Review of DotEcon's Recommendations

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The Dutch government intends to hold a spectrum auction of the 700 MHz, 1400 MHz, and 2100 MHz frequency bands at the end of 2019 or early 2020. The Ministry of Economic Affairs has asked DotEcon to make a recommendation about the appropriate auction model and rules. We were asked by the Ministry to provide independent peer review of DotEcon's advice. This report comments on DotEcon's recommendations, "Recommended auction model for the award of 700, 1400 and 2100 MHz spectrum".

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1 Introduction

We have been asked by the Dutch Ministry of Economic Affairs and Climate Policy (henceforth the Ministry) to provide independent peer review of DotEcon's draft recommendations on the spectrum auction of 700 MHz, 1400 MHz, and 2100 MHz frequency bands (henceforth Dutch multiband auction). This report evaluates DotEcon's draft recommended auction model for the award of 700, 1400, and 2100 MHz spectrum[2].

This report is prepared with the following objectives in mind:

1) To assess whether DotEcon's draft recommended auction model is the result of careful consideration of the relevant factors that go into an advice on the choice of auction format.

2) To assess whether DotEcon's draft recommended auction model is sufficiently motivated.

As part of this task, we have reviewed the inputs and thoroughly evaluated DotEcon's recommended auction model considering the Ministry's auction objectives.

2 Ministry objectives and key assumptions

The Ministry laid out the auction objectives as follows.

> *The auction should produce an efficient allocation of the available spectrum. This will firstly require making sure that all potential participants to the auction have a realistic chance of winning, and secondly, that the auction produces a realistic revenue. Any strategic bidding behavior, for example with the intent to keep out new entrants or thwart competitors, will prevent an efficient allocation from emerging and the auction design should not incentivize or facilitate this behavior. Within this overarching objective of an efficient allocation the Ministry's goals for the auction are, in order, simplicity, transparency, and freedom of choice.*

We evaluate the recommended auction model and alternatives in light of these objectives, recognizing the specific setting of the auction. The primary objective is putting the spectrum to its best use—an efficient allocation of the spectrum. Secondary objectives, in order, are realistic revenues, simplicity, transparency, and freedom of choice.

Following the merger of T-Mobile and Tele2, the Ministry in an addendum to the advice request dated 20 June 2019 asks that specific attention be given to the objective of realistic revenues in light of the post-merger market structure with three similar-sized incumbent providers.

2.1 Spectrum packaging

The proposed spectrum packaging is:

[2] DotEcon. Recommended auction model for the award of 700, 1400 and 2100 MHz spectrum, June 2019.

6 lots of 2x5 MHz at 700 MHz

8 lots of 5 MHz at 1400 MHz

12 lots of 2x5 MHz at 2100 MHz

This packaging is consistent with common practice in nearly all markets. Moreover, it facilitates substitution across bands, which is consistent with the efficiency and simplicity objectives. It also works well with the competition safeguard, which we discus next. We agree that this packaging is best.

2.2 Competition safeguard

The Dutch competition authority ACM has recommended the following long-term spectrum caps to prevent excessive concentration of spectrum:

- Overall cap: A 40% cap on mobile communications spectrum, including 700, 800, 900, 1400, 1800, 2100, and 2600 MHz as well as other frequency bands for mobile communication such as 3.5 GHz.
- Sub-1 GHz cap: A 40% cap on low-band spectrum—all spectrum below 1 GHz—designated for mobile communications (700, 800, and 900 MHz), rounded up to the nearest multiple of 10 MHz.

The recommended auction model must work well with this competition safeguard. This is not a problem, as we explain below.

