A combinatorial auction to sell TV broadcasting rights in league sports[1]

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Abstract

The centralized sale of TV broadcasting rights in league sports constitutes a cartel which in many European countries is allowed only if it complies with certain conditions set by competition authorities. Two of the most important conditions are: i) partial unbundling, i.e. the rights must be unbundled into several separate packages; and ii) the no-single-buyer rule, i.e. the packages must be sold to different broadcasters. This article shows how a combinatorial auction can be employed to sell broadcasting rights allocating them *endogenously* based on the broadcasters' bids and, thus, without requiring the seller to pre-determine the packages of such rights. This feature can address various competition policy issues, including facilitating market entry and preventing coordination among bidders. Also, a combinatorial auction has the potential to achieve higher levels of allocative efficiency and higher revenue levels compared to auctions with pre-determined packages of broadcasting rights.

Keywords: auctions; competition policy; league sports; packages; TV broadcasting rights.

1 Introduction

Background and motivation. The sale of audio-visual rights for the main league sports in the US and Europe is a big business. EY (2021) reported that in the US, on average, per season, the National Football League (NFL) received €7 billion (b) (during 2014-2022) for their audio-visual rights, the National Basketball Association (NBA) achieved €2.4b (2016-2025), and the Major League Baseball (MLB) reached €1.7b (2014-2021). In the same report, the equivalent figures in some of the main European football[3] leagues are: €2.8b for the Premier League (England, 2019-2022); €1.9b for La Liga (Spain, 2019-2022); €1.5b for the Bundesliga (Germany, 2017-2021); €1.4b for Serie A (Italy, 2018-2021); and €0.9b for Ligue 1 (France, 2016-2020).

In Europe, the sales of rights to broadcast live sports on TV have gradually shifted from a model where each club individually sells the rights to its home matches, to another where the league sells

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[3] Hereafter, the term "football" refers to European-style football as opposed to American football.

the rights jointly on behalf of all the clubs.[4] For example, the Premier League has sold collectively the TV rights to live matches since its inception in 1992. Other examples of collective sales in European football leagues comprise (EY, 2021; DN/Lusa, 2021): Ligue 1 (since 1984), Bundesliga (2003), Serie A (2008), La Liga (2015), and Primeira Liga (to be implemented by 2027/28).

The collective sale of TV broadcasting rights is attractive to European football leagues because it allows them to promote two main objectives. First, it maximizes the joint revenue of the TV rights sales allowing the clubs to invest further and bring more talent to the league, e.g. top players and coaches. The collective sale of TV broadcasting rights effectively shifts the market for TV rights into a monopoly where buyers, i.e. the broadcasters, can only buy from a single seller, i.e. the league. Second, it allows leagues to distribute the revenue of the TV rights sales more uniformly among clubs, when compared to the model of sales by clubs individually. This reduces financial disparities promoting a better competitive balance between big and small clubs and, consequently, the attractiveness of the league as a product to be sold to sports fans and TV viewers.

Despite the benefits of potentially greater investments and better competitive balance in the league brought about by collective sales, the European Commission (EC) and other competition authorities have raised concerns regarding this sales model. In particular, the centralization of the sales generates a market-wide cartel with potential negative impacts on consumer welfare. In the absence of intervention, the league's objective of maximizing revenue may result in the sale of all or a sufficiently large relevant part of TV sports rights to a single broadcaster that would be able to exploit the monopolization of such rights. Thus, consumers could be harmed with: higher prices (or more advertising time) to watch live matches on TV; a restricted number of matches for which TV rights are available for sale;[5] and hindering innovation.[6] In that view, competition authorities have allowed the collective sales of TV broadcasting rights in various jurisdictions but subject to certain conditions.[7] For example, according to the EC, the main remedies for clearance of the collective sale of TV broadcasting rights of football matches are the following (Budzinski et al, 2019).[8]

- *Partial unbundling*: the TV broadcasting rights must be split into at least two balanced and meaningful packages.
- *No single buyer*: the packages must be sold to different broadcasters of football matches to avoid a monopoly and promote competition between them.[9]

[4] In the US, in general, the NFL, MLB and NBA teams centralize the sale of audio-visual rights via the respective league. The exceptions to centralization are the rights for some regional matches, which are sold by the clubs individually. See EY (2021).

[5] See Ofcom (2016) for a Competition Act investigation into the sale of live UK audio-visual media rights to Premier League matches. Ofcom decided not to intervene and closed the investigation in 2016 considering the Premier League's decision to increase the number of matches available for live broadcast in the UK, to a minimum of 190 per season from the start of the 2019/20 season. This represented an increase of at least 22 matches per season over the number sold for live broadcast in the Premier League's auction in 2015.

[6] See AdC (2018) and Budzinski et al (2019) for discussions of the negative and positive welfare effects as a result of the centralized sales of broadcasting rights.

[7] In accordance with Article 101 (3) TFEU, collective sales are exempted from the cartel prohibition only if they satisfy certain remedies seeking to safeguard competition and consumer welfare.

[8] These conditions come from three major case decisions by the EC covering centralized sales arrangements by the UEFA Champions League, the Premier League and the Bundesliga.

[9] The no single buyer per se does not imply partial unbundling, e.g. two sufficiently large buyers could buy all TV sports rights if sold on a non-exclusive basis. If so, this could facilitate downstream coordination between the two large broadcasters (e.g. in terms of retail prices) as they would be selling the same bundle of matches in the market. Under partial unbundling, coordination is more difficult to achieve as different broadcasters will be selling different bundles of matches, so there is not a clear focal point for coordination.

- *Competitive tendering*: the bidding process must be non-discriminatory and transparent giving all potential buyers an opportunity to compete for each of the packages.
- *Sun-setting*: the contract duration is limited and may not be extended automatically. The current EC practice in football is that the contract duration should not exceed a period of three years.
- *Fall-back option*, *use obligation* and *parallel exploitation*: to remedy potential output restrictions, unused rights should fall back to the individual clubs for parallel, competitive exploitation.
- *Trustee supervision* of the tender procedure.

Not all matches have the same commercial value of TV broadcasting rights. This depends on the status of the participating teams, and the number of followers, among other factors. The main European leagues with centralized sales typically structure their TV broadcasting rights in packages of matches. The strategy and criteria for such packaging are defined by the league (EY, 2021). Then, the packages are typically auctioned or negotiated directly with potential buyers (BBC Sport, 2021; Forbes, 2021). This article focuses on the case where TV broadcasting rights are auctioned (rather than negotiated), as recommended by the EC and other European competition authorities (AdC, 2018; Budzinski et al, 2019).

