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Auction special issue

dot·econ Perspectives

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Digital Dividend, the Danish way

The Danish 800MHz auction stands out from the recent slew of Digital Dividend auctions for a number of reasons. Even though it produced only two winners and some of the lowest prices in Europe, competition in the auction has been effective. And uniquely amongst recent spectrum auctions, the Danish 800MHz auction also took care of allocating fairly demanding coverage obligations alongside spectrum usage rights. As a result, virtually all Danes will have access to fast broadband in the short term.

Digital dividend spectrum for fast wireless broadband coverage

The next generation mobile technology will bring substantial improvements in data communication. A file, song or video can be downloaded in a quarter of the time needed using a typical 3G device, and possibly even less. Several mobile operators are already offering 4G services in Danish cities, using higher frequency spectrum in the 1800MHz or 2.6GHz band.

Higher frequency spectrum has one disadvantage, however. Radio waves in that frequency range do not travel very far, which means that many cell sites are needed to cover a given area. This does not matter so much in densely populated areas, where base stations need to be built in any case to provide capacity – but it makes covering sparsely populated, rural areas rather unattractive. Lower frequencies would be much more suitable for this. With signals travelling farther, fewer cell sites are needed to cover any given area.

The spectrum traditionally used for terrestrial television broadcasting fits the bill perfectly. And with the move from analogue to digital transmission, a sizeable portion of this spectrum has become available. Using this so-called 'digital dividend' to bring fast mobile broadband services to areas where there is a need to improve the availability of access to broadband services is therefore an attractive policy option.

Faster services for more users

Improving access to broadband in Denmark however is no mean feat. Basic broadband is available to almost every citizen. At present 99.9% of the population have access to download speeds of at least 2 Megabit per second (Mbps) - virtually all Danes can download a music album in less than 15 minutes. 96% of the population have access to connection speeds of 10Mbps (where the same album downloads in less than three minutes), and a 100Mbps service (where the download takes seconds) is available to almost 40% of the population.[1]

With virtually everyone enjoying some form of broadband access, improving services means extending the reach of higher bandwidth offerings. The Danish government has an ambitious target that all households and businesses should have access to at least 100Mbps by 2020.[2] While 4G networks may not necessarily be able to deliver such an ultra-fast service, they can serve to improve the availability of fast broadband access in the interim.[3]

Demanding coverage obligations flexibly assigned

Extending broadband coverage is an important policy goal in Denmark and the government has used coverage obligations to achieve this in the past. For instance, the 3G licences awarded in 2001 came with an obligation to serve 80% of the population.

1 See Danish Business Authority's 2011 broadband mapping: "Bredbåndskortlægning 2011, version 8th March 2012".
2 See The High Speed Committee's 2010 statement: "Denmark as a high-speed society", and the Danish Business Authority's 2011 broadband mapping, ibid.
3 Although 4G networks are capable to provide theoretical peak speeds of over 100Mbps, in practice, users will experience somewhat reduced speeds. When TeliaSonera launched its 4G network at the end of 2010, it estimated average speeds of between 10-40Mbps.

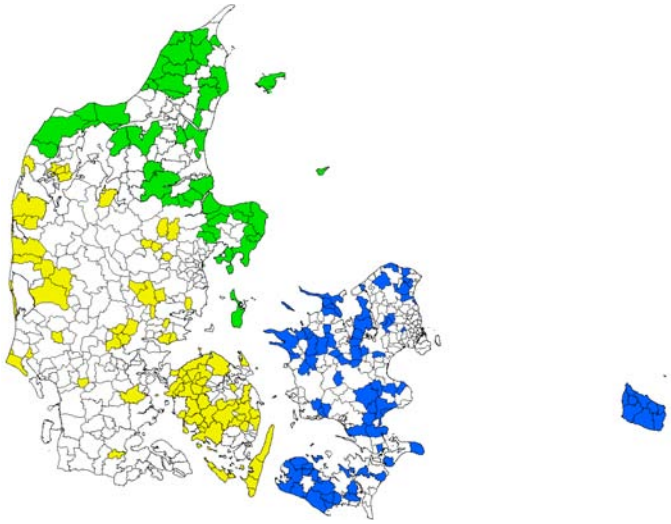

Figure 1: Postcodes to be covered

Fast forward to 2012, and coverage obligations are used again in the 800MHz award to drive availability of faster services. And those obligations are fairly onerous – given that availability of basic broadband is sorted, the name of the game now is an obligation to provide services offering download speeds of at least 10Mbps. By comparison, other countries require coverage with services that offer access speeds of 1 or 2 Mbps.[4] The Danish regulator identified a list of 207 postcodes where the availability of a 10Mbps service was poor. These postcodes were then grouped into three regions as shown in the figure above.

While the coverage obligation in itself was fairly demanding, the Danish auction offered some flexibility in how it would be met. Specifically, the Danish auction allowed individual winners of spectrum to bid for being exempt from the coverage obligation in one or more regions, provided that overall the obligation would still be met.

The coverage obligation was initially attached to all blocks. In the auction, bidders could bid for exemptions from the coverage obligation alongside the spectrum they wished to acquire. Winning a particular regional exemption would exempt the licensee from serving the coverage obligation in that region and winning all regional exemptions would exempt the licensee from the obligation completely. Therefore unlike in other European countries where the coverage obligation had been attached to specific lots, the Danish auction supported a range of spectrum and coverage obligation assignment outcomes. One operator could be assigned the obligation in all three regions or a different operator could be assigned the obligation in each region. The operator would also have the flexibility to choose the spectrum package required to serve the coverage obligation.

