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Abstract

In this classroom exercise, instructors use the NCAA basketball tournament to help teach important concepts in auction theory, risk management, and portfolio theory. Students represent different athletic apparel companies vying for the sponsorship rights to NCAA tournament teams. Each NCAA team places its sponsorship rights on the auction block. The value of these rights is determined by exposure in the NCAA tournament. Risk management is examined by allowing students to diversify their portfolios by buying and selling full or partial shares of the sponsorship rights. The exercise simulates the many phenomena associated with auctions of commodities with unknown values.

KEYWORDS: classroom game, auction theory, risk management, portfolio theory, expected values, sports

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Introduction

Each spring, the NCAA basketball tournament brings March Madness onto campuses across the United States. Using the *March Madness in the Classroom* exercise described in this paper, instructors can channel the energy from the tournament into their classroom to help teach important concepts in auction theory, risk management, and portfolio theory.

In the exercise, students represent different athletic apparel companies vying for the sponsorship rights to NCAA tournament teams. Each NCAA team puts their sponsorship rights on the auction block individually, and the student with the highest bid wins the rights to that team. The value of each sponsorship right is determined by the exposure a team achieves in the NCAA tournament. The longer a team stays in the tournament, the more valuable the sponsorship. Before the tournament begins, students calculate their a priori expected utility of each team to determine their bid valuations in the ensuing auctions. Instructors may use a sealed bid auction, an open outcry auction, or a combination of both auction designs. Risk management is examined by allowing students to diversify their portfolios by buying and selling full or partial shares of their sponsorship rights.

The exercise simulates the many phenomena associated with auctions of commodities with unknown values, and the exercise provides students with numerous learning opportunities. Students experience first-hand the mechanics of an auction that is like oil lease auctions and the Federal Communication Commission's spectrum auctions. Students perform a very intricate calculation of the expected value of each tournament team using spreadsheet software. Students determine their attitude toward risk as they transform risk neutral expected values into maximum valuations for bidding in an auction. Students learn how to bid in different auction formats and understand the effects of learning and competition in an open outcry auction. Students experience the winner's curse, and they manage risk by diversifying their portfolio of sponsorships.

Literature

The literature is rich with uses of classroom games and experiments to enhance learning in the business, economics, and industrial organization classroom. Becker and Watts (1998) and Bergstrom and Miller (1997) provide a wide range of examples. Capra et al. (2000) develop a useful classroom predatory pricing game and survey a series of other classroom games motivated by industrial organization issues. Holt (1996) places students into a pit market trading game to help students discover the laws of supply and demand. Holt and Sherman (1999)

situate students in a specific market problem where buyers and sellers have asymmetric information about product quality. Students experience the *lemons problem* as the sold products have qualities that fall to inefficiently low levels. Gremmen and Potters (1997) provide evidence that classroom experiments do enhance learning. They show that students who participated in classroom simulations exhibited increased performance on various learning outcome measures.

Auctions are also used in the classroom to facilitate learning. Bernard and Shulze (2000) construct an exercise that uses a computerized, multiple-unit English auction in a market with many sellers and a single buyer. Students learn how marginal cost is connected to the supply curve and the efficiency of competitive markets. Swanton (1999) uses an auction exercise to teach students how interest rates affect the equilibrium in credit markets. Estenson (1994) uses an auction exercise to have students experience the declining price phenomenon in auctions in which a similar item will be sold for more at the beginning of an auction than at the end of an auction.

The March Madness in the Classroom exercise continues this trend of success in using simulations to enhance learning in the classroom. The exercise provides students with numerous opportunities for learning auction theory, risk management, and portfolio management. Unlike many of the simulations described above, the March Madness in the Classroom exercise is conducted over a number of weeks providing students with many chances to retain learning.

Pre-game Warm-ups

Auction Theory and Risk Management Class Discussion

To get the most benefit out of the exercise, instructors should ensure that their students are familiar with a number of auction and risk management concepts. Samuelson and Marks (2006) is a good reference. If the following concepts were not previously discussed, the instructor may elect to spend a one-hour class session reviewing these topics.

