Real Options Applied to Consumer Goods: Maximizing Profits and Fan Welfare

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ABSTRACT

The use of pre-sale options for tickets is underutilized in sports. In this study, we show that the use of pre-sale options increases profits, but also increases consumer utility – making both parties better off. Thus, the efficiency gains and profit gains make incorporating options with advanced selling, as opposed to just advanced selling, an optimal strategy. Through this ticket pricing strategy, the organizer can realize a significant increase in profits from a separating equilibrium pricing strategy while simultaneously consumer welfare increases as fans know, with certainty, they have tickets to the game if their team participates. If these options were offered by participants instead of the organizer it also allows the participant to smooth their revenues over time.

Keywords: option pricing, pricing under uncertainty, event tickets, consumer options

JEL Classification Code: G13 - Contingent Pricing; Futures Pricing & Z23 Sports Economics - Finance

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I. Introduction

Financial options allow a company or individual to manage their risk (or take more risk). The use of options, when applied to consumer goods, can be used to increase profits and/or consumer welfare (utility). This study demonstrates that both fan utility and firm/league profits can be increased for any event where participants are unknown and, ideally, the competition is played at a designed site, i.e. a neutral site. This option model can be applied to many different neutral-site sporting events where the participants are unknown in advance, such as the Olympics, the FIFA World Cup, the Super Bowl, National Collegiate Athletic Association (NCAA) Football Bowl and playoff games, or any NCAA tournaments (i.e. basketball, hockey, baseball, etc.). These options also work for any other elimination style tournament, such as reality television shows: i.e. American Idol, The Voice, or America's Got Talent. This form of options can also be applied to other forms of consumer goods, such as airline tickets.[2]

Although the applications of this model are numerous, we focus on sporting event applications in this study, as previous research has discussed similar strategies focusing on the sports industry. We suggest that the organizer or teams themselves (which is discussed later in the paper) can utilize an option pricing model for tickets, along with traditional advance selling, to maximize profits by generating a separating equilibrium between two types of fans. Whereas the consumer's utility is also increased relative to an advanced selling strategy. The application of options also allows the event organizer to benefit from the resale of options, transactions that would

[2] The application is not limited to sports, this model can also be utilized for flights and hotels where the travel will occur if a given event occurs; their team makes the tournament, if there are no hurricanes at the vacation destination, or just the expectation of a business meeting. Currently Air France and United Airlines allow customers to reserve flight prices at a cost of $7-$20 depending on flight destination and length of option. The option allows the customer to exercise the option for up to seven days, reserving a seat on a specific flight at the fixed price.

normally be transacted in the secondary or black market via scalping.[3] Although the structure of this study assumes the organizer will offer options, if the organizer does not or chooses not to, participants can offer the options themselves. When the participants offer options each year, whether they make the event or not, they can both increase their overall revenue and smooth their revenue stream over time.

Given the rules established by many tournament organizers, participants are left in a unique situation: the organizer dictates that participants must sell tickets at a predetermined price (face value), which is often significantly below the market clearing price. While these participants cannot sell tickets for more than the face value, the organizer's bylaws do not disallow the sale of options before the event occurs. This loophole provides the opportunity for the sale of call options, but, ironically, there is no risk associated with a short call because there is no infinite loss function in this structure. The lack of risk on these short calls is the result of there not being any forgone opportunity cost, as the seller cannot sell these tickets above face value (which, with these high profile events are always worth more than the tickets' face value). The ability to sell a long call without bearing the exposure associated with the short call, provide a unique opportunity to increase profits while increasing fan welfare, and if options are offered by the participants directly it could help them smooth revenue from year to year.

This study provides a model that uses options as a profit enhancement strategy in tournament ticket markets, with the beneficial side effect of also increasing consumer welfare. We expand upon previous work on consumer options in ticket pricing, which was established by Happel and Jennings (2002) and Sainam et al. (2010).

[3] Scalping has become more common and tolerated. The creation of StubHub and other exchanges, some through the leagues and teams, where sellers can link with buyers for a fee has also created a new dimension to the secondary market.

We contribute to the literature in two specific ways. First, we use a traditional option approach that involves options which do not always end up in the money, while previous literature uses an option strategy that is always exercisable. The events that fall into our focus are typically the highest and, in many cases, the most sought-after tickets. Thus, any option that is exercisable will be exercised even if the option holder has zero interest in attending the game because it can always be sold at a higher price on the secondary market. This results from the high demand for these tickets and the limited supply which allows the option holder to exercise the option and sell the tickets at a premium. Our approach allows more options to be sold as only those options that have a given team in the game can be exercised, allowing options to be written on all teams, even those with a small chance of qualifying for the given game. An added side effect of this strategy is the options will be exercised by fans that are interested in attending the event. Secondly, by using options and advance selling together our model generates a separating equilibrium. This allows an organizer to differentiate between the types of fans, game-based fans and team-based fans; allowing the organizer to increase his revenue while increasing the fan's utility.

II. Implementing Options in Tournaments

Although tickets exist for the organizer, sponsors, media, game officials, future tournament hosts, and participants; we focus on the distribution by the organizer to the fans, i.e. the general public, and touch upon the implications of allowing participants to issue options themselves. In traditional option underwriting the short position, in this case the organizer or participant bears the risk of the option expiring "in-the-money." However, given league/tournament rules, there is no downside risk to the short position, the seller, because they cannot sell the tickets above the face value, even though the ticket's market value is well above the face value.