Spectrum was offered as a 2x10MHz 'A' block located at the bottom of the 800MHz, with the rest of the band being split into four generic 'B' blocks (2x5MHz). Winners of any B block would have to cover all three regions, unless they also won an exemption from covering particular regions. Because the A block was subject to usage restrictions to protect adjacent DTT transmission, the winner of that block would have to cover postcodes in the green region only, unless accompanied by an exemption.

In order to ensure that the coverage obligation would be met, a bidder bidding for a spectrum package with exemptions was required to place a reserve price bid for the same spectrum package without any exemptions. Therefore, a bidder who wanted to participate in the auction had to be prepared to serve the coverage obligation if it were awarded spectrum at the reserve price. Reserve prices were kept at a moderate level not to discourage participation in light of this requirement, which ensured that the coverage obligation could always be assigned if suitable spectrum was sold.

Keeping the number of available exemptions in each region below the number of winners,[5] the price of exemptions could then be determined in the auction alongside the price of spectrum.

Overall, this process ensured that the coverage obligation would be assigned in the most effective manner. The most efficient operator with the lowest cost of serving the obligation should have the lowest willingness to pay for an exemption and is thus least likely to win the exemption in that region. Through competition in the auction, *both* spectrum and the coverage obligation would be efficiently assigned. This minimised the risk that spectrum (and thus the obligation) might not be assigned.

A happy ending

In the end, there were only two winners in the auction. TDC won 2x20MHz of spectrum – twice the amount of any other operator in Europe to date. TT-Network, a joint venture between TeliaSonera and Telenor, paid the lowest price per population in Europe for their 2x10MHz licence, and secured an exemption from serving out the coverage obligation.[6] In light of this result, has the auction achieved the government's objectives?

Given that there was no specific revenue raising objective for the 800MHz auction, the fact that licence prices were low is moot. Rather, the main objective was to ensure that both spectrum and the 10Mbps coverage obligation would be efficiently assigned. This was achieved by enforcing bids that could fulfil the coverage obligation as a pre-condition for participating in the auction, and only selecting outcomes in which the coverage obligation was fully met. The low licence prices are thus simply a feature of these restrictions and the moderate reserve prices.

A more appropriate measure of success is to look at whether the coverage obligation assigned in the process will ultimately bring fast broadband to virtually all Danes. With three out of the four mobile operators having access to digital dividend frequencies, 4G services will be available to virtually everyone in Denmark with the coverage obligation ensuring that those in more remote locations are not left behind.

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4 Germany and Sweden required the provision of a service that would allow a user to experience download speed of 1Mbps while Italy imposed a slightly higher bar of 2Mbps. France defined its service required in terms of theoretical peak speed of 30Mbps while Portugal defined the required access speed to be that subscribed to by the lowest quartile of consumers. Spain specified an access speed requirement of 30Mbps though there is no clarity whether this would be a peak or average user experience speed or some other metric.

5 In coverage area 1, the number of exemptions available is the total number of winning bidders less one. In coverage area 2 and 3, the number of exemptions available is the number of winning bidders of B lots less one.

6 As a matter of comparison, operators in other European countries paid between two and eight times what TT-Network did in the Danish auction for essentially the same frequencies. TT-Network won frequencies in the range of 791-801MHz paired with 832-842MHz. Other European countries however may impose different usage conditions than Denmark on the use of these frequencies.

After the Big Bang

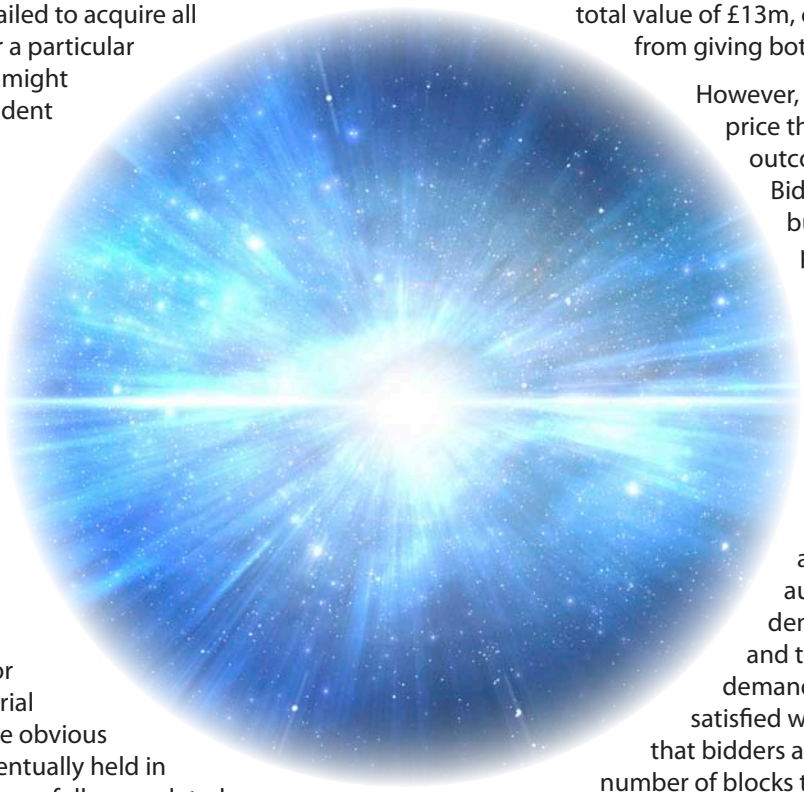
The recently completed Swiss multi-band auction can justly be regarded as a success: one of the most complex award processes has produced a spectrum allocation that allows all bidders to innovate and deploy new technologies while safeguarding existing services. At the same time, many commentators were put off by the fact that bidders acquiring similar spectrum portfolios ended up paying rather different amounts. Whilst this might appear at first blush to be a major flaw, the outcome simply puts the spotlight on the incentives created by the auction design, and the tension that could exist between efficiency and uniform pricing.