It is noteworthy that there are some similarities between spectrum auctions and auctions for TV sports rights. Spectrum auctions in Europe are often designed to promote the interests of consumers (e.g. see the Communications Act 2003 in the UK). Additionally, there is a duty to promote the efficient management and use of the spectrum (e.g. see the Wireless Telegraphy Act 2006 in the UK) but there is no obligation to secure the highest financial return from spectrum licences. Usually, spectrum auctions place more weight on their objectives of efficient allocation and on promoting downstream competition than on revenue-raising. These three objectives are also relevant to sports broadcasting rights, but the league owners are likely to give primacy to revenue. Other similarities between spectrum auctions and the centralized auctions of TV sports rights include: i) the number of bidders that tends to be relatively small, with bidders being the same over time; and ii) like in the centralized sale of TV sports rights by a league, the sale of spectrum bands in European countries is usually centralized by a regulator.

Contribution of this article. This article addresses the problem of designing a *combinatorial* auction for allocating TV broadcasting rights for which competing broadcasters would submit package bids. To the best of my knowledge, this article constitutes the first attempt to apply a combinatorial auction to the centralized sale of TV broadcasting rights in league sports. Such design can offer multiple advantages compared to non-combinatorial ones with pre-determined packages both from the seller's and competition authorities' points of view.

A combinatorial auction can potentially achieve higher levels of auction revenue for sellers (Koutroumpis and Cave, 2018). This is because such design: i) allows bidders to express the value of complementarities among different matches;[10] and ii) can be set to select the optimal combination of bids that maximizes revenue. This means that sellers do not have to pre-determine packages for sale when using a combinatorial auction. The packages are instead an outcome of the auction based on the bids made for different bundles of matches. This feature does not mean that a combinatorial

[10] Complementarity of value refers to circumstances in which the value attributed to a whole is greater than the sum of the values assigned to the individual parts. An example would be the matches, as a visitor and visited, of a football club in which the value by some consumers of a package that includes all these matches will be higher than the sum of the value of packages that separate such matches.

auction will necessarily achieve the optimal allocation but by giving more flexibility to bidders in terms of the packages that they can bid for there is potential to achieve an allocation of TV rights that is socially preferable to the pre-determined packages by the league.

A combinatorial auction can address to some extent competition concerns typically raised by authorities. First, coordination (e.g. market division) is likely more difficult to achieve under a combinatorial auction. In particular, it might be more difficult for bidders to find a focal point for coordination in the absence of any pre-determined packages by the seller. Second, it is simple to implement caps on the matches that can be won by a single bidder in order to avoid foreclosure in the auction. Thus, even a large bidder would be unable to hoard the TV rights for all the matches or any other specific bundles of matches deemed unacceptable by the authority. Bidders would still be able to compete for any combination of matches insofar as such bundles are considered feasible by the authority. This bidding flexibility is not possible in auctions with pre-determined packages. Third, it is easier for new entrants to bid for small packages of TV rights promoting market entry. In a limit case, a new entrant could bid for the TV rights of only one match, which may *not* be feasible to do in a non-combinatorial auction with pre-determined bundles.

The rest of this article is organized as follows. Section 2 describes the current and potential types of auctions for the sale of broadcasting rights in league sports. Section 3 sets out a combinatorial auction adapted to the sale of TV broadcasting rights and provides a hypothetical numerical example. Section 4 discusses how a combinatorial auction can be a useful mechanism to address competition concerns related to collective sales of TV broadcasting rights. Also, this section considers whether the advantages of a combinatorial auction may be achieved alternatively with a simple disaggregation of bundles and suggests the next steps for implementing a combinatorial auction for the sale of TV broadcasting rights. Section 5 concludes.

2 Current and potential types of auctions for sports rights

This section describes the most common procedures when sports rights have been auctioned: the English auction (open bid, first-price); and the sealed-bid first-price auction (Solberg, 2006). In general, these auctions offer the same packages for sale at regular time intervals, and the participating bidders are frequently the same. Additionally, the section describes a potential type of auction for sports rights: the combinatorial auction. Combinatorial auctions have been used in a number of industries, however, not for the sale of TV rights in league sports until now.

2.1 English auction

The English auction starts with a low price, which thereafter is raised successively until only one bidder remains (McAfee and McMillan, 1987). The winner of the auction is the highest bidder, who pays the bidding price. The dominant strategy in this auction is to bid slightly above the rival's bid until bidding reaches the bidder's own valuation, then stop bidding. The auction will end with a price just above the second-highest valuation among bidders. This means that the English auction can serve the seller's interest well if the highest and second-highest valuations are close to each other. Also, the information-sharing feature of the English auction can help bidders more accurately predict the market value of TV rights. This may incentivize risk-averse bidders to bid more aggressively and increase the auction revenue.

2.2 Sealed-bid first-price auction

In the sealed-bid first-price auction, each bidder submits one bid without observing any information from other bidders (McAfee and McMillan, 1987; Gibbons, 1992). The winner of the auction is the highest bidder, who pays the bidding price. Given that a bidder is unable to observe information

about the rivals, this auction format may disincentivize participation from risk-averse bidders. Nonetheless, this format may be more profitable to the seller than an English auction if there is a wide gap between the highest and second-highest valuations. In sealed-bid auctions, bidders face a trade-off between profit margin and probability of winning.

2.3 Combinatorial auction

A combinatorial auction is a type of mechanism in which bidders can place bids on combinations (or packages) of discrete heterogeneous items. These auctions are particularly useful when bidders have non-additive valuations on bundles of items. In other words, bidders value the combinations of items above or below the sum of the valuations of the individual items.

The combinatorial design eliminates the *aggregation risk* for bidders as posed by other traditional auctions that do not allow for package-based bids. For example, if bidders could only bid for individual shoes (and not pairs), they would risk getting only the right or the left shoe at the end of the auction. A combinatorial auction would guarantee bidders to win exactly a pair of shoes or nothing (unless bidders have placed bids both for individual shoes and pairs of shoes).

Complementarities are likely to apply to TV sports rights for various reasons, e.g. the following.

- Consumers are likely to be interested in a package of matches to watch how the performance of teams evolves over the season (as a story in a soap opera), rather than only one isolated match. Note that season tickets are popular in various leagues such as the Premier League (Bloomberg UK, 30 May 2022).
- It might be easier and less costly for consumers to subscribe to a single TV service with a bundle of matches rather than multiple TV services to watch the same bundle of matches.
- Bundling TV sports rights mitigates risks for broadcasters. For example, with a larger package of matches, broadcasters mitigate the risk of not having purchased matches of the teams that will be in the top 5 standings in the league table.

Combinatorial auctions can cope with bids for many different combinations of items allowing bidders to express their complementarities. Consequently, a combinatorial auction may allow for more efficient allocations of items than would otherwise be possible. Moreover, this design is adaptable to specific bidder caps and other auction-specific rules.[11] Also, there is empirical evidence that some combinatorial auctions tend to generate higher revenues compared to other formats (Koutroumpis and Cave, 2018).[12] Researchers have developed methods for boosting revenue in combinatorial auctions (Likhodedov and Sandholm, 2004).

