10. Harnessing auctions for better-informed public policy decisions

Summary

- Auctions can help to elicit market information that is otherwise hard to obtain and can improve public policy decisions.
- Where there is a choice between alternative spectrum that can be reserved to promote competition, utilising auction bidding can assist in deciding the more economically efficient option (thereby mitigating the regulatory failure of the regulator having to make a less informed decision before the auction). This approach was implemented in the UK's 2013 auction through the use of flexible reservation ('spectrum floors').
- Auction bids can also be used to provide information on the costs of coverage obligations, enabling a better understanding of the balance between their costs and benefits.

The information usually elicited by auction bids relates to deciding the identity of the winning bidders in the auction and the prices to be paid. By examining actual and proposed examples in the UK, this chapter shows how auctions can also be designed to incentivise auction bidders to reveal other valuable information which might otherwise be difficult or impossible to obtain. Public policy decisions often involve weighing up pros and cons, or costs and benefits. The examples show how information drawn from auctions can illuminate different parts of a cost-benefit analysis, including the opportunity cost of policy alternatives.

With an objective of economic efficiency, the regulator seeks to design the auction to obtain accurate information through straightforward bidding. Fully achieving this is difficult due to auction design complications and the scope for strategic bidding. Nevertheless, auctions can often be designed to provide reasonable incentives. If so, they can yield good evidence that would otherwise be lacking, as for deciding how much of the band to clear in the USA's incentive auction in 2016–17 (see Section 6.1): 'the novel two-sided broadcast auction successfully reallocated 84 MHz of prime

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spectrum, raised almost $20 billion in gross revenue, compensated winning television stations, and deposited $7.3 billion in the Federal Treasury'.[1] The first section considers how reserving spectrum flexibly can help improve the economic efficiency of regulatory interventions, and the second section then looks at eliciting more accurate views from mobile providers about their costs of providing different levels of coverage.

10.1 Flexible spectrum reservation: mitigating regulatory failure

In the UK's 2013 auction the regulator Ofcom had a choice of spectrum bands to reserve in order to promote downstream competition, but was uncertain which would be more efficient. Ofcom considered it was important to maintain downstream competition between four credible operators, but one firm (H3G, the smallest incumbent) was at risk. Ofcom identified different minimum spectrum portfolios which could be reserved to provide the required capability for a fourth credible operator to be sustainable – either H3G or a new entrant. The alternatives were either a smaller amount of higher-value *coverage* spectrum in a low-frequency band, or a larger amount including higher-frequency *capacity* spectrum. But each of these alternative portfolios was also different between the two types of eligible bidder for reserved spectrum, because a new entrant without any pre-existing holdings would have needed more spectrum than H3G, especially low-frequency spectrum in order to build new national coverage.[2]

The usual method would be for the regulator to pre-specify the spectrum to be reserved (set-aside). However, this would require two levels of regulatory choice. The first decision would be whether to pick a spectrum amount for a new entrant or for H3G, since these were different. The second decision would be whether to favour reserving coverage or capacity spectrum. In an impact assessment, the analytical problem would be to balance the costs and benefits for each decision. Would the additional opportunity costs of reserving a larger amount of spectrum needed by a new entrant justify the incremental competition benefits compared to reserving spectrum for H3G? And which of the coverage or capacity spectrum requirements would achieve a better trade-off between the competition benefit and the opportunity cost of denying use of the reserved spectrum to other operators, the larger incumbents? A proxy for this second question was the balance between the value of each spectrum requirement to the beneficiary (H3G or new entrant) and the opportunity cost to other bidders. (It was a proxy because it would reflect the values to operators, not final consumers, even if there was likely to be a correlation between the two.) The values and opportunity costs depended on private information held by the operators which was not and could not be known by the regulator. Firms' self-interest meant that they did not generally have the incentive to provide this information.

