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Some Observations on Spectrum Auctions

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The talk is based on

- Some recent academic articles
 - ‘Bargaining in Spectrum Auctions: A Review of the German Auction in 2015’, *Telecommunications Policy* (41), pp. 325-340, with Martin Bichler and Vitali Gretschnko.
 - ‘Raising rivals’ cost in multi-unit auctions?’, *International Journal of Industrial Organization* 2017 (50), pp. 473–490, with Vladimir Karamychev.
 - ‘Spiteful bidding and gaming in combinatorial clock auctions’, *Games and Economic Behavior* 2016 (100), pp. 186-207, with Vladimir Karamychev.
 - ‘On the Clock of the Combinatorial Clock Auction’, with Bernhard Kasberger.
- Experience in advising bidders in SMRAs and CCAs in Europe and North America, and evaluation of two Canadian CCA auctions



Historical Background

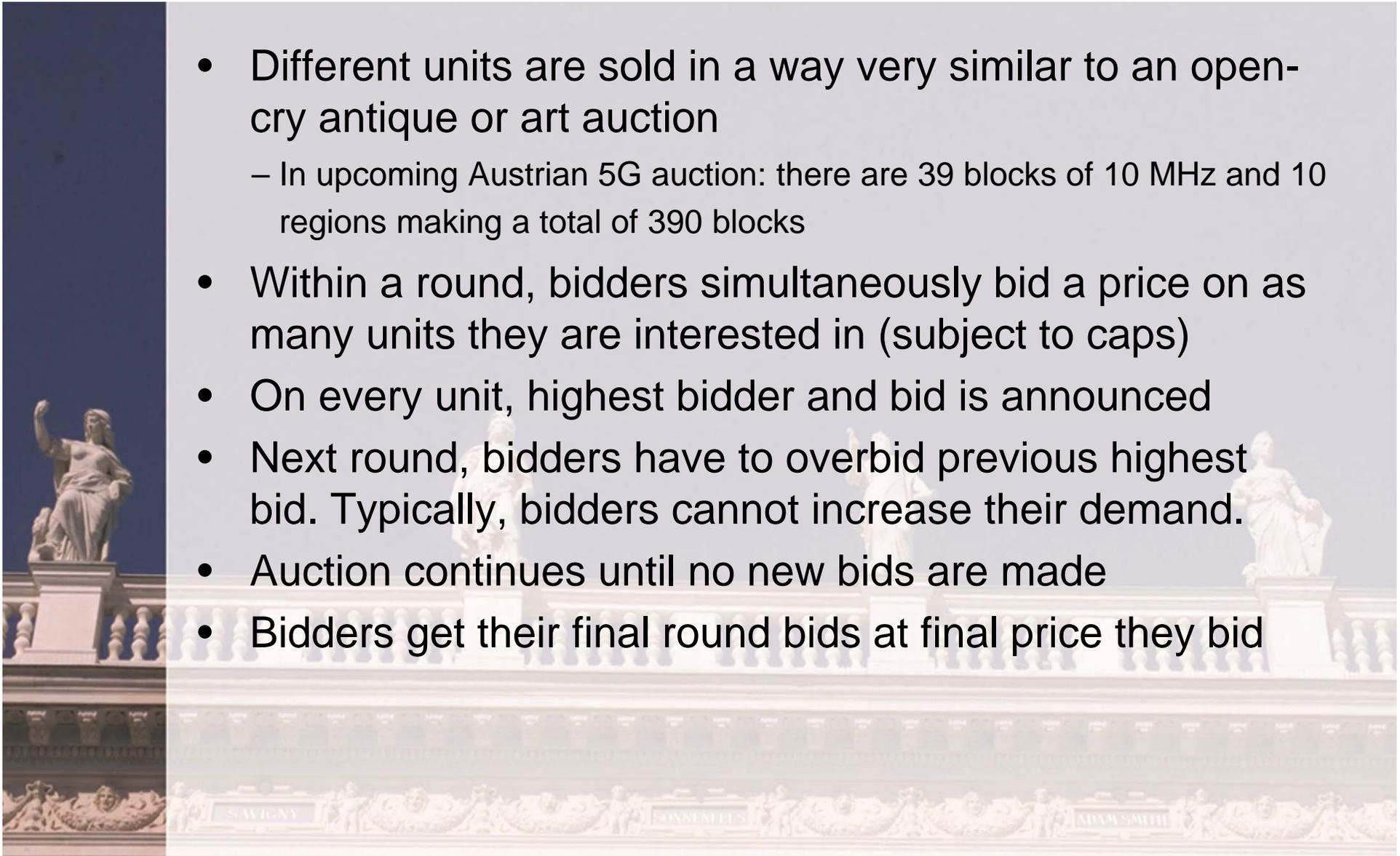
- FCC started auctioning spectrum rights in 1994 in USA
- Until 2012 SMRA was most frequently used auction method to allocate spectrum for mobile telecommunication usage
- Lots of experience led to two concerns:
 - Strategic demand reduction (tacit collusion)
 - Exposure problem
- CCA was invented to overcome these two issues:
 - Package bidding to overcome exposure problem
 - Second price rule to incentivize bidders to bid value (prevent demand reduction)
- Very short timeline between theoretical design and practical implementation
 - Only recently, some concerns with CCA are publicly documented
- Search for other auction formats
 - CMRA, simple clock auction (the one now proposed in Austria)
 - No auction format is the best in all circumstances