On the downside, a combinatorial auction is more complex and presents computational challenges compared to traditional designs (Levin and Skrzypacz, 2016). An example of a computational problem is how to determine the allocation of items once the bidders have submitted their bids. This problem becomes increasingly difficult to solve requiring more computational time to find the solution as the number of items and bidders expands. This is the so-called “winner determination

[11] For example, in 2013, “the approach to competition issues in the UK 4G spectrum [combinatorial] auction involved the innovative use of spectrum floors, i.e. the flexible reservation of portfolios of spectrum for either a new entrant or the smallest incumbent national mobile competitor” (Myers, 2013).

[12] The dataset employed in the article by Koutroumpis and Cave (2018) comprises spectrum prices paid by telecommunications operators over two decades across 85 countries. This result does not automatically translate to TV broadcasting sports rights. However, it shows empirically that there are indeed cases where a combinatorial auction generates higher revenues than many other alternative designs. Also, this empirical finding is consistent with theoretical factors supporting the potential for higher revenues in combinatorial auctions, specifically due to bidders’ ability to express complementarities.

problem" (WDP), i.e. given a set of bids the objective is to find an allocation of items to bidders that maximizes the auction revenue (or achieves some other goal defined by the auctioneer). Consequently, there is an element of unpredictability associated with the auction outcome. In particular, bidders will make bids for various packages without knowing which (if any) will be part of the solution to the WDP. Estimating valuations for multiple packages of matches could be more costly for bidders to derive than for a small set of pre-defined packages by the auctioneer.[13] Also, bidders would need to judge their bid strategies carefully, given the importance of the differences in bidders' incremental bid values between packages for the outcome of a combinatorial auction. Moreover, budget-constrained bidders may face risks in their bidding decisions in a combinatorial auction, which can influence the package they win (Ofcom, 2018).

Combinatorial auctions have been employed across various industries for several years. Examples of recent proposals and applications of a combinatorial design are in the allocation of:

- radio spectrum for wireless communications, e.g. see Ofcom (2011) for the UK 4G auction;
- airport landing slots, e.g. see CMA (2018) and Bichler et al (2006);
- real estate, e.g. see Goossens et al (2014);
- items in public procurement, e.g. see Cantillon and Pesendorfer (2004) for the case of London bus routes; and
- materials and services in industrial procurement, e.g. see Bichler et al (2006) for the case of Mars, Incorporated.

Given that procurement frequently entails costly and time-consuming negotiations over multiple items with multiple suppliers, a combinatorial reverse auction can be a more systematic and cost-effective alternative to such negotiations (Al Shaqsi, 2018).[14]

3 Description of a combinatorial mechanism for TV rights allocation

This section sets out a potential application of a combinatorial auction for TV broadcasting rights allocation. The auction comprises two stages: principal; and assignment.

First, in the principal stage, matches with similar market value (such as those featuring teams with similar investment levels or comparable numbers of viewers) will be grouped into pre-determined categories. Then, bidders can make multiple, mutually exclusive bids for packages of matches across the pre-determined categories. For simplicity, assume that each match is broadcasted exclusively by the winner of the TV rights. However, the design of a combinatorial auction can be adapted to non-exclusive rights. For example, the auctioneer can pre-determine categories for matches with two or more licences for TV broadcasting or other types of media broadcasting. Second, in the assignment stage, bidders can express their preferences for specific matches within a category, given the number of matches they were awarded in the principal stage. Below, I describe the details of each stage of the auction and provide an illustrative example of how the auction may work in practice.

Also, I assume throughout the article that the auctioneer is neutral about the number, size and identity of auction winners. This is a standard (implicit) assumption in the academic literature on

[13] Bichler et al (2013) found from experimental evidence that bidders make use of simple heuristics and focus on a small number of packages. In particular, they found that bidders in a combinatorial auction submitted bids for only a fraction of all bundles with a positive valuation. The absence of relevant package bids can be a significant impediment to achieving desirable outcomes in combinatorial auctions (Kagel et al, 2014).

[14] In a reverse auction, the buyer is the auctioneer who receives proposals from potential suppliers of inputs. In this type of auction, the reserve prices define the maximum the buyer is willing to pay for each item. The buyer solves the WDP to find the set of proposals that minimize expenditure.

auctions. Therefore, this is not considered by the WDP when selecting the combination that maximizes total bid value. Should the auctioneer have preferences on the number and size of the auction winners, in theory, such preferences may be reflected in the WDP. In particular, the WDP may be set to maximize total value, i.e. the sum of total bid value plus the auctioneer value. This may be a valid topic for future research, in particular, how the auctioneer preferences may be considered in the auction, whether such preferences should be announced publicly before the auction, and (if so) to what extent would that influence the bidders' behaviour. Note that this issue on the auctioneer preferences is *not* specific to combinatorial auctions.

3.1 Principal stage

A principal stage may have multiple rounds. However, for this analysis, it is not relevant in which round each package bid was made. Therefore, for simplicity, the principal stage can be construed as a one-shot sealed-bid auction with package bidding (see Rassenti, 1982). The advantages discussed in this article on the use of combinatorial auctions for the sale of TV rights carry over to more complex package-bidding auctions with multiple rounds.[15]

The principal stage determines the number of matches that each broadcaster wins in each category by solving the WDP,[16] but not the *specific* matches they receive (e.g. whether it is the first or second leg match between two teams). This approach requires that the matches in each category are close substitutes having similar market value. However, to the extent that bidders may have a preference over which specific matches they receive within a category, this can be expressed in the assignment stage (see section 3.2 below).

Below I discuss how the auctioneer may pre-determine the match categories; which price rule to use; and issues to consider when setting reserve prices.

3.1.1 Match categories

A main task in a combinatorial auction for TV broadcasting rights is to categorize matches in terms of their closeness of substitution and potential market value. To see why categorization is important, let's take the example of the Premier League with 20 football teams and 380 matches per season. In the absence of restrictions, a bidder can win any of the $2^{380} - 1$ possible non-empty combinations of matches. This is a very large number of possible packages of matches, which would make it very difficult for a bidder to express a valuation for each feasible package. The impracticality of reporting so much information on valuations raises an important question: what information should be used in the auction to allocate matches?

Putting matches that are relatively close substitutes and with relatively close valuations in the same category (i.e. as if they had the same value) allows bidders to focus their attention on valuations for packages of matches that are significantly different. The risk of having broader categories (i.e. more conflation of matches) to reduce the number of possible combinations is that there may exist substantial heterogeneity, i.e. matches that are not close substitutes, within a category. If so, the bids submitted during the principal stage may not reflect such heterogeneity and, thus, the auction

[15] For example, combinatorial clock auctions and iterative combinatorial auctions allow bidders to interact over a number of rounds with the purpose of helping them form more accurate expectations of their willingness to pay.

[16] There may exist multiple solutions to the WDP, i.e. there might exist more than one combination of bids that achieves the maximum revenue. In that case, the auctioneer may simply randomise among the solutions that achieve the maximum revenue or may set a list of criteria to choose between them. For example, the auctioneer may prefer a solution where the number of winning broadcasters, or the number of new entrants, is highest.

outcome may not be a good approximation to an efficient allocation of TV rights. See Milgrom (2011) for an excellent discussion on standardization and conflation including examples in various markets, e.g. electricity, wheat and financial.

