Product-Mix Auctions: Examples, and Introduction to the PMA web app

Companion Slide Set

The code is being developed further; in particular, some graphs may be differently titled on the screenshots than in the current version of the web app.

Please send any questions to paul.klemperer@nuffield.ox.ac.uk

Product-Mix Auctions

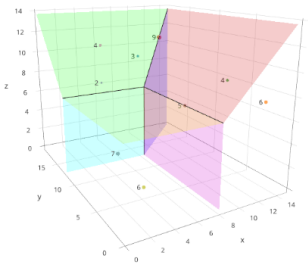
We provide open-source software for three different Product-Mix Auctions. (All Product-Mix Auctions are single-round sealed-bid auctions for multiple units of multiple distinct goods.)

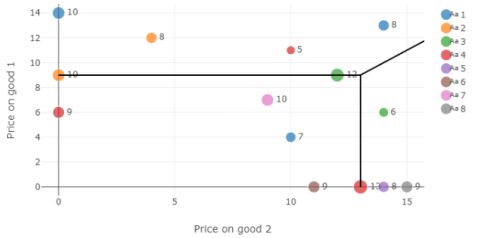
- **Standard Version.**
  - This is a generalisation of the design that is the basis of the "ILTR" auction that is now regularly used by the Bank of England — see paper.
  - It permits flexible buyer and seller preferences over an arbitrary number of goods.
- **Version for Budget-constrained bidders.**
  - This version was originally designed for the Government of Iceland.
  - As in the standard version, bidders simultaneously make sets of bids. In this case, however, each of a bidder's bids can specify a total budget to be spent.
- **"Positive and negative dot-bids" Version.**
  - This version extends the standard version to permit all participants (buyers and seller) to express *any* strong substitute preferences for indivisible goods.

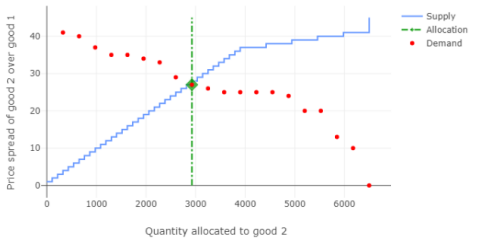
This software is available both as a command-line program `pma`, and a web application `pma-server` (all open-source). The latter provides a single-user interface allowing an auction specification to be constructed in a web browser form. We host the web application here and also provide the code so users can host it locally.

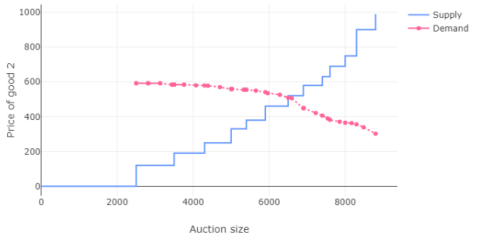
Please contact Elizabeth Baldwin or Paul Klemperer for the password to access this software, or for further information about it; its use is free of charge.

Download software and documentation (requires password)









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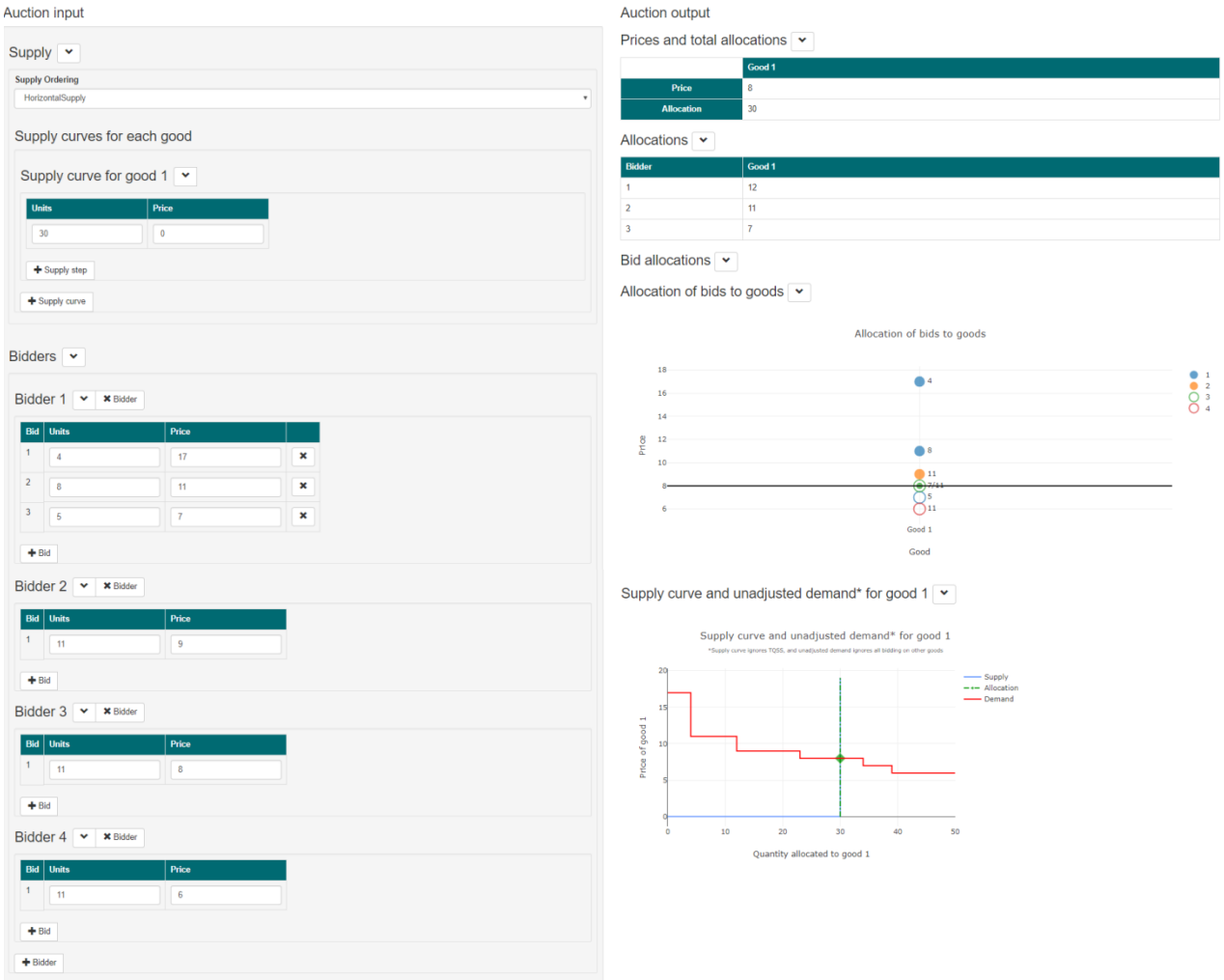
Section 1
Section 1.1

