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800MHz Band Auction Design: Externalities require a change to the auction design

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About Dr. Chris Doyle

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He has written about spectrum auctions and advised numerous clients on the design of spectrum auctions and worked with leading experts in the field, including Professors Peter Cramton and Paul Milgrom. Chris provides consulting services through Apex Economics. In 2003 Chris was a key member of the team retained by the UK regulator Ofcom to review opportunity cost based spectrum pricing methods. More recently he has been advising Ofcom during the course of its on-going review of spectrum pricing.

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Key message of this report:

- **The auction design for the frequency blocks in the 800MHz auction is intended to allow for efficiency**
- **An unintended consequence of the flexibility built into the proposed rules is an opportunity for strong bidders to act strategically**
- **The strategic advantage that may be exploited derives from externalities associated with limiting the number of contiguous 2 x 10MHz blocks to two**
- **A simple modification to the auction rules would overcome this problem by preserving three contiguous 2 x 10 MHz blocks in circumstances where three or more bidders enter the auction with two bidding points**
- **Allowing for both simple package bids and individual 2 x 5 MHz bids from bidders with one bidding point accommodates scenarios with bidders obtaining differing amounts of frequencies**
- **The modification is unlikely to lead to unused spectrum, and would deal effectively with strategic bidding aimed at lowering the number of attractive 2 x 10MHz packages**
- **The report sets out the proposed amendment to the auction rules**

1. Introduction

This report is about specific features of the auction design proposed by the regulator PTS for the grant of spectrum licences in the 800MHz frequency band.[1]

The design of spectrum auctions has evolved considerably over the last twenty years, with some recent auctions having very sophisticated and complex designs.[2] The auction design proposed by PTS is relatively simple: six 10MHz blocks of 2 x 5MHz paired frequencies nationally defined are being offered. The blocks are to be offered to prospective licensees simultaneously in an open ascending bid auction format.

The auction will feature a reserve price, a spectrum cap limiting bidders to no more than two blocks paired, activity rules, eligibility rules, and additional obligations attached to one set of frequencies to ensure coverage in less densely populated areas.

A Simultaneous Multi Round Auction (SMRA) is the terminology used by PTS to describe the proposed design. Variants of the SMRA format have been applied in many different countries and have performed well on many occasions. By performing well I mean the outcomes of SMRA spectrum auctions appear consistent with economic efficiency – in short the winners are viewed as those entities able to contribute the most to economic welfare.

As PTS remarks:[3]

"An auction according to LEK [the telecommunications law] also increases the probability of efficient spectrum use, as licences will be assigned to the stakeholders that value them the most."

There have been some cases, however, where SMRA spectrum auctions have performed poorly. These have tended to occur in circumstances where bidders are limited in number (competition is muted) and when there is asymmetry across bidders, and/or where the rules have not been carefully

[1] This report was commissioned by Tele2 AB and is concerned with the proposed auction design format for frequencies in the 800MHz band as outlined in "Open invitation to apply for a licence to use radio transmitters in the 800MHz band", consultation PTS 7 September 2010 available at www.pts.se ("the Consultation"). Section 6 of the document describes the auction design and bidding rules.

[2] See Cramton, Peter (2009) "Spectrum Auction Design" Department of economics, University of Maryland mimeo (available at http://www.cramton.umd.edu/papers2005-2009/cramton-spectrum-auction-design.pdf); Klemperer, Paul (2004) *Auctions: Theory and Practice*, Princeton University Press, and Milgrom, Paul (2004) *Putting Auction Theory to Work*, Cambridge University Press. An introduction to spectrum auctions is presented in Martin Cave, Chris Doyle and William Webb (2007) *Essentials of Modern Spectrum Management*, Cambridge University Press.

[3] Page 7 of the Consultation *op cit.*

thought through.[4] *Some of the SMRA spectrum auctions for 3G licences in* Europe in 2000/01 performed poorly because of limited competition (e.g. Switzerland), or because of poor rules (e.g. Netherlands) and/or asymmetry (e.g. Italy, Germany).

It is important therefore that PTS considers carefully the auction design so that the prospect of increasing the probability of efficiency is attained.

This short paper highlights a concern about the proposed design of the auction. The rules as understood appear to leave open the door to strategic bidding that could enable the leverage of market power.