Examples of potential metrics to inform which matches are likely close substitutes with similar commercial value can be: i) the amount invested in each participating team; ii) the table standings in the previous season; and iii) the number of expected viewers for a match.[17] At one extreme, if all matches in a league were expected to be close substitutes with similar commercial values, then all matches could fall into the same category. At the opposite extreme, if all matches were expected to have substantially different commercial values, different possibilities may be explored: i) for a relatively small number of matches, each match could have its own category; and ii) for a relatively large number of matches, the auctioneer may have to strike a balance between homogeneity of categories vs practicability for bidders and computational feasibility. In a nutshell, the exact number and definition of categories will be specific to each case depending on the number of matches whose TV rights are for sale and on the expected heterogeneity among such matches.

In leagues with a large number of matches and high levels of heterogeneity among all of them, the auctioneer may consider an intermediate solution between an auction of pre-determined packages and a combinatorial auction of individual matches. In particular, the auctioneer may consider a combinatorial auction of sub-packages of matches in that bidders can bid for combinations of such sub-packages. This intermediate solution would require the auctioneer to define the sub-packages but would still give more flexibility to bidders compared to an auction with fully pre-determined packages. Note that a recent trend in auction design has been to simplify by targeting near-optimal outcomes instead of searching for the full theoretical optimum. See Leyton-Brown et al (2017) for a concrete example in the FCC's incentive auction.

The aggregation of matches in sub-packages is a potential solution to mitigate the heterogeneity issue within categories. For example, the auctioneer may aggregate the matches sufficiently such that each sub-package has its own category. Alternatively, if there are two or more comparable sub-packages, the auctioneer may consider putting them in the same category of sub-packages. However, this solution comes at the cost of bidders losing flexibility in the packages that they can bid for.

The consequence of the auctioneer failing to estimate the closeness of substitution of matches accurately (before the auction) is more heterogeneity within a category than expected. More heterogeneity within a category increases the risks for bidders in the principal stage. This is because, at the end of the principal stage, bidders do not yet know which specific matches will be awarded to them but only the number of matches awarded per category. Therefore, during the principal stage, bidders may be unable to reflect the heterogeneity of matches in a category in their bid values. For example, risk-averse bidders could set their bid values assuming that they would be awarded their least preferred matches in each category. However, the same bidders may be willing to bid higher in the assignment stage when becomes clear which specific matches they are bidding for.

Below it is set out a simple hypothetical illustration of how matches in a league may be categorized. Suppose that fans and broadcasters consider that there are essentially 3 tiers of quality among the teams in a league: top-table teams, mid-table teams, and bottom-table teams. In particular, the quality of the teams within a category is similar, while for teams in different categories there are

[17] Such metrics may inform to what extent different matches may be substitutes from the bidders' perspective and, thus, whether they may fall in the same category in the auction (or not).

significant quality differences. In such case, a possible categorization for the matches may be as follows:

- category A comprises only the top matches (e.g. derbies only) with a top-table team playing against another top-table team;
- category B comprises the matches where a top-table team plays against a mid-table team;
- category C comprises the matches where a top-table team plays against a bottom-table team;
- category D comprises the matches where a mid-table team plays against another mid-table team;
- category E comprises the matches where a mid-table team plays against a bottom-table team; and
- category F comprises the matches where only bottom-table teams participate.

While matches in different categories are heterogeneous (not close substitutes for each other), the matches within the same category are likely close substitutes with similar market value. Section 3.3 below shows an application of the categories of matches set out above in the case of a 6-team league with 2 top-table teams, 2 mid-table teams and 2 bottom-table teams. For larger leagues with a wider range of quality of teams, it might be necessary more than 3 tiers of team quality and, thus, more than 6 categories of matches. In such cases, as discussed above, the auctioneer might need to strike a balance between the homogeneity of matches within each category and the practicability for bidders and computational feasibility.

"Fine-grained differentiation may be theoretically appealing but present meaningful complications to bidders that may reduce competition for each product and make markets thinner" (Milgrom and Vogt, 2021). All the advantages and disadvantages of disaggregation should be taken into account so that the auctioneer can choose the right level of (dis)aggregation in each particular case.

3.1.2 Price rules

Second-price rules promote allocative efficiency by incentivizing buyers to bid their true valuations. The truth-telling incentive is because bidders know that, if they win, they only need to pay the second-highest bid value, rather than their own bid value. A second-price rule may simplify the bidding strategies for bidders allowing them to focus only on their own willingness to pay for a package, avoiding the need to estimate what rivals would do in the auction.[18]

However, a second-price auction is less transparent in terms of the price paid by the winner. For a second-price rule to fulfil its purpose, bidders must trust that the price paid by the winner will indeed correspond to the second-highest bid submitted and that this value was not inflated by the auctioneer. Otherwise, the truth-telling incentive is impacted. The integrity and reputation of the auctioneer are particularly important in the case of a second-price rule in a combinatorial auction. This is because the second price in a combinatorial auction is calculated as the value of the items (TV rights) won by the winner that was denied to the losing bidders. Such calculation can be mathematically complex as illustrated by the formulae for the Vickrey prices in the combinatorial auction for mobile broadband services (700 MHz band) in Canada.[19] Thus, bidders need to trust that

[18] A more sophisticated version of second prices is "core pricing" which ensures that no individual winning bidder or coalition of winning bidders pays less than the respective opportunity cost imposed on the losing bidders. However, the use of core prices involves potentially further complications for the bidders as well as the auctioneer. This is because under some circumstances core pricing may generate strategic incentives to depart from truthful bidding (Erdil and Klemperer, 2010).

[19] See https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf08697.html#a3 (accessed on 10 March 2023).

the auctioneer will do the correct calculations, particularly if the bid data will not be in the public domain and prices cannot be verified. The supervision of a trustee, as recommended by the EC (see section 1 above), is particularly important under these circumstances. See Myers (2023) for a detailed discussion on "regulatory reputation as key market infrastructure for success" within the context of combinatorial auctions for spectrum bands.

Also, auctions for TV broadcasting rights are repeated over time (the EC recommends at least once every three years) and the bidders are often the same (Solberg, 2006). This may give the seller the ability and incentive to use reserve prices (see section 3.1.3 below) to increase their revenues under a second-price rule. In particular, if the auction closing prices (i.e. the second prices) are significantly lower than the highest bids, the league may decide to raise the reserve prices strategically to increase the revenue in the following auction. Over time, this behaviour may erode trust in the benefits of a second-price auction for TV broadcasting rights, as bidders, anticipating the behaviour of the league, have the incentive to bid below their valuations. The auction may then become closer to what would be a first-price auction (i.e. pay-as-bid), despite the second-price rule. An example of the materialization of this type of concern was in 2019 when Google switched from second- to first-price auctions for online ads. The "move to first-price auctions ratified what was already taking place in practice and made the auction mechanisms more transparent" (CMA, 2020, Appendix M).