1. Independent Auctions
1.1 Auctioning a Single Variety

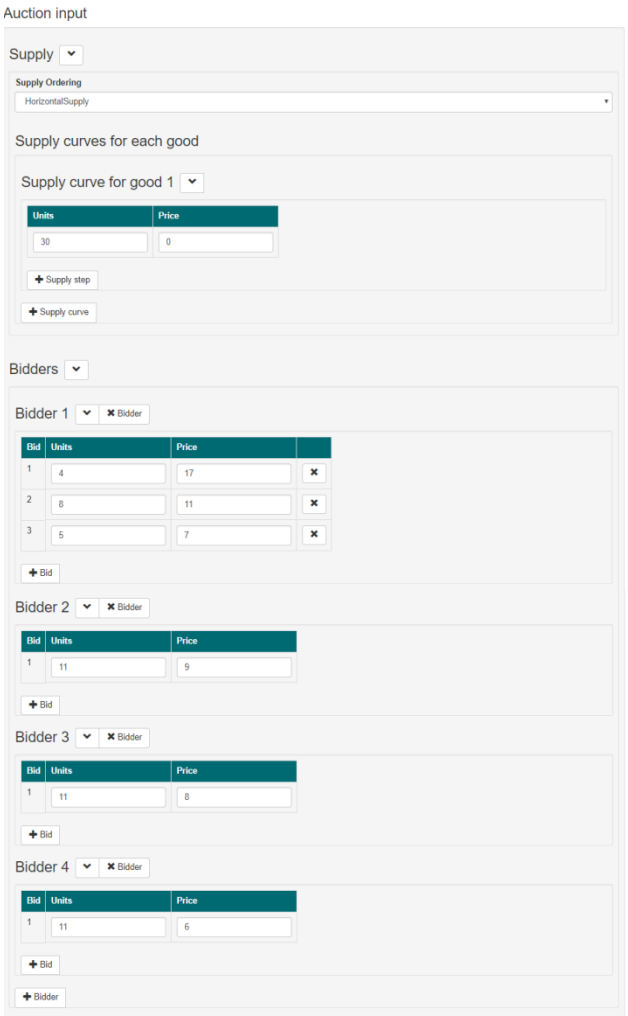


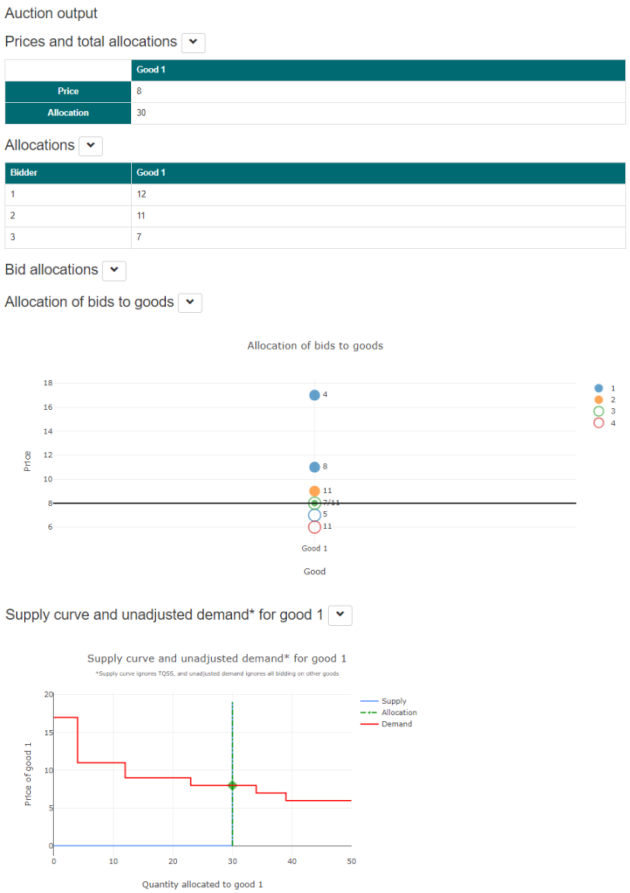
The bottom-right corner indicates the example corresponding to the current slide → **demoSingle**

