# BUEC 311: Business Economics, Organization and Management Oligopoly and Monopolistic Competition

Fall 2020

#### Outline

- Overview
- Cartels
- Cournot Oligopoly
- Bertrand Oligopoly
- Monopolistic Competition

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#### Two Additional Market Structures

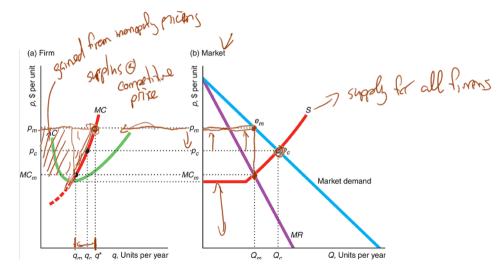
- So far, we have discussed markets with many firms (perfect competition) or one a single firm (monopoly).
- There are two additional market structures we need to consider.
  - Oligopoly: A market with few sellers and barriers to entry, so each individual firm has market power.
  - Monopolistic Competition: A market in which each firm has market power, but there is free entry in the long run.

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- Oligopolistic firms have an incentive to form a cartel in which they collude and set prices or quantities to increase profits.
  - E.g. OPEC, Montreal's snowplow cartel.
- Typically, each member of a cartel agrees to reduce its output below the level that would be individually profit maximizing.
  - Idea: Increase market price, so firms in cartel earn higher profits.
    - Ideally, the cartel would reduce market output to the monopoly level; this
      gives highest possible collective profit.
  - Issue: Each member of the cartel has an incentive to cheat.

- A cartel will form if its members believe that they can raise their profits by coordinating their actions.
- By coordinating, the cartel accounts for how output changes from each member firm affect all other members of the cartel.
- This means the aggregate profits of the cartel can exceed the combined profits of the same firms if they acted independently.



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- Cartels are hard to sustain in practice:
  - External factors:
    - Cartels are generally illegal in most developed countries. Risk of high fines/jail time may prevent collusion.
    - Some cartels fail because they do not control enough of the market.
  - Internal factors:
    - Cartel members have incentives to cheat other members of the cartel.

- To sustain a cartel, members must be able to detect cheating and punish violators.
  - To detect cheating:
    - Some cartels give members the right to inspect each other's accounts, or divide the market by region/customer.
    - Cartels may also turn to industry organizations to collect data on a firm's market share.
  - To enforce the cartel:
    - Most-favored-customer clause: The seller would not offer a lower price to any other current or future buyer without offering the same price decrease to the firms that signed these contracts.

- Some cartels result from government policy.
  - Sometimes governments help create and enforce cartels, exempting the participants from antitrust and competition laws.
- Some cartels result from barriers to entry into a market.
  - With high barriers to entry, a cartel with have few members. Fewer firms makes it easier to find cheaters and impose penalties.

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# Types of Oligopoly



- If they are not actively trying to collude and form a cartel, oligopolistic firms can compete by independently setting prices or quantities.
- The model we need to use to understand how oligopoly will work depends on whether firms are setting quantities or prices.
  - If firms are **independently setting quantities**, we need to use the Cournot model.
  - If firms are **independently setting prices**, we need to use the Bertrand model.



- The Cournot model is based on four key assumptions:
  - Few firms and no entry.

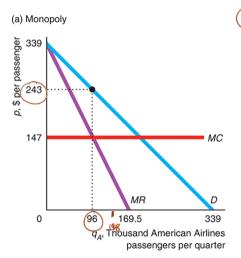
  - Identical costs.Identical products.
  - Firms choose output levels independently and simultaneously.
- Level of output is a strategic choice.
  - Firms set quantities independently, but prices adjust as needed until market clears.
    - This means that firm profits are interdependent.

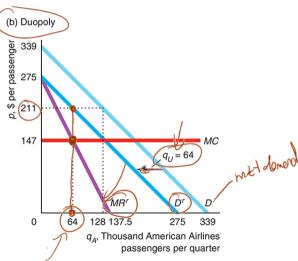
- Oligopolistic firms choose output to maximize profits.
- Key departure: Firms make profit maximizing decision based on their residual demand curves.
  - The residual demand curve is the market demand that is not met by other sellers at any given price:

$$D^r(p) = D(p) - Q^0$$

- Profit maximizing decision ( $\underline{MR} = \underline{MC}$ ) yields the firm's best response.
  - Best response tells firm the profit maximizing level of output given what other sellers are producing.