The fan is buying the option to have the right to purchase a ticket to a specified event.[4] If the team (participant) competes in the event, then the option can be exercised. Since the tickets can be sold on the secondary market for more than the face value, the payoff function is positive even when the holder of the option has no value in attending the event. This allows for more liquidity by allowing speculators into the market. If the designated participant does not qualify for the event the option is not exercisable and expires worthless.

While the concept of using options to sell tickets may seem new and too complicated for consumers, there have been several websites in the past and one current website that offer some type of derivative on sporting events.[5] OptionIt.com, which has recently folded, offered individuals the opportunity to buy a ticket to a specified regular season or playoff game for a specific professional and college team via options. The second website, operated by TTR Inc, called TicektReserve.com, which too has recently folded, used another derivative that employs a novel pricing technique. TTR defines the derivative offered as a future contract for March Madness and Rose Bowl tickets. CFP-RSVP is the latest to offer a derivative-based pricing strategy for sporting events, they do it by offering futures contracts for a ticket to the BCS National Championship if the team makes it.[6]

III. Literature Review

Advance Selling

[4] The organizer or participant could offer options for each round before the semifinals but for many tournaments, this adds one more component of uncertainty, the location of the game. The uncertainty of location may make certain destinations more desirable depending on their proximity to the buyer's home or the other activities the site (city) has to offer.

[5] One reason on why these websites may have folded is because it is difficult to get buy-in from the teams. This is why we believe an organizer offered option would be best, it would eliminate this problem.

[6] See https://cfp-rsvp.com/home.

Advance selling occurs when sellers allow buyers to purchase a game ticket preceding consumption, the most common way to buy sporting event tickets. This mode of selling tickets presents issues for buyers since they must incur the uncertainty about future valuation (via the quality of matchup, the fans' ability to attend, the weather, traveling, or other distractions). In tournaments, Xie and Shugan (2003) and Shugan and Xie (2004) show that profits from advance-selling do not result from buyer surplus, but from more buyers purchasing in advance due to uncertainty, which occurs due to the large number of different teams that could partake in the tournament. This results in team-based fans for each of the possible teams being interested in the tickets when they are initially sold. This increases the number of people interested in attending the game compared to when teams are predetermined, leaving only the participating teams' fans interested in attending the game.

Xie and Shugan (2003) also show that a capacity constraint has conflicting effects on the profitability of advanced selling. First, it allows buyers to believe the price will rise in the future as the number of available seats decreases. Second, a capacity constraint reduces the need for advanced sales because of the natural limitation on the number of seats. Additional studies have looked at the impact of resale (i.e. scalping) on sellers' profits when analyzing advance selling (see Courty, 2003 and Depken, 2007).

Consumer Options

Sainam et al. (2010) create a ticket pricing strategy that entails consumer options, which can always be exercised for a ticket to the semifinals, commonly referred to as the Final Four, of March Madness, also known as the NCAA's basketball tournament. It is important to emphasize their options are always exercisable, which is one of the constraints we relax in this study. These authors recognize two types of basketball fans: team-based fans, who only desire to attend the Final Four

if "their" team participates, and game-based fans, who attend regardless of who plays but still have a premium when their favorite team plays. Sainam et al. (2010) show that as long as the expected valuation of the team-based fan (EV_T) for the Final Four game is less than the expected value of the game-based fan (EV_G), the league can utilize consumer options to induce different behaviors from the two fans and obtain higher profits from consumer options than from advance selling. These authors find that consumer surplus, on average, increases with consumer option pricing (relative to advance selling pricing), resulting in consumer options leading to a win-win situation.

Cui et al. (2013) demonstrate that ticket options allow organizers to generate higher profits and reduce scalping, relative to advance selling at a fixed price, using hard tickets or paperless tickets.[7] We expand these previous studies by developing a pricing strategy that uses both advanced selling and traditional options to differentiate between game-based and team-based fans. Our strategy will lead the organizer to extract larger profits while also increasing fan utility. In addition, our pricing strategy allows for more team-based fans to attend when their utility is high.

IV. The Separating Equilibrium Pricing Strategy

Given the many potential applications of real options in consumer goods, we focus the examples in this study on the semifinals of a tournament (specifically March Madness), but know the general model structured here has many additional applications. This structure allows for a direct comparison to Sainam et al. (2010) findings.

Ultimately in all sports there are two types of fans; team-based fans and game-based fans. Team-based fans gain utility if their team makes the game, otherwise their utility is zero. Game-based fans are interested in watching a great game (i.e. a game between two high quality teams)

[7] Paperless tickets have been utilized and discussed in the literature to reduce speculators, i.e. scalpers, from entering the market.

and are not necessarily interested in a specific team playing. It is possible for game-based fans to have a higher utility from watching a specific team play; however this does not impact our findings.

