Analysis of the Proposed Viterra Port Capacity Auction Mechanism

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Introduction

Viterra have recently proposed adopting an allocation mechanism for grain port capacity. This paper assesses the proposed wheat port capacity auction mechanism and finds that this mechanism has certain flaws. Specifically:

- The auction mechanism may not, in certain circumstances, come to an outcome at all. In other circumstances the auction will reach a conclusion but the outcome of the auction will not reflect an efficient allocation of scarce port capacity (that is, valuable port capacity will not be allocated at the auction). This effect arises as a consequence of the rebating of the proceeds of the auction to exporters. In the presence of the rebate exporters do not care about the level of the auction price for a capacity slot, but only the difference in the auction price and the rebate for that slot, which we might call the "net price" or the "effective price". In order for the auction to achieve an efficient allocation the effective price paid should increase until supply and demand balance. However, while the auction design ensures that the auction price increases when demand exceeds supply, the effective price may not increase at all when demand exceeds supply, or may continue to increase after demand falls short of supply. As a consequence there is no guarantee that the auction will terminate or will terminate at an efficient allocation.

- Capacity which is not allocated through the auction process is allocated through a first-come-first-served (FCFS) mechanism. The possibility of resorting to the FCFS mechanism alters the incentives on exporters to participate in the auction process, particularly for slots with a high (effective) price and particularly for an exporter which can be reasonably sure of obtaining the allocation that it desires in the FCFS mechanism.

Overview of the Proposed Port Capacity Auction Mechanism

Under the proposed capacity allocation mechanism, the year is divided into 24 half-month periods. A combination of a port and a half-month time interval is known as a slot. The capacity of a port to load grain during each half-month slot is expressed in tonnes (or thousand tonnes, kt, or million tonnes, mt).

These slots are divided into two groups. The so-called "Harvest Shipping Period" runs from 1 October of each year to 31 January. The remainder of the year is called the "Non-Harvest Shipping Period" and runs from 1 to 30 September each year. It is proposed that capacity in these slots is allocated through a series of three auctions – one auction for the Harvest Shipping Period (which is proposed to take place in August) and two auctions for the Non-Harvest ShippingPeriod (which are proposed to take place in November and December).

Following the Harvest Shipping Period auction, any Harvest Shipping Period capacity which remains unallocated is made available using a First Come First Served mechanism. Following the first Non-Harvest Shipping Period auction, any capacity remaining unallocated is made available in the second

Non-Harvest Shipping Period auction. Following the second Non-Harvest Shipping period auction, any capacity remaining available is allocated using a First Come First Served mechanism.

The auction mechanism itself is a simultaneous multiple round ascending bid clock auction. Each round, given the current price for each slot, interested parties are able to submit bids for capacity in each of the slots on offer. If the total capacity demanded exceeds the capacity available in any slot, the price increases in the next round by the proposed auction increment of 50 cents, otherwise the price in that slot remains the same. This process is repeated every 30 minutes. The auction stops when the capacity requested by bidders is less than the capacity available in every slot.

Importantly, since the auction mechanism is designed to be revenue-neutral, the total revenue collected through the auction process (less the cost of operating the auction) is rebated back to shippers at a flat rate per tonne shipped. The rebate is calculated at the end of each season as the total auction proceeds (less auction costs) divided by the total volume of wheat shipped under capacity acquired in the auction process. Therefore the actual or effective price paid for a unit of capacity is not the amount paid in the auction but the amount paid in the auction less the rebate. Since the rebate reflects, in essence, the average price paid in the auction, the effective price for some slots will be negative – that is, the shipper will, in effect, be paid to ship grain in those slots (i.e., in the specified ports and times).[1]

The rebates are separate for the Harvest Shipping Period and the Non-Harvest Shipping Period. There is a single rebate for the Non-Harvest Shipping Period (i.e., the total auction proceeds for the two Non-Harvest Shipping Period auctions divided by the total shipped volume).

The effect of the rebate can be made clearer through an example. It might be, for example, that prices for different slots in the Non-Harvest Shipping Period auction range from values around, say, $4/tonne up to $30/tonne. Let's say the auction proceeds are $100 million and 5 million tonnes of wheat are forecast to be shipped in the Non-Harvest Shipping Period. The forecast rebate is therefore $20/tonne. Shippers who will export wheat in low-priced slots will, in effect, receive a net payment of ($4 less $20 or) $16 per tonne shipped, while shippers exporting in high-priced slots must make a net payment of up to ($30 less $20 or) $10/tonne shipped.