- As an example, consider competition between American Airlines and United Airlines on flights between Chicago and Los Angeles.
  - This is an example of a duopoly.
  - Total market output:  $Q = q_A + q_U$
- For simplicity, assume that American and United face the same marginal costs.
- First step: Determine how much American will produce given United's output.



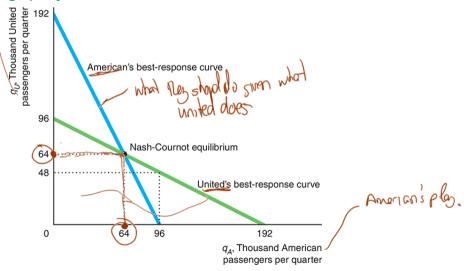




• American repeats this exercise for every level of residual demand:

$$q_A = Q(p) - q_u$$

- This yields American's best response to any level of output from United.
- United's best response is determined in an analogous way.



#### Definition (Nash-Cournot Equilibrium)

A set of quantities chosen by firms such that, holding the quantities of all other firms constant, no firm can obtain a higher profit by choosing a different quantity.

• Equilibrium quantity must be on the best response curve for all firms.

- We can also solve for the equilibrium algebraically.
- Suppose the market demand function is Q=339-p and that both companies have MC=AC=147 per passenger per flight.
- The then residual demand function for American is  $q_A = (339 p) q_U$  or  $p = 339 q_A q_U$ .
- This means American's marginal revenue is given by:

$$MR^r = 339 - 2q_A - q_U$$



• American's profit maximizing choice:

$$MR^r = MC$$
$$339 - 2q_A - q_U = 147$$

So American's best response is:

$$q_A = 96 - 0.5q_U$$

Similarly, United's best response is:

$$q_U = 96 - 0.5q_A$$

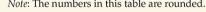
• We can determine the Nash-Cournot equilibrium by substitution:

$$q_A = 96 - 0.5(96 - 0.5q_A) = 64$$
  
 $q_U = 96 - 0.5(96 - 0.5q_U) = 64$ 

• Hence, 
$$Q = q_A + q_U = 128$$
, and  $p = $211$ .

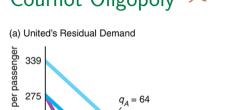
- If two Cournot firms set output independently, the Nash-Cournot equilibrium price to consumers is lower than the monopoly price.
  - It is possible to verify, with one firm, in our airline example, Q=96 and p=\$243.
- As the number of firms increases, the equilibrium price is even lower.
  - With a large enough number of firms, the Nash-Cournot equilibrium approaches the competitive outcome.

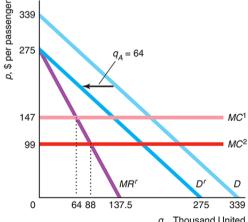
Number of Firms, n	Firm Output, q	Market Output, Q	Price, p	Firm Profit, π (\$ thousands)
1 (monopoly)	96	96	243	9,216
2 (duopoly)	64	128	211	4,096
3	48	144	195	2,304
4	38	154	185	1,475
5	32	160	179	1,024
10	18	175	164	305
50	4	188	151	14
100 (nearly competitive)	2	190	149	4

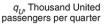


- In our example, firms had the same costs and were selling the same product. In reality, firms can have different costs and/or differentiate their products.
- In the Cournot model, a change in costs shifts a firm's best response function.
  - Recall: For a profit maximizing firm, MR = MC, so a change in cost changes what level of output is profitable given what other firms are doing.
- As an example, suppose that United's MC falls from \$147 to \$99.

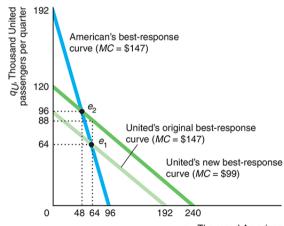
# Cournot Oligopoly $\checkmark$











q<sub>4</sub>, Thousand American passengers per quarter



- If an oligopolistic firm can differentiate its products from its rivals, it can shift its demand curve to the right and make it less elastic.
- The less elastic the demand curve, the more the firm can charge because consumers are willing to pay more for a product that "seems" superior.
- Although differentiation leads to higher prices, which harms consumers, differentiation can be desirable in its own right.
  - Consumers value having a choice, and some may prefer new brands to existing ones.
- If consumers think products differ, then Cournot quantities and prices may differ across firms.
  - Each firm faces a different inverse demand function and hence, charges a



- Oligopolistic firms may desire to merge to increase profit.
- In general there are two types of mergers:
  - Vertical mergers that may lower cost with more efficient supply chain organization.
  - Morizontal mergers that may increase market power and reduce competition.
- Mergers designed to reduce competition are rarely profitable unless accompanied by a cost reduction.