Assumptions

To develop this pricing technique, we need to clarify a few assumptions. While many of the assumptions may seem obvious or intuitive it is important that we lay the foundation for our strategy. First, we assume the expected value to the game-based fan (EV_G) is larger than the expected value to the team-based fan (EV_T) attending the game, $EV_T < EV_G$. This assumption is consistent with expectations, since game-based fans have a value of attending regardless of who plays, but can also have a higher value for when their favorite team plays. In comparison, team-based fans only have value of attending when their favorite team plays, and a value of zero, or near zero value, otherwise. The only possible way a team-based fan's expected utility of attending a game can be higher than a game-based fan's expected utility is when two things occur simultaneously: 1) the team-based fan has a high utility of attending when his favorite team plays and 2) this team has a high probability of playing in the semifinals.[8]

Second, the team-based fan's willingness to pay for a game involving his favorite team (U_{Ti}^{+}) is assumed to be greater than the expected value of the game-based fan (i.e. $U_{Ti}^{+} > EV_G$), which holds for all teams. Where utility for a fan, *U*, has a subscript *T* indicating a team-based fan and subscript *G* indicating a game-based fan. If the fan's favorite team is playing in the game it is noted by a subscript +, otherwise it is noted by a subscript -. A summary of these variables is presented in Table 1.

[Table 1]

[8] This also assumes that game-based fans do not have as high a utility as team-based fans when there designated team plays.

Third, assume there are team-based fans, N_T, for all potential participants in the tournament. This assumption is reasonable since all sports teams have a strong fan base and Sainam et al. (2010) notes that 90% of their survey respondents list their home university (i.e. their alma mater) as their favorite team in the Men's NCAA Division I (DI) basketball tournament. For international play this implies most team-based fans are fans of their home country. It can be extended that fans prefer the participant that they have the strongest connection to, in many cases a geographic preference.[9]

The fourth assumption is that the number of game-based fans, N_G, is at least equal to the total number of tickets made available to the team-based fans of the participating teams. This assumption simplifies the model, but can easily be relaxed to end up closer to the extreme cases of all advance sales or only selling options. The organizer can also change this assumption to increase the number of game-based fans or team-based fans in attendance. To put this in perspective, most semifinals are played in large stadiums that can hold at least 50,000 plus attendees. As a result, we propose that the organizer sells 20,000 tickets to the general public allowing the remaining tickets to be provided to sponsors, the media, organizer executives, and the participants. For simplicity, assume half of the 20,000 tickets would be sold via advance selling while the other half would be sold via options. Hence, under this situation, there needs to be at least 10,000 team-based fans in total. Since there are four teams in the semifinals and many sporting events sell one ticket to both semifinal games, 2,500 options can be sold on each team, requiring the N_T for each team to be 2,500. Given the demand for attendance to these highly sought after semifinals, these assumptions are not restrictive.[10]

[9] In the next section when we discuss valuing the options, we are able to relax this assumption.
[10] With the market value of a ticket exceeding the face value every year for many semifinal matchups, the reduction or elimination, of the constraint on the number of game-based or team-based fans is not a restrictive aspect to this model.

The Proposed Model – Team Options and Advanced Selling

The proposed model does not ignore any fans and provides a ticket opportunity for all interested fans, which separates our work from the previous literature. Restricting the options in this model to only be in-the-money if the designated team makes the Final Four, otherwise the option is worthless, allows this opportunity to occur. In our pricing strategy there needs to be a price for tickets sold via advanced selling (P_{AS}), a price for each team's option (P_{Oi}), and an exercise price for each team option (P_E). Regardless of which team the option is purchased for, all options will have the same P_E. This occurs because all tickets are required to be sold at face value. It is important to note that some teams are going to have a low probability of making the semifinals (γ_i), but all teams have a positive γ_i, even if some γ_i are close to zero.

For simplicity, we can utilize betting markets in many cases to calculate the probability, γ_i, for each team. Many betting markets offer wagers on different teams making it to a championship game or in many cases divisional championships or semifinals, or even making the playoffs or tournament. For these lines, it is common that lines are offered for each team unless the pool of teams is too large, then the top contenders have individual lines offered with the remainder of the contenders being offered as "the field." Thus, we follow this assumption and offer options for top contenders with an option for the rest of the field if needed.[11] This means if you purchase an option for the field, your option is in-the-money and can be exercised for a ticket to the semifinals as long as one of the teams without a line makes it.[12] For a discussion of converting betting lines into probabilities see Berkowitz, Depken, and Gandar (2018).

The expected utility of each team-based fan (EV_{Ti}) is:

[11] Simplifying assumption: It is feasible to generate an option for each team.

[12] This allows for the assumption of N_T to be reduced for those teams that are not major contenders. Additionally this allows some investors to have an option in the money when their utility is zero. When this is the case they could allow the option to expire or more likely sell the option to someone who wants to attend.

$$EV_{Ti} = \gamma_i U_{Ti}^{+} \quad (1)$$

where U_{Ti}^{+} is the fans utility of attending the game if their team plays. Note that the fans utility of attending the game if his team does not play (U_{Ti}^{-}), is zero.[13] Also, $\sum_{i=1}^{n} \gamma_i = 4$ as four teams participate in the semifinals.[14]

For game-based fans their expected utility (EV_G) is:

$$EV_G = U_G \quad (2)$$

As a game-based fan, the same utility is obtained regardless of who plays.[15]

Now that we know each fan's expected value the price of each option (P_{Oi}) and exercise price (P_E) can be put into the following equation.

$$P_{Oi} + \gamma_i \times P_E = EV_{Ti} = \gamma_i U_{Ti}^{+} \quad (3)$$

This holds for all team-based fans. As a result, we have an equation for each of the top teams plus one for the field, each with a similar equation, but with different probabilities of making the semifinals.