Simultaneous Multi-Round Auction SMRA

- Different units are sold in a way very similar to an open-cry antique or art auction
 - In upcoming Austrian 5G auction: there are 39 blocks of 10 MHz and 10 regions making a total of 390 blocks
- Within a round, bidders simultaneously bid a price on as many units they are interested in (subject to caps)
- On every unit, highest bidder and bid is announced
- Next round, bidders have to overbid previous highest bid. Typically, bidders cannot increase their demand.
- Auction continues until no new bids are made
- Bidders get their final round bids at final price they bid





Example Demand Reduction

- Consider three bidders and three licenses for sale
- Bidders do not know precisely how much the other bidders value the spectrum, but they do know that others have a very high value (say in the order of 1 Billion EUR) for one license, and a high value (say in order of 100 Million EUR) for second license.
- Bidding start at 10 million EUR
- If bidders bid according to value, prices will rise until they reach order of 100 million and then bidders one by one reduce their demand to 1 until all demand one license
- *But bidders are smart* and can foresee that the natural outcome is that each gets one license. They can reduce their demand much earlier to save money
- Auction revenue low and prices do not reflect value
- In more complicated cases, inefficiencies may arise





Example Exposure Problem

- Consider bidder A who values two licenses at 100 M€ and one license at 10 M€; he knows bidder B values only one license somewhere between 30 and 60 M€
- Suppose the auction price starts at 0 M€ per license, and B demands one unit. *What should bidder A do?*
 - If he also reduces demand to one, he makes a surplus of 10 M€
 - If he continues bidding he either gets one license (if bidder B's value turns out to be larger than 50), making a loss of at least 40 or two (if B's value turns is smaller than 50), making a surplus of 0, 40 M€
- Exposure Problem arises if bidders value a package, but not so much the individual parts and package bidding is not allowed
 - In SMRA all bids are for individual lots
 - If bidder A drops, outcome is inefficient if B value is smaller than 50



Combinatorial Clock Auction (CCA)

- There is first a clock phase with multiple rounds
- In every round, at given prices bidders can express how many units they demand *as a package*
 - In Austrian auction: 10 different clocks with supply of 39 for each clock
- Clock prices go up for clocks where demand $>$ supply; bidders demand new packages at these new prices
- Clock phase ends when no clock has excess demand
- Final sealed-bid round, where bidders can express many supplementary package bids subject to some constraints
 - In clock phase, bidders may not have been able to express their interest in alternative packages they value
- Winning packages and prices are determined by optimization tool where second price principle is used
 - Combination of bids that maximizes sum of bids is chosen
 - Bidders do not pay their own bid



Problems SMRA exaggerated?

- Demand reduction (tacit collusion)?
 - Of course, if you allocate 6 licenses among three equally strong bidders, then there is a strong tendency for the bidders to end the auction at reserve prices with two units each
 - But if you allocate 5 or 7?
 - Focal points (allocations) matter, but in many allocation problems they may not exist.
 - German 2015 auction shows that dividing 6 700 MHz blocks, 7 900 MHz blocks and 10 1800 MHz blocks among three bidders with similar market shares is not easy and they even started to compete in 700 MHz band when an equal split allocation was already long established.
- Exposure problem?
 - Common knowledge that in 1800 MHz band bidders want to get at least 4 licenses and that marginal values after that are much lower. If there are 15 licenses to be allocated and three bidders, then very likely that each acquires at least 4.
- Numbers and local context matter
 - Austrian 2001 auction is different from Austrian 2018 auction