It is also noteworthy that, under a second-price rule, bidders may engage in strategies attempting to inflate the prices paid by their rivals, i.e. price driving (Ofcom, 2018). Such strategies are a concern to efficiency if bidders win less or more broadcasting rights than they should win, based on their valuations. This risk also exists under the first-price rule in a multi-round (but not in the sealed-bid) auction, where the winning bidder is induced to pay a higher price round after round to outbid the price-driving bidder. With either pay-as-bid or second-price rules, the price-driving bidder runs a risk that its price-driving bid (above its valuation) could inadvertently win, and where this risk is material, it can deter strategic bidding. Bids made under a first-price rule are also subject to other distortions as discussed below.

A first-price rule, in which bidders pay their winning bid values, would not provide a truth-telling incentive to bidders. This is because, under a first-price rule, bidders are trading-off higher margin with lower probability of winning a package. Thus, a first-price rule may result in:

- a bidder with the highest willingness to pay for a package being outbid by another bidder; and
- differential bid shading, i.e. bidders may have an incentive to shade their bids differently across packages (Ausubel et al, 2014), which could distort bidders' incremental bid values between packages and the outcome of a combinatorial auction.

Consequently, a first-price rule does not guarantee an efficient allocation of TV broadcasting rights. This is regardless a combinatorial mechanism is used, or not, for the allocation of the rights. However, given the context discussed further above, for a second-price rule to work effectively, the auctioneer may need a *credible* commitment device in that bid information from previous auctions of TV rights will not be used by the league to increase (reserve) prices in future auctions.[20] In the absence of such credible commitment, a first-price rule may be a more transparent and attractive option. Additionally, Koutroumpis and Cave (2018) show empirically that a first-price rule may have

[20] The issue would vanish if the auctions for TV broadcasting rights were for periods of, say, 20 years, similarly to auctions for spectrum licences in a number of countries. The bidding data of an auction after 20 years is unlikely to be representative of the market conditions and technology for the following decades. This means that, in practice, the seller is unable to take informational advantages from one auction to the next.

a stronger positive effect on the revenue than any type of second-price rule. This empirical evidence from spectrum auctions reinforces the idea that a combinatorial auction with a first-price rule may be a strong candidate for an auctioneer whose main objective is revenue maximization (see also footnote 12 above).

3.1.3 Reserve prices

A reserve price for a match (or package of matches) is the price below which bids cannot be made. The seller should set a reserve price for matches in each category, with matches in different categories likely with distinct reserve prices. Setting the right level of reserve prices is a balancing act.

On the one hand, reserve prices *too high* may disincentivize new entrants from participating in the auction and even result in unsold TV rights for some matches. On the other hand, reserve prices *too low* may increase the probability of coordination in the auction (see Ofcom, 2018, for a discussion on reserve prices for spectrum lots in the UK 5G auction). This is because the gains brought about by coordination are potentially higher when reserve prices are lower. The gain resulting from a bidding coordination strategy corresponds to the difference between the price that each successful bidder would pay in a competitive auction and the price paid in an auction under coordination. If the final price paid in an auction under coordination is the reserve price, then the gain resulting from the bidding coordination strategy is higher as the reserve prices decrease.

Reserve prices may also be set secretly by the auctioneer, i.e. not be announced publicly. An advantage of doing so is a lower probability of coordination among bidders. However, empirical evidence from online auctions suggests that a secret reserve price may hurt sellers, by reducing the probability of the auction resulting in a sale, deterring some bidders from entering the auction, and lowering the expected auction revenue (Katkar, 2001). The willingness of the auctioneer to safeguard that the reserve prices will be kept in any possible outcome, even if no bidder meets them, may also affect the bidders' bidding strategies (Koutroumpis and Cave, 2018). For example, Stafford et al (2006) investigated bidders' bidding behaviour in online auctions with and without a reserve price. They found that an auctioneer's decision to use a reserve price lowers the buyer's level of perceived risk such that bidding activity is stimulated and, as a result, the final bid prices are higher. These design issues are relevant for auctions even without a combinatorial feature.

3.2 Assignment stage

The winners of the principal stage are guaranteed a certain number of matches in each category. In the assignment stage, they can make bids for packages of specific matches within each category compatible with the number of matches won in the principal stage. In the absence of any bids in the assignment stage, then the matches may simply be randomly allocated among the principal stage winners of each category.[21] For categories with a single match or categories where all the matches were awarded to a single bidder, the assignment is automatically determined.

In the remaining cases, a further WDP needs to be solved for each category in the assignment stage. There are two main differences between the principal stage and the assignment stage.

[21] Like in the principal stage, the WDP might have multiple solutions in the assignment stage, depending on the bids made. In this case, the auctioneer can use a tiebreaker like randomization or another criterion (see footnote 16 above).

- Exactly one package bid (within each category) will be won by each bidder in the assignment stage,[22] while in the principal stage, at most one bid will be won by each bidder. Additional prices in the assignment stage to be paid by winners are determined using a first- or second-price rule (see discussion in section 3.1.2 above).
- Reserve prices in the assignment stage are set to zero. Broadcasters may be indifferent between any matches in a category. If so, a broadcaster is not required and has no incentive to bid during the assignment stage. Instead, the broadcaster will simply accept any assignment of specific matches that is consistent with the number of matches won in the principal stage.

3.3 Illustrative hypothetical example

Considering the discussion in section 3.1.2 above, this section illustrates a combinatorial auction with a first-price rule both for the principal and assignment stages. This hypothetical example is intended to illustrate the mechanics of a combinatorial auction within the context of a sports league. The values used in this example were randomly chosen and are not intended to reflect the reality of any specific league. Moreover, these figures are not intended to be forecasts or predictions of the impact of implementing a combinatorial auction. Bidders and bid values will vary substantially from league to league. Note that the scale of the revenue from TV broadcasting rights in the illustrative example is substantially lower than the actual broadcasting rights revenue currently obtained by the top European football leagues (over €1b per season).

Consider a league with six teams where each team $i = 1, \dots, 6$ will play twice (home and away) against each one of the other five, i.e. the season includes a total of 30 matches. Teams 1 and 2 are top-table; teams 3 and 4 are mid-table; and teams 5 and 6 are bottom-table. Table 1 below shows the application of the match categorization rules illustrated in section 3.1.1 above. There are six categories of matches with the expected market value per match decreasing from category A (highest value) to F (lowest value).

Table 1: Distribution of match categories in a league with six teams

Match categories		**Away team**					
		Team 1	**Team 2**	**Team 3**	**Team 4**	**Team 5**	**Team 6**
Home team	**Team 1**	NA	A	B	B	C	C
	Team 2	A	NA	B	B	C	C
	Team 3	B	B	NA	D	E	E
	Team 4	B	B	D	NA	E	E
	Team 5	C	C	E	E	NA	F
	Team 6	C	C	E	E	F	NA

Note: NA stands for “non-applicable”.

[22] This is to guarantee that each broadcaster receives the number of matches already won in the principal stage.

Table 2 below summarizes the number of matches (supply) available for sale in each category (based on Table 1 above); and sets out the reserve price per match as well as the total reserve price for all the matches in a category in millions (m) of euros.