The *winner's curse* occurs when the winner of an auction for a commodity with unknown value is the bidder who has the highest estimated value of the good. The winner overestimates the value and then overpays in the auction. Bidders should significantly shade their bids to ensure that if they are the highest estimator of value, they do not overpay. Before the March Madness in the Classroom auction, an instructor can discuss the winner's curse using a Jar of Pennies auction. The instructor brings in a jar of pennies and asks students to estimate the number of pennies in the jar. The instructor then allows students to

bid on the jar (using a sealed bid or an open outcry format). Invariably, the student who wins the auction has overestimated the number of pennies in the jar and spends more than the jar's value.

The *auction design* has an impact on the results of the exercise. Any auction design may be used in the March Madness in the Classroom exercise. An instructor may elect to split the field of NCAA teams to use more than one design, so students may compare and contrast the different formats. An instructor should discuss bidding strategies in a first-price open outcry auction, a first-price sealed bid auction, and a second-price sealed bid (Vickrey) auction. It may also help if students are familiar with how their bidding strategies change when valuations are common or private and known or unknown. In the March Madness in the Classroom auctions bidders' valuations are private and unknown.

Each student's *attitude toward risk* will affect how they bid in the exercise. As explained in the next section, a student's estimation of an NCAA team's sponsorship value is based on the student's privately constructed matrix of probabilities that shows the chance every team has to win against every other team. Each team's estimated value is the average payout the student can expect if the tournament is played an infinite number of times. Only a risk neutral bidder can examine this expected value and compare it with a guaranteed payout of the same value. An instructor may discuss attitudes toward risk before the auction to ensure that students properly interpret their expected values.

Students will have the opportunity to study *risk management* while participating in the exercise. In the auction individual students purchase full sponsorship rights to NCAA teams in the tournament. Once the auction is complete, students may sell these rights in full or partial shares at any time during the tournament. The spreadsheet included with this paper calculates the utility a bidder assigns to each team in the tournament assuming that each team is evaluated independently. However, the number of teams in the students' portfolio may affect the utility realized from one team. The spreadsheet does not update utilities based on a student's entire portfolio.

The students' utilities for the teams will also change as the tournament progresses and stronger teams are upset. The spreadsheet included with the exercise can easily be adapted to update utilities as the tournament progresses. A market often develops as students buy and sell their positions on teams.

Before the auction, students may consider working in a group. It is up to the instructor to encourage students to do this or to observe whether they do it on their own. One member of a group may purchase a team and then sell partial shares to the rest of the group after the auction. This practice may limit the group's risk and it may keep bid prices lower as there is less competition for sponsorships.

Calculating the Expected Values Class Discussion

Before the auction, students compute their own expected values of all sixty-four teams in the tournament. Because the calculations are intricate, it may be necessary for the instructor to spend a one hour class on this topic. Students estimate the potential returns from each team so they may determine their maximum bid for each team in the ensuing auction. The students' objective is to make the most profit. Students may buy the rights to as many teams as they like and they have no budget limit. When a student wins an auction, the bid is paid to the NCAA team for the sponsorship right (this is the student's cost). The student makes a profit when the actual sponsorship value (determined by success in the tournament) is greater than the bid amount paid to the team. The NCAA basketball tournament (both men and women) invites sixty-four teams to play, so each team can play up to six games.

The payout structure for the March Madness in the Classroom exercise is as follows:

- The thirty-two teams that win their first-round game provide \$10,000 in sponsorship value to their apparel company. (The thirty-two teams that initially lose do not provide any value to their sponsoring company.)
- The teams that win their second game to reach the "sweet sixteen" provide an additional \$20,000 in sponsorship value (\$30,000 total).
- The teams that win their third game to reach the "elite eight" provide an additional \$25,000 in sponsorship value (\$55,000 total).
- The teams that win their fourth game to reach the "final four" provide an additional \$50,000 in sponsorship value (\$105,000 total).
- The teams that win their fifth game to reach the championship final game provide an additional \$75,000 in sponsorship value (\$180,000 total).
- The team that wins its sixth game and is crowned the "NCAA champion" provides an additional \$100,000 in sponsorship value (\$280,000 total).