2012 CCA Auction results Switzerland

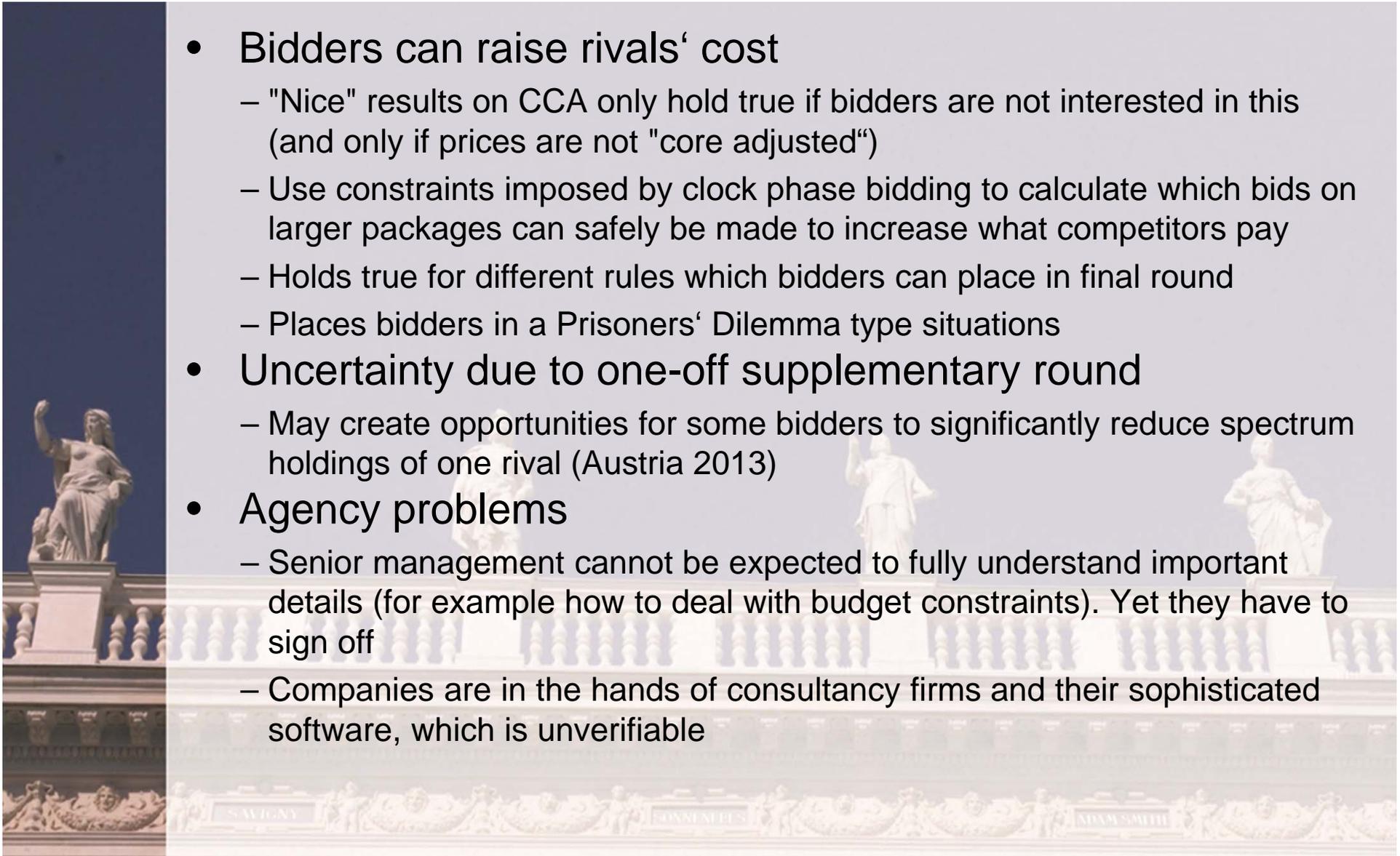
Frequency band	Orange	Sunrise	Swisscom
800	20	20	20
900	10	30	30
1800	50	40	60
2.1 GHz FDD	40	20	60
2.1 GHz TDD	0	0	0
2.6 GHz FDD	40	50	40
2.6 GHz TDD	0	0	45
Price	154'702'000	481'720'000	359'846'000

- Who did a good/bad job?
- The way the final outcome is presented makes that bidders care about relative payments
- Valuations (or business cases) are soft, money spent is tangible
- Payment of your competitors depends on how high you bid on packages you do not win
- Bidders may have very different absolute bidding limits – so one bidder may and others not be able to place bids to raise rival prices



Problems with CCA

- Bidders can raise rivals' cost
 - "Nice" results on CCA only hold true if bidders are not interested in this (and only if prices are not "core adjusted")
 - Use constraints imposed by clock phase bidding to calculate which bids on larger packages can safely be made to increase what competitors pay
 - Holds true for different rules which bidders can place in final round
 - Places bidders in a Prisoners' Dilemma type situations
- Uncertainty due to one-off supplementary round
 - May create opportunities for some bidders to significantly reduce spectrum holdings of one rival (Austria 2013)
- Agency problems
 - Senior management cannot be expected to fully understand important details (for example how to deal with budget constraints). Yet they have to sign off
 - Companies are in the hands of consultancy firms and their sophisticated software, which is unverifiable





Upcoming Auction in Austria

- Proposal to have Regional Licenses
 - Not very common in Europe, mobile operators operate nationwide
 - Makes it more important to have a package auction so that nationwide licenses can be constructed
- Simple Clock Auction (“Romanian model”)
 - At each price you can express package demand
 - Pay your own Bid





Some points for discussion

- Arguments for overall choices are not (yet) provided
 - Regional licenses give regional broadband providers chance to acquire spectrum, but is it worth additional complication?
 - Spectrum caps still seem to be undecided and responses of operators are mentioned as if they could vote; what about consumer welfare and how to protect competition in the Austrian market?
- Limited attempt to rationalize the choice of auction model
 - Simple clock auction has quite some attractive features
 - Simple, package bids, first price
 - Would be good to have arguments why more established auction formats would not perform well in *the Austrian context*
 - how robust are models to alternative objective functions of bidders (raising rivals' cost, preferences over full allocations)
 - Exit bids not very useful if complementarities exist
 - E.g., if a bidder values combined license A and B at 15, but does not value A and B individually, and clock price increases from 10 to 20, then bidder cannot express his value of 15 without risking to win A or B.