Given the existing spectrum holdings and the proposed spectrum award, the spectrum caps would imply the following limits on the bidding of incumbent carriers:

- KPN and Vodafone each can win at most 2x20 MHz (4 lots) at 700 MHz
- T-Mobile can win at most 2x15 MHz (3 lots) at 700 MHz
- KPN can win at most 140 MHz in the auction overall
- Vodafone can win at most 125 MHz in the auction overall
- T-Mobile can win at most 80 MHz in the auction overall

Spectrum caps prevent excessive concentration of spectrum. They are intended to promote competition in the downstream market for mobile services by limiting the holdings of any one provider. The caps are not a device to promote competition in the auction. Indeed, in this auction, there is a risk of tacit collusion and a low-price outcome, the most likely of which is an equal split of the 700 MHz spectrum (2 lots each) and 2100 MHz spectrum (4 lots each). One concern is that spectrum caps may facilitate tacit collusion by preventing bidders from bidding for larger quantities. The recommended spectrum cap, however, still lets the incumbents, especially KPN and Vodafone, to bid aggressively for spectrum. Competition among carriers will almost surely prevent extreme outcomes where one or two bidders dominate the auction. Thus, we anticipate that the competition safeguard is unlikely to have much impact in the auction and is unlikely to facilitate tacit collusion.

2.3 Preferences

Carriers provide service with a portfolio of spectrum. Low-band spectrum is especially useful in providing coverage, whereas mid-band and high-band spectrum is better suited for capacity. The incumbent carriers all have substantial holdings of low-band and mid-band spectrum. Thus, it is natural to assume that this spectrum award is primarily about incremental capacity. From this perspective, we would expect complementarities to be weak across bands. Indeed, the most likely complementarity may come from improved spectral efficiencies in moving from a single lot to two lots of 2x5 MHz, but even this potential synergy appears not to be large.

Within band differences among the lots appear to be minor. Lots are nearly perfect substitutes within a band, although there is a preference for contiguous lots.

Thus, it is important that the auction handle substitutes well. Handling complements is less important in this setting. We agree with DotEcon on this point.

3 Recommendations

With this background, we can identify design features that will best meet the Ministry objectives. For the most part, we arrive at recommendations that are consistent with DotEcon's recommendations.

3.1 Generic lots

The spectrum award is ideally suited to use generic lots within each band. This greatly simplifies the auction. It improves substitution as the lots in a band become perfect substitutes. This strengthens competition and guarantees the award of contiguous spectrum, which improves efficiency—the primary Ministry objective. There is a long record of success with generic lots in settings like this. No party has suggested that the lots within the same band have significantly different values. The decision to use generic lots is an easy one. We agree with DotEcon on this point.

3.2 Assignment stage

An auction with generic lots requires an assignment stage to determine specific frequency assignments. This is readily accomplished with a single-round sealed-bid auction with second-pricing. Within each band, winners only have a few options, so it is an easy matter for bidders to assess the relatively minor value differences among options. With three winners, each winner has at most four options in a band.[3] The recommended version of second-pricing—Vickrey-nearest core pricing—provides good incentives for truthful bidding, which supports the efficiency objective. There is a long record of success with this approach. It is used almost universally. Because there are potential value interdependencies between the specific assignments that a bidder obtains in the 700 MHz and the 1400 MHz band resulting from passive

[3] With three winners, there are 3! = 3 x 2 x 1 = 6 different frequency assignments. However, a winner will have at most 4 options, since the low option and the high option each correspond to two frequency assignments, which are identical for the winner. That is, if the winners are A, B, C, there are six distinct orderings of A, B, C, but ABC and ACB are equivalent for A, and similarly BCA and CBA are equivalent for A. If B and C win the same quantity, then A has only three options, since BAC and CAB become equivalent in this case.

intermodulation issues, DotEcon proposes to collect assignment bids for assignments in the 2100 MHz band, and for combinations of assignments in the 700/1400 MHz bands. This makes sense. We agree with DotEcon on the assignment stage.