Now we derive the separating equilibrium prices. If we set P_{AS} equal to EV_G, then the game-based fan will buy the ticket in advance. However, since the team-based fans have lower expected utility (EV_{Ti}), one of our assumptions, they will not buy the ticket in advance. Additionally, because the exercise price of all options is set by the NCAA, it will be set equal to the advanced selling price, and thus equal to EV_G.

$$P_{AS} = P_E = EV_G \quad (4)$$

[13] The value of U_{Ti}^{-} can be above zero, but still relatively small if the fan receives a small amount of utility from the game even if their favorite team is not playing.
[14] By making the simplification of only offering an option on the top contenders and one for the rest of the field.
[15] If the game-based fan has a higher utility for a specific team the expected value of the game-based fan will be $EV_G = \gamma_i U_G^{+} + (1 - \gamma_i) \times U_G^{-}$, where U_G^{+} is the utility the game based fan receives for attending a game with his favorite team and U_G^{-} is the utility he receives from attending a game where his favorite team is not playing.

Since the purchase of the option requires a fee to be paid up front, P_{Oi}, as well as the exercise price, P_E, which by design combines to be more than EV_G the game-based fan is priced out of the option market.

Given that game-based fans only buy tickets via advance selling; only team-based fans will buy options absent any arbitrage opportunity in the secondary market for tickets. With the market-value of the ticket above the face-value of the ticket, the option value when exercised will be positive and the difference between the market-value and face-value.

With team-based fans deriving utility from seeing their team playing, team-based fans only buy an option for their favorite team and will do so as the cost of the option, P_{Oi}, is below EV_{Ti}. All team-based fans will exercise their option since P_E is less than their expected utility when their favorite team plays in the semifinals. Now the only question that remains is: what is the price of each option? By plugging in EV_G for P_E the option prices (P_{Oi}) can now be solved using the following equations:

$$P_{Oi} = \gamma_i \times [U_{Ti}^{+} - EV_G] \quad (5)$$

With these prices the strategy would result in the following profit for the NCAA:

$$\pi^{*} = 20{,}000 \times EV_G + 10{,}000 \times \sum_{i=1}^{n} \gamma_i \times [U_{Ti}^{+} - EV_G] \quad (6)$$

By comparing the profits from Sainam et al. (2010) consumer option is:

$$\pi_S^{*} = 20{,}000 \times EV_G + 10{,}000 \times \gamma_{10} \times [U_{T10K}^{+} - EV_G] \quad (7)$$

Where U_{T10K}^{+} is the utility of the team-based fan who has the 10,000th highest EV_{Ti} and γ_{10K} represents the probability of the fan's team making the Final Four. Additionally, under the current advance selling strategy the profits are:

$$\pi_{AS}^{*} = 20{,}000 \times EV_G \quad (8)$$

It becomes clear that our separating equilibrium pricing strategy would allow the organizer to not only provide more fans with an opportunity to attend the game, but also allows the organizer to generate higher profits.

Allowing the options to become worthless provides the organizer the opportunity to sell options to team-based fans for each of the top teams plus the field, or for every team, and also results in a higher proportion of team-based fans attending the semifinals enabling them to see their favorite team play. This not only increases the organizer's revenue from ticket sales but also has the potential to create a better environment for the games, as more of each teams' fans are in attendance, creating a more energetic crowd. Given this pricing technique, it allows all the teams to have a large cheering section at the game, which can add more value to both teams and the fans.[16]

This also allows for a potential increase in overall utility for the fans. Before the teams are decided, fans of every team, through the purchase of these options, know they have tickets if their team makes it.

V. Valuing the Options

First and foremost, the use of real options allows more team-based fans the opportunity to obtain a ticket than through the traditional advance selling technique, or through a consumer option strategy where the option is always exercisable. Allowing more team-based fans the opportunity to attend the games when their favorite teams are competing would enhance the experience for all in attendance. As mentioned, if fans enjoy having more of their fans in attendance rooting for their

[16] Sainam et al. (2010, pg 411) argue "fans are likely to derive some positive externality from the presence of additional team-based fans." This is also why organizers have started to host student sections at the biggest games.

team alongside them, which occurs under this pricing strategy, then providing options can increase expected value, which, in turn, increases the value of the option. Fan welfare also increases as each fan knows they have a guaranteed ticket for the game if their team makes it and will be in a section with others cheering on their team.

Additionally, this pricing strategy reduces the probability of scalping by allowing team-based fans to purchase tickets through the option market, rather than on the secondary market after the teams are determined. Before the teams are set, each option will have a different price; based on a given team's odds of making the game. However, once all four teams are determined for the semifinal, each option will sell for the same price: the market value minus the face value. If this does not occur an arbitrage opportunity exists, anyone who wants to attend the tournament could buy an option with any of the four teams as the underlying and exercise the option and receive a ticket to the tournament.[17] This could allow a legal way for fans to sell their ticket, through the sale of their option. This also provides a profit opportunity for the organizer, if they act like a broker, by charging a transaction cost per trade, similar to brokers buying/selling financial derivatives. Then the organizer would benefit from each transaction that otherwise would have resulted in scalping.