As we will explore further below, the rebate has a fundamental effect on the incentives of the parties in the auction. As a consequence of the rebate mechanism, participants in the auction do not care very much about the overall *level* of prices in the auction. Rather, the parties care primarily about the *relative* price of high-priced slots relative to low-priced slots. I will therefore distinguish between two prices: The *auction price* (which is the nominal price for a slot as quoted in the auction process) and the *effective price* (which is the nominal or auction price for a slot less the forecast rebate).

Capacity acquired through the FCFS mechanism does not participate in the rebate scheme – that is, wheat shipped through capacity acquired in the FCFS mechanism does not count towards the calculation of the rebate, and is not paid a rebate.

Concerns with the proposed auction mechanism

In my view, the concerns with the proposed auction mechanism can be divided into two categories: The first arises from the rebate mechanism. The second arises from the interaction of the auction with the FCFS mechanism. We will explore each in turn.

[1] Under Viterra's proposed auction system, all shippers are also required to pay Viterra's port handling charges, which reflect the costs of actually shipping grain through the port.

Problems arising from the rebate mechanism

As already noted, the effective price paid for a slot at the auction is not the auction price, but the auction price less the rebate. As we will see, depending on the behaviour of the rebate, the auction mechanism may fail to reach an outcome at all, or may reach an outcome which is inefficient in the sense that capacity is left unallocated even though there are exporters willing to pay for that capacity.

In order for the auction to come to a conclusion at or near an efficient allocation, the effective price for a slot must rise (by a small but positive amount) from one auction round to the next if there is excess demand for a slot (that is, if the amount of capacity demanded at that effective price is greater than the capacity available) and the effective price must not rise when a slot is in a state of excess supply. Yet, it is straightforward to show that, depending on the supply and demand characteristics in the market, the effective price may not increase at all from one round to the next or may even fall when a slot is in a state of excess demand, or the effective price may continue to increase, even when the amount of capacity demanded is *less* than the capacity available.

As already noted, the effective price is equal to the auction price less the rebate. So, to understand how the effective price changes from one auction round to another we need to understand how the rebate is calculated. The rebate is equal to the total auction proceeds (less the auction costs) divided by the volumes actually shipped. The amount shipped by an exporter in a slot may be less than the total volume of capacity which they purchase in the auction but (presumably) cannot be any larger. Let's start with the assumption that each shipper expects to use all of the capacity it purchases in the auction – so that the forecast volume shipped is equal to the amount of capacity allocated in the auction. The total rebate is then equal to the total auction proceeds (less auctions costs) divided by the total amount of capacity allocated in the auction.

Now consider what happens if, at some point in the auction process, every slot is oversubscribed, so that the price for each slot increases by, say, 50 cents. The total auction proceeds are then forecast to increase by 50 cents times the total capacity available in the auction. The forecast rebate per tonne which (as we have just noted) is equal to the total auction proceeds divided by the total capacity available in the auction, also increases by 50 cents. The effective price for each slot – which is the auction price less the rebate – remains exactly unchanged.

If the effective price remains the same, each exporter has no incentive to reduce its bid for each slot. But if every exporter holds its bid the same, every slot will be oversubscribed in the next round, and the process will continue: the auction price will increase by 50 cents again; the rebate will also increase by 50 cents; and the effective price will again remain the same.

In principle, this process could go on *ad infinitum*. An exporter who is willing to pay up to $5/tonne effective price for a slot, would in principle be indifferent between the combination of an auction price of $10/tonne and a rebate of $5/tonne, or an auction price of $30/tonne, with a rebate of $25/tonne, or an auction price of $100/tonne, with a rebate of $95/tonne. In principle, the auction process may never reach a conclusion.

However, in practice, at some point other factors may come into play. For example, the auction price must be paid at the end of the auction process, whereas the rebate is not received until the end of the season. The higher the auction price, the greater the financial outlay required by the exporter and the greater the risk that the exporter does not use some of the capacity that it purchases at the auction. Eventually, in practice, as the auction price increases, some exporters may be forced to drop out due to less "deep pockets" (ability to finance the auction price) or less able to bear the risk of shipping less than the capacity purchased at the auction. Eventually, perhaps, sufficient exporters will drop out so that

demand for slot capacity drops below the available capacity and the auction mechanism will come to a conclusion. However, at this point the auction mechanism is not necessarily allocating capacity to those who value it most highly, but to those with the deepest pockets or the greatest ability to bear risk. This may not be an efficient allocation, and may not be consistent with a level playing field, or the promotion of competition.

A worked example may also make this point clearer. Suppose that there are four capacity slots up for auction, labelled A, B, C, and D. The demand function for each slot is as given in the table below, along with the capacity for each slot.