Exploiting the potential of auctions to elicit private information, Ofcom chose a flexible reservation solution using 'spectrum floors' instead of setting aside pre-specified spectrum. The CCA format used in the 2013 auction allowed operators to bid for many different packages of spectrum. Each bidder eligible for the reserved spectrum made mutually exclusive bids for its alternative spectrum floors. The difference between these bid amounts was that operator's incremental bid value to prefer one package of reserved spectrum over the other – this was the benefit side of the equation. The cost side was derived by comparing different package bids made by other operators. They could place bids for all the spectrum in the auction, even though some of it would ultimately be reserved for the winning eligible bidder. So the relevant combinations of their various package bids identified their combined bid values for each spectrum floor which they could be denied the opportunity to acquire. The difference between these bid values for the spectrum in the different floors was therefore the opportunity cost

of one floor being reserved instead of the other. The choice of reserved spectrum from among the specified options was then determined as the spectrum floor, which optimised the net effect between the positive incremental bid value to the eligible bidder and the negative opportunity cost to other bidders. The approach of spectrum floors was designed to mitigate the regulatory failure that could have arisen under simple set-aside from the regulator choosing the wrong spectrum to reserve, i.e. involving a worse balance between costs and benefits.

The choice of minimum or reserve prices also helped to mitigate another type of regulatory failure. Ofcom set the reserve price for the more valuable, low-frequency band (800 MHz) closer to expected market value than its usual practice, in order to manage the trade-off between auction efficiency and the promotion of competition. The higher reserve price required substantial financial commitment to bid for spectrum floors – £225 million for H3G, and £480 million for a new entrant. Although far from a guarantee, this level of commitment mitigated the risk that reserved spectrum might be won by an operator that would only have a limited impact on competition, not justifying the probable loss in auction efficiency from reserving the spectrum and thereby denying it to the larger incumbents.

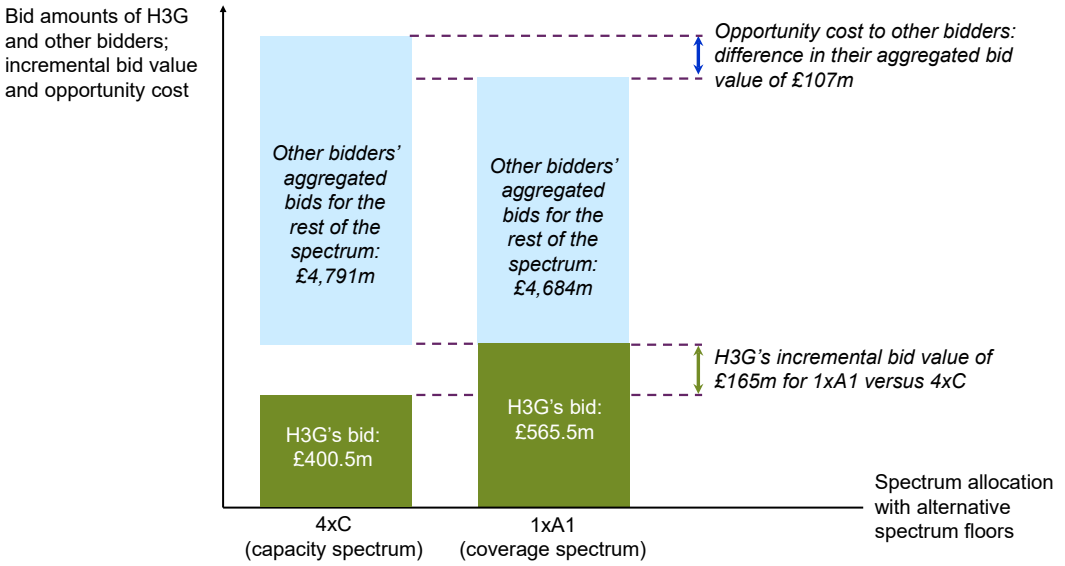
The auction design to implement the approach of spectrum floors meant that, in effect, the outcome was determined through linked sub-auctions within the overall auction:

- For reserved spectrum (4–16 per cent of the total spectrum auctioned) there could be competition between the two types of eligible bidder (H3G and new entrants), bidding for different spectrum floors.
- For unreserved spectrum other bidders (plus the eligible bidders beyond their spectrum floors) competed like they normally would for most of the spectrum in the auction.
- The choice of spectrum floor to be reserved then took account of both the benefits revealed by the bids of eligible bidders for reserved spectrum and the opportunity costs indicated by the bids of other companies.