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- In the Bertrand model, prices are the strategic choice.
  - Firms set prices and then consumers decide how many units to buy.
- Firms must account for the pricing decisions of all other firms in the market.
  - E.g. Duopoly
    - Firm 1's best response curve comes from answering "What price should we (Firm 1) set if Firm 2 sets a price of  $p_2 = x$ ?" for all possible values of x.
    - Firm 2's best response curve comes from answering "What price should we (Firm 2) set if Firm 1 sets a price of  $p_1 = y$ ?" for all possible values of y.

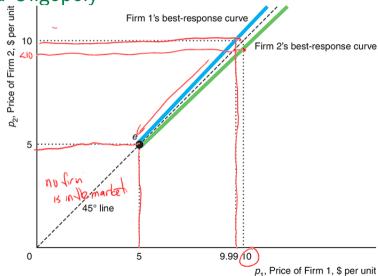
#### Definition (Nash-Bertrand Equilibrium)

The set of prices such that no firm can obtain a higher profit by choosing a different price if the other firms continue to charge these prices.

 Nash-Bertrand equilibrium differs from the Nash-Cournot equilibrium; with Bertrand, firms only earn positive profits if they produce differentiated products.



- As an example, consider a price-setting oligopoly where firms have identical costs and produce identical products.
- Suppose there are two firms (Firm 1 and Firm 2) that produce identical products, and have identical costs so MC = AC = \$5.
- What price should each firm charge?

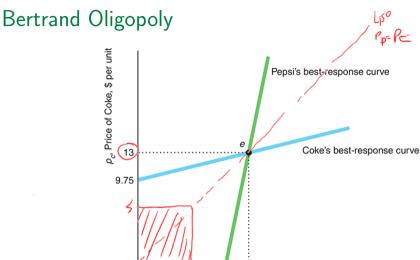


- When firms produce identical products, the Nash-Bertrand Equilibrium
   outcome is the same equilibrium as perfect competition.
  - This seems implausible for two reasons:
    - In a market with few firms, why would firms compete so vigorously that they earn no profit?
    - Equilibrium depends only on costs; it is insensitive to demand conditions or the number of firms.
  - Implication: Nash-Cournot model is better suited for understanding markets with identical products.

- The Bertrand model is better suited for understanding markets featuring differentiated products.
- E.g. Coke and Pepsi
  - Two firms with nearly identical costs:

$$MC = AC = $5$$

- Products are differentiated, so some consumers prefer one to the other regardless of price.
  - **★•** This means neither firm has to exactly match a price cut by its rival.



10.4 (13)

 $p_{o}$ , Price of Pepsi, \$ per unit

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#### Monopolistic Competition

- Final market structure: Monopolistic Competition
  - Features the price setting characteristics of monopoly and oligopoly and the free entry of perfect competition.

    - Firms face downward sloping demand curves, and have market power.
       Firms may earn zero profit in the long run due to free entry.
- Demand may be downward sloping for two reasons:
  - Market demand may be limited so there is only room in the market for a few firms; each firm faces a residual demand curve that is downward sloping.
  - E.g. A market may only be large enough to support a few service providers (barbers/plumbers/etc).
  - Firms produce differentiated products. Each firm can retain those customers who like product more even if its prices is above that of rivals.
    - E.g. Food trucks.



## Monopolistic Competition \$ per unit MC р, monopoly ents MR = MCMR

q



q, Units per year

#### Monopolistic Competition

- If all firms in a monopolistically competitive market produce identical products and have identical costs, each firm earns zero economic profit in the long run.
- If firms have different cost functions or produce differentiated products, then firms will likely differ in their long run profitability.
  - Low-cost firms, or firms with superior products may earn positive economic profit in the long run.