1. Independent Auctions
1.1 Auctioning a Single Variety

Supply curves

Bidders/ Bids





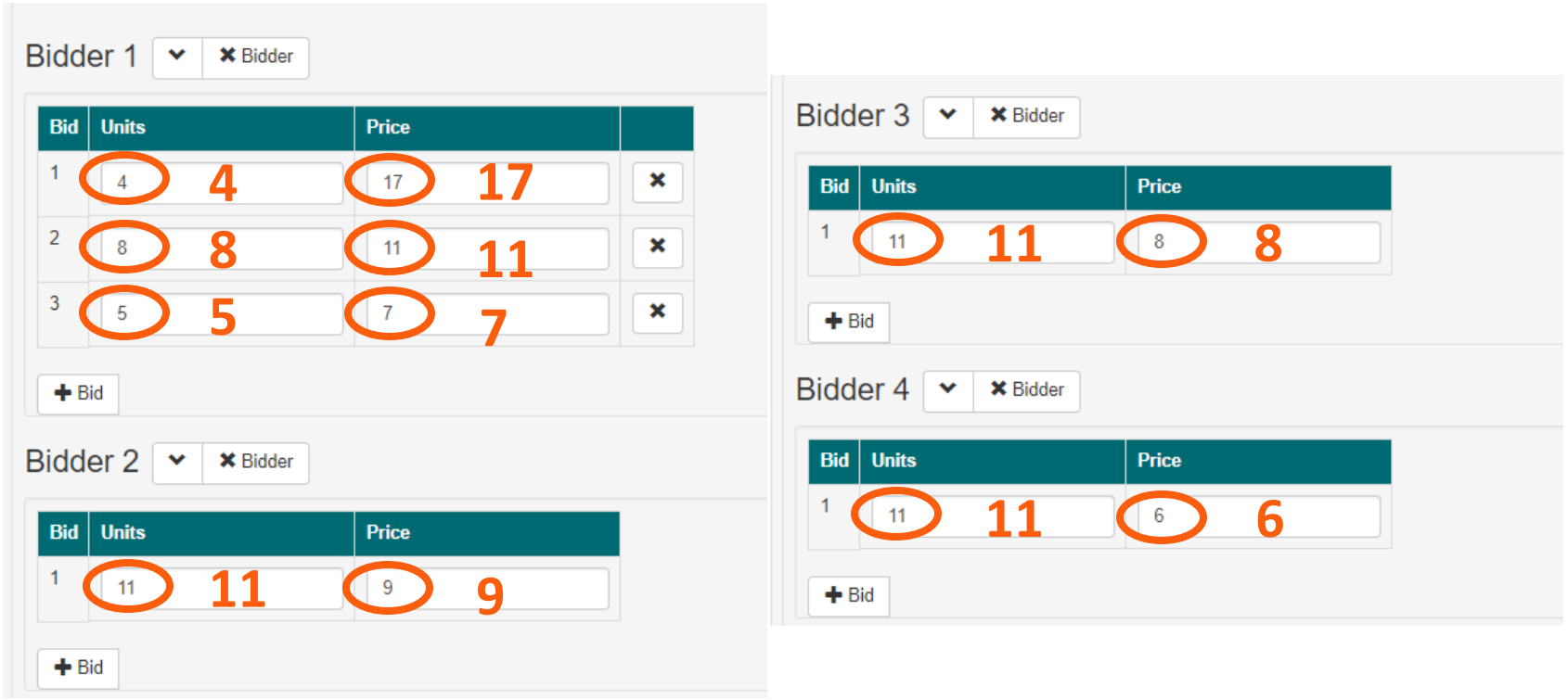
Prices& Allocations

Allocations of bids to goods

Demand, supply & allocations

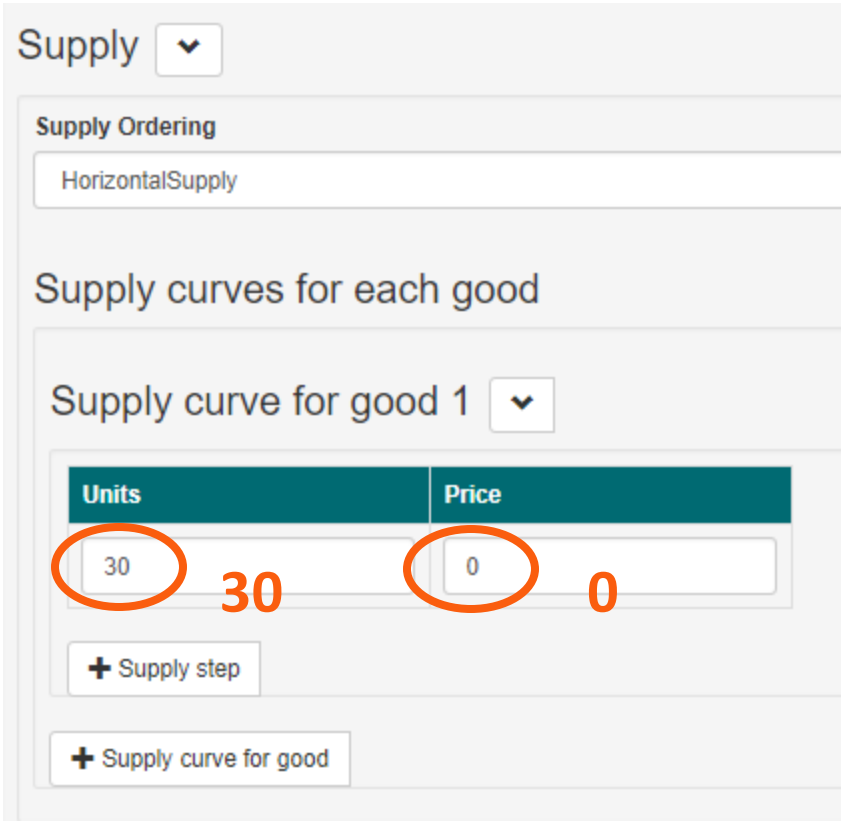
demoSingle