Mission impossible? Mission accomplished.

When the Swiss Communications Commission at the end of 2008 decided to offer all spectrum suitable for the provision of mobile services in one go, the path was set for one of the most complex spectrum auctions held to date.

The frequencies on offer covered five different bands and would become available at different dates from the beginning of 2013 to the end of 2017. Spectrum would be offered in small chunks, allowing bidders to assemble whatever spectrum portfolio they needed to continue their existing business and plan for the future deployment of new technologies.

While this gives bidders maximum flexibility in terms of how they meet their spectrum needs, it also means that the value of individual blocks on offer depends on what other spectrum a bidder expects to win. Because new technologies benefit from larger amounts of contiguous spectrum, and because spectrum in different bands is needed for coverage and capacity, there were likely to be synergies across the individual frequency blocks on offer, both within bands and across bands. This meant that bidders could be exposed to so-called 'aggregation risks': if they failed to acquire all the spectrum they need for a particular deployment scenario, they might be left with a rather severe dent in their business case, like someone who tries to put together a jigsaw puzzle and finds that one or two pieces are missing.



In order to remove this risk, the auction format had to allow bidders to bid for packages of frequency blocks. They would only ever win a usable combination of blocks and would not face the prospect of ending up with an incomplete combination of blocks and pay more than its worth. For this reason, the Combinatorial Clock Auction (CCA) was the obvious choice. The auction was eventually held in February 2012, and was successfully completed within two and a half weeks. All bidders managed to leave the auction with comprehensive and future-proof spectrum portfolios. The main objective for the award process had been achieved.

A fly in the ointment?

But the outcome also has attracted some attention and criticism because bidders who acquired broadly comparable spectrum packages ended up paying substantially different amounts. In particular, the difference in the amount paid by Swisscom and Sunrise for broadly similar spectrum portfolios has variously been described as an indication that the CCA is susceptible to strategic bidding or a major design flaw because the format does not guarantee uniform or comparable prices.

This critique is however misguided. Uniform pricing, or ensuring that bidders pay comparable amounts is not an objective of the CCA. On the contrary, the major selling point of the CCA is that it supports outcomes that do not require (or imply) uniform per-lot prices because such prices would be incompatible with efficiency.

Consider a very simple example with two bidders competing for two identical spectrum blocks. Assume that their valuations are as shown in the following table.

Value of … (£m)	Bidder A	Bidder B
Single block	4	9
Two blocks	12	10

Bidder A values one block at £4m, and two blocks at £12m. The bidder benefits from synergies – the value of two blocks is higher than twice the value of a single block. Bidder B, by contrast, places a high value on the first block, but has a low incremental value of the second block.

The efficient outcome – the one that generates the highest value – is to give one block to each bidder. This produces a total value of £13m, compared with at most £12m from giving both blocks to Bidder A.

However, there is no uniform per-block price that would support such an outcome. At any price at which Bidder A would be prepared to buy a single block, it would prefer to have two blocks. There simply is no per-block price that would lead to market clearing.

Consider the case of a simple clock auction in which bidders nominate the number of blocks they would like to acquire at a price announced by the auctioneer. If there is excess demand, the price increases, and the auction ends when demand from the bidders can be satisfied with existing supply. Assume that bidders at any given price bid on the number of blocks that gives them the greatest surplus (that is the maximum difference between their

Irish multi-band auction completed

The Irish telecoms regulator, ComReg, has released the results of its multi-band auction on 15 November 2012. H3GI, Meteor, Telefonica and Vodafone won spectrum rights in the 800MHz, 900MHz and 1800MHz bands paying €854.64 million of which €481.7 million will be paid upfront and the remaining €372.95 million paid in annual fees over the 17 year licence period.

DotEcon advised ComReg throughout the process and the auction was run on DotEcon's WebBidder auction platform.

The auction followed a "Combinatorial Clock Auction" (CCA) format similar to that proposed by Ofcom for the upcoming 4G auction in the UK and used in number of recent spectrum auctions including the Danish 800MHz auction and the Swiss multi-band auction (see separate articles). The Irish auction included a number of novel features, such as the use of two time slices – requiring innovative activity rules – and party-specific lots giving bidders the option to liberalise existing spectrum holdings.

valuation and the amount they would pay).

Bidder B will bid on two blocks up to a price of £1m, and will then drop back to bidding on one block only. At this price, bidder A would still wish to acquire two blocks. It will continue to bid on two blocks until the price reaches £6m, and then stop bidding completely. The auction ends, Bidder B wins one block for £6m and one block remains unsold – clearly not the efficient outcome.