To calculate the expected value of a particular team in the tournament, it is necessary to determine (a) the probability that the team will reach an additional round in the tournament, (b) the probability the team will face a particular opponent, and (c) the probability the team will beat the opponent. Conceivably, a team could end up playing any of the other sixty-three teams in the tournament, so it is necessary for the student to consider the probability, $p_{i,j}$, that team i will beat opponent j for all possible i and j . To simplify the mathematics, it is helpful

to also define the probability, q_i^r , to represent the probability team i wins round r in the tournament.

Equation 1 displays an example of the expected sponsorship value (EV) of a team identified as team one. The numbers of the other teams in this example do not represent the seeding in a tournament. Team 1 plays team 2 in the first round; if team 1 wins it plays the winner of team 3 versus team 4 in the second round; if team 1 wins the second round it plays either team 5, 6, 7, or 8 in the third round; etc.

$$\begin{aligned} \text{EV} = & q_1^1 * \$10,000 + q_1^2 * \$20,000 + q_1^3 * \$25,000 + q_1^4 * \$50,000 + \\ & q_1^5 * \$75,000 + q_1^6 * \$100,000, \end{aligned} \quad (1)$$

where $q_1^1 = p_{1,2}$,

$$q_1^2 = q_1^1 (p_{3,4} p_{1,3} + p_{4,3} p_{1,4}),$$

$$q_1^3 = q_1^2 (q_5^2 p_{1,5} + q_6^2 p_{1,6} + q_7^2 p_{1,7} + q_8^2 p_{1,8}),$$

$$q_1^4 = q_1^3 \left(\sum_{j=9}^{16} q_j^3 p_{1,j} \right),$$

$$q_1^5 = q_1^4 \left(\sum_{j=17}^{32} q_j^4 p_{1,j} \right), \text{ and}$$

$$q_1^6 = q_1^5 \left(\sum_{j=33}^{64} q_j^5 p_{1,j} \right).$$

Calculating the expected value for each team in the tournament appears to be a daunting task, yet using a spreadsheet package like Microsoft Excel can significantly ease the process. An Excel spreadsheet is included with this paper, *MarchMadness.xls*, that automatically calculates each team's expected value once students enter their own probabilities for every $p_{i,j}$. The expected values are useful to a risk neutral bidder who can examine this expected value and compare it with a guaranteed payout of the same value. Because bidders are likely to be risk averse, the spreadsheet also displays the probability each team will attain a particular payoff. The spreadsheet allows the student to determine a risk coefficient to adjust the risk neutral expected values based on the student's personal attitude toward risk.

Spreadsheet Homework Assignment

The instructor may assign students to create a spreadsheet to estimate the potential returns from each tournament team so they may determine their maximum bid in the auctions. In the assignment sheet provided with this paper, students create an eight-team tournament spreadsheet. The instructor may choose to have the students create a spreadsheet for a tournament of any size. (The NCAA basketball tournament invites sixty-four teams to play, and the sixty-four team spreadsheet included with this paper may be provided to students before the auctions.)

In an eight team tournament, sponsorship values are determined by a team's success in the tournament:

- The four teams that win their first-round game provide \$10,000 in sponsorship value to their apparel company. (The four teams that initially lose do not provide any value to their sponsoring company.)
- The two teams that win their second game provide an additional \$20,000 in sponsorship value (\$30,000 total).
- The team that wins the championship (and the third game) receives an additional \$25,000 in sponsorship value (\$55,000 total).

Equation 2 displays the expected sponsorship value of a team identified as Team one. Team one plays team eight in the first round; if team one wins it plays the winner of team four versus team five in the second round; if team one wins the second round it plays either team three, six, seven, or two in the third round.

$$EV = q_1^1 * \$10,000 + q_1^2 * \$20,000 + q_1^3 * \$25,000 \quad (2)$$

where $q_1^1 = p_{1,8}$,

$$q_1^2 = q_1^1(p_{4,5}p_{1,4} + p_{5,4}p_{1,5}), \text{ and}$$

$$q_1^3 = q_1^2(q_3^2p_{1,3} + q_6^2p_{1,6} + q_7^2p_{1,7} + q_2^2p_{1,2}).$$

Students develop a spreadsheet for an eight team tournament. The Excel workbook has three sheets.