1.1 Auctioning a Single Variety
Bidders/Bids



demoSingle

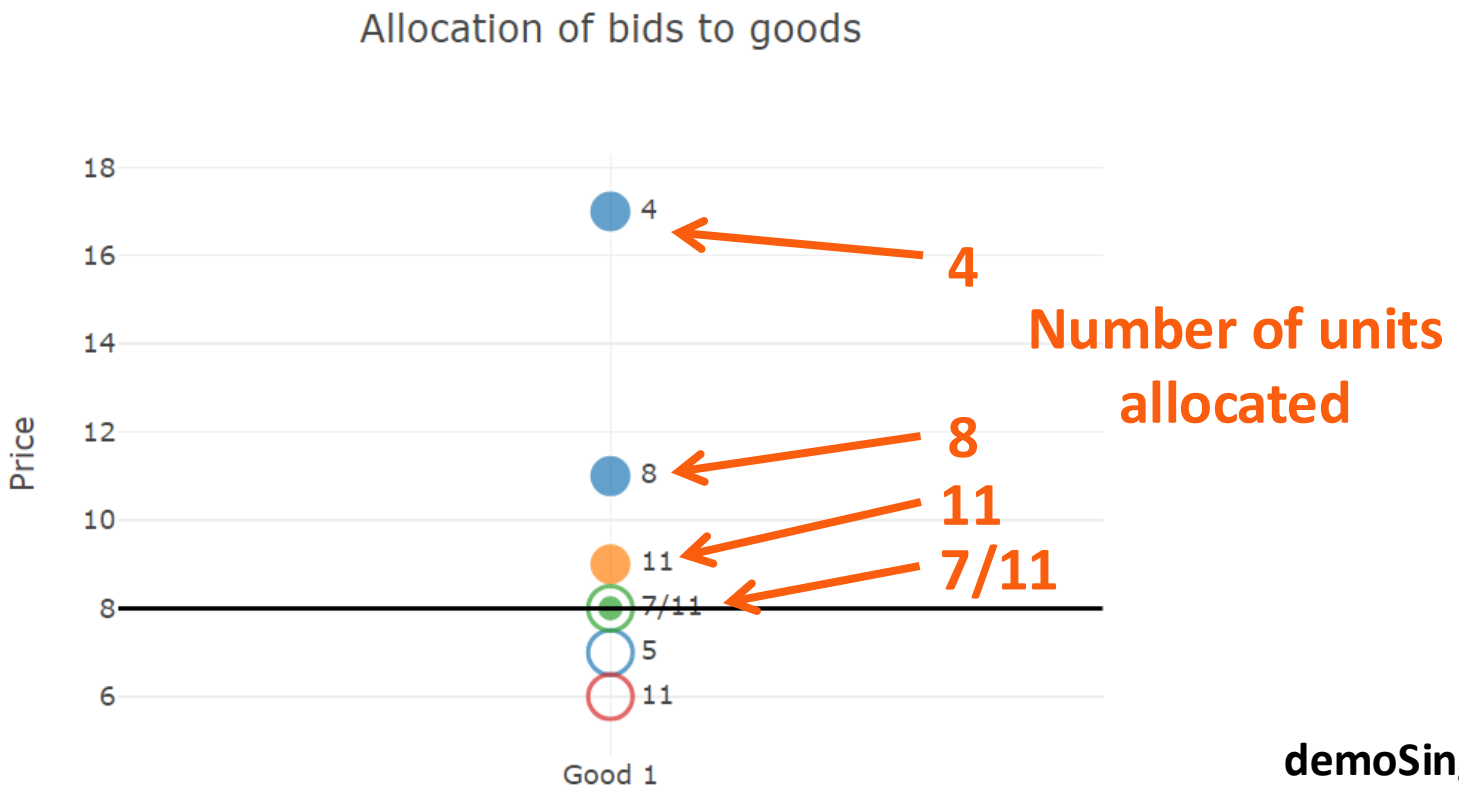
1.1 Auctioning a Single Variety
Supply Curves



demoSingle

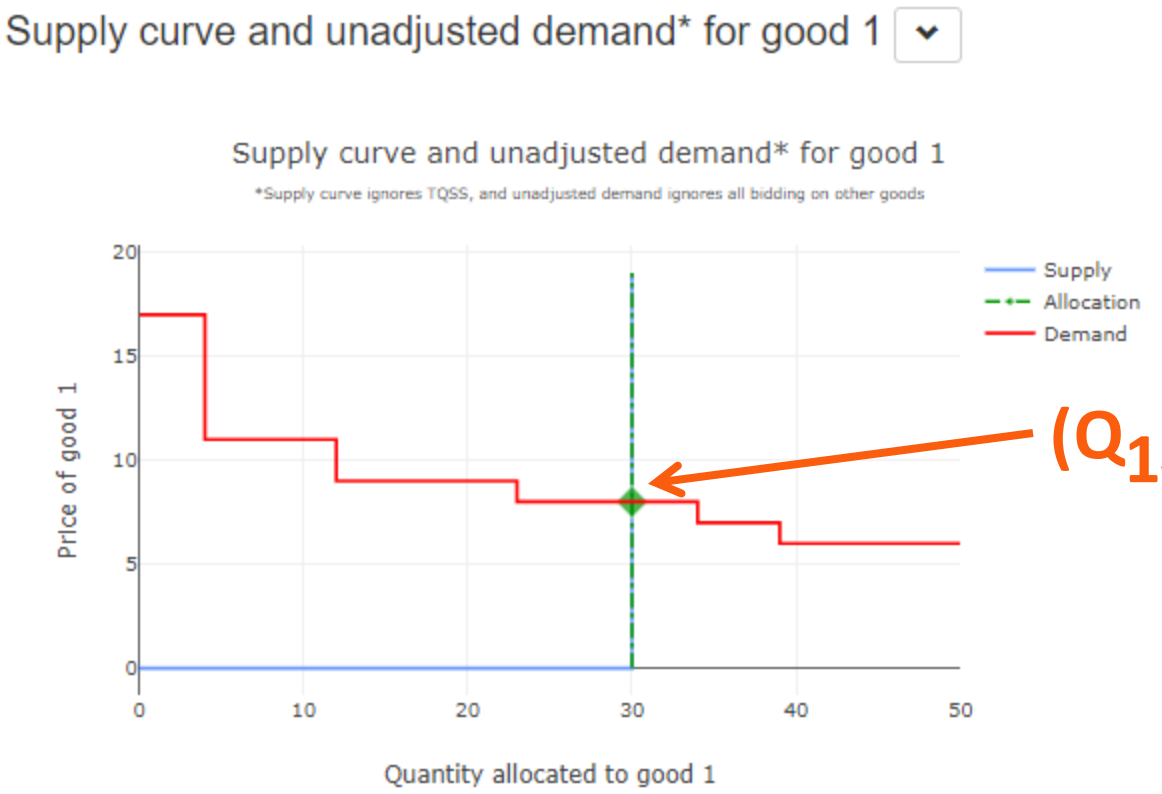
1.1 Auctioning a Single Variety
Allocation of Bids to Goods