What about the standard simultaneous multi-round ascending auction? Here, bidders make bids on individual blocks at block prices announced by the auctioneer. The price of a block that receives more than one bid goes up, and a new round takes place. If a block receives only one bid, the bidder who has made this bid is standing high bidder and wins the block if the auction ends. If two bidders have bid on a block, one of them will be chosen at random to be the standing high bidder. Bidders cannot increase the number of blocks on which they bid as the auction progresses, and standing high bids from the previous round are counted as bids in the current one.

in a CCA bidders can safely express value for incremental spectrum without affecting their own prices.

Let's label the blocks as Block X and Block Y, and start with block prices of £0.5m for each block. Both bidders bid on both blocks in round one, and assume that Bidder A is selected as standing high bidder on both blocks. The price of both blocks increases, say to £1m. Bidder B will then bid on both blocks in round 2, and overbid Bidder A. The price of both blocks increases further, say to £1.5m, and in round three Bidder A will bid on both blocks, overbidding Bidder B. The price of both blocks increases to £2m. In round four, Bidder B will bid on only one block – say Block X, leaving Bidder A to be the standing high bidder on Block Y. The price of Block X goes up to £2.5m. It is now Bidder A's turn, and being standing high bidder on Block Y, it will place a new bid on Block X in round five. In round six, Bidder B will bid on Block Y, which still costs only £2m. Bidder A will bid back on this block in round seven, and the price of this block now too goes up to £2.5m. Bidding continues until the price of the cheapest block reaches £6.5m. At this point, Bidder A will be standing high bidder on one block with a previous bid of £6m. It will have won a single block at a price that exceeds his single block valuation. Both bidders will pay the same, and the efficient outcome is reached – but only at the cost of one bidder suffering a substantial loss.

A farewell to efficiency

Of course, Bidder A may be aware of this risk and may decide to drop back to bid on one block as soon as Bidder B bids on only one block, i.e. at a price of £1m. In this case, both bidders enjoy a surplus. Similarly, in the clock auction Bidder A may expect that it will ultimately not be able to win both blocks, and rather than winning nothing at all may drop its demand to a single block at a price below the one-block value, ending the auction there and then.

Such an outcome looks fairly attractive from the perspective of bidders. They enjoy a higher surplus and avoid overpaying. However, reducing demand in order to keep prices low poses a substantial threat for efficiency. For example, even if Bidder A had a valuation for two blocks of £20m and it would therefore clearly be efficient to award both blocks to that bidder, the bidder is clearly better of settling for a single block at £1m if it expected that it would take a price of £8.5m or more per block before Bidder B stopped bidding. Uniform per-block pricing discourages competition for incremental spectrum because each bidder has an incentive to try and keep prices down. In particular where the number of bidders is limited, this means that the auction process becomes completely ineffective as a mechanism for finding out who values spectrum most and can make best use of it.

The truth, the whole truth and nothing but the truth …

The CCA gets round these problems by allowing bidders to make bids on multiple packages, knowing that they would win at most one of them and pay the minimum amount they could have bid to achieve this outcome. This does away with the requirement that winners pay the same price, and provides strong incentives for bidders to make bids that reflect their true valuation. It removes the risk of over-paying, and encourages bidders to bid for additional blocks without fear that they would drive up the price they have to pay if they ultimately had to settle for smaller packages.

So let's go back to the simple example above. Assume that both bidders submit bids for one and two blocks respectively at their valuations. The auctioneer determines the combination of bids with the largest total value that can be accommodated with the given supply, taking at most one bid from each bidder. By definition, this produces an efficient outcome. The auctioneer then establishes the lowest amount that each bidder could have bid and still won. This is the minimum amount that the bidder needs to pay to win over competing demand expressed in the bids of other bidders. Giving one block to Bidder A means that Bidder B has to be denied the second block, so Bidder A pays the difference between Bidder B's bids for two blocks and the bidder's one-block bid, that is £1m. Similarly, Bidder B pays the difference between the two-block bid and the one-block bid made by Bidder A, i.e. £8m.

Although both receive the same, one pays eight times as much as the other (though both pay less than the amount of their bid and so enjoy a surplus).

If the additional value that Bidder A puts on the second block is greater than the value that Bidder B bids on the first, and it is therefore efficient to award both blocks to Bidder A, the CCA will produce this outcome. Bidder A can safely express this additional value in the difference between its one-block bid and its two-block bid knowing that it will not affect its own price should it end up winning only one block. Of course, the bidder will in this case have to pay a price that reflects the cost of denying Bidder B two blocks (i.e. £10m), and this keeps the bidder from over-stating his willingness to pay for two blocks in order to increase the price that Bidder B might have to pay. For example, Bidder A in the above example might consider making a two-block bid for £14m in order either to win the two blocks, or to make Bidder B pay more. In this case, Bidder A would indeed win the two blocks, but be left with a surplus of £2m rather than the £3m it would have enjoyed from truthful bidding. Similarly, the bidder cannot increase its surplus by reducing bid amounts – if it wins, the price it pays is not affected by the amount of his bids, so by reducing bid amounts the bidder only runs the risk of losing altogether.[1]

Deficient or efficient?