The paper is organised as follows. In Section 2 I provide a backdrop and illustrate the key features of the proposed auction format. In section 3 I discuss the auction design proposed by PTS within the context of the current market structure of mobile telecommunications in Sweden. This section highlights a problem with the auction design. In section 4 I propose a modification to the auction rules and section 5 concludes.

[4] Other auction formats, such as sealed-bid auctions, have also performed poorly in such circumstances; see Milgrom (2004) *op cit.*

2. The proposed auction design

PTS is proposing to hold a SMRA auction for six lots of 2 x 5MHz paired frequencies in the 800MHz band between 791-821MHz (downlink) and 832-862MHz (uplink). The licences are referred to as FDD1 through FDD6. Licence FDD6 has coverage obligations attached and bidders are invited to make bids with regard to coverage as well as money.

Each frequency block will be awarded a point and bidders will not be allowed to bid for more than two points (there is a spectrum cap of 2 x 10 MHz). The spectrum cap is a good feature of the auction and is intended to prevent a large bidder from acquiring most or all of the frequencies available.

The auction process will be electronic and each block has a reservation price of SEK150m. Bidders must deposit a bank guarantee of SEK25m for each point, not exceeding two points.

Each bidder is allowed to submit a bid on any block in each round, assuming a bidder has at least one bidding point. A bidder is able to increase a current bid, and a bidder may also move a bid. If a bidder moves a bid to another frequency block, the previous bid is cancelled.

The ability to move a bid distinguishes the auction from many other auctions of this kind. Typically a bidder holding the highest standing bid on a frequency block would only submit another bid if that bid were out bid by another bidder.

PTS would appear to have allowed highest standing bidders to shift bids so that the bidders are able to re-organise their packages. For example, if A is the highest standing bidder on FDD2 and FDD3 and B outbids A on FDD3, then A may choose to submit bids alternatively on FDD4 and FDD5. The rule is I believe intended to cope with the *exposure problem* (another solution would be to allow for package bidding).

The *moving bids* rule appears directed towards resolving exposure like problems, but bidders nevertheless are allowed to choose moves absent changes to their current standing highest bids. Thus if A has the highest standing bids on FDD2 and FDD3, it could elect to place bids on two other blocks. This might be because a bidder observes that another bidder has moved from those frequency blocks and the prices are sufficiently attractive to warrant a move.

Finally, the auction also allows bidders three rights to pass (waive). It is not clear what benefits derive from allowing so many passes and there is a likelihood bidders will seek to use these strategically. I understand the purpose of passing is not to facilitate strategizing, but rather to accommodate

unforeseen events (e.g. computer crash at the bidder's premises) or events preventing a bid (e.g. management are required to attend an AGM) that confront the bidder.

The information made available during the auction relate to round times and bidding levels, and at the end of each round publication of the highest standing bid on each frequency block and the aggregate activity in the auction. Data appears to be presented in anonymous form, presumably to minimise possible communication among bidders.

3. Auction format

The SMRA format was pioneered in the United States acting on advice received from auction theorists such as Professor Paul Milgrom.[5] In the United States the SMRA format has worked particularly well as major spectrum auctions attract hundreds of bidders and involve hundreds of geographically defined licences.

In the case of the digital dividend frequencies in Sweden, PTS has packaged the frequency blocks into six lots which is small. Furthermore, the auction format limits bidders to bidding for no more than two blocks.

The number of bidders is likely to include existing mobile telecommunications companies holding spectrum licences, and possibly other entities seeking to acquire radio spectrum (e.g. virtual operators).

PTS has clearly designed the auction so that bidders can aim to buy 2 x 5 MHz or 2 x 10 MHz. The former may appeal to smaller entities, particularly those currently without radio spectrum.

My assessment of the evidence and analysis of the mobile telecommunications market suggests that there are asymmetries among existing firms. This is highlighted in Figure 1 which shows that TeliaSonera has had a consistently high market share of subscribers above 40% since 2004. Furthermore, the share gained by the new entrant spectrum licensee Hi3G has been modest and stands below 10%.

Although these data are limited, they do convey an impression of a market that is dominated by TeliaSonera. It is this fact which raises a concern about the current proposed design for the auction.

The rules of the auction allow any bidder, including TeliaSonera, to move bids. Where bidders are without market power, or alternatively symmetrically placed and relatively small compared to the market, the rule ought to work well at dealing with the exposure problem.