As it turned out, only one eligible bidder, H3G, was willing to pay the reserve price for the spectrum floors, so there was no competition in the sub-auction for reserved spectrum. Ultimately, the reserved spectrum won by H3G was the smaller amount of low-frequency coverage spectrum, namely one 10 MHz lot of the 800 MHz band in category A1 (referred to as '1xA1') instead of the larger amount of higher-frequency capacity spectrum which was four 10 MHz lots of the 2.6 GHz band in category C ('4xC').[3] As shown in Figure 10.1, H3G preferred 1xA1 over the alternative spectrum floor of 4xC, and its bids indicated a benefit of £165 million – H3G's incremental bid value, the difference between its bids of £565.5 million for 1xA1 and £400.5 million for 4xC. This *benefit* exceeded the *opportunity cost* to other bidders of them being denied 1xA1 instead of 4xC – they would also have preferred to win 1xA1 instead of 4xC, but the strength of that preference expressed in their bids was £58 million less at only £107 million. (The reasoning to derive that opportunity cost was that, if the spectrum floor of 4xC were to be reserved for H3G in the first column of Figure 10.1, then the other floor of 1xA1 would be unreserved and available to other operators – their aggregated bid value for unreserved spectrum including 1xA1 was £4,791 million. Alternatively, if 1xA1 were the reserved spectrum for H3G in the second column, other bidders' aggregated bid value for unreserved spectrum including 4xC was £107 million lower at £4,684 million.)[4]

The use of spectrum floors in the 2013 auction serves to illustrate strengths and limitations of innovative market design. The regulator had no way outside auction bids to estimate reliably the benefits and opportunity costs of alternative spectrum floors. In the absence of better information, the

Figure 10.1. Choice of low-frequency spectrum (1xA1) as the winning spectrum floor in the UK's 2013 auction, because H3G's incremental bid value exceeded the opportunity cost to other operators



Source: Author from published bids in the 2013 auction.[5]

regulator was more likely to have chosen to reserve the lower-value capacity spectrum (4xC), if it had been forced to decide which spectrum to set aside before the auction. Based on the actual bids made, this would have been the wrong choice.

However, did the bids identify the most efficient outcome in this case? Some types of strategic bidding were foreseen and prevented by Ofcom's design choices. But H3G exploited a remaining gaming opportunity and guaranteed that it only paid the reserve price for its selected spectrum floor (by bidding an incremental value between the floors that matched the difference in their reserve prices of £225 million for 1xA1 and £60 million for 4xC). The firm's incentive to undertake this bid strategy was not entirely clear because the auction's pricing rule preserved a profit incentive to bid more straightforwardly. Also, H3G's approach was not driven by a simple budget constraint, because it ended up winning the much more expensive spectrum floor.

The bidding indicated a significant gap of £58 million between the incremental value to H3G for the higher-value coverage spectrum floor (1xA1) and the opportunity cost to other bidders. Compared to pre-auction expectations, it was surprising that the opportunity cost for this coverage spectrum was not higher, but it reflected a consistent pattern of bidding in the auction (especially EE's aggressive bidding at the margin for the higher-frequency capacity band). The question of the efficient choice of spectrum floor seems to turn on whether H3G's bid strategy substantially exaggerated its incremental intrinsic value. If H3G's true incremental intrinsic value was at least £107 million (the opportunity cost), an efficient choice was made in the auction. Only H3G held that information. However, if H3G's incremental intrinsic value was less than £107 million, it would have been more profitable for the firm to bid differently, reflecting that smaller differential value than the £165 million in its actual bids. The more that H3G's bid strategy departed from the difference in its intrinsic values, the larger a loss

in profit it would have been risking. These incentives reduced the likelihood that H3G's incremental intrinsic value was more than 35 per cent less than in its actual bids and below the opportunity cost of £107 million (see Annex C1). Although not conclusive, the evidence is consistent with the auction mechanism of spectrum floors used by the UK regulator having made the economically efficient choice in the 2013 auction.