The example, though very simple, highlights a number of points:

- An outcome where all bidders pay the same price for similar or identical lots may be incompatible with efficiency.
- Setting per-block prices may also tempt bidders to hide their demand to keep prices low rather than to compete for incremental spectrum.
- Providing bidders with incentives to reveal their true valuations can result in prices that are different – and potentially substantially so.
- Bidders who place very little, or no value on spectrum above and beyond what they win in a CCA cause little or no opportunity costs for others who may therefore pay relatively less compared with the amounts of their bids.

In light of these insights, the results of the Swiss multi-band auction should look less surprising. They do not suggest a defect in the auction format, but rather highlight the way in which the CCA aims at efficiency, and the way in which valuations may differ substantially across bidders. They are simply the consequence of the valuations expressed by bidders for different spectrum portfolios.

Some may still consider such a result to be unfair, but given the importance of efficient spectrum use, an outcome with similar prices could have had a huge efficiency cost.

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1 This may not be the case where the opportunity costs caused by groups of winners exceeds the sum of their individual opportunity costs and they collectively have to come up with an additional payment. In this case, there will be incentives to shade down bids to some extent. However, this bid shading incentive only arises where bidders expect to be members of winning coalitions.

DotEcon ITU broadband report

On 4 October 2012, a DotEcon report on broadband regulation was presented to an audience of regulators and policy makers at the International Telecommunication Union (ITU) Global Symposium for Regulators in Colombo, Sri Lanka. DotEcon was commissioned by the ITU Telecommunication Development Bureau to consider current industry trends and their implications for regulatory policy. In its report DotEcon shows how market convergence and resulting shifts in market definitions play a crucial role for the future of broadband regulation.

In particular, DotEcon examined the growth in demand for bandwidth, the economies of scope brought about by convergence, the increased prevalence of bundling and the importance of mobile broadband services. The report then considered the implications of these developments for regulators seeking to establish market boundaries and to regulate players with significant market power. DotEcon concluded that coming up with recommendations suitable for regulatory policy across a range of different jurisdictions with very different broadband ecosystems and very different economic conditions is impossible, and that a set of different measures may be necessary in order to deal with the various issues raised by convergence in the different circumstances.

A full copy of DotEcon's report is available the ITU's symposium website.

Fibre to the Home Council publishes DotEcon report

Fibre to the home (FTTH) networks are expected to play a key role in meeting the European Commission's Digital Agenda targets for roll-out and take up of ultra-fast broadband by 2020.

DotEcon has prepared a report for the Fibre to the Home (FTTH) Council Europe that examines how regulatory policy could support investment in fibre access networks, both in terms of applying the existing regulatory framework in the most conducive manner and pursuing additional policy options that would promote such investment.

The full report is available to download here.

FTTH Conference 2013

The FTTH Council Europe's annual FTTH Conference will be held in London next year. See www.ftthconference.eu for more details.

Big but not beautiful …

The Combinatorial Clock Auction (CCA) design has become the format of choice for large multi-band awards over the last few years. It makes bidding decisions simple for bidders and supports flexible lot structures. Bidders do not need to worry that much about how rivals might bid as bid decisions depend primarily on bidders' own valuations. This increases the chance of an efficient outcome. However, the CCA only works well if bidders can evaluate all the bidding options that are open to them. Such an evaluation will be challenging in the upcoming Canadian and Australian 700MHz auctions owing to the large number of lots on offer. Whether bidders will be able to manage this complexity is unclear. Whilst the CCA is good for solving complex allocation problems, this should not be an excuse for excessive and unnecessary complexity in the design of lots. Allocation mechanisms should be as complex as they need to be – but no more – to have the best chance of achieving an efficient outcome.

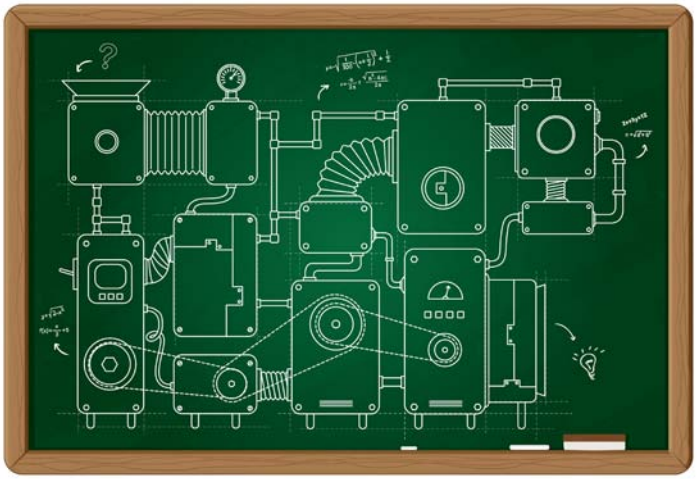
Valuation, valuation, valuation

The CCA has proven excellent in delivering efficient outcomes for a variety of reasons.

First, the CCA avoids the aggregation risks endemic in the more traditional SMRA. Offering radio spectrum in small slices – and possibly across a number of bands in one auction - gives bidders flexibility to acquire the combination of frequencies that best suits their needs. This is great for efficiency provided the auction format eliminates the risk of ending up with some unwanted subset of the lots sought.