[5] Milgrom (2004) *op cit.*

Diagram 16 Market shares – number of subscriptions for mobile call services and mobile data

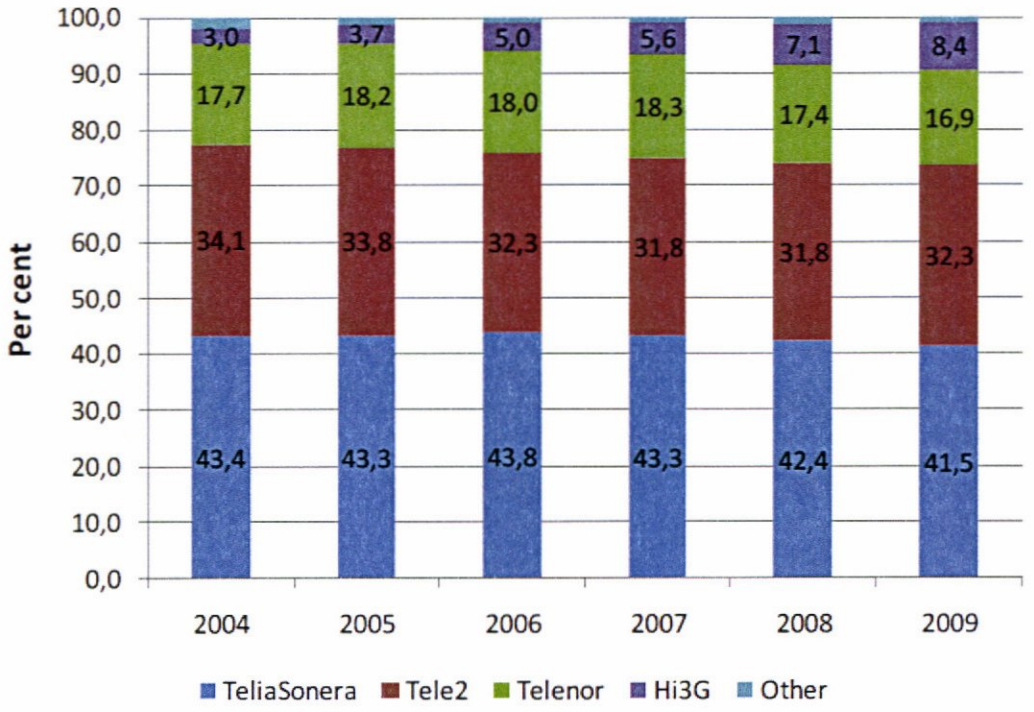

Figure 1: Market shares in Sweden's mobile telecommunications market
Source: PTS June 2010 *The Swedish Telecommunications Market 2009*, 3 June 2010

Consider however a situation where a large bidder has two bidding points and wishes to obtain 2 x 10MHz paired. The bidder has a range of options but would prefer frequency bands that are contiguous, as these allow for more efficient and hence lower cost operations. If contiguous blocks are desirable it follows non-contiguous blocks are less desirable for bidders seeking 2 x 10MHz paired.

The auction rules are such that a bidder is able to affect valuations of other blocks – there is an *externality* effect. For example, if bidder A submits bids for FDD4 and FDD5, it follows that FDD6 cannot be made contiguous and is therefore less attractive to a bidder seeking 2 x 10MHz paired.

Suppose there are three relatively large bidders, but two have greater access to capital than the other. A scenario that could unfold under the rules is a situation whereby the two bidders with access to capital focus on FDD2, FDD3 and FDD4,FDD5. The least strong of the three would then be left with FDD1 and FDD6 – which would be less attractive and involve greater costs.

It could be argued that non-contiguous blocks are not an issue because the price differential between the 2 x 10 MHz paired blocks would compensate for the perceived quality differences. But the fact bidders can move bids means that in an ascending auction of this kind it may be strategically possible to raise the bid values of your rivals on blocks that are non-contiguous, before it is revealed that the strong bidders are focussing on FDD2,FDD3 and FDD4,FDD5.

Perhaps a more worrying feature of the auction is the fact a strong bidder knows that by bidding on either FDD2,FDD3 or FDD4,FDD5 it reduces the number of contiguous blocks from 3 to 2. There is likely therefore to be a bidding premium attached to this outcome.

In some respects there is an analogy with the findings of Hoppe, Jehiel and Moldovanu (2006).[6] These authors show under plausible conditions that auctioning more licences need not result in a more competitive final outcome. As the authors make clear:

"Firms competing to acquire a license are not indifferent about the final form of the market structure (in particular about how many and which other firms are going to be licensed)."