Each round proceeds as follows: At the start of each round, given a set of set of bids for capacity in each slot at the end of the previous round, we can work out the supply-demand balance for each slot, and which prices should increase and which prices should remain the same. Once the new prices have been determined, the forecast rebate can be computed (based on the existing bids, under the assumption that all capacity purchased at the auction will eventually be used). Given the new prices and the new rebates, the participants in the auction can then submit a new set of bids for each slot, and the round ends.

Let's assume the prices start at zero, with the rebate also at zero. At this price, there is excess demand for slots A, B, and C, and excess supply of slot D. Since there is excess demand for slots A, B, and C, the auction price for these slots rises while the auction price for slot D stays at zero. The rebate also increases, which makes the effective price for slot D negative.

The table below shows the price, rebate, effective price, and demand, at the end of each round.

This process continues until round 54, at which point the demand for slot D exceeds the available capacity. Now all four slots have excess demand. At this point the auction price for all four slots increases each round, and the rebate increases by precisely the same amount. The effective price for every slot is therefore unchanged. This auction will therefore never reach a conclusion.

Table 1: Illustration of an auction which does not reach a conclusion

Slot	A		B		C		D	
Demand	*Q=133.3-6.667P*		*Q=30-0.15P*		*Q=2666.67-66.67P*		*Q=138.88-2.78P*	
Capacity	50		10		1000		200	
Round	Price Eff Price	Rebate Demand	Price Eff Price	Rebate Demand	Price Eff Price	Rebate Demand	Price Eff Price	Rebate Demand
1	$0.50 $0.06	$0.44 132.95	$0.50 $0.06	$0.44 29.99	$0.50 $0.06	$0.44 2662.81	$0.00 -$0.44	$0.44 140.12
2	$1.00 $0.12	$0.88 132.55	$1.00 $0.12	$0.88 29.98	$1.00 $0.12	$0.88 2658.88	$0.00 -$0.88	$0.88 141.34
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53	$26.50 $4.20	$22.30 105.32	$26.50 $4.20	$22.30 29.37	$26.50 $4.20	$22.30 2386.58	$0.00 -$22.30	$22.30 200.83
54	$27.00 $4.21	$22.79 105.29	$27.00 $4.21	$22.79 29.37	$27.00 $4.21	$22.79 2386.24	$0.50 -$22.29	$22.79 200.82
55	$27.50 $4.21	$23.29 105.29	$27.50 $4.21	$23.29 29.37	$27.50 $4.21	$23.29 2386.24	$1.00 -$22.29	$23.29 200.82
56	$28.00 $4.21	$23.79 105.29	$28.00 $4.21	$23.79 29.37	$28.00 $4.21	$23.79 2386.24	$1.50 -$22.29	$23.79 200.82

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The key conclusion here is that if, *at any time* in the operation of the auction, a situation is reached where there is excess demand at every slot, the auction will not conclude.

The discussion above made the assumption that exporters expect to use all of the capacity purchased at the auction. In practice, exporters may use less than all of the capacity they purchase at the auction. If they forecast to only use some fraction (say 90 per cent) of the capacity purchased at the auction, the rebate will increase by *more* than 50 cents when the auction prices increase by 50 cents. As a result, the effective price for slots will *decline*, even though every slot is oversubscribed. In other words, if exporters expect to use less than all the capacity they purchase at the auction, the problem that the auction may not reach a conclusion is made even worse.

There is a second problem that arises from the rebate mechanism – the auction may not converge to a desirable outcome. The easiest way to see this is with an example. Let's take the example of four slots again, with the same demand curves and capacities as in the example above. But now let's change the demand for slot D so that the auction can continue for a longer period of time. The demand curve for each slot is as given in Table 2 below.

Table 2 shows the evolution of the auction in this case. By around round 245, the effective price of slot A has reached $12.55, and the supply and demand for slot A are close to balance. The effective price for slot A remains around $12.50 for the next one hundred or so rounds. The process continues to round 352 when the effective price of slot C reaches around $25. At this point slot C is close to balance. However, there is a slight "overshoot" (since the auction price increases in discrete increments each round). The forecast demand for slot C drops slightly below the capacity of 1000. Since the demand curve for slot C is elastic in the region of the supply/demand intersection, this overshoot reduces the forecast auction proceeds and the forecast rebate.[2]

From round 362 on the rebate reduces each round. This increases the effective price for the slots which are already in balance – including slot C. The increase in the effective price further reduces demand for slots A, B and C, further reducing the auction proceeds, and therefore further reducing the rebate, increasing the effective price. This results in a downward spiral, with rebate falling and effective prices increasing, even for slots which are undersubscribed. This process continues to the point where the demand for slots A and C drops to zero.