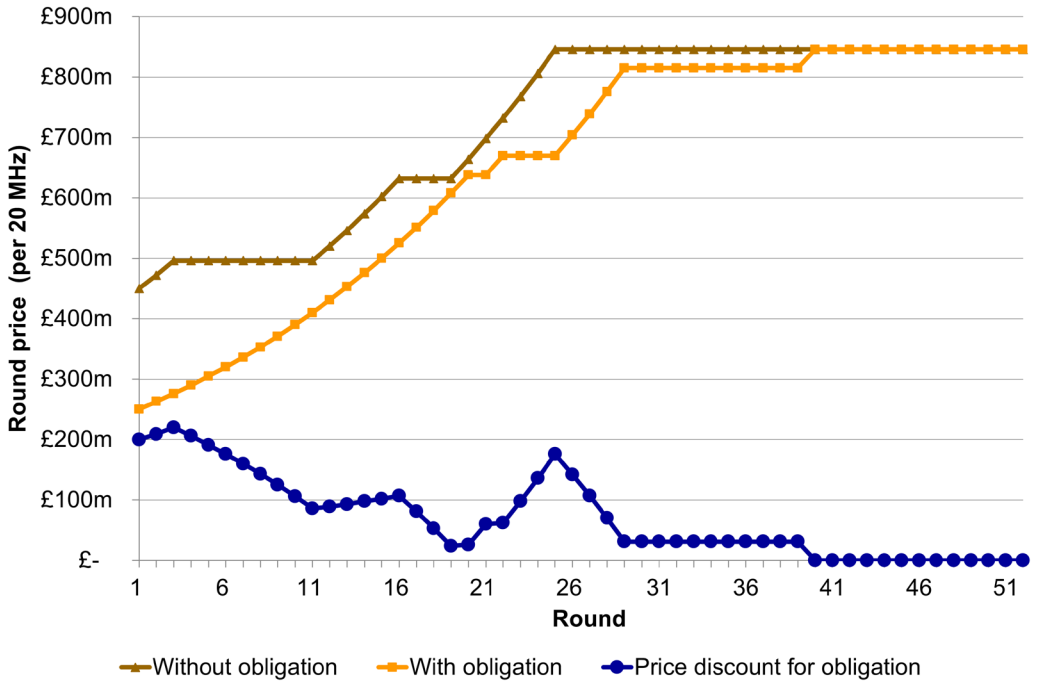
10.2 Extending mobile coverage: eliciting better information on costs

Another potential source of regulatory failure is misjudging the balance between costs and benefits of coverage obligations, which provide a challenging arena for impact assessments. The benefits of extending mobile coverage are not amenable to simple quantification and require significant policy judgement about the relevant broader social or public value. The costs to operators to expand their network coverage can be estimated by using network cost modelling. However, one reason for a potentially large error margin in any cost estimate is that it relates to a network which, by definition, has not yet been built, so requiring a range of assumptions to be made. Also, there is asymmetric information between the operators and the regulator. The operators would be the ones building the extended network, so they have better information about their costs. But their self-interest means they may not have an incentive to provide the regulator with unbiased cost estimates. Even without seeking to deliberately mislead the regulator (which can happen), operators are inclined to take a conservatively high view of the costs.

The price-setting function of auctions can illuminate the costs (but not usually the benefits) through pricing the coverage obligations. This was vividly seen in the UK's 2013 auction when the winning bidder, Telefónica, made the same bid for spectrum with and without the obligation (which was pre-attached to one of five lots in the low-frequency band, 800 MHz). These bids expressed a net cost of the obligation to Telefónica of zero, compared to Ofcom's deliberately conservative pre-auction estimate of £200 million, which in turn took account of pre-auction submissions from operators.[6] The contrast is illustrated by the evolution of prices in the clock stage shown in Figure 10.2. The blue line shows the price discount for the coverage obligation in each clock round. The discount is derived as the difference between the price for the same amount of 800 MHz spectrum without the obligation (the brown price line) and with the obligation (the orange line). The discount started in the first round at £200 million, the difference in the reserve prices chosen by Ofcom to reflect its pre-auction estimate of the cost of the obligation. By the end of the clock stage the discount had fallen to zero. An auction forces operators to put their money where their mouth is. In this way, it can reveal valuable market information that highlights the extent of regulatory failure in cost estimates.