3.3 Ascending auction

In contrast to the assignment stage, the primary auction should be an ascending auction. In the primary auction there are an exponential number of possible assignments. It is unrealistic to expect bidders to fully consider and express all these possibilities as would be required in a sealed-bid design. Rather, an ascending auction provides valuable outcome discover about prices and likely assignments, which enables the bidder to focus valuation efforts and better express preferences as the auction proceeds. This improves auction efficiency. This is the primary reason ascending auctions are used in this setting. Sealed-bid auctions would involve too much guesswork and too little bid expression, which would damage efficiency.

3.4 Clock or SMRA-Clock Hybrid

One of the more difficult decisions is whether to use a combinatorial auction in which bidders bid on packages of items. A combinatorial auction is desirable when complementarities are large. Then bidders can bid for synergistic packages and not be exposed to aggregation risk. However, we believe that complementarities are weak in this setting. Thus, the added complexity of a combinatorial auction is not warranted. DotEcon arrived at the same conclusion.

There are two ascending auctions well-suited for a multi-band auction with generic lots: the clock auction (CA+ in the DotEcon report) and the SMRA-clock hybrid. In both auctions, bidders express demand for lots in each band. Prices increase when there is excess demand. The key difference between the two formats is in the clock auction there is no notion of standing high bidder; whereas, in the SMRA-clock hybrid in each round standing high bidders are determined, as in an SMRA, and each bidder is informed on which lots the bidder is standing high bidder. Both formats have been used successfully in prior spectrum auctions. In both cases, the version we are considering prevents changes in demand that would lead to excess supply and the possibility of unsold lots. For the clock auction, this means that reductions in demand are only accepted to the point where demand equals supply. For the hybrid auction, it means no withdrawals—a standing high bidder is stuck until bumped by another bid.

DotEcon argues that the SMRA-clock hybrid is the preferred choice in this setting (section 3.3). DotEcon argues that informing bidders about standing high bidder status helps bidders accomplish substitution across bands. For example, when a standing high bidder is bumped on two lots in a band, the bidder knows that it can switch that demand to another band or reduce demand. In the clock auction, the bidder can ask for a switch or a reduction, but the switch or reduction may not be accepted because it would create excess supply.

We argue that having this high-bidder information does not eliminate substitution risk. Suppose the bidder wants to switch his demand of 2 lots from band A to B. Suppose the bidder is bumped on 1 lot on band A and therefore is standing high bidder on 1 lot in A. What should the bidder do? The bidder cannot switch to 2 lots on B. The bidder is left with two options, assuming he wants to maintain his eligibility. He can rebid on A, even though B is preferred, or he can bid 1 lot on B, hoping that he will be able to switch the second A lot in a future round. Both options involve substitution risk.

DotEcon also argues that the hybrid form avoids the risk of price overshoot and unsold lots that is inherent to clock auctions. We would however argue that in clock auctions, unsold lots are easily avoided with the rule above that does not accept bids that would create excess supply. Price overshoot is eliminated by letting bidders name the price point of the change in demand. Both rules are commonly used in clock auction implementations, as in recent auctions in the US and Australia.

The clock auction allows more direct expression of demand. Changes in demand can be expressed at any price between the prior posted price and the current clock price. In the SMRA-clock hybrid, these changes in demand cannot be expressed for standing high bids. The clock auction has more flexible bid expression; whereas, the hybrid approach has more certainty about whether changes in demand will be accepted. The two approaches become more similar with small bid increments.

The case for the clock auction version is best seen in a single-band auction. Then it seems clear that the clock auction implementation is superior to the hybrid. The clock auction is simpler. The bidder expresses demand at the starting price and then names the price points at which demand reduces. This continues until the price where supply and demand balance is reached. By contrast, the hybrid implementation progresses more slower when there is little excess demand and may end with price overshoot–excess demand at the award price and excess supply at the final round price. The auctioneer can limit this inefficiency with a smaller bid increment, but then the hybrid auction takes even longer.

Thus, in a multiband auction where linkages between bands are sufficiently weak, the clock auction should remain the superior choice. It is simpler and allows improved pricing with intra-round bids. However, if linkages between bands are stronger, then it is unclear whether the clock or hybrid design should be preferred.