Unfortunately, aggregation risks may be substantial in an SMRA, as standing high bidders are determined separately for each lot in each round. Bidders win their standing high bids when the auction ends, giving rise to the possibility of winning some lots they do not want because they have failed to win other complementary lots. This risk is hard to manage. It distorts bidding incentives and generally means that SMRAs cannot be expected to generate efficient outcomes where there are strong synergies between lots (as is typical in spectrum auctions). Aggregation risk is entirely absent in the CCA as bids are made for packages of lots, rather than individual lots (see box overleaf). In a CCA bidders can freely express their valuations for different packages without the fear of ending up winning something unusable.

Second, the approach used to determine winning bidders and prices in a CCA greatly reduces the decision-making burden on bidders. Unlike in an SMRA, there is no incentive to reduce the quantity bid for prematurely (so called strategic demand reduction). Straightforward bidding – bidding on the most preferred package in each clock round and then making supplementary bids according to valuations – is hard to beat in a CCA. Indeed, the activity rules and pricing rules are designed specifically to encourage such behaviour. The incentive for straightforward bidding also means that the bids made in the clock auction are likely to be informative about bidders' underlying valuations and so the clock rounds can reduce common value uncertainty.



Removing the need to think hard about bid strategy and making truthful bidding the path of least resistance allows bidders to focus on the key task of determining their valuations for different packages of spectrum. This ability to deliver efficient outcomes is why the CCA has become popular for spectrum awards around the world, in particular for large multi-band auctions.

A few thousands are company, millions are a crowd

Of course, simpler decisions for bidders only come at the cost of increased complexity within the auction mechanism. In particular, incentives for straightforward bidding and the CCA's ability to deliver efficient outcomes rely on the 'black box' of winner determination and second pricing that relies on some sophisticated mathematics.

As the complexity of the lot structure increases, the number of possible packages grows exponentially.

As the number of lot categories and lots within each category increases, the number of possible packages of lots balloons exponentially. In turn, this creates an exponential ramp-up in the computational demands of determining the winning bids and prices.

Many CCAs place a cap on the number of distinct packages that a bidder may bid for, primarily for reasons of practicality. However, where the lot structure becomes complex, this cap may well be needed to rein in the computational demands of determining the winners and prices within a reasonable time. For example, in the Swiss multi-band auction held at the beginning of the year, bidders could in theory bid on up to 2.8 million different packages. Allowing bidders to submit 2.8 million bids could potentially lead to scenarios where it would become computationally infeasible to find the winning outcome within a reasonable time. The maximum number of bids during the supplementary round was therefore restricted to 3,000.

Do such caps on the number of submitted bids undo much of the flexibility given to bidders in the first place? Usually not, as the efficiency of the CCA does not require bidders to make bids on all possible packages, but only those that are likely to be potential winning outcomes. The clock rounds provide a rough indication of likely market-clearing prices, which helps bidders to narrow down the packages on which they should focus their attention. Also, many theoretically possible packages would not make commercial sense anyway. This is how "big" multiple band auctions – such as the recent Irish and Swiss auctions –

Basic features of a Combinatorial Clock Auction

The CCA is aimed at giving bidders good incentives to reveal their valuations for different combinations of the available lots. Achieving an efficient outcome is then a matter of picking the combination of bids with the highest value that can be satisfied with a given supply. In the CCA, bidders bid on packages of lots. This removes the risk of ending up with unwanted combinations of lots that bidders face in the more traditional simultaneous multi-round ascending (SMRA) format. The second-price rule used in the CCA encourages straightforward bidding. The auction mechanism sets the prices to be paid by winners at the lowest hypothetical bid amount with which they could have still won. The format is ideal if spectrum is to be offered in small slices that are recombined, as bidders have the flexibility to obtain precisely what they need.

The CCA begins with one or more clock rounds. Similar lots are grouped into categories. The auctioneer announces a price for each lot category and bidders state how many lots in each category they want. If total demand in a category exceeds the available supply, the price for that category goes up in the next clock round. If there is no lot category with excess demand then the clock rounds end and a single further round – the supplementary bids round – takes place. In this round, bidders can make multiple bids, potentially both raising bids for packages already bid for in the clock rounds and making new bids for additional packages not yet bid for.

All clock bids and all supplementary bids are used for determining winners and prices. Taking at most one bid from each bidder, the auctioneer selects the combination of bids with the highest total value that can be satisfied within the available supply. The auctioneer then calculates the amount that the winners pay according to the second-price rule.

Open bidding over the clock rounds is aimed at mitigating the effect of common value uncertainty, which arises where the valuations of different bidders are affected by common uncertain factors (e.g. by the timely availability of technology or changes in consumer demand). Bidders' valuations may differ because of different expectations about the common factors, with the most optimistic bidder being the most likely to win. A rational bidder should bid cautiously to avoid over-paying (the so-called 'winner's curse'). Information about others' bids – even aggregate demand each round rather than full transparency of all bids – is helpful for firming up each bidder's valuations. This both reduces the risks faced by bidders and improves the chances of an efficient outcome as relevant information is pooled across bidders.

The supplementary round is aimed at allowing bidders to express their interest in a wider range of alternative packages. Unlike in the clock rounds, bids are not subject to the constraint that bid amounts have to be based on a common price per lot for individual lot categories. This allows bidders to reflect synergies in combining different lots (i.e. where the value of a combination of lots is higher than the sum of its parts).