Table 2: Number of matches available per category, reserve price per match, and total reserve price per category

Match category	**A**	**B**	**C**	**D**	**E**	**F**
Number of matches (supply)	2	8	8	2	8	2
Reserve price per match (€m)	5	4	3	3	2	1
Total reserve price per category (€m)	10	32	24	6	16	2

3.3.1 Principal stage outcome

Assume that three broadcasters, Big, Medium, and Small, are bidding for the league matches. Table 3 below sets out all the bids made during the principal stage by the three bidders, and the winning bid for each bidder.[23] The allocation of matches that maximizes the auction revenue (€193.5m) is thus:

- bidder Big with TV rights for 2 matches in category A, 6 matches in category B, and 5 matches in category C, for a price of €122.5m;
- bidder Medium with TV rights for 2 matches in category B, 3 matches in category C and 4 matches in category E, for a price of €50m;
- bidder Small with TV rights for 2 matches in each category D, E and F, for a price of €21m; and
- the league retains 2 unsold matches in category E.

Based on the bids in Table 3 below, any other selection of packages by the league would lead to a revenue drop. A combinatorial mechanism eliminates the need for the league to anticipate, likely at substantial cost, the packages that are valued most highly in the market. For example, let's suppose that the league pre-determined three packages for sale:

- package 1 with 1 match in category A, and 5 matches in each category B and C;
- package 2 with 3 matches in each category B and C, and 6 matches in category E; and
- package 3 with 2 matches in each category D, E and F.

In such case, package 1 would be awarded to Big for a price of €100m, package 2 to Medium for a price of €66m, and package 3 to Small for a price of €21m, i.e. a total revenue of €187m, which is below the €193.5m raised when other combinations of matches are feasible.[24] This 3-package

[23] In this illustrative example, for simplicity, for a package bid to be feasible it suffices that its value is equal or above the reserve price for the respective package. Alternative auction rules may require, in addition, that, for any given bidder, the bid differential between any two packages is at least the respective reserve price differential. This additional rule is equivalent to having the seller making bids for each match and package of matches at the reserve price level.

[24] In this hypothetical example, the auction revenue increases by 3.5% due to the change from the current practice where leagues pre-determine the packages for sale to a combinatorial auction. For a league such as the Premier League with 20 clubs, this would correspond to a revenue increment of c. €98m per season, i.e. an average of almost €5m, per season, per club. Such revenue increment alone would be sufficient to cover more than 80% of the second highest transfer fee of a football manager in 2022, Unai Emery, who transferred from

auction assumes that bidders would still bid the same way as they did in the combinatorial auction. However, that assumption may not hold because coordination is likely easier between broadcasters in an auction with only three pre-determined packages. If so, the incremental revenue because of the combinatorial auction (compared to pre-determined packages) would be even higher.

Table 3: All bids made during the principal stage by bidders Big, Medium, and Small

Bidder	A	B	C	D	E	F	Package reserve price (€m)	Bid value (€m)
Big	2	8	8	2	0	0	72	180
Big	2	7	7	2	0	0	65	162.5
Big	2	8	8	0	0	0	66	165
Big	2	6	6	0	0	0	52	130
Big	2	6	5	0	0	0	49	122.5
Big	2	5	6	0	0	0	48	120
Big	1	5	5	0	0	0	40	100
Big	1	4	5	1	0	0	39	97.5
Big	0	4	4	1	0	0	31	77.5
Medium	2	4	4	2	6	1	57	114
Medium	0	4	4	2	4	1	43	86
Medium	1	4	4	2	4	1	48	96
Medium	0	3	3	0	6	0	33	66
Medium	0	3	3	0	5	0	31	62
Medium	0	2	3	0	4	0	25	50
Medium	0	6	2	0	0	0	30	60
Medium	0	6	0	0	6	0	36	72
Medium	0	0	6	2	2	0	28	56
Small	0	0	0	2	2	2	12	21
Small	0	0	0	0	2	2	6	10.5
Small	0	0	0	0	2	1	5	8.75
Small	0	0	0	0	1	1	3	5.25

Note: green rows denote the winning bids, i.e. the set of bids that solves the WDP.

3.3.2 Assignment stage outcome

This section sets out the assignment stage outcome for each category.

Category A (2 matches). In this category, all matches were awarded to Big in the principal stage. No bids or additional revenue were made in category A.

Category B (8 matches). In this category, 6 matches were awarded to Big, while the remaining 2 were awarded to Medium. Medium submitted bids for 7 pairs of specific matches, while Big submitted bids for 6 bundles of specific matches, as set out in Table A.1 below. The assignment of matches that maximized total bid value in category B was to assign matches 3 and 7 to Medium for

Villareal to Aston Villa for €6m. See https://en.wikipedia.org/wiki/List_of_most_expensive_association_football_transfers (accessed on 10 March 2023).

€0.05m, and the remaining matches to Big for €0.3m. Additional revenue of €0.35m was made in category B.

Category C (8 matches). In this category, 5 matches were awarded to Big and 3 matches to Medium. None of the bidders submitted bids in this category. The matches were randomly assigned between Big and Medium. No additional revenue was made in category C.

Category D (2 matches). In this category, all matches were awarded to Small in the principal stage. No bids or additional revenue were made in category D.

Category E (8 matches). In this category, 4 matches were awarded to Medium, 2 matches to Small and 2 matches were unsold, i.e. remained with the league. None of the bidders submitted bids in this category. The matches were randomly assigned among Medium, Small and the league. No additional revenue was made in category E.

Category F (2 matches). In this category, all matches were awarded to Small in the principal stage. No bids or additional revenue were made in category F.

3.3.3 Final allocations

Table 4 below sets out the full outcome of the combinatorial auction achieving a total revenue of €193.85m, i.e. €193.5m in the principal stage plus €0.35m in the assignment stage.

Table 4: Combinatorial auction outcome

Bidder	A	B	C	D	E	F	Package reserve price (€m)	Base price (principal stage, €m)	Additional price (assignment stage, €m)	Total price (€m)	% of total matches
Big	2	6	5	0	0	0	49	122.5	0.3	122.8	43%
Medium	0	2	3	0	4	0	25	50	0.05	50.05	30%
Small	0	0	0	2	2	2	12	21	0	21	20%
Unsold	0	0	0	0	2	0	4	0	0	0	7%
Total	**2**	**8**	**8**	**2**	**8**	**2**	**90**	**193.5**	**0.35**	**193.85**	**100%**

4 Discussion

This section, first, discusses how a combinatorial auction may help to address competition policy issues related to the centralized sales of TV broadcasting rights in league sports. Second, it considers to what extent the advantages of a combinatorial auction may be obtained alternatively with a simple disaggregation of bundles of TV broadcasting rights. Third, it sets out potential next steps for implementing a combinatorial auction for broadcasting rights in league sports.

4.1 Promoting competition with combinatorial auctions

"The most important issues in auction design are the traditional concerns of competition policy – preventing collusive, predatory, and entry deterring behaviour" (Klemperer, 2002). A combinatorial auction can provide a response to such competition policy issues.