Potential scalpers and speculators would also be able to purchase these options, which would increase the liquidity of the market and drive up any underpriced markets. Since speculators add liquidity to the market, as they do in financial markets, they will benefit the option market on the whole. As a result, it can be viewed that if speculators remain in the market they add value to the market by offering the market liquidity and make sure fair prices are being offered.

[17] Assuming the value of sitting in any one teams section is equal to any other section.

This part of the structure also provides the price of each option. Through the Efficient Market Hypothesis (Fama and French, 1996), the price of the option cannot exceed the amount that one would have to bet in order to receive a payoff great enough to buy the tickets at market price when the games occur. Thus, the price of the option is a function on the odds of a team making it that far in the tournament, which is a simple conversion of the money line (see Berkowitz, Depken, and Gandar, 2018).

VI. Implementation by the Participants

The use of this pricing strategy can also be expanded to be utilized by the participants themselves. This opportunity would appeal to each individual team if the organizer does not offer the option or if they want to offer options themselves. This strategy may be best demonstrated in the NCAA market where many universities could be interested in offering options to March Madness, the College World Series, and other national championships that are played at neutral sites. For universities and other sporting event participants offering options directly not only allows for an increase in profits, but it also smooth profits over the years, as they can sell options even in years where they do not make the tournament or selected round. Although we structure the model around semifinals, this strategy could be utilized by participants for any round in a tournament (i.e. they can sell options if their team makes the tournament). Given the league/organizer does not allow participants to sell tickets above face value, the sale of these options, which allows the option holder the right to buy the ticket at face value, would increase the participant's revenue. This would also allow participants to smooth their revenues over multiple years, because the options would be sold in years they make the tournament and years they do not; without the potential downside risk of being on the short side of a traditional call option because they do not have a loss function.

From a March Madness prospective, this hedge allows traditional basketball powerhouses, like Duke and the University of North Carolina (at Chapel Hill), to have high option prices every year, because their odds of making the Final Four is relatively high in each year. But it also allows all the other universities to increase their revenue every year. To the extent that fans are risk averse, fans will continue to buy the options, even in years where the odds of making the tournament are low; providing an opportunity for all universities in both good and bad years to increase revenue.

Universities can also increase their revenue and smooth revenues across the years, by offering options to all rounds of the tournament, especially for the beginning rounds. This works for all teams at all levels of DI play, since every DI conference gets one automatic bid to the tournament. Thus, providing most universities a quantifiable chance of making the tournament. Given that automatic bids exist for all conferences, all universities can increase their revenues by selling options to all rounds of the tournament, rather than just Final Four games.

VII. An Empirical Application (Example)

To help visualize our options and their pricing, this section will go through an empirical computation of determining ticket options prices. As we have been using the Final Four in March Madness as our conceptual example – we will continue with this example here. The data that is needed and collected for this example are Final Four betting odds from a bookmaker (we utilize data from DraftKings), historical pricing of resale ticket prices after teams have been announced, and cost (face value of the ticket) of buying a ticket to the event when they go public.

Multiple websites and news articles are analyzed to look at the cheapest and average ticket price for the semi-final and final game.[18] The price is also given for the entirety of the Final Four, as these tickets are sold as a bundle (so the semi-final and final game separation come from the secondary ticket market). We were able to access data pre-pandemic, from 2011-2019, for ticket prices – which is presented in Table 2. The cheapest seat for each year is listed for the semi-final and championship games.[19] The last column lists the average ticket price, on the secondary market, for the National Championship and both Final Four games. Two noticeable things stand out: (1) variation is modest between years, likely the result of various popularity of teams competing each year as well as the location of the Final Four each year, and (2) prices can get very high. The average price of tickets between the Final Four and National Championship is $818.92, and one can see Final Four tickets are more expensive as noted from the cheapest ticket sold and the facts that a ticket to the Final Four lets you watch two games and there are fans from four teams that want seats, compared to the Championship when only one game is played. As a result, it is reasonable to think that the price for a ticket to see the Final Four games could easily hit $1,000.

[Table 2]

The DraftKings betting odds for teams to make it to the 2022 Final Four, commonly referred to as Futures Lines, was collected on July 8, 2021 and reported in Table 2. Berkowitz, Depken, and Gandar (2018) discuss the different approaches for converting betting lines into subjective probabilities and note the standard normal probabilities as preferable as we do not have a favorite-longshot bias in our data. (see Berkowitz, Depken, and Gandar for discussion on the

[18] Although we look at multiple websites, the TicketIQ provides most of these prices with tables of the changes in prices over time (see https://blog.ticketiq.com/blog/cheapest-ncaa-mens-basketball-tournament-tickets).

[19] See TicketIQ

conversion of betting lines into subjective probabilities). Team future lines and the standard normal approach for subjective probability for Final Four are provided in Table 3.