Sheet 1: Probability Entry Sheet. This sheet has the probability entry matrix for all eight teams in the tournament. The spreadsheet has an entry for the probability that team eight beats team one (for example), and the probability that team one beats team eight is a calculation. The only place for data entry in the workbook is on this sheet. Only half of the probability matrix is entered – the other half is automatically calculated.

Sheet 2: Expected Values Sheet. This sheet will calculate q_i^r for each team for each round. Teams are placed in rows and each of the three rounds is placed in a column. A final column is used to calculate the sum of the three rounds and each team's expected value.

Sheet 3: Probability of Payoff Sheet. This sheet calculates the probabilities that each team receives of each of the four possible payoffs for the eight team tournament. A team can win \$0, \$10000, \$30000, or \$55000. Teams are placed in rows and each of the four rounds is placed in a column.

- $P_i(\$0) = 1 - q_i^1$
- $P_i(\$10000) = q_i^1 - q_i^2$
- $P_i(\$30000) = q_i^2 - q_i^3$
- $P_i(\$55000) = q_i^3$

Sheet 4: Expected Values adjusted for Attitude toward Risk . This sheet adjusts the expected values from Sheet 2 according to the function, EV^a , where a represents the coefficient of risk. The value of a is greater than zero. When a is equal to one, the student is risk neutral. When a is less than one, the student is risk averse. The closer a is to zero, the more risk averse is the student. When a is greater than one, the student is risk loving. The higher the value of a , the more risk loving the student is.

The Big Game

The auction exercise takes a one hour class to administer. The instructor may choose the type or types of auctions to sell the sponsorship rights of the sixty-four tournament teams. The instructor may choose to sell each of the sponsorships twice - once in a sealed bid auction and then again in an open outcry auction. The instructor may also choose to auction off half of the teams with an open outcry auction and the other half with a sealed bid auction. If two separate sponsorship auctions are conducted, the class can discuss comparisons between the different auction designs.

Students represent athletic apparel companies that bid on sponsorship rights for individual teams in the tournament. Each student represents his or her own company, although they may share their rights with other students to reduce risk. Students use their risk adjusted expected value calculations to assist with bidding. The students' profits are the actual sponsorship value (determined by success in the tournament) minus the bid amount paid in the auction. The students' objective is to make the most profit. Some spend a lot of money on one team while others purchase many teams for small amounts. Students may opt to

not bid as well. How students manage risk is an excellent follow-up discussion in the class following the auction.

If two different auctions are used, the instructor may wish to proceed in the following manner. Beginning the Monday morning after the tournament teams are selected, students may enter a sealed bid to purchase sponsorship rights for any team. The sealed bid auction ends at the start of the open outcry auction (typically held on Wednesday or Thursday morning), so no bidders learn anything about the valuations of other bidders during the sealed bid auction. The results of the sealed bid auction are not announced until after the open outcry auction ends.

The second auction is conducted in an open outcry format and is held during one class period (50-60 minutes). Students take turns placing a team on the block (in any order) by announcing an initial bid for a team still available. In the open outcry format every student has an opportunity to win the sponsorship contract by being the highest bidder.

Once the auctions are complete, the students may buy or sell their sponsorship rights to other students at any time during the tournament. There is no limit to the amount that the rights may be sold for later in the tournament. As the tournament progresses, students recalculate their expected values of the remaining teams as additional information is received.

Post-Game Interviews and Analysis

While the results of the March Madness in the Classroom exercise can be easily followed outside of the classroom, it is useful to have a one hour follow-up discussion with the class. The spreadsheet, *MarchMadnessResults.xls*, may be used to keep a record of the students' progress.

There are a number of learning points that are useful to discuss after the auctions ended: Is there a winner's curse? How did students manage risk? What were students' attitudes toward risk during the exercise? Was there a significant difference in bid prices based on the type of auction used? What bidding strategies did students employ? How did these strategies change from one auction design to another?