#### **Takeaways**

- Oligopolistic firms have an incentive to collude and form a cartel.
  - firms have individual disincetive
- In oligopolies, firm profits are interdependent. Profitability depends on differences in cost and product differentiation.
- In monopolistically competitive markets, profitability also depends on differences in cost and product differentiation. If firms produce identical goods with identical costs, they all earn zero economic profit in the long run.

# BUEC 311: Business Economics, Organization and Management Strategic Behaviour Part I Game Theory and Business Strategy

Fall 2020

#### Outline

- Oligopoly Games
- Auctions

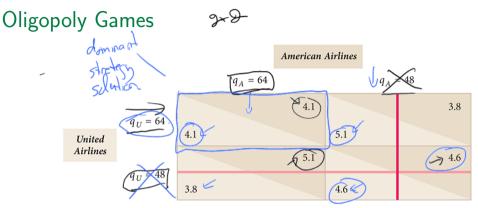
#### Strategic Interaction

- Thus far: We have primarily focused on cases where firms are not interacting strategically.
  - But we often need to understand the potential decisions of rivals.
  - We need a toolbox for understanding strategic decision making.
- Game Theory: A set of tools used to analyze strategic decision making.
  - Idea: Model strategic interactions as a game in which players interact according to a set of rules.
    - Players decide <u>strategies</u> based on <u>payoffs</u>, the level of <u>information</u>, and their rationality.
    - Outcome of a game is a <u>Nash Equilibrium</u>; depends on information and rationality.
  - Game theory can be used to understand strategic behaviour by firms, outcomes in bargaining, and auctions.

#### Outline

- Oligopoly Games
- Auctions

- Ex. A duopoly game between American Airlines and United Airlines
  - Players and rules:
    - Two players: American and United, play a static game to decide how many passengers to fly per quarter. Each airline's objective is to maximize profit.
    - Rules: Firms announce output levels simultaneously, but cannot communicate otherwise (no side deals or coordination is allowed).
    - \* Complete information: Firms know all strategies and payoffs.
  - Strategies:
    - Each firm's <u>strategy</u> is to take one of two available actions: ether choose low output (48k passengers per quarter) or high output (64k passengers per quarter).
    - Both firms know all strategies and the corresponding payoffs for each firm.
    - We can summarize these strategies in a payoff matrix (or profit matrix).



*Note*: Quantities are in thousands of passengers per quarter; (rounded) profits are in millions of dollars per quarter. The payoff to American Airlines is in the upper-right corner of each cell and the payoff to United Airlines is in the lower left.

Figure: The Payoffs for American and United

#### **Dominant Strategies**

• If one is available, a rational player always uses a dominant strategy.

#### Definition (Dominant Strategy)

A dominant strategy is a strategy that produces a higher payoff (profit) than any other strategy the player can use, no matter what its rivals do.

- In our airline duopoly example, high-output (64k) is the dominant strategy for both firms.
  - High output yields the highest profit *regardless of what the other firm is doing*.
  - Hence, the dominant strategy solution is  $q_U = q_A = 64$ .

#### **Payoffs**

- A dominant strategy solution does not necessarily lead to the best outcome for firms.
  - In our example, United and American choose strategies that do not maximize their joint or combined profit.
    - Each firm could earn \$4.6 million if they both chose to produce a low level of output (48k).
  - Game between United and American is an example of a <u>Prisoner's Dilemma</u>.
    - All players have dominant strategies that lead to a profit that is inferior to what they could have achieved if they cooperated.
    - Individual incentives cause players to choose strategies that do not maximize joint profits.

## Prisoner's Dilemma Example

• Suppose that United and American are now choosing whether or not to invest in new planes. Currently, each airline earns a profit of \$25 billion using their old fleet of planes. If American upgrades to new planes and United does not, then American steals some of United's customers and increases its profits to \$35 billion, while United's profits fall to \$10 billion. Similarly, if United upgrades and American does not, United's profits increase to \$35 billion and American's profits fall to \$10 billion. If both airlines upgrade to new planes, then they each will earn \$20 billion. What will each firm do? What will they earn in equilibrium?

Pagalts is not a Nost aguilibrium 1) Dominant shortgres? 2) Not equilbrium? Devotion from strategés

#### Best Responses \*

• Many games do not have a dominant strategy solution. In this case, we can use the approach of best response to determine the outcome of a game.

#### Definition (Best Response)

A best response is the strategy that maximizes a players payoff (profit) given its beliefs about the strategies of its rivals.