(auctioneer is selling 30 units; reserve price 0)



demoSingle

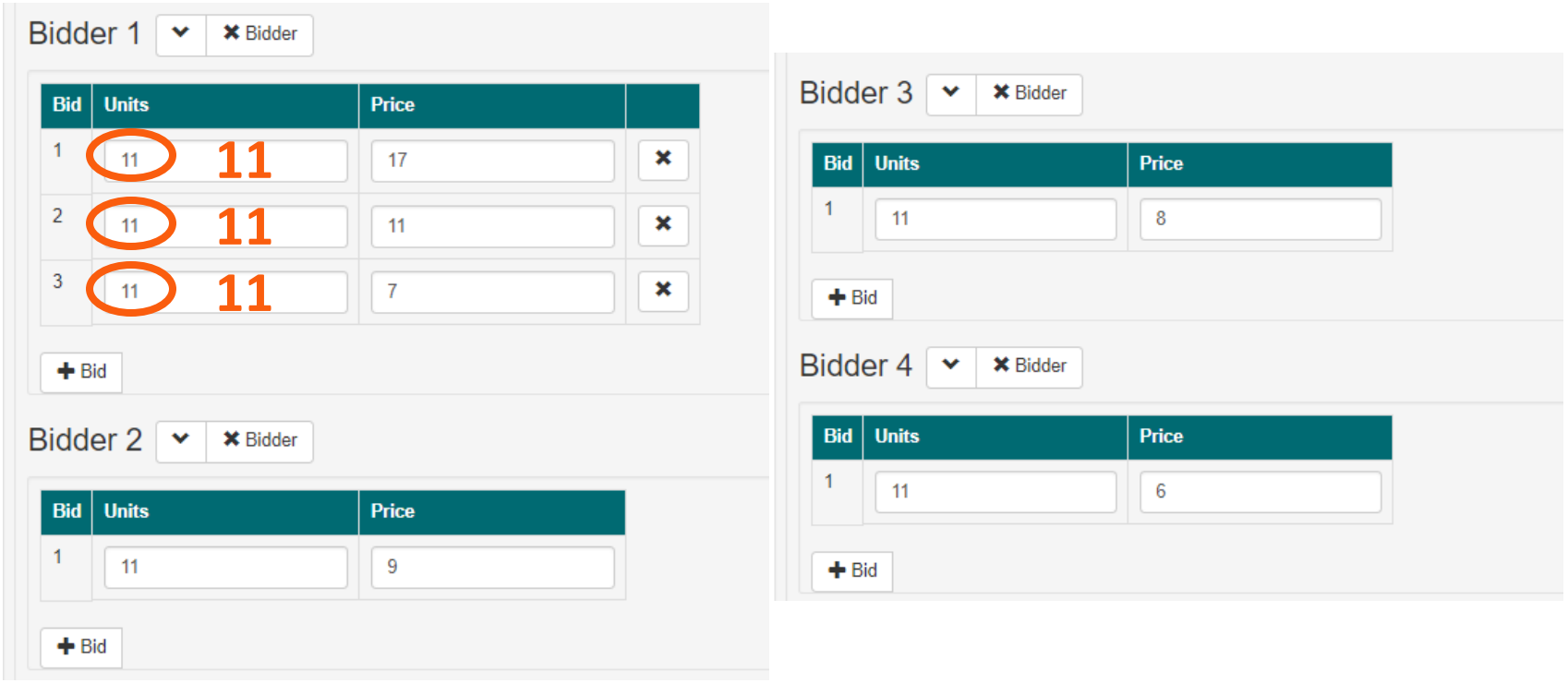
1.1 Auctioning a Single Variety Demand, Supply, & Allocation



$(Q_1,P_1) = (30,8)$

demoSingle

1.1 Auctioning a Single Variety Bidders/Bids



demoSingle2

1.1 Auctioning a Single Variety
Prices & Allocation of Bids to Goods

Auction output

Prices and total allocations

	Good 1
Price	9
Allocation	30

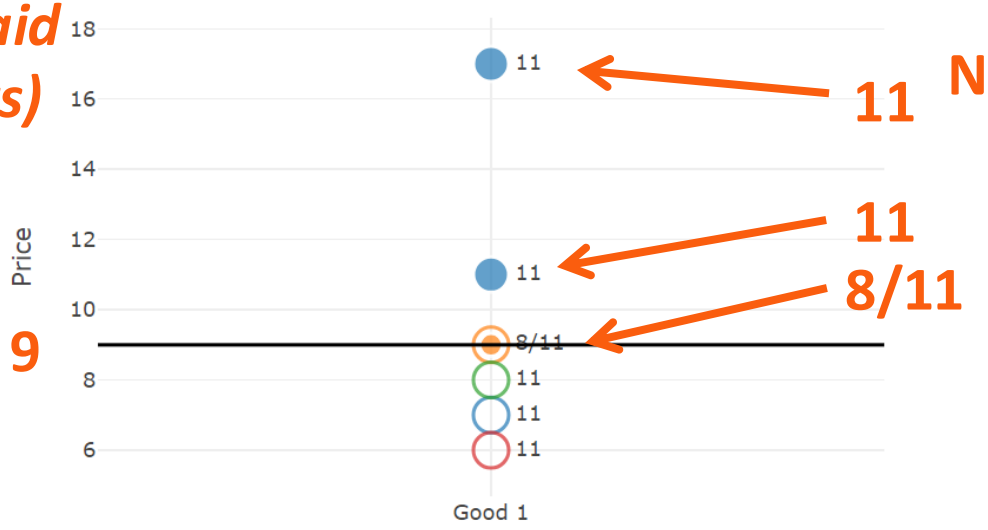
9

30

Allocations

Bidder	Good 1
1	22
2	8

Uniform Price
(Same Price paid by All Winners)