When the March Madness in the Classroom Exercise is conducted at Mount Saint Mary's University, the winner's curse tends to result when the students participating in the exercise are less risk averse. Typically, the winner of a sponsorship right overestimates its value and overpays in the auction. In a class conducted in 2004, two auctions were conducted in one class. In an open outcry auction, bids totaled \$3,939,150 while the total payout was only \$1,290,000. Only five out of twenty-one students made a profit. The students shaded their bids to some extent in the sealed bid auction, but the bids still totaled \$2,511,219. Only four students in the sealed bid auction made a profit. In a class conducted in

2005, the bidders claimed to be much more risk averse. As a group they still overspent, but they each overpaid by less than \$200,000.

An open outcry auction may generate higher bid prices than a sealed bid auction as bidders have an opportunity to learn the expected valuations of the other bidders. Competition between bidders may drive prices up further. Conducting two auctions using different formats (sealed bid versus open outcry) will allow students to experience the differences first hand.

In the previously cited example the bids in the open outcry auction totaled \$3,939,150 while the bids in the sealed bid auction totaled \$2,511,219. The difference between the two (\$1,427,931) occurred as a result of competition between the students as they bid for sponsorship rights. For example, Duke University sold its sponsorship rights for \$240,000 in the open outcry auction and \$148,000 in the sealed bid auction. Competition drove up the price \$92,000. However, bidders also learned how others students valued Duke as the auction progressed. The winning bidder in the sealed bid auction had a pre-auction expected value of \$157,348. The winner in the open outcry auction, however, had a pre-auction expected value of \$81,256. In the open outcry auction, the eventual winning bidder learned that another bidder valued Duke at least \$76,092 more. Certainly students realized that the open outcry auction format will generate more revenue for a seller with a group of irrationally exuberant bidders.

The strategies students employ during the auctions also provides rich discussion. If a second-price sealed bid (Vickrey) auction is used, students learn that their optimal strategy is to bid their valuation. Invariably, one student admits to bidding the most a team can earn (\$280,000) on a favorite team. The high bid assures that the student will get the team and pay the second highest bid. As long as there is no other irrational bidder, the strategy works. However, it typically ends up that the second highest bidder also bids an unusually high amount and foils the strategy.

Students also discuss employing strategies in an open outcry auction that Estenson (1994) describes in his simulation: bumping, dumping, and holding out. Students bid on teams they do not want in the hopes of *bumping* up the amount other students pay. This strategy forces other students to pay more for teams initially, and although students do not have a maximum budget, they become hesitant to bid later in the auction. For similar reasons, students will also employ the *dumping* strategy. They will place a team on the block that they do not want, so other students will bid on the team. This will force another student to buy the team and make them less likely to bid on another team later in the auction. The last strategy is simply *holding out*. Some students simply do not bid early in the auction when there are numerous students bidding. Although there is no limit to the number of teams a student may purchase, many students do stop purchasing once they feel they have enough teams. If these strategies are employed

successfully, the relative prices of teams may decline as the open outcry auction progresses.

March Madness All Year Long: A Variant of the Exercise for Other Months

An instructor can create a "fantasy tournament" using another sport. For example during the fall semester, the National Football League (NFL) may be used to create a fantasy tournament with NFL quarterbacks. This is a 32 quarterback tournament conducted over a period of 5 weeks. The instructor sets up the tournament pairings. The first week, there are sixteen match-ups, and the second week, there will be eight match-ups, etc. A contest is decided between two quarterbacks by using their statistics from their actual NFL game on a particular Sunday. (The beauty of the fantasy scoring is that the quarterbacks do not have to actually be playing each other in a real game.) Students calculate their expected values and participate in an auction to buy sponsorship rights for the quarterbacks in the same manner as the NCAA tournament.

Calculation of Fantasy Points Scored for Quarterbacks

- 6 points per touchdown
- 1 point per carry/rush
- 1 point per completion
- 1 point per 10 rushing yards (+3 bonus points if ≥ 100 yards)
- 1 point per 20 passing yards (+3 bonus points if ≥ 300 yards)
- -5 points per interception

Using the NCAA basketball tournament as a vehicle for learning is very rewarding for students. The exercise incorporates a sophisticated spreadsheet analysis and teaches auction theory, risk management, and portfolio diversification. A little extra madness in March, or any time of year, is never a bad idea.

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