The last two columns in Table 3 are estimated values for each team's option. Note the value of the option is defined in Eq. (5). The only missing piece of the equation is the value of the game-fan or as Eq. (4) notes the strike price of the option which is the same as the face value of the ticket, the price via advance selling. The first approach uses the cheapest sale price, a conservative value of the ticket value resale. This is a conservative value as these tickets are likely sold shortly before game time, single tickets, and/or have another reason these tickets are likely heavily discounted. These tickets are also the cheapest tickets to start with, so the face value is also the lowest face value offered for the game. With a historical average cheapest sales price of $245.89 and that the most recent seasons are trending to higher prices an estimated cheapest value for attending the game is $250. Collecting data from old ticket stubs which last had face values printed on them in 2016. Data was collected from the internet from eBay and Worthpoint. Ticket prices for the least expensive tickets were $87.50 for 2013, $95 for 2014 and 2015, and $100 for 2016. As a result, we estimate the face value of the cheapest ticket for 2022 tickets would be $125. The column labeled Minimum Option Price is estimated from this information as well as the subjective probabilities for each team to make the Final Four. The other estimates of option values use the Average Price for All Sessions, which likely is skewed down as some of the earlier rounds and even the Finals have a lower value for most cases than the Final Four. While there are cases that other sessions, which could include the Championship, may have higher demand if some premier teams with a high wealth or larger fan base were competing and need to consider venue location. However, the Final Four is usually one of the highest demanded tickets in March Madness as it is four of the top teams in the country playing in two games, back-to-back, and with these four teams

generating demand for the same number of tickets to the National Championship game, where only two teams generating demand, the estimate of using the average session ticket price is conservative and the price is likely significantly higher. From the information in Table 2, the average ticket price for all sessions is $818.92 over our entire sample. Thus, in the last of the columns in Table 2 the expected team-fan value of attending is 900 a more realistic estimate. To determine the exercise price of these options as previously noted this would be the same as the presale price, i.e. face value. Reviewing online ticket stubs from previous years we estimate the average ticket price is roughly $250 for a Final Four ticket, making the value of exercising one of these options $650.

For some cases in Table 3 the estimated option price can yield some teams that have lower option prices than $1 or even $5. It is our belief that every university has a portion of their alumni base that would always be willing to pay $1 or in some cases $5, or even $10 for this option.[20] As a result, it is not unreasonable to expect the lowest option price for these teams' options to be sold for a minimum or $1 or possibly $5, especially if universities sold these options directly to alumni. Speculators would clearly want to exploit any mispricing like this, but the issue is that in order to exploit a security that is overpriced, one needs to short sell the security or sell one that you already own. Given that these markets will not offer short selling, the only choice would be to sell the option they own – this implies they value it at this price, as the owner already purchased the security at the inflated price.

[20] It is likely the case that many universities may have minimum option values greater than the calculated option value. For example, The University of Arizona (Arizona) has an option value of $21.71, but with a large fan base at a basketball powerhouse, it could be the case they could see their options for $25 or even $30. This point just enforces the argument that our numbers presented here are likely to be conservative.

[Table 3]

In our data, Gonzaga has the highest odds of making it to the Final Four with a 14.70% chance. This implies a value of $95.55 in the secondary market for each ticket. Thus, for a team offering 2,500 tickets the additional revenue to the university athletic department is nearly $240,000. When looking at the top 25 teams to most likely make the Final Four the median price of a ticket is $59.72, which would yield the university athletic department almost an additional $150,000 of revenue. This is much smaller for the teams with lower odds, those teams with the longest shot of making the tournament have only a 0.15% chance of making the final four, leading to a value of each ticket of $0.95. At this value, the athletic department would only make an additional $2,375 for selling options, assuming these teams do not have a minimum option price. Note these teams are the teams that are in the DraftKings offering of the remaining field, i.e. their probabilities are individually near zero.

When including all the teams with the lowest odds (but still excluding NJ teams' odds because of NJ gambling laws with this data), the average value of the Final Four option is $23.85. This means that for the average university offering 2,500 options to buy tickets to the Final Four, the average university athletic department would bring in $59,625. But remember, that is an extra $59,625 per year, each year, whether they make the Final Four (or tournament at all) or not. Whereas the best powerhouse basketball team will start the season with a 10% chance of making the tournament (or better). At these odds, the value of the option would be $65, meaning these programs would be expected to bring in extra revenue of $162,500 per year, every year, even when they do not have a deep run in the tournament (or even make the tournament) for just selling options to the Final. As a consistent stream of income, this would have a major impact on the university athletic department (and certainly cover the costs of running the option system for the

university). This does not factor in the value of selling options to other round games. Note within this discussion we also did not incorporate any minimum option price for universities, with a likely minimum option price of $1, $5, or even $10. This would increase the revenue stream that would be generated for these teams as well as for the average university.

VIII. Conclusion

By offering tickets to future events with unknown participants through both advance selling and option pricing, we show that the organizer benefits from an increase in revenue through a separating equilibrium pricing strategy. In addition, fans end up with increased utility from knowing they have a ticket. Also, more of each team's fans will be in attendance, which benefits the participants with additional support and can make the fan experience more enjoyable. Thus, we have both an increase in revenues and an increase in fan utility from this pricing strategy.

The creation of an exchange for these options by the organizer will also benefit the organizer, through transaction fees, while also increasing fan benefits. The organizer would benefit from increased revenue generated from transaction fees. The organizer could also be the broker of the option market, allowing the re-sale of the option and continuing to receive the listing fees. These are sales that would have otherwise occurred in the black market (i.e. through scalping). Fan's utility will increase from this strategy as well. This occurs through the guarantee of tickets for team-based fans. Along with this guarantee, there would be an increase in other team fans cheering in the same section for the same team.