This auction does reach a conclusion. But the final result is that only 4.4 per cent of the total capacity available is allocated through the auction. And this is despite the fact that at the outset of the auction (at the price of zero), the total capacity demanded exceeded the total capacity available by 2.3 times.

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[2] The impact of the "overshooting" on the auction proceeds depends on the elasticity of demand. Where demand is elastic an increase in the effective price will lower the total auction proceeds and therefore will lower the rebate, further increasing the effective price. This situation is therefore unstable and can lead to outcomes such as the one illustrated in Table 2. On the other hand, where the demand is inelastic, an increase in the effective price increases the rebate, reducing the rebate. This situation is stable and should converge to an efficient allocation.

Table 2: Illustration of an auction which converges to an inefficient outcome

Slot	A		B		C		D	
Demand	*Q=133.3-6.667P*		*Q=30-0.15P*		*Q=2666.67-66.67P*		*Q=41.67-0.833P*	
Capacity	50		10		1000		200	
Round	Price Eff Price	Rebate Demand	Price Eff Price	Rebate Demand	Price Eff Price	Rebate Demand	Price Eff Price	Rebate Demand
352	$164.00 $12.51	$151.49 49.90	$176.00 $24.51	$151.49 26.32	$176.00 $24.51	$151.49 1032.35	$0.00 -$151.49	$151.49 167.90
353	$164.00 $12.14	$151.86 52.37	$176.50 $24.64	$151.86 26.30	$176.50 $24.64	$151.86 1023.69	$0.00 -$151.86	$151.86 168.21
354	$164.50 $12.25	$152.25 51.66	$177.00 $24.75	$152.25 26.29	$177.00 $24.75	$152.25 1016.65	$0.00 -$152.25	$152.25 168.54
355	$165.00 $12.36	$152.64 50.94	$177.50 $24.86	$152.64 26.27	$177.50 $24.86	$152.64 1009.36	$0.00 -$152.64	$152.64 168.87
356	$165.50 $12.47	$153.03 50.21	$178.00 $24.97	$153.03 26.25	$178.00 $24.97	$153.03 1002.08	$0.00 -$153.03	$153.03 169.19
357	$166.00 $12.58	$153.42 49.48	$178.50 $25.08	$153.42 26.24	$178.50 $25.08	$153.42 994.79	$0.00 -$153.42	$153.42 169.52
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362	$166.00 $14.12	$151.88 39.20	$181.00 $29.12	$151.88 25.63	$178.50 $26.62	$151.88 892.02	$0.00 -$151.88	$151.88 168.23
363	$166.00 $14.98	$151.02 33.46	$181.50 $30.48	$151.02 25.43	$178.50 $27.48	$151.02 834.56	$0.00 -$151.02	$151.02 167.52
364	$166.00 $16.47	$149.53 23.56	$182.00 $32.47	$149.53 25.13	$178.50 $28.97	$149.53 735.60	$0.00 -$149.53	$149.53 166.28
365	$166.00 $19.50	$146.50 3.33	$182.50 $36.00	$146.50 24.60	$178.50 $32.00	$146.50 533.26	$0.00 -$146.50	$146.50 163.75
366	$166.00 $28.64	$137.36 0.00	$183.00 $45.64	$137.36 10.00	$178.50 $41.14	$137.36 0.00	$0.00 -$137.36	$137.36 156.13

My conclusion is that there is no guarantee that the proposed port capacity auction mechanism will either reach a conclusion or will efficiently allocate port capacity. This arises due to the role of the rebate mechanism. Exporters pay only the effective price (the auction price less the rebate). While the auction price may adjust to balance supply and demand from one round to the next, the effective price may move in the opposite direction or not move at all.

Let's turn now to explore problems arising from the first-come-first-served mechanism.

Problems arising from the FCFS mechanism

As noted earlier, capacity which is not allocated through the auction mechanism is made available to exporters through a FCFS mechanism. However, the presence of this FCFS mechanism can give rise to strategic behaviour and inefficient outcomes in the auction.