9

11

11

8/11

Number of units allocated

demoSingle2

Section 1.2

1. Independent Auctions
1.2 Two Separate (Uniform-Price) Auctions

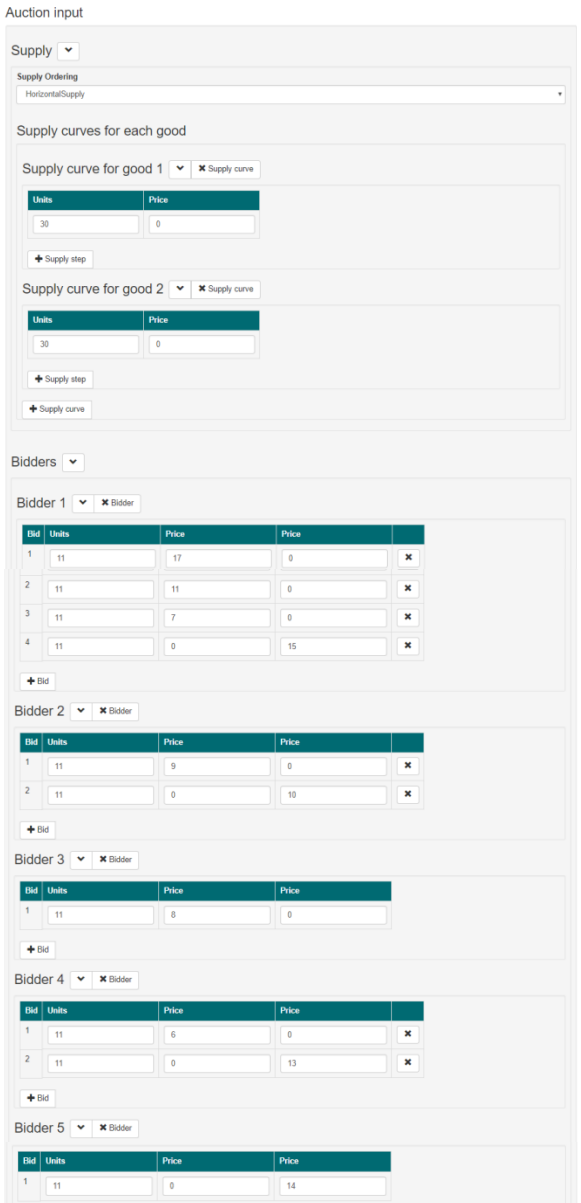
Supply curves

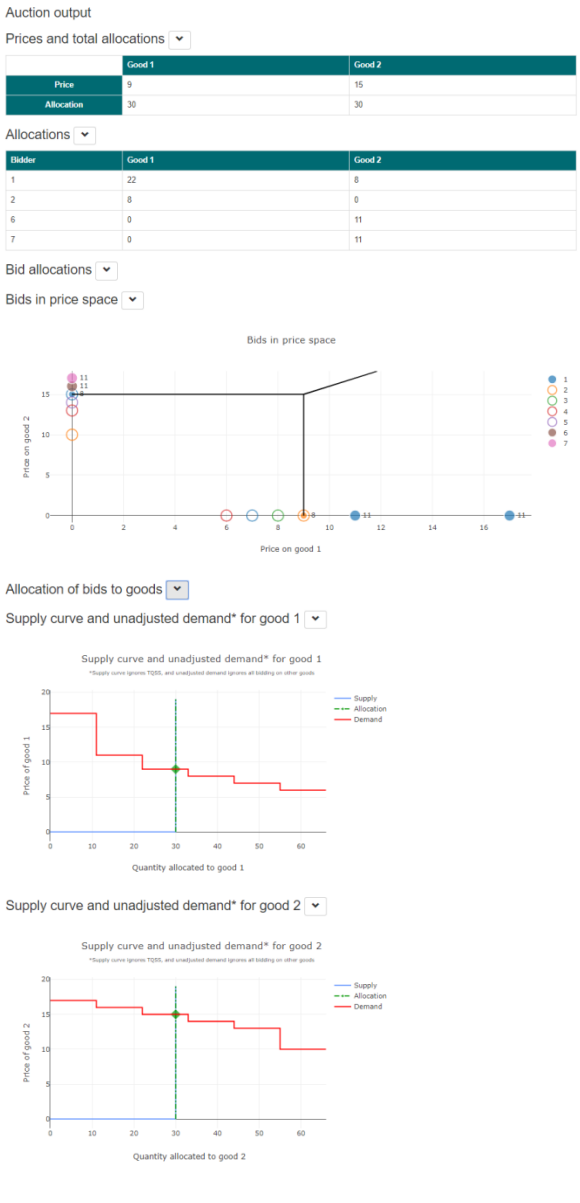
Bidders/ Bids

Prices& Allocations

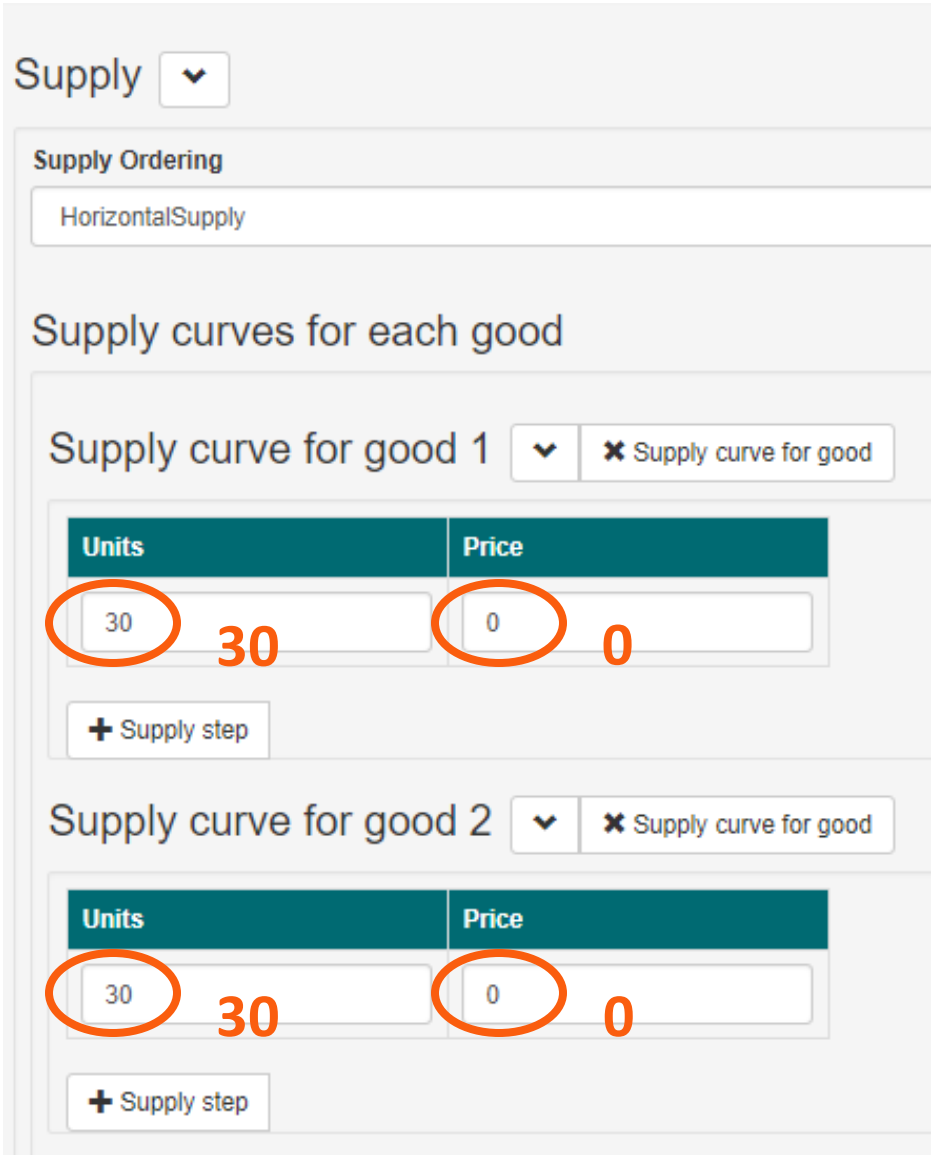
Bids in price space

Demand, supply & allocations



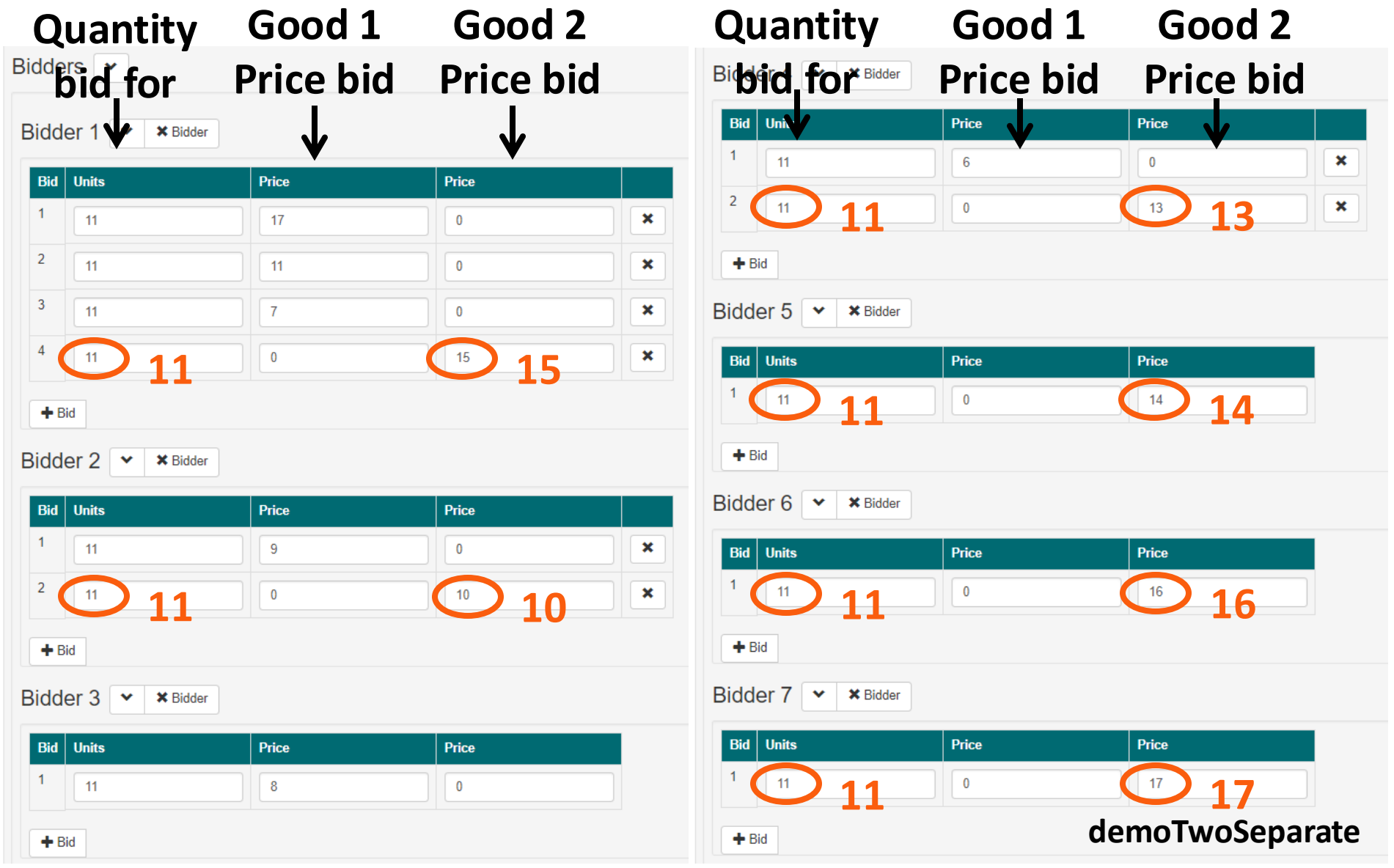