When the participants offer the options directly, it will both generate more revenue while smoothing revenues over the years even when they do not make the tournament. The benefits to the fans remain the same, as they are unaffected by who offers the option on the ticket.

While this study provides the groundwork for the application of consumer options, there are still questions that need to be addressed. One issue may be to find opening prices, especially if betting lines are not offered yet. Although this could provide a complication the first time the options are listed, a price that will entice enough interest from fans and provide the originator enough money to generate these options will emerge quickly. Additional issues to consider are how large the transaction fees should be, how liquid these options would be, and the startup costs of creating such a market. These are left for future research.

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Table 1: Variables used in study

Variable	Description
EV_G	The Expected Value of the Game-Based Fan
EV_T	The Expected Value of the Team-Based Fan
U^+_{Ti} U^-_{Ti}	The Team-Based Fan's Willingness to Pay when: (+) their favorite team is playing or (-) their team is not playing
N_T N_G	The Number of Team-Based Fans or the Number of Game-Based Fans
P_{AS}	Pricing for tickets sold via Advanced Selling
P_{Oi}	Price for team i's Option
P_E	Exercise Price for each teams option
γ_i	The probability of team i making the semifinals
Assumptions	
$EV_T < EV_G$	
$U^+_{Ti} > EV_G$	

Table 2: Ticket prices for different final four events by year.

Year	Final Four Semi-final Ticket Prices (Cheapest price on Secondary Market)	Championship Game Ticket Prices (Cheapest Price on Secondary Market)	Average Ticket Price for Either Session (Final Four & National Championship
2011	$ 161.00	$ 60.00	$ 648.85
2012	$ 190.00	$ 65.00	$ 486.00
2013	$ 309.00	$ 90.00	$ 1,021.00
2014	$ 199.00	$ 90.00	$ 1,141.00
2015	$ 290.00	$ 181.00	$ 1,054.34
2016	$ 239.00	$ 102.00	$ 365.39
2017	$ 214.00	$ 133.00	$ 945.34
2018	$ 330.00	$ 84.00	$ 1,088.34
2019	$ 281.00	$ 111.00	$ 620.00
Average	$ 245.89	$ 101.78	$ 818.92

Table 3: 2022 Calculated Team Option Price

This table provides the odds of each team making the 2022 Final Four (from DraftKings, as of July 8, 2021 – excludes NJ Teams) as well as the calculated option price for each team.

Rank	Team	DraftKings Final Four Line	Subjective Probability of Making the Final Four	Minimum Option Price (250-125)	Option Price (900-250)
1	Gonzaga	150	14.70%	$ 18.37	$95.55
2	Michigan	175	13.36%	$ 16.70	$86.86
3	Kansas	200	12.25%	$ 15.31	$79.62
3	Villanova	200	12.25%	$ 15.31	$79.62
5	Kentucky	275	9.80%	$ 12.25	$63.70
5	Purdue	275	9.80%	$ 12.25	$63.70
7	Alabama	300	9.19%	$ 11.48	$59.72
7	Duke	300	9.19%	$ 11.48	$59.72
7	Houston	300	9.19%	$ 11.48	$59.72
7	Louisville	300	9.19%	$ 11.48	$59.72
7	Ohio State	300	9.19%	$ 11.48	$59.72
7	Texas	300	9.19%	$ 11.48	$59.72
7	Virginia	300	9.19%	$ 11.48	$59.72
14	Baylor	350	8.17%	$ 10.21	$53.08
15	Arkansas	400	7.35%	$ 9.19	$47.77
15	Oregon	400	7.35%	$ 9.19	$47.77
15	Virginia Tech	400	7.35%	$ 9.19	$47.77
15	West Virginia	400	7.35%	$ 9.19	$47.77
19	LSU	500	6.12%	$ 7.66	$39.81
19	Michigan State	500	6.12%	$ 7.66	$39.81
19	Oklahoma	500	6.12%	$ 7.66	$39.81
19	USC	500	6.12%	$ 7.66	$39.81
19	Wisconsin	500	6.12%	$ 7.66	$39.81
24	Creighton	550	5.65%	$ 7.07	$36.75
25	Florida State	600	5.25%	$ 6.56	$34.12
25	North Carolina	600	5.25%	$ 6.56	$34.12
25	Texas Tech	600	5.25%	$ 6.56	$34.12
28	Auburn	700	4.59%	$ 5.74	$29.86
28	Clemson	700	4.59%	$ 5.74	$29.86
28	U Cconn	700	4.59%	$ 5.74	$29.86
28	Drake	700	4.59%	$ 5.74	$29.86
28	Iowa	700	4.59%	$ 5.74	$29.86
28	Maryland	700	4.59%	$ 5.74	$29.86
28	Memphis	700	4.59%	$ 5.74	$29.86
28	Oklahoma State	700	4.59%	$ 5.74	$29.86