Taking this one step further, innovation in design can harness the auction to contribute to some other difficult decisions which are prone to regulatory failure, such as the number and level of coverage obligations. Market information derived from auction bids can be used to conduct parts of the cost-benefit analysis within the auction itself. This approach draws on the insight that including coverage obligations in spectrum auctions makes them double-sided, with two logically distinct functions. The auction includes the *procurement* of coverage extension for public value, where the government pays operators to expand their network coverage. It also includes the *sale* of spectrum licences for economic efficiency, where the operators pay the government for rights to use valuable spectrum. The traditional approach is to link the two functions by pre-attaching a defined coverage obligation to specific spectrum in the auction, as in the UK in 2013. This method can work well, but it also has weaknesses because it mixes the two distinct functions when deciding the winner of the spectrum lots

Figure 10.2. Clock prices in the UK's 2013 auction for 800 MHz spectrum with and without the coverage obligation



Source: Author from published bids in the 2013 auction.[7]

that have pre-attached coverage obligations – the winning operator may bid the highest either because it has the lowest cost of expanding its network to meet the coverage obligation, or because it has the highest value for the spectrum attached to the obligation.

There are methods that can decouple obligations from spectrum, so that the logical distinction between the functions is also reflected in the structure of the auction.[8] Direct procurement outside the spectrum auction is, of course, one way to separate the expansion of coverage from the allocation of spectrum, for instance through procurement auctions such as the USA's rural broadband auctions.[9] The approach of holding separate spectrum and procurement auctions has three types of advantages:

- Efficient spectrum allocation: The spectrum can be allocated more efficiently, to the operator with the highest value (auction efficiency), regardless of the operators' relative costs of meeting the obligation.
- Lowest-cost operator: The obligation can be awarded to the lowest-cost provider of extended coverage (productive efficiency), regardless of the operators' relative values for spectrum.
- Better-informed judgement about the balance of costs and benefits: By eliciting improved information about the costs of the obligation, more informed public policy decisions can be made.

Some of these advantages can also be obtained when there are coverage obligations in the auction through decoupling the functions of procurement and spectrum allocation. Two examples of partial decoupling are the 2018 proposals in the UK, and Austria's 2020 auction.

Figure 10.3. Proposed lot structure in 2018 with unbundled coverage obligations

Source: Author from Ofcom (2018b).

2018 proposals in the UK: cost-benefit analysis within the auction

Ofcom made proposals for coverage obligations in 2018 (as noted in Section 5.3). They were not implemented, because the 2020 agreement between the government and the operators provided for expanded mobile coverage, so that the obligations were not needed and taken out of the auction held in 2021. However, the way that the regulator proposed to integrate the obligations into the auction design demonstrates some of the possibilities from harnessing auctions. The approach is illustrated in Figure 10.3, showing the proposed lot structure in the CCA design, including separate lot categories for spectrum (shown in green) and for coverage obligations (in red).

The two different types of lot mirror the two functions of the auction. As usual, the spectrum lots have positive prices. Operators have to pay a price at least as high as the reserve price (the minimum acceptable sale price) to acquire the spectrum in three bands: 700 MHz paired, 700 MHz SDL, and 3.6–3.8 GHz. The second type of lot is the two decoupled (or unbundled) coverage obligations. If there is a cost associated with meeting coverage obligations, operators have to be compensated to take them on, so that the coverage lots have a negative price – a subsidy, or discount on the price of spectrum that the operator also wins. This discount provides an incentive to attract bids for the obligations, with the regulator setting the negative reserve prices (the maximum discount). Competition in the auction affects the price of both types of lot. Excess demand for a lot category leads to the price being raised. For spectrum this means a higher price for the relevant spectrum band. For coverage obligations, raising the price means a lower negative price, or a smaller discount. The unbundling of the coverage obligations allows bidders to select the spectrum they want to bid for alongside a coverage obligation, thereby mitigating the regulatory failure of the regulator choosing the wrong spectrum to pre-attach to obligations. Unbundling also removes the risk of unsold spectrum from the coverage obligations being too onerous. Operators can bid for spectrum that they value, either with or without bidding for coverage obligations.

In this novel design the spectrum and coverage obligations are awarded simultaneously, allowing the auction to perform a role to balance the benefits and costs of the obligations. The benefit side of the equation is performed by the maximum discount, if it is set by the regulator to reflect the benefits (public value) from an obligation expanding mobile coverage. On this basis the UK regulator indicated in its 2018 proposals a maximum discount in a range of £300–400 million.[10] The cost side of the equation is derived from auction bids, as the difference in total bid value with and without an obligation. The coverage obligation cost in the cost-benefit analysis is then endogenous to the auction, reflecting two cost categories. There is a network cost of meeting the obligation, the cost an operator expects to incur by building out its network to achieve the required coverage extension (net of revenues it expects to receive). In addition, there can be an opportunity cost from a change in the allocation of spectrum due to the coverage obligations, e.g. an operator winning more spectrum because of leveraging its lower costs of meeting the obligation (instead of the allocation just

being determined by operators' values for that spectrum). A change in allocation can occur if there is incomplete decoupling of spectrum allocation and coverage procurement in the auction – in the UK, such partial decoupling arose from legal constraints.[11] The ability to identify the opportunity cost of a change in spectrum allocation exploits the richness of information and flexibility in the CCA format, as explained in the worked example in Annex C2.[12]

