanism design theory relies on stark and exaggerated assumptions to reach theoretical conclusions that can sometimes be fragile. Among these are the assumptions (i) that bidders' beliefs are well formed and describable in terms of probabilities, (ii) that any differences in bidder beliefs reflect differences in their information, (iii) that bidders not only maximize, but also cling confidently to the belief that all other bidders maximize as well. These assumptions are extreme, and they are typically compounded in practice by the use of additional simplifying assumptions. Mechanisms that are optimized to perform well when the assumptions are exactly true may still fail miserably in the much more frequent cases when the assumptions are untrue. Useful real-life mechanisms need to be robust. Those

Paul Milgrom, *Putting Auction Theory to Work*, Cambridge UP, 2004

Arguing about auctions

- *What to sell?* If a farmer dies, should the entire farm be sold as a unit? Or should some fields be sold to neighbors? The house and barn as a holiday and weekend home? How should the FCC cut up the radio spectrum? Should power suppliers be required to bundle regulation services, or should they be priced separately?
- *To whom and when?* Marketing a sale is often the biggest factor in its success. Bidders may need to study the opportunity and line up partners, financing, regulatory approvals, and so on. Conditions may change: financing may be more easily available at one time than another; uncertainties about technology or demand may become partly resolved; etc. Bidders may actively try to discourage others from bidding, hoping to get a better price.[23] Auctioneers may seek to screen bidders to encourage participation by those who are most qualified, or may subsidize some participants to increase competition.
- *How?* For example, if the deal is complicated and needs to be individually tailored for each bidder, a seller might prefer to engage in a sequence of negotiations to economize on costs. If an auction is to be used, the right kind can depend, as we have already seen, on whether the items are substitutes or complements.

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Combinatorial Auctions

- A combinatorial auction is an auction where several inhomogeneous items are at sale and where bidders can place bids on combinations of items at the same time (packages).
- Given a set of bids in a combinatorial auction, find an allocation of items to bidders—including the possibility that the auctioneer retains some items—that maximizes the auctioneer's revenue. This problem is, in general, NP-complete. (In other words, combinatorial optimization techniques are needed.)
- The next lecture will deal with some aspects of combinatorial auctions.

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New Zealand

1.2.2 New Zealand's Rights Auction

New Zealand conducted its first auctions of rights to use radio spectrum in 1990. Some of the rights took the traditional form of *license rights* to use the spectrum to provide a specific service, such as the right to broadcast television signals using those frequencies. Others consisted of *management rights* according to which the buyer may decide how to use the spectrum, choosing, for example, television broadcasts, wireless telephones, paging, or some other service. In theory, when management rights are sold, private interests have an incentive to allocate spectrum to its most profitable uses, but the problem of coordinating uses among licensees can also become more complex.

Acting on the advice of a consulting firm – NERA – the New Zealand government adopted a *second-price sealed-bid auction* for its first four auction sales. As originally described by Vickrey (1961), the rules of the second-price auction are these: Each bidder submits a sealed bid. Then, the license is awarded to the highest bidder for a price equal to the *second* highest bid, or the reservation price if only one qualifying bid is made. The auction gets its name from the fact that the second highest bid determines the price.

New Zealand

The actual outcome of the first New Zealand auction is shown in Table 1. Notice that one bidder, Sky Network TV, consistently bid and paid much more for its licenses than other bidders. The Totalisator Agency Board, which bid NZ$401,000 for each of six licenses, acquired just one license at a price of NZ$100,000, while BCL, which bid NZ$255,000 for just one license, paid NZ$200,000 for it. Without knowing the exact values of various numbers of licenses to the bidders, it is impossible to be certain that the resulting license assignment is inefficient, but the outcome certainly confirms that the bidders could not guess one another's behavior. If Sky Network, BCL, or United Christian had been able to guess the pattern of prices, they would have changed the licenses on which they had bid. The bid data shows little connection between the demands expressed by the bidders, the numbers of licenses they acquired, and the prices they eventually paid, suggesting that the outcome was inefficient.

New Zealand

A second problem was even more embarrassing to New Zealand's government officials.[15] McMillan (1994) described it as follows: "In one extreme case, a firm that bid NZ$100,000 paid the second-highest bid of NZ$6. In another the high bid was NZ$7 million and the second bid was NZ$5,000." Total revenue, which consultants had projected to be NZ$250 million, was actually just NZ$36 million. The second-price rules allowed public observers to get a good estimate of the winning bidders' profits, some of which were many times higher than the price. To avoid further embarrassment, the government shifted from the second-price sealed-bid format to a more standard *first-price* sealed-bid format, in which the highest bidder pays the amount of its own bid. As we will see later in this book, that did not guarantee higher prices. It did, however, conceal the bidders' profits from a curious public.