- A dominant strategy is a strategy that is a best response to all possible strategies a rival might use.
- In the absence of a dominant strategy, each firm can determine its best response to any possible strategy chosen by its rivals.

#### Nash Equilibrium **\***

• Best responses are the basis of a Nash Equilibrium.

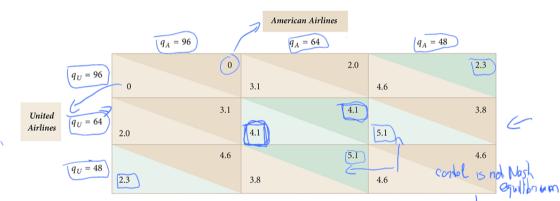
#### Definition (Nash Equilibrium)

A Nash equilibrium is a set of strategies such that if, when all other players use these strategies, no player can obtain a higher profit by choosing a different strategy.

- In a Nash equilibrium, players are "best-responding" to each other.
  - This means the Nash equilibrium is self enforcing.
- Two steps to find the Nash Equilibrium:
  - Determine each player's best response to any given strategy of the other player.
  - Check whether pairs of strategies are best responses for both firms; these pairs are Nash equilibria.

- As an example, consider a more complicated game between American and United.
  - Now both firms have 3 possible strategies:
    - High output (96k passengers/quarter).
    - Medium output (64k passengers/quarter).
    - Sometime to the second of t
  - Otherwise, the rules are the same as before:
    - Static simultaneous move game.
    - Perfect information.





 $\textit{Note:} \ Quantities \ are \ in \ thousands \ of \ passengers \ per \ quarter; (rounded) \ profits \ are \ in \ millions \ of \ dollars \ per \ quarter.$ 

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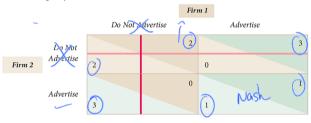
- Determine equilibrium via two step method:
  - Determine best responses for United:
    - If United chooses  $q_U = 96$ , American's best response is  $q_A = 48$ .
    - If United chooses  $q_U = 64$ , American's best response is  $q_A = 64$ .
    - If United chooses  $q_U = 48$ , American's best response is  $q_A = 64$ .

#### And for American:

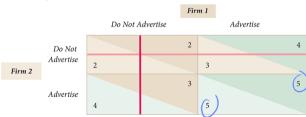
- If American chooses  $q_A = 96$ , United best response is  $q_U = 48$ .
- If American chooses  $q_A = 64$ , United best response is  $q_U = 64$ .
- If American chooses  $q_A = 48$ , United best response is  $q_U = 64$ .
- Determine the Nash Equilibrium
  - The Nash equilibrium is  $q_A = q_U = 64$ .
  - This outcome is a Nash equilibrium because neither firm wants to deviate from its strategy *given what the other firm is doing.*
  - Note: The Nash Equilibrium does not maximize joint profits.

- In general, whether or not the Nash equilibrium maximizes the combined payoff to players (i.e. profits for firms) depends on the payoff matrix.
- As an example, consider a static game where firms decide to 'advertise' or 'not advertise'.
- The effects of advertising depend on whether advertising brings new customers into the market.

#### (a) Advertising Only Takes Customers from Rivals



#### (b) Advertising Attracts New Customers to the Market



- Example highlights a phenomenon often observed in practice:
  - In oligopolistic markets, the effect of firm advertising depends on whether it helps (increases the size of the overall market) or hurts (steals customers) rivals.
- In some industries, advertising primarily steals customers from rivals.
  - E.g. market for cola; market for erectile dysfunction drugs.
- In other industries, advertising by any firm increases the size of the market.
  - E.g. market for beer; market for cigarettes.
- It is possible to observe market size and business stealing effects simultaneously.

#### Outline

- Oligopoly Games
- Auctions

#### **Auctions**

#### Definition (Auction)

A sale in which a good or service is sold to the highest bidder.

- Game theory can be used to understand behaviour in auctions.
  - An auction is a game in which players (called <u>bidders</u>) devise bidding strategies without knowing the payoff functions of other players.
  - Bidders need to know the rules of the game:
    - The number of units being sold.
    - The format of bidding.
    - The value that potential bidders place on the good.