With the maximum discount set by the regulator to reflect policy judgement about the scale of coverage benefits and operators' bids revealing better-quality information about coverage costs, the cost-benefit-analysis role of the auction is twofold. The obligations can only be awarded if the discount is large enough to attract bids, meaning that an operator considers the benefits in the maximum discount are larger than its network costs of meeting the obligation. In addition, an obligation is awarded by the regulator only when the benefits represented by the maximum discount are at least as large as the costs reflected in auction bids, including the opportunity costs.

In this way the number of obligations procured is decided on the basis of the cost-benefit analysis of policy alternatives conducted within the auction (with the benefit side of the equation determined by the regulator in advance). Although not included in the regulator's 2018 proposals, the same principles could be applied to improve the choice of level of obligation – for example, whether the obligation should be for 90 per cent landmass coverage (as proposed by the regulator) or higher at 92 or 95 per cent. Optional add-ons to the basic 90 per cent obligation of +2 or +5 per cent could be offered at additional maximum discounts, reflecting the regulator's judgement of incremental coverage benefits. As for determining the number of obligations, the selected level of obligation would reflect the cost-benefit analysis within the auction. An add-on would only be awarded if it attracted bids and if the total costs, including any opportunity costs, did not exceed the benefits in the additional maximum discount.

The auction design therefore enables useful information about costs to be elicited from operators, allowing more informed decisions about coverage extension. There is a risk that strategic bidding could distort this information. However, sound auction design choices can mitigate strategic incentives (although not usually eliminate them). This means that market information from auctions can be better quality than pre-auction regulatory estimates 'in the dark'. The potential advantage is illustrated by the stark difference between the market information from the UK's 2013 auction, that the cost of the coverage obligation to the winning operator was zero, compared to the regulator's pre-auction estimate of £200 million. For the novel design in the 2018 proposals, implementation of the auction approach also requires the regulator to estimate the benefits of the obligation. That task is far from easy, but it can be done as indicated in 2018. Another way for public policy decision-makers to think about benefits is highlighted by the break-even cost-benefit question. How large would the costs have to be before, on balance, the obligation becomes disproportionate?

Austria's 2020 auction: granular coverage obligations

The 2020 spectrum auction in Austria included three bands – 700 MHz, 1500 MHz, and 2.1 GHz – and a range of coverage obligations.[13] It adopted a mixed model for the coverage obligations. Some were pre-attached to 700 MHz spectrum lots. Others were decoupled in a subsequent procurement stage, when operators could obtain a discount on the spectrum they had won in the previous stage. The product design for the obligations involved a large number of granular requirements, specified for 2,100 underserved municipalities. In all, 900 of the granular obligations were pre-attached to spectrum lots. Obligations for the remaining 1,200 municipalities were offered in the procurement stage. The granular obligations in this design offered a number of advantages of flexibility, especially in the

procurement stage, in a trade-off against the increased complexity. Obligations could be taken on by the operator best able to supply each municipality at lowest cost. Operators could assess their costs, and decide which obligations to bid for in small increments of municipalities. The auction rules also provided for subsequent swaps of granular obligations between operators, using an exchange (web portal) set up by the regulator acting as a clearinghouse, to assist in fine-tuning the efficiency of the obligations' allocation.

A large proportion (81 per cent) of the coverage obligations for municipalities were taken up by operators (about 1,700 out of 2,100). The obligations were only awarded if the reserve price restrictions were met, which were set by reference to an estimate of coverage costs, not benefits.[14] As such, the reserve prices were performing more of a check on cost efficiency and a limit on the budget of available funding, rather than a cost-benefit function as in Ofcom's 2018 proposals in the UK.