UMTS in Germany

The German UMTS-Auction in August 2000 attracted, like similar auctions in Great Britain and The Netherlands earlier in the year 2000, a lot of public attention and money. At this auction 4 to 6 licenses to offer third generation cell-phone service in Germany were on the block to be sold, raising a total revenue of 98,8072 BDM. The publicity surrounding

UMTS in Germany

Eine aus spieltheoretischer und ökonomischer Sicht sehr interessante Situation entstand als Debitel, eine der Firmen ohne eigenes Handynetz, die Auktion verließ. Der Preis pro Block lag zu diesem Zeitpunkt bei 2,5 Mrd €. Nun hätte die Auktion ziemlich schnell gestoppt werden können, da nur 6 Firmen um 6 Lizenzen geboten haben. Stattdessen wurden die Gebote immer weiter erhöht. Das liegt daran, dass die beiden großen Handynetzbetreiber mehr Kapazität erwerben wollten. Dies hätte nur funktioniert, wenn mindestens eine weitere Firma die Auktion verlassen hätte. Dies wollte jedoch niemand, wahrscheinlich weil allgemein recht hohe Erwartungen an UMTS gestellt wurden und somit auch die Kapitalmärkte einen gewissen Druck ausübten. Firmen, die keine Lizenz erhielten, ließen sich zu diesem Zeitpunkt schlecht als Investitionen in die Zukunft vermarkten. Die Konsequenz war, dass die Preise enorm stiegen. Nun hatten die Kapitalmärkte wiederum einen Einfluss auf den Auktionsverlauf. Viele Analysten und Ratingagenturen erkannten, dass die Preise für die Lizenzen sehr stark gestiegen waren und die Firmen somit hohe Schulden machen mussten. Dies würde zu höheren Kreditzinsen und weniger Gewinnen führen, mindestens für die Zeit bis zur UMTS-Einführung. Daher wurde die Auktion nach vielen Runden beendet. Die Unternehmen mussten zusammen 20 Mrd mehr zahlen, als sie dass gemusst hätten, wenn sie die Auktion direkt nach dem Debitel-Ausstieg beendet hätten. Diese Entwicklung wurde dadurch begünstigt, dass durch das Auktionsdesign nicht genau klar war, wie viele Lizenzen letztendlich verkauft werden würden. Dadurch wird es schwieriger für die Unternehmen Pläne aufzustellen. Außerdem wäre es für die großen Handynetzbetreiber profitabel gewesen, wenn sie es geschafft hätten zusätzliche Kapazität zu erwerben, denn dann hätte, wie im Modell bewiesen, mindestens ein Neueinsteiger die Auktion verlassen müssen. Dadurch wäre weniger Wettbewerb auf dem Markt entstanden, was sich positiv auf die Gewinnmargen ausgewirkt hätte. Eine weitere Erklärung für das Entstehen der hohen Preise wäre, dass die France Telecom, die über Mobilcom auch an der Auktion beteiligt war, vor der Auktion von der Deutschen Telekom nicht gerade freundlich behandelt wurde. Daher könnte die Firma aus Rache die Preise hochgetrieben haben. Rache ist aber nicht gerade etwas, dass Manager großer Konzerne, in die viele Aktionäre ihr Geld gesteckt haben, bei ihren Entscheidungen leiten sollte.

Darüber hinaus wurde von einigen die Behauptung aufgestellt, dass die Deutsche Telekom die Preise absichtlich hochtreiben sollte. Der Grund dafür wäre, dass der Bund, der Hauptaktionär der Telekom ist, von hohen Preisen höhere Einnahmen hätte. Daher hätte die Telekom auf diese Weise ihrem Hauptaktionär geholfen. Aber auch das sind alles Thesen, die sich ohne Weiteres nicht belegen lassen.

The Winner's curse

- English auction of calculating machines (early computers)




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Each participant gets an endowment

- 100 ZIB Mark for everyone on an individual account..
- You can use it for bidding (for real objects or rights).
- We will not tell you all items that will be up for bid in the beginning.
- You can borrow or buy (with real money) ZIB Mark from others.
- You can “pool” your ZIB Mark and bid in a team.
- We don’t care what you do with your ZIB Mark, but as soon as you have won a bid you must pay it from your account. If you have to pay more than is on your account, you will not be allowed to participate in the excursion (penalty).
- The auctions we run now are meant to give you a feeling of the subtleties of bidding that are not necessarily reflected in mathematical statements about auctions and bidding.

1. Auction

- English auction of

2. Auction

- Dutch auction of

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3. Auction

- Sealed first prize auction of

- Get paper ready for your bid

4. Auction

- Vickrey auction of

- Get paper ready for your bid

5. Auction

- auction of

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6. Auction

- English auction of




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Introduction to different types of auctions

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The End

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