Hoppe *et al.* emphasise the importance of externalities, which is the concern I wish to raise about the auction design proposed by PTS. Strong bidders in the auction are likely to comprise incumbents and these will therefore bid in ways to defend their current positions. The auction design proposed by PTS by allowing bids to move and by not restricting what combination of packages can be bid for means strong bidders would find it advantageous to bid for FDD2,FDD3 and FDD4,FDD5.

[6] "License Auctions and Market Structure", *Journal of Economics and Management Strategy*, vol. 15, no. 2, 371-396.

4. Modification to the auction rules

If there are three or more bidders with two points in the auction at the start, the rules should change, as described below. Where there are two or one bidders with two bidding points at the start, the rules can be as described in the Consultation. However, in the interest of anonymity – it would be preferable to adopt one set of rules ahead of knowledge about the number of bidders and bidding points.

Let us consider a thought experiment. Consider the case with three or more bidders with two bidding points at the start of the auction. To overcome the externality problem identified in the previous section, I suggest that PTS changes the rules of the auction. The rule changes incorporate a package bidding element but constrains bidding on packages to ensure that three contiguous 2 x 10 MHz blocks are available for those holding two bidding points.

It is important to emphasise that the rule change is directed towards maximizing the probability of efficiency as required under LEK.

Rule changes:

1. Where a bidder purchases two bidding points at the start of the auction and there are three or more such bidders, each of these bidders is only allowed to bid on one of three packages: [FDD1,FDD2] or [FDD3,FDD4] or [FDD5,FDD6]. In addition to a package bid, each bidder is allowed to submit up to two individual bids on each block in the package.

2. Bidders with one point can bid, as under the current rules, on any individual block.

3. The highest standing bids are defined as the maximum of: [the sum of individual bids; the package bid]

Example 1:

Bidder A has two points and bids 60 on FDD3,FDD4 and submits individual bids 20 on FDD3 and 40 on FDD4.

Bidder B has one point and bids 25 on FDD3

Bidder C has one point and bids 30 on FDD4

The highest standing bid is the individual bid of A on FFD4 at 40 and B on FDD3 at 25

In the next round Bidder A continues to have one bid package point and one bidding point.
The next round might result in:

Bidder A bids 90 on FDD3,FDD4 and submits individual bids 25 on FDD3 and 60 on FDD4.

Bidder B has one point and bids 25 on FDD3

Bidder C has one point and bids 31 on FDD4

The highest standing bid is the package bid from A at 90

Example 2:

Bidder A has two points and bids 55 on FDD3,FDD4 and individual bids 30 on FDD3 and 5 on FDD4

Bidder B has one point and bids 30 on FDD3

Bidder C has one point and bids 35 on FDD4

The highest standing bids are bidder B on FDD3 and Bidder C on FDD4 as these in aggregate exceed the bid for the package submitted by bidder A, and the individual bids submitted by A.

5. Conclusion

The significance of radio spectrum for the delivery of mobile broadband services, which is the primary attraction of the 800MHz frequency band, was emphasised by the Chairman of the Federal Communications Commission very recently: [7]

"Spectrum is the oxygen of our mobile communications infrastructure and the backbone of a growing percentage of our economy. Spectrum enables wireless innovation that will grow our economy and create jobs of the future."

PTS needs to balance the risk of strategic externalities in the current design versus, in my opinion, the remote prospect of a block remaining unsold. The rule changes I have proposed accommodate both 2 x 10MHz paired and 2 x 5MHz paired, but restrict outcomes in all cases to three packages. Thus an outcome may involve (5,5,10,10) or (10,5,5,10) or (10,10,5,5) or (10,10,10) or other combinations of 2 x 5MHz paired.

The rule changes proposed refine the auction design and afford protection against the danger of the market structure becoming less competitive over time.

It is crucial therefore that in moving forward PTS accommodates changes to the design of the auction to deal with the problem of externality. I have set out a straightforward solution that I believe is compatible with the LEK maximisation of efficiency requirement.

[7] Extract from speech given by Chairman Julius Genachowski, Federal Communications Commission, at the FCC Spectrum Summit "Unleashing America's Invisible Infrastructure" Washington, D.C. 21 October 2010, available at: http://www.fcc.gov/Daily_Releases/Daily_Business/2010/db1021/DOC-302331A1.pdf.