1.2 Two Separate (Uniform-Price) Auctions
Supply Curves



demoTwoSeparate

1.2 Two Separate (Uniform-Price) Auctions
Bidders/Bids



demoTwoSeparate

1.2 Two Separate (Uniform-Price) Auctions
Prices & Allocations

Auction output

Prices and total allocations

	Good 1	Good 2
Price	9	15
Allocation	30	30

9 15 30 30

Allocations

Bidder	Good 1	Good 2
1	22	8
2	8	0
6	0	11
7	0	11

22 8

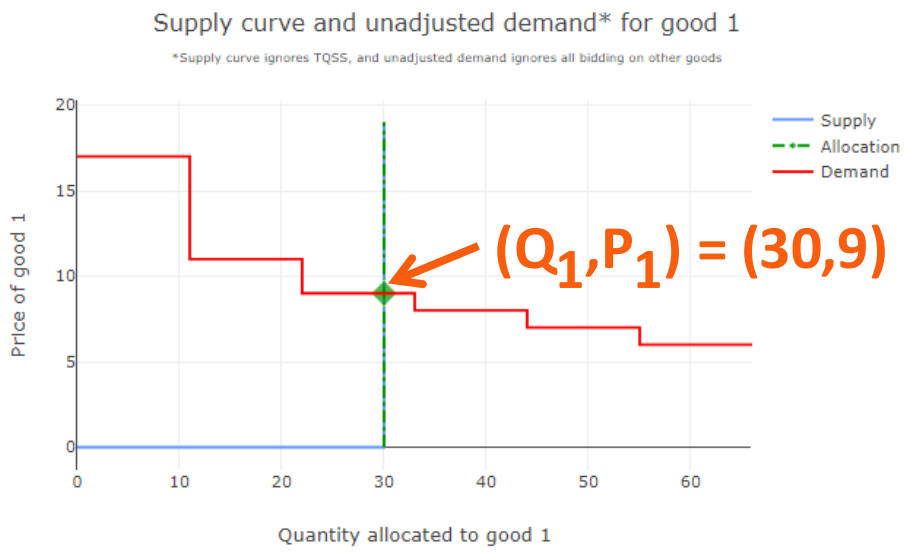