Preventing coordinated behaviour. Bidders that participate regularly in repetitive auctions over time may be able to coordinate with the aim of reducing the amount they pay for TV rights. This could reduce competition within the auction, resulting in potentially lower revenue and inefficient allocation of TV rights. For example, in a sealed-bid auction with pre-determined packages, the

bidder with the highest number of subscribers only bids for the largest package of TV broadcasting rights, the second largest bidder in the number of subscribers only bids for the second largest package of TV broadcasting rights, and so on. This hypothetical market division could be a relatively simple strategy to implement.

However, in a combinatorial auction, in general, the unpredictability of the outcome brought about by the WDP (see section 2.3 above) makes coordination more difficult to implement compared to non-combinatorial auctions with pre-determined packages. For example, under a combinatorial auction, a strategy of market division may be unclear as there are many feasible packages for each bidder. Even if each bidder will only bid for packages within a certain range of number of matches, there is a risk that the WDP selects an allocation that differs from the market division envisaged by the bidders in coordination. For example, three smaller bidders together could outbid a bidder that has only bid for large packages, even if it was not the smaller bidders' intention to leave the larger bidder without any broadcasting rights.

To the extent that the outcome of a combinatorial auction is unpredictable, it might be difficult for bidders in a cartel to ascertain whether an outcome is different from what was envisaged due to: deviation, or something else that was difficult to predict. As a result, competition in future auctions might be fiercer under a combinatorial auction because those who cheated might remain undetected by the other bidders in the cartel. Note that this might depend on what information becomes publicly available post-auction, e.g. the full list of bids by each bidder.

The fact that the auctioneer does not need to pre-determine packages of TV rights (as these will be endogenously determined) in a combinatorial auction removes potential focal points of coordination. Although, depending on market circumstances, other focal points may still arise in a combinatorial format.[25]

Moreover, the unpredictability of a combinatorial auction means that bidders can end up with fewer broadcasting rights, or different packages than expected.[26] The possibility of an unexpected outcome with a combinatorial auction is a concern to efficiency if it changes the way bidders bid and, as a consequence, they win less or more broadcasting rights than they should win, based on their valuations (see Ofcom, 2018, for the equivalent issue in spectrum bands). In extreme cases, the prospect of an unexpected outcome may be a concern both from the efficiency and revenue points of view if it affects the decision of bidders to participate in the auction. However, note that even in auctions with pre-determined packages, bidders face a degree of uncertainty in the auction outcome.

Preventing predation. A combinatorial auction can address predation, i.e. foreclosure in the auction to harm downstream rivals' competitiveness, via the implementation of caps on the number of matches that can be awarded to a single bidder. Authorities may consider the standard ability-incentives-effects framework to assess this concern (CMA, 2021). To reach a substantial lessening of competition finding, all three questions below must be answered affirmatively.

- *Ability*: would a firm have the ability to control the TV broadcasting rights to harm the competitiveness of its downstream rivals?

[25] For example, if bidders are the same over time, the outcome of the previous auction could be a potential focal point. However, even in such case, the set of TV rights for sale are likely to change from auction to auction because of team promotions and relegations.

[26] Under a first-price rule, bidders do not face unpredictability with respect to the price paid for the broadcasting rights as it happens with a second-price rule.

- *Incentive*: would it be profitable to do so?
- *Effect*: would the foreclosure of bidders in the auction substantially lessen competition in the downstream market?

Caps may vary among bidders depending on their pre-auction TV rights holdings. Thus, even a large bidder would be unable to hoard the TV rights for all the matches excluding potential competitors from broadcasting football matches. Bidders would still be able to compete for any combination of matches insofar as such bundles are considered feasible by the authority. This bidding flexibility is not possible in auctions with pre-determined packages.

Promoting market entry. A combinatorial auction can facilitate market entry for TV broadcasting rights. This is because in a combinatorial auction, an entrant, which is unable to afford and compete for larger packages of TV rights, would be able to bid for smaller packages. In a limit case, a new entrant could bid for the TV rights of only one match, which may be impossible to do in an auction with pre-determined bundles. Nonetheless, potential issues for smaller bidders in combinatorial auctions of TV broadcasting rights are as follows.

- A smaller bidder may have difficulties with valuations of multiple packages of TV broadcasting rights. However, even in a non-combinatorial auction, the smaller bidder would still have to evaluate at the very least one package. In a limit case, the smaller bidder could still participate in a combinatorial auction with only one bid for a single package. See footnote 13 above.
- A smaller bidder would need to formulate a suitable bidding strategy for a combinatorial auction, particularly if intends to bid for multiple packages. However, a cost regarding the bidding strategy would still be incurred by the smaller bidder even under other auction formats. For example, if a sealed-bid first-price auction, the bidder would have to decide to what extent should bid below its valuation for a package.
- A smaller bidder may also face the so-called “threshold problem”. The threshold problem is an inefficiency that arises when smaller bidders withhold profitable bids on their packages, in the expectation that other smaller bidder will increase its bid sufficiently for the combination to defeat a larger bidder. Kagel et al (2014) found that the threshold problem, in theory, can interfere with allocative efficiency, although it has been found that this is not the case in many experiments. Furthermore, they discuss how certain bidding tactics by smaller bidders may mitigate the threshold problem.

4.2 Bundle disaggregation and package-based bidding

Disaggregating the bundles of matches into more granular bundles but without package-based bidding may solve some of the issues identified in this article but likely only partially when compared to a combinatorial mechanism. This section discusses the impacts of disaggregation alone compared to a combinatorial auction, in terms of: auction revenue, allocative efficiency, coordinated behaviour, market entry and predation.

Auction revenue and allocative efficiency. The disaggregation of bundles of matches per se (without package bidding) does not allow bidders to express the value of complementarities among different matches. A combinatorial auction, by design, allows bidders to express complementarities. Koutroumpis and Cave (2018) provide empirical evidence that combinatorial auctions, in particular the combinatorial clock auctions with a second-price rule (core pricing), are among the auction designs considered in their article that offer the highest revenues.

Importantly, the absence of combinatorial functionality in an auction with granular bundles enhances the aggregation risk (see section 2.3 above), particularly when complementarities are material. If complementarities between matches are weak or inexistent, then the complexity of a combinatorial auction becomes more difficult to justify. In such circumstances, a non-combinatorial auction with disaggregated bundles may be a more appealing option for the league and bidders. However, in practice, complementarities among matches seem material (see section 2.3 above) and this likely explains partially why leagues already sell TV broadcasting rights in bundles.

Coordinated behaviour. The disaggregation of bundles of matches alone may reduce the risk of coordinated behaviour because it increases uncertainty for bidders on who will win which matches. Nonetheless, under a combinatorial mechanism, the outcome may be even more uncertain due to the complexity of the WDP (see section 2.3 above). The inherent complexity of combinatorial auctions further reduces the likelihood of coordinated behaviour.