Specifically, consider the position of a large player in the auction who considers that he/she has a good chance of acquiring any capacity which is not allocated through the auction mechanism through the FCFS process. As the auction rounds proceed, eventually a point may be reached where the excess demand on the high-priced slots is relatively small. At this point the exporter will be in a position where he/she can

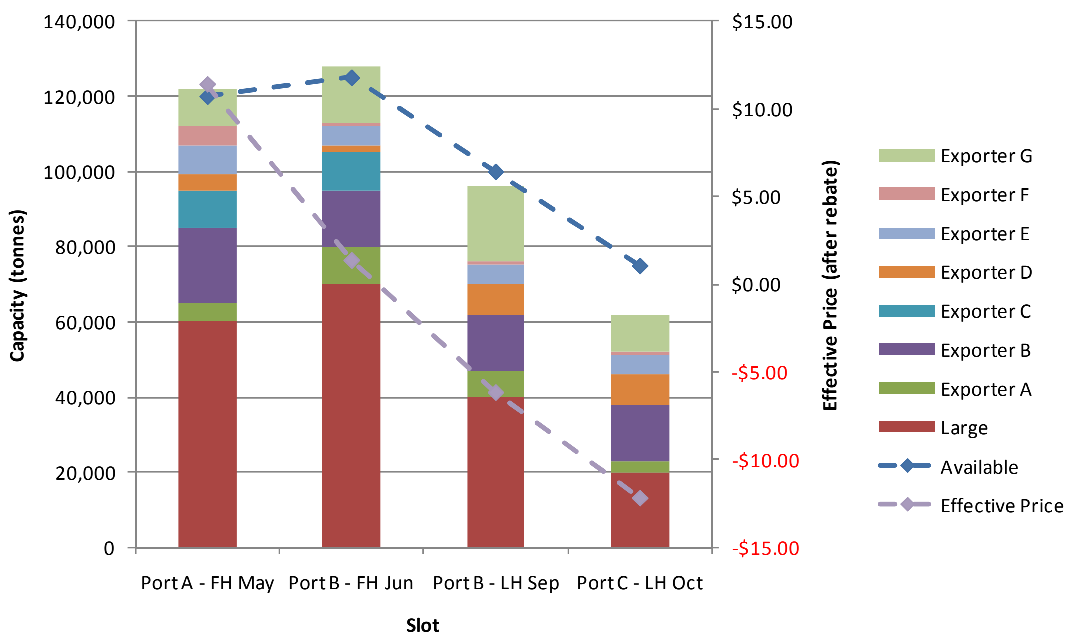
bring the auction to an end by submitting a bid of zero for the high-priced slots. The auction will end, and the exporter will receive an allocation of zero of the high-priced slots. However the exporter can then go to the FCFS mechanism where it will (by assumption) receive an allocation, perhaps acquiring almost as much as it was previously seeking to acquire in the auction.

The benefit of this strategy is that the exporter has acquired high-priced capacity at a zero price, placing it at an advantage over its rivals (who have paid a high effective price for the same capacity). At the same time, the large player can choose to retain its auction allocation of low-priced capacity for which it expects to receive a rebate. In effect, the exporter has paid zero for highly valued capacity while continuing to receive a rebate (that is, be paid to use) the low-valued capacity.

As an illustration of how this might work, let's suppose again that there are just four slots being auctioned (that is four port-time combinations), as indicated in the graph below. Figure 1 below illustrates a hypothetical situation in the second-to-last round of an auction. In the second-to-last round of this auction, the price has risen to $27.50 and $17.50 for the first two slots, and $10 and $4 for the last two slots. The forecast rebate at these prices is $16.16/tonne. The first two slots are slightly over-subscribed while the last two slots are under-subscribed (that is the total amount demanded is less than the capacity available).

Faced with this situation the large player can bring the auction to an end by changing its bid to zero on the two high-priced slots. The large player will receive no allocation in the auction for these first two slots, but (by assumption) can expect to pick up this capacity in the FCFS mechanism. The cost of this strategy is a small loss in volume for the high-priced slots (in this example, it implies a loss of 2000 units of the first slot and 3000 of the second slot). The benefit of the strategy is the reduction in the cost of acquiring port capacity, relative to rivals.

Figure 1: Hypothetical second-to-last round of an auction



For this strategy to be successful, the player must not expect to lose too much capacity. This implies that (a) the player's bid must be large relative to the excess demand for a slot, (b) that the player can be

reasonably certain of the auction coming to an end, and (c) that the player can have a strong assurance of being able to acquire any capacity that is foregone in the auction mechanism through the FCFS process.

Conclusion

This paper has highlighted theoretical and practical problems with the port capacity allocation mechanism proposed by Viterra in SA. Specifically, this paper suggests that (a) the auction mechanism may fail to reach a conclusion, or may reach a conclusion in which only a fraction of the available capacity is allocated through the auction, even when there is excess demand for port capacity; and (b) the auction mechanism is potentially subject to gaming by an exporter which can expect to receive its desired allocation through the FCFS mechanism..

These problems arise due to the rebate mechanism and the FCFS mechanism.