Conclusions

The standard approach to coverage obligations is pre-attaching them to specified spectrum blocks. The examples from the simultaneous approach in the UK's 2018 proposals and the sequential stages for granular obligations in Austria's 2020 auction highlight that much more can be done through innovations in auction design to improve the procurement of increased mobile coverage and balance it with efficient allocation of spectrum. A similar point about the scope for innovative design is demonstrated in Section 10.1 on using the UK's 2013 auction to choose the spectrum to be reserved between alternatives to promote downstream competition. The wider lesson is that talk is cheap, whereas auctions bids are binding commitments. In the right circumstances, this power of well-designed auctions can be harnessed to incentivise the provision of market information to make better-informed public policy choices, thereby mitigating risks of regulatory failure and enhancing decisions about cost-benefit trade-offs. The auctions for coverage obligations illuminated the cost side of the equation, whereas in the example of spectrum floors, auction bids provided information on both the benefits and costs of policy alternatives.

Notes

[1] Kwerel et al. (2017, p.467).

[2] Specifically, the choice of spectrum floors for H3G was either 10 MHz at 800 MHz, or 40 MHz at 2.6 GHz; and for a new entrant either 30 MHz at 800 MHz, or 40 MHz across both the 800 MHz and 2.6 GHz bands (20 MHz in each).

[3] In practice, the determining bids were made in the supplementary bids round. For further explanation of the bidding, see Myers (2013).

[4] Figure B1.8 in Annex B1 also shows further detail of each operator's specific winning and alternative packages and their associated bid amounts for H3G to win 1xA1 compared to 4xC as the reserved spectrum.

[5] See Ofcom '800 MHz & 2.6 GHz Combined Award: Details of Bids made in the Auction', Zip file, https://webarchive.nationalarchives.gov.uk/ukgwa/20220104120035mp_/http://static.ofcom.org.uk/static/spectrum/800_2.6_auction_bid_data_files.zip.

[6] In fact, Telefónica made a slightly higher bid by £1,000 for spectrum with the obligation. Its winning bid was £1,219.003 million for 20 MHz in the 800 MHz band including the obligation, and it bid £1,219.002 million for the same amount of 800 MHz spectrum without the obligation. The auction price that Telefónica paid was based on the second-price rule, reflecting the highest losing bid for the obligation by Vodafone, and included a discount of £31 million compared to the price without the obligation – see Ofcom (2015, paragraph 2.59a)).

[7] See Ofcom '800 MHz & 2.6 GHz Combined Award: Details of Bids made in the Auction', Zip file, https://webarchive.nationalarchives.gov.uk/ukgwa/20220104120035mp_/http://static.ofcom.org.uk/static/spectrum/800_2.6_auction_bid_data_files.zip.

[8] Ihle and Taylor (2020).

[9] FCC 'Rural Broadband Auctions', https://perma.cc/L427-GG5F.

[10] For various complications and the derivation of the proposed range for the maximum discount, see Ofcom (2018b, annex 13).

[11] The incomplete decoupling was caused by the UK regulator's statutory powers not allowing it to make a net outpayment to any auction bidder. This restriction limited the largest size of any bidder's discount to the price paid for the spectrum that it acquired in the auction, which Ofcom called the 'positive price constraint', because the overall price paid in the auction by any bidder, net of discounts for a coverage obligation, was not legally permitted to be negative. The positive price constraint could lead a bidder for a coverage obligation to artificially increase the amount of spectrum in its package in order to increase its effective discount. In other countries where the regulator has powers to make net outpayments to a bidder from an auction, the unbundling of the coverage obligations could fully decouple procurement of coverage extension from spectrum allocation. The cost-benefit issue would then just be about attracting bids at a maximum discount that is set by reference to the expected benefits of the obligation.

[12] In addition, a *simultaneous* auction of spectrum and coverage obligations (as in the 2018 proposals) can derive this opportunity cost of different spectrum allocations depending on whether the coverage obligation is awarded. However, it would not be revealed in a *sequential* award of spectrum and then obligations.

[13] RTR 'Multi-band auction 700/1500/2100 MHz (2020)', https://perma.cc/ZCY2-DWWT.

[14] There was a maximum total discount for the procurement stage that the bidders could obtain between them, and also a maximum discount for a certain number of municipalities.

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Note: means an open access publication.

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