Market entry. The disaggregation of bundles of matches alone can promote market entry. This is because an entrant may be unable to afford and compete for larger packages of TV rights but is able to compete for smaller packages. However, as discussed above, without the package bidding functionality in the auction, the simple disaggregation of bundles enhances the aggregation risk, particularly for bidders interested in larger packages.

Predation. Foreclosure in the auction can be avoided by implementing caps on the number of matches that bidders can bid for. These caps can be implemented under combinatorial auctions but are *not* specific to such type of auction design.

4.3 Implementing a combinatorial auction for TV broadcasting rights

There should be extensive discussion on combinatorial auctions with the media industry, leagues, sporting communities, practitioners in competition policy and auctions, and academics. A combinatorial mechanism is, generally, more complex than other traditional auctions. On the one hand, complexity may represent a cost to bidders, e.g. in the form of further preparation time and more external advice for participation in the auction. On the other hand, complexity is likely to generate some benefits in terms of competition in the auction. This is because a focal point for coordination in the auction, e.g. in terms of the division of packages of TV rights among bidders, may become less obvious (see Ivaldi et al, 2003). Moreover, a combinatorial auction has the potential to achieve a more efficient allocation of TV rights and higher revenue levels than would otherwise be possible (see section 2.3 above).[27] A question for wider discussion is whether the complexity brought about by a combinatorial auction strikes the right balance between additional costs for bidders (namely in the short term) and tackling competition concerns.

Auction experiments need to be completed, e.g. mock auctions as organized by some regulators when planning to auction spectrum bands (Ofcom, 2021). These experiments are important to get answers to questions such as:

- how many packages do broadcasters wish to bid for; and
- how many match categories should be implemented.[28]

[27] A combinatorial auction offers the flexibility to bidders to express value for multiple packages, rather than only those pre-determined by the league. Based on the bids made, the WDP can find the optimal allocation of TV rights across bidders such that it maximizes the auction revenue. Also, the package bids reduce the aggregation risk for bidders if compared to other auction formats that do not allow for package-based bids.
[28] Both questions may have an impact on the WDP, see section 2.3.

Depending on the results of such experiments, the next step might be the design of a pilot case in collaboration with leagues with fewer teams, e.g. a regional league.

Also, a combinatorial auction is adaptable to environments with different types of platforms, e.g. free-to-air TV channels, pay-TV channels, and OTT media services.[29] Potential ways of dealing with different platforms in the same auction are as follows.

- Treat all platforms equally with all competing for the same broadcasting rights on equal terms. However, in practice, this may put less profitable platforms at a disadvantage. For example, less profitable platforms may only be able to compete for matches of lower quality and fewer matches.
- Consider reserved broadcasting rights for some matches that can only be allocated to specific types of platforms, e.g. free-to-air TV channels or an OTT regime. See Myers (2013) for the case of reserved spectrum for new entrants and smaller operators in the UK 4G auction.
- Restrict the exclusivity of the broadcasting rights of a match, as recommended by Budzinski et al (2019). The TV rights of each match may be sold with exclusivity, i.e. only the winning bidder can broadcast or resell a given match, or without exclusivity, i.e. there may exist multiple winning bidders that can broadcast or resell the match. The non-exclusivity is equivalent to having more lots for sale in each category, e.g. the broadcasting rights of each match (or a subset of matches) can be sold twice.

5 Conclusions

This article sets out how a combinatorial auction can be used to sell TV broadcasting rights in league sports. Combinatorial auctions are technically complex but can also offer several advantages, including the following.

- First, bidders can express non-additive valuations for multiple different packages of matches in a combinatorial mechanism. This feature is particularly relevant if, for example, there are material complementarities among matches (AdC, 2018; Budzinski et al, 2019). A more accurate expression of the bidders' valuations, including complementarities, via the bids made can potentially: i) address the bidders' aggregation risk; ii) lead to a more efficient allocation of TV rights; and iii) result in higher auction prices and revenue for the league.
- Second, the league does *not* need to pre-determine packages of TV broadcasting rights in a combinatorial mechanism. In a combinatorial auction, the bundles of matches to be sold to each bidder are defined endogenously on a competitive basis depending on bidder valuations. This feature addresses various competition issues, namely facilitating market entry and preventing coordination among bidders.

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7 Annex

Table A.1: Assignment stage bids and outcome for category B (8 matches)

Bidder	Package	Assignment bids (€m)	Bidder	Package	Assignment bids (€m)	Total bid value (€m)
Medium	(1,2)	0.1	Big	(3,4,5,6,7,8)	0	0.1
Medium	(1,3)	0.15	Big	(2,4,5,6,7,8)	0.1	0.25
Medium	(1,4)	0.1	Big	(2,3,5,6,7,8)	0	0.1
Medium	(1,5)	0	Big	(2,3,4,6,7,8)	0	0
Medium	(1,6)	0	Big	(2,3,4,5,7,8)	0	0
Medium	(1,7)	0.2	Big	(2,3,4,5,6,8)	0	0.2
Medium	(1,8)	0	Big	(2,3,4,5,6,7)	0	0
Medium	(2,3)	0	Big	(1,4,5,6,7,8)	0	0
Medium	(2,4)	0	Big	(1,3,5,6,7,8)	0.2	0.2
Medium	(2,5)	0	Big	(1,3,4,6,7,8)	0	0
Medium	(2,6)	0	Big	(1,3,4,5,7,8)	0	0
Medium	(2,7)	0	Big	(1,3,4,5,6,8)	0	0
Medium	(2,8)	0.1	Big	(1,3,4,5,6,7)	0	0.1
Medium	(3,4)	0	Big	(1,2,5,6,7,8)	0	0
Medium	(3,5)	0	Big	(1,2,4,6,7,8)	0	0
Medium	(3,6)	0	Big	(1,2,4,5,7,8)	0	0
Medium	(3,7)	0.05	Big	(1,2,4,5,6,8)	0.3	0.35
Medium	(3,8)	0	Big	(1,2,4,5,6,7)	0	0
Medium	(4,5)	0.15	Big	(1,2,3,6,7,8)	0	0.15
Medium	(4,6)	0	Big	(1,2,3,5,7,8)	0.25	0.25
Medium	(4,7)	0	Big	(1,2,3,5,6,8)	0	0
Medium	(4,8)	0	Big	(1,2,3,5,6,7)	0.1	0.1
Medium	(5,6)	0	Big	(1,2,3,4,7,8)	0	0
Medium	(5,7)	0	Big	(1,2,3,4,6,8)	0	0
Medium	(5,8)	0	Big	(1,2,3,4,6,7)	0	0
Medium	(6,7)	0	Big	(1,2,3,4,5,8)	0.2	0.2
Medium	(6,8)	0	Big	(1,2,3,4,5,7)	0	0
Medium	(7,8)	0	Big	(1,2,3,4,5,6)	0	0

Note: green row shows the assignment outcome that attains the highest total bid value. Specific matches are numbered from 1 to 8. The total bid value in each row corresponds to the sum of the respective assignment bids from bidders Medium and Big.