Rank	Team	DraftKings Final Four Line	Subjective Probability of Making the Final Four	Minimum Option Price (250-125)	Option Price (900-250)
28	St. Bonaventure	700	4.59%	$ 5.74	$29.86
28	Syracuse	700	4.59%	$ 5.74	$29.86
28	Tennessee	700	4.59%	$ 5.74	$29.86
39	UCLA	800	4.08%	$ 5.10	$26.54
40	Arizona	1000	3.34%	$ 4.18	$21.71
40	Florida State	1000	3.34%	$ 4.18	$21.71
40	Georgia Tech	1000	3.34%	$ 4.18	$21.71
40	Illinois	1000	3.34%	$ 4.18	$21.71
40	Missouri	1000	3.34%	$ 4.18	$21.71
40	Richmond	1000	3.34%	$ 4.18	$21.71
40	St. John's	1000	3.34%	$ 4.18	$21.71
40	San Diego State	1000	3.34%	$ 4.18	$21.71
40	Stanford	1000	3.34%	$ 4.18	$21.71
40	Texas A&M	1000	3.34%	$ 4.18	$21.71
40	Xavier	1000	3.34%	$ 4.18	$21.71
51	Loyola Chicago	1200	2.83%	$ 3.53	$18.37
51	Marquette	1200	2.83%	$ 3.53	$18.37
51	Oregon State	1200	2.83%	$ 3.53	$18.37
51	Pittsburgh	1200	2.83%	$ 3.53	$18.37
51	Saint Louis	1200	2.83%	$ 3.53	$18.37
56	Dayton	1300	2.62%	$ 3.28	$17.06
57	Boise State	1800	1.93%	$ 2.42	$12.57
57	Colorado	1800	1.93%	$ 2.42	$12.57
57	Indiana	1800	1.93%	$ 2.42	$12.57
57	NC State	1800	1.93%	$ 2.42	$12.57
57	Ole Miss	1800	1.93%	$ 2.42	$12.57
57	SMU	1800	1.93%	$ 2.42	$12.57
57	UNLV	1800	1.93%	$ 2.42	$12.57
57	Wichita State	1800	1.93%	$ 2.42	$12.57
65	Butler	2000	1.75%	$ 2.19	$11.37
65	Cincinnati	2000	1.75%	$ 2.19	$11.37
65	Colgate	2000	1.75%	$ 2.19	$11.37
65	Davidson	2000	1.75%	$ 2.19	$11.37
65	Georgetown	2000	1.75%	$ 2.19	$11.37
65	Liberty	2000	1.75%	$ 2.19	$11.37
65	Miami (FL)	2000	1.75%	$ 2.19	$11.37
65	Mississippi State	2000	1.75%	$ 2.19	$11.37
65	Nevada	2000	1.75%	$ 2.19	$11.37
65	North Western	2000	1.75%	$ 2.19	$11.37
65	Notre Dame	2000	1.75%	$ 2.19	$11.37

Rank	Team	DraftKings Final Four Line	Subjective Probability of Making the	Minimum Option Price (250-125)	Option Price (900-250)
65	Penn State	2000	1.75%	$ 2.19	$11.37
65	Providnece	2000	1.75%	$ 2.19	$11.37
65	South Carolina	2000	1.75%	$ 2.19	$11.37
65	VCU	2000	1.75%	$ 2.19	$11.37
65	Wake Forest	2000	1.75%	$ 2.19	$11.37
81	Arizona Sate	2500	1.41%	$ 1.77	$9.19
81	Nebraska	2500	1.41%	$ 1.77	$9.19
83	Belmont	4000	0.90%	$ 1.12	$5.83
83	BYU	4000	0.90%	$ 1.12	$5.83
83	Gerogia	4000	0.90%	$ 1.12	$5.83
83	Harvard	4000	0.90%	$ 1.12	$5.83
83	Iona	4000	0.90%	$ 1.12	$5.83
83	Iowa State	4000	0.90%	$ 1.12	$5.83
83	Kansas State	4000	0.90%	$ 1.12	$5.83
83	Umass	4000	0.90%	$ 1.12	$5.83
83	Minnesota	4000	0.90%	$ 1.12	$5.83
83	New Mexico	4000	0.90%	$ 1.12	$5.83
83	Saint Mary's	4000	0.90%	$ 1.12	$5.83
83	TCU	4000	0.90%	$ 1.12	$5.83
83	Temple	4000	0.90%	$ 1.12	$5.83
83	Utah	4000	0.90%	$ 1.12	$5.83
83	Yale	4000	0.90%	$ 1.12	$5.83
98	Boston College	6500	0.56%	$ 0.70	$3.62
98	DePaul	6500	0.56%	$ 0.70	$3.62
98	East Tennessee State	6500	0.56%	$ 0.70	$3.62
98	New Mexico State	6500	0.56%	$ 0.70	$3.62
98	Northern Iowa	6500	0.56%	$ 0.70	$3.62
98	Penn	6500	0.56%	$ 0.70	$3.62
98	Rhode Island	6500	0.56%	$ 0.70	$3.62
98	Vanderbilt	6500	0.56%	$ 0.70	$3.62
98	Washington	6500	0.56%	$ 0.70	$3.62
98	Western Kentucky	6500	0.56%	$ 0.70	$3.62
108	Howard	10000	0.36%	$ 0.45	$2.36
109	All other Teams (each)	25000	0.15%	$ 0.18	$0.95