The information revealed in the open stage is only valuable if bidders make bids that sufficiently reflect their true valuations. For the auction to achieve an efficient outcome, supplementary bids must reflect the value that bidders place on different packages rather than being driven by a desire to misrepresent valuations for strategic reasons. Activity rules encourage bidders to reveal their demand throughout the open stage. The second-price rule largely removes the incentive to bid strongly below valuation or for fewer lots than actually wanted in order to reduce winning prices.

have been successful despite the large number of potential packages.

The more you need, the less you get …

As the lot structure becomes more complex, there are more choices about how to combine individual lots creating an exponential blow-up in the number of possible packages. As a result, caps on numbers of bids may need to be tightened for practical reasons. At the same time bidders may require bids on many packages in order to express their preferences across reasonable alternatives.

The more complex the lot structure, the larger the number of combinations on which a bidder might reasonably bid. Even if a complex lot structure introduces distinctions that do not matter to a bidder, this still increases the number of bids needed even to express a lack of preference. For example, if a single lot now comes in the seven colours of the rainbow, expressing the fact that any colour would do takes seven bids. If we started with two lots (and the bidder wants both) and then make each one available in seven colours, the poor bidder has to make 49 bids to express the fact she does not care about the colour.

Offering spectrum on a regional basis is a particular problem in this regard. For example, the Australian and Canadian regulators have recently published their auction designs for awarding spectrum in the 700MHz band, which both feature a very complex lot structure.

- The Australians combine the award of national licences in the 700MHz band with that of regional licences in the 2.5GHz band. Given the proposed spectrum caps, a national operator who is interested in acquiring either a national or a regional footprint of 2.5GHz spectrum alongside 700MHz spectrum might need to evaluate up to 156 billion packages.
- The Canadians are planning to offer the 700MHz spectrum in regional blocks. Given the spectrum caps, a large wireless provider who is interested in either a national or a regional footprint may have valuations for up to 370 million billion packages. To put this in context, this means that if a bidder were presented with prices for each lot category and asked which package it preferred, the question is effectively unanswerable within any reasonable time unless simplifying assumptions are made (such as that categories are independent of each other). Therefore, the auction design is providing flexibility that could never practically be used by any bidder.

To reduce the computational load for determining the winning bids in the Australian and Canadian auctions, bidders are only allowed to submit up to 500 bids in total. This is a very limited number compared with the potential 156 billion or 370 million billion packages a bidder may be interested in.

How relevant is this? To a large part the answer depends on how informative the clock rounds are. In particular, the clock rounds must effectively provide bidders with the opportunity to identify the packages they are most likely to win. Bidders will truly need to find a needle in a haystack, or in the Canadian case, an atom in a needle in a haystack.

New activity rules to the rescue?

What if we tighten up the activity rules to increase the role of the open rounds and limit the impact of supplementary bids on the outcome? The open rounds at least allow bidders another shot if lots are oversubscribed.

The rules proposed for the Canadian and Australian auctions include activity rules that place great emphasis on the requirement that bids submitted during the auction need to be consistent with stable and consistent preferences maintained over all clock rounds. The proposed activity rules largely cement the final clock round outcome in place, meaning that bidders will have the option of guaranteeing that they obtain at least the lots on which they bid in the last clock round, regardless of the supplementary bids made by others. This means that limitations on the number of supplementary bids that a bidder is allowed to make have little impact on the outcome, as this is strongly fixed by the final clock round outcome. It also means that bidders better not make any errors during the clock rounds. Because any round could be the last, not bidding on the most preferred package at any point in time could do serious damage to a bidder and the efficiency of the outcome.

At first sight, that looks helpful; after all, we want strong incentives for bidders to bid straightforwardly as this promotes efficiency. However, there is a catch. Penalising bidders for deviating from their preferences is a good idea if they can reasonably be expected to work out exactly how they should value the various lot combinations on which they might bid, and to identify the best combination of lots at any particular set of prices (i.e. through global optimisation, not heuristics). If they can do this only approximately due to the intrinsic difficulty of answering the question "what do I want?", they may become tangled up in the web of activity constraints intended to promote straightforward bidding. This approach creates immense practical issues for bidders, contrary to the underlying ethos of the CCA that the auctioneer gathers complexity unto itself to make life easy for bidders.

Furthermore, this approach is inconsistent with the very fact that the CCA is a multiple round auction which seeks to mitigate common value uncertainty by allowing preference updating. Bidders may update their valuations during the clock rounds in light of information they receive about what other bidders are doing. If activity rules are too onerous, bidders may not be able to change their valuations in light of information received during the open rounds due to the constraints created by their earlier bids. If activity rules allow so little latitude that preference updating is effectively impossible, then there is little reason for an open auction at all.

Although the Canadian and Australian awards are substantially more complex for bidders than the Swiss auction, the activity rules that constrain bidding in the clock rounds and link the supplementary bids to clock bids are significantly more restrictive and unforgiving. Any bidding mistake during the clock rounds can have serious consequences, not only for the bidder, but also for the efficiency of the outcome.

Know thy limitations

There is no solution to the conundrum that greater flexibility implies greater complexity, which needs to be dealt with by either bidders or the auctioneer. Making the lot structure more differentiated means that bidders need to value a greater number of potential packages, and may need to make more bids. At the same time, there are constraints on the computational complexity of finding the winning outcome, which means that stricter limits may need to be placed on the number of bids.