#### Auctions

- Auctions are frequently used in practice:
  - Government auctions:
    - Government procurement, auctions for electricity and transport markets. auctions to concede portions of the airwayes for radio stations, mobile phones and wireless internet access; auctions for oil and gas leases.
  - Market transactions:
    - Goods commonly sold at auction are natural resource such as timber and drilling rights for oil, as well as houses, cars, agricultural products, horses, antiques and art. And of course, goods online in sites like eBay.

- Elements of Auctions

  Number of units: auctions can be used to sell one or many units of a good.
  - Format of bidding:
    - the last bidder for the highest bid. Commonly used to sell art/antiques.
    - <u>Dutch auction</u>: Descending-bid auction process where the seller reduces the price until someone accepts it and buys at that price. Often used in government procurement.
    - Sealed-bid auction: Bidders submit bids simultaneously without seeing anyone else's bid and highest bidder wins. In a 1st price sealed-bid auction, the winner pays its own, highest bid. In a 2nd price sealed-bid auction, the winner pays the amount bid by the 2nd highest bidder.
  - Value:
  - Private value: Individual bidders know how much the good is worth to them. but not how much other bidders value it.
    - Common value: The good has the same value to everyone, but no bidder knows exactly what that value is.

#### Second Price Sealed Bid Auctions

- Rules:
  - Each bidder has a different private value for a single indivisible good.
  - Bidders simultaneously submit sealed bids without knowledge of other bids.
- Design of auction means that amount that you bid affects whether you win, but it does not affect how much you pay if you win (which is equal to the second-highest bid).
- Best strategy: Bid your highest value.
  - This strategy weakly dominates all others.
  - Ex: Suppose that you value a folk art carving at \$100. If you bid \$100 and win, your CS=100-2nd price. If you bid less than \$100, you risk not winning. If you bid more than \$100, you risk ending up with negative CS.
  - Thus, bidding \$100 leaves you at least as well off as bidding any other value.

#### **English Auctions**

- Rules:
  - Each bidder has a different private value for a single indivisible good.
  - Ascending-bid auction process where the good is sold to the last bidder for the highest bid.
- Design of auction means that amount you bid affects whether you win and how much you pay.
- Best strategy: Raise the current highest bid as long as that value is less than the value you place on the good.
  - Ex: Again suppose that you value a folk art carving at \$100. If you bid an amount b and win, CS = 100 b. CS is positive or zero for  $b \le 100$ , but negative if b > 100. So it is best to raise bids up to \$100 and stop there.
  - If all participants bid up to their value, the winner will pay slightly more than the value of the second-highest bidder. Thus, the outcome of an English auction is essentially the same is a in a sealed-bid, second-price auction.

#### Other Auctions

- Two other common private value auctions:
  - Dutch Auction: Descending-bid auction where the seller reduces the price until someone accepts the offered price and buys at that price.
  - First-Price Sealed-Bid Auction: Bidders submit bids simultaneously without seeing other bids. Highest bidder wins and pays amount of bid.
- In both cases, the amount that you bid affects whether you win and pay.
- The best strategy in both auctions is to bid an amount that is equal to, or slightly greater than what you expect will be the second-highest bid, given that your value is the highest.
  - Bidders shade bids to less than their value to balance the effect of decreasing the probability of winning and increasing CS. Bid depends on beliefs about strategies of rivals.

#### **Auctions**

- Key point: Expected outcome is the same across private value auctions.
  - Winner is the person with the highest value, and the winner pays roughly the second-highest value.
- Is there any reason that a seller still might choose one format over an alternative?

#### **Auctions**

- Key feature of common-value auctions: the Winner's Curse.
  - Winner's bid exceeds the value of item up for bid; winner pays too much.
  - Occurs due to uncertainty about the true value of the good.
    - E.g. Timber land auctions/auctions for oil and gas leases.
- Best strategy to avoid Winner's Curse: Shade/reduce bids to below estimates of value.
  - The amount of reduction depends on number of other bidders; more bidders
     more likely winning bid is an overestimate.
- While Winner's Curse is a well known phenomenon, there is strong empirical evidence it continues to happen in practice (e.g in the corporate acquisition market).
  - One possible explanation: Bounded rationality.

#### **Takeaways**

- Insights from game theory can be used to improve outcomes when making strategic decisions.
- Bargaining can lead to efficient outcomes.
- Sest strategy in most auctions is to bid your valuation, but it may be useful to shade bids to avoid the Winner's Curse.