Procedurally, the hybrid approach does have one advantage. Since the standing high bids remain, bidders only need to submit bids for quantity that was bumped in the prior round, rather than full demands. This may simplify bidding. However, in an auction with three products this is not a significant advantage.

Our conclusion is that either the clock or hybrid formats will work well in this setting. Both formats have advantages. Both have been used successfully in a variety of recent spectrum auctions. For example, the clock auction has been successfully used in recent auctions in the U.S., Canada, Australia, and Singapore. We find the absence of standing high bidders in a clock auction to be an advantage as it treats all bidders symmetrically and allows a more direct expression of demand. DotEcon prefers identifying standing high bidders (and the resulting asymmetric treatment of bidders), since it reduces uncertainty about whether a switch to another band will be processed. Based on our successful experience with clock auctions in many countries and our belief that linkages across bands are not too great, we favor the clock auction in this setting. We nonetheless conclude that the clock and clock hybrid are quite similar. Both should perform well with respect to the Ministry's objectives.

3.5 Activity rule

With the proposed spectrum packaging, the activity rule choice is easy. Use an eligibility point rule and assign 2 eligibility points to each 2x5MHz lot and 1 eligibility point to each 1x5MHz lot. A bidder's total demand in MHz can stay the same or decrease as prices rise. This is the initial proposal of DotEcon. We agree this is best.

An alternative would be to base eligibility points on relative expected value. Higher-valued bands would have proportionally higher eligibility points. However, given the uncertainty in relative values and the fact that the three bands are broadly comparable, we favor the simpler rule, which eases substitution across bands.

DotEcon also suggests the possibility that substitutability across bands may be with respect to downlink capacity. Then 1 lot at 1400 MHz would substitute with 1 lot at 700 MHz, rather than 2 for 1. We suspect that substitution is more apt to happen between the two paired bands and that the linkage with the unpaired band to be weak. Moreover, given price expectations from prior auctions, basing eligibility points on downlink capacity would give bidders an easy means of hiding demand for 700 MHz with bids for 1400 MHz. For this reason alone, we recommend rejecting this downlink-based alternative.

Activity rules sometimes impose a weaker activity requirement, less than 100% of current eligibility, early in the auction, and then raise this requirement later in the auction. This is especially useful when spectrum is auctioned on a regional basis, rather than nationwide. Given the use of nationwide lots of equal size in each band, we believe that there is no need for a weaker activity requirement early in the auction. We agree with DotEcon on this point.

3.6 Bid withdrawal

The SMRA format often allows a limited number of bid withdrawals. This is intended to let a bidder back out of a failed aggregation of spectrum lots. For example, a bidder may want two lots or none. The bidder may get stuck as the standing high bidder on one lot and find the price too high to continue to bid for two. The bidder could then withdraw its standing high bid.

Experience has shown that withdrawals are used for various gaming purposes beyond the intended purpose. Given that we expect synergies to be small and manageable within the context of the proposed auction design, it seems prudent to not allow bid withdrawals.

If synergies were thought to be important, then a preferred design would be a simple clock auction that allows reductions in demand that create excess supply. Unsold lots are then sold in a second stage in advance of the assignment stage. The simple clock auction lets bidders express preferences for packages of lots in response to linear prices. Both exposure risk and substitution risk are eliminated. The downside is that some lots may go unsold as a result of multi-lot reductions in demand. Having a second stage for unsold lots in advance of the assignment stage mitigates the problem of unsold lots. The second stage must be designed carefully to mitigate strategic behavior in the first stage. For example, to discourage price driving strategies one can forbid the bidder that created the excess supply with the multi-lot reduction at the clearing price from bidding for the product in the second stage.

Simple clock auctions have been used successfully for many years. They work especially well in situations where auctions are conducted periodically. Then any unsold quantity can be carried forward to the next auction.