The inherent trade-offs have to be acknowledged. Shifting complexity back on bidders certainly is not an easy way out. With so many packages on offer, telling bidders that all they need to do is simply to bid on their most preferred package in each clock round is perhaps a touch too simplistic.

Sophisticated auction designs have greatly assisted regulators by reducing their need to make administrative decisions on lot packaging. The CCA has tremendous potential to allow the market to explore alternative outcomes, for example choosing between different band plans or technologies that might have otherwise required a poorly informed administrative decision. However, the tool should not be imposed to allow regulators to skip all decisions on the lot structure and push unwarranted complexity back to bidders as a result.

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Competition and regulation digest

CC issues statement on Yellow Pages undertakings

On 27 November 2012, the Competition Commission (CC) published an issues statement in respect of the undertakings given to it by Yell Group plc (now Hibu plc) following the classified directories market investigation of 2006. In its October 2012 recommendation to the CC, the OFT noted that circumstances have now changed as a result of growth in internet access and usage by consumers and advertisers, which has likely led to the broadening of the range of competitive constraints on suppliers of printed classified directories. The OFT also noted that the use of printed directories appears to be in decline. In this context, the OFT considered that the CC's previous findings on Yell's market power may no longer be applicable and that the case for releasing Yell from its undertakings should be heard (subject to an assessment of the impact of removing the undertakings on other providers of printed classified directories).

DotEcon had provided support to a printed classified directories provider in respect of the CC's previous findings and the development of undertakings to apply within the market.

Ofcom BCMR consultation

On 15 November 2012, Ofcom published a further consultation document in respect of its Business Connectivity Market Review (BCMR), in which it had considered competition in the provision of leased line services in the UK. Ofcom makes a number of significant changes to the proposals made in its June 2012 BCMR consultation. In particular, Ofcom now proposes to impose certain accounting obligations on BT and KCom, in the product market areas where it submits that BT has significant market power (SMP).

In its earlier consultation, Ofcom consulted on its identification of a number of relevant wholesale and retail markets in specific geographic areas of the UK, its determinations in respect of the designation of SMP on BT and KCOM and its proposals on remedies to be imposed on the operators (in the form of services conditions and directions set out in the draft leased lines charge control document of July 2012). Ofcom now proposes to impose cost accounting obligations on BT and accounting separation obligations on both operators in each of the relevant wholesale product markets in which Ofcom has proposed that they have SMP.

DotEcon is providing expert economic advice and support to a telecommunications provider in its responses to the Ofcom BCMR and LLCC consultations.

Ofcom consumer choice research

On 13 November 2012, Ofcom published research that it had commissioned earlier in the year to understand the breadth of communication methods used by UK adults. This research included a review of consumer preferences for different forms of communication depending on whether they were communicating with friends and family or with businesses. The research considered ways such as meeting face to face, using voice calls on fixed landline or on mobile phones, text messages, emails, instant messaging, social networking and post. The report segmented the UK consumer population into five distinct groups according to their attitudes, ranging from heavy communicators that are 'Always-on' to more 'Detached' users for whom communication is not a priority. The findings are expected to feed into Ofcom's existing work on understanding consumer behaviour.

This research provides pertinent customer attitudinal evidence in the context of the regulation of fixed voice services, which are now subject to increasing substitution from means such as text messaging and emails. DotEcon had undertaken a number of regulatory projects in respect of such substitution, and is currently providing support to a telecommunications operator assessing the increase in competitive constraints on its provision of voice calls.

CAT Pay-TV judgement

On 26th October 2012, the Competition Appeals Tribunal (CAT) published a non-confidential version of its full judgement with respect to the appeals brought against Ofcom's decision to impose a wholesale must-offer (WMO) remedy on Sky. The WMO remedy required Sky to wholesale its Sky Sports 1 and 2 channels to rival pay TV retailers at a price set by Ofcom. Sky, Virgin Media, BT and the Premier League lodged their appeals with the CAT in June 2010. Sky had appealed Ofcom's decision on three grounds, two relating to Ofcom's jurisdiction and a third relating to Ofcom's findings.

In its judgement the Tribunal dismissed both of Sky's jurisdictional grounds of appeal, but upheld Sky's third ground of appeal noting that evidence from negotiations between Sky and rival retailers illustrated that Sky did, on the whole, engage constructively despite having a strong preference to self-retail. The CAT did not find it necessary to consider grounds of appeal raised by other parties to the case, notably in respect of the terms of the WMO remedy.

DotEcon has been providing expert economic advice to a media client over the course of this appeal.

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About DotEcon

We provide strategy and consulting advice to networked industries, offering analytical and empirical support to public sector bodies and private sector companies. The range of our services includes:

- **Regulatory advice**
- **Design of auctions or trading mechanisms and bidder support**
- **Economic and market analysis in competition cases and commercial litigation**
- **Public policy design and impact assessments**
- **Demand modelling, including econometric analysis of customer data, and development of pricing tools**
- **Business strategy and decision support**

We integrate rigorous theoretical economics with a thorough understanding of market realities to provide reliable, practicable and concise advice. Our consultants draw on a wide range of specialist skills including econometric analysis, economic and financial modelling, and the development of bespoke software tools.