3.7 Minimum requirements

The most common synergy is a minimum requirement for lots in a band. For example, a business plan may require that the bidder wins at least two lots in a band. Some auctions allow the bidder to specify

minimum requirements before the auction starts. During the auction the bidder then can reduce demand from the minimum requirement to zero without fear of winning some of what is needed. This creates the possibility of unsold lots. However, the unsold lots can be sold in a single stage in advance of the assignment stage.

Although there are several auctions that allowed bidders to specify minimum requirements in this way, the actual use of the minimum requirements by bidders has been rare. We agree with DotEcon and recommend against the use of minimum requirements here. They would add complexity without much benefit in this setting.

3.8 Waivers

The SMRA often includes a limited number of waivers from the activity rule. When a waiver is applied, the bidder's eligibility is not reduced, despite failing to satisfy the activity requirement. This gives the bidder a round to reflect on new information before committing to a course of action. It also can be applied automatically in instances where a bidder fails to bid for whatever reason.

DotEcon argues that waivers may help a bidder overcome a switching impediment. For example, a bidder wanting to switch two lots from one band to another, who is bumped off a single lot, can use the waiver to see if he is bumped off his second lot in the next round and thus free to bid on two lots in the other band. We are skeptical that such a use would be effective and important in this setting where synergies are weak.

We recommend either no waivers or a small number, such as 1 or 2. We think the chief benefit is providing insurance that eligibility will not be lost in the unlikely event that the bidder fails to submit a bid in a round.

3.9 Starting prices

Starting prices can play an important role in the auction. In competitive settings, it is best to err on the low side. Competition will push prices up to competitive and efficient levels. However, in settings where bidding may be limited due to low participation—as seems likely here—it is advisable to have higher starting prices that assure realistic revenues and reduce the incentive for bidders to coordinate on a low-price outcome, which harms both the efficiency and revenue objectives. That said, the worst outcome is setting starting prices so high that lots go unsold. One advantage of lower starting prices is they may encourage greater participation from potential new entrants. Starting prices should be selected with care. DotEcon only provides a limited discussion of starting prices in the draft recommendation.

3.10 Information policy

We agree with DotEcon that the preferred information policy is to reveal aggregate demand by band at the end of each round, but not the individual bids. Revealing individual bids enables collusive strategies that are apt to harm both efficiency and revenues. There is no countervailing benefit to the release of individual bids during the auction.

One could reveal even less information, for example, reveal only total demand across all bands, but we believe that knowing the demand by band is helpful to desirable outcome discovery that will improve

bidding and auction efficiency. The recommended information policy—revealing demand by band at the end of each round—is our preferred choice in all the clock-based auction models: SMRA-clock hybrid, clock (CA+), and simple clock.

One motivation for not revealing information about excess demand by band is the desire to limit potential tacit collusion. If only the three incumbents bid, the bidders may attempt to coordinate on a low-price equilibrium in which each reduces demand to an equal share of the available spectrum. However, we do not see why revealing aggregate demand by band would increase this possibility. Coordination on a low-price equilibrium would seem to be equally effective whether demand is revealed or not.

After the auction, we prefer that all bids be revealed in the interest of transparency. We agree with DotEcon on this point.

4 Conclusion

For the most part, we agree with DotEcon's recommendations on auction rules for the award of 700, 1400, and 2100 MHz spectrum. The analysis is broadly consistent with our understanding of the problem, the setting, and the Ministry's objectives. The main point of disagreement is DotEcon's favoring of the SMRA-clock hybrid, where we favor a clock auction that avoids standing high bids. Nonetheless, the two formats are quite similar. Both are apt to perform well in this setting with respect to the Ministry's objective.

Our biggest concern is the potential for tacit collusion. Absent a credible new entrant, incumbents may cooperate on a low-price outcome. With the recommended design, the best and perhaps only defense against tacit collusion is setting high starting prices that guarantee realistic revenues.

The advice of DotEcon is the result of careful consideration of the relevant factors that go into advice on the choice of auction format. The advice of DotEcon is sufficiently motivated.