demoTwoSeparate

1.2 Two Separate (Uniform-Price) Auctions
Bids in price space & Allocations of bids to goods

demoTwoSeparate

1.2 Two Separate (Uniform-Price) Auctions
Demand, Supply & Allocations

Supply curve and unadjusted demand* for good 1



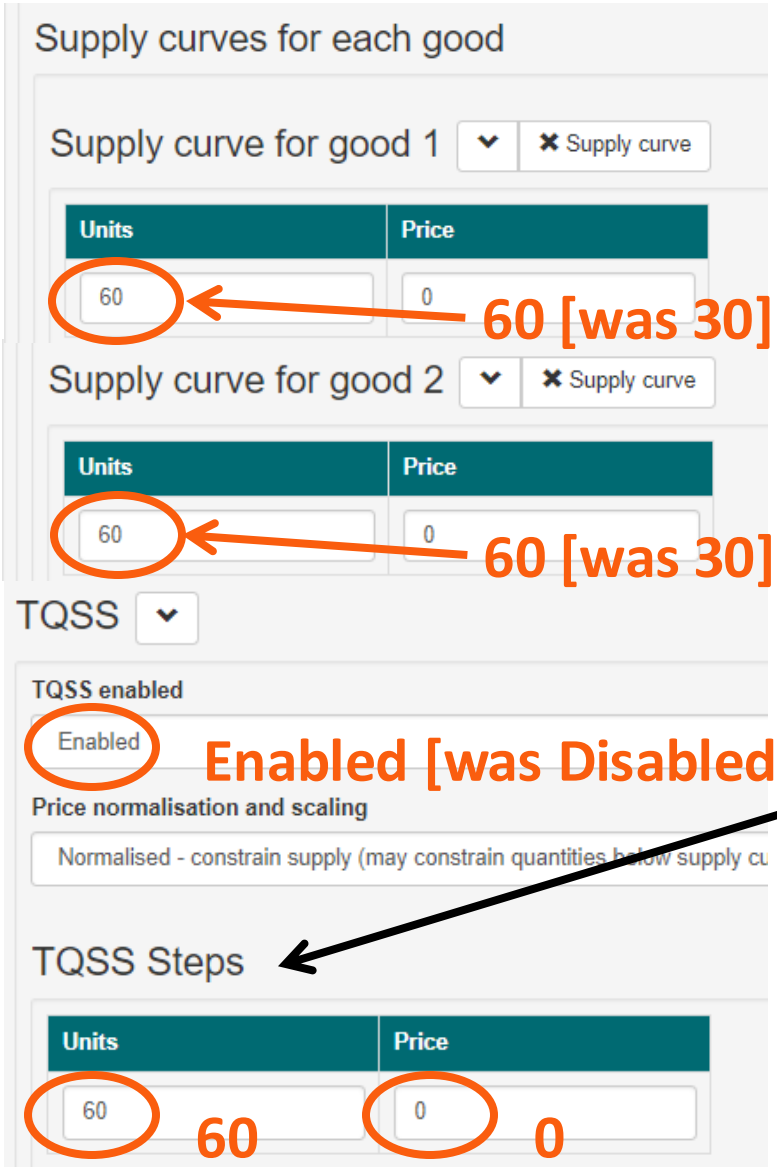
Supply curve and unadjusted demand* for good 2

demoTwoSeparate

Section 2
Section 2.1

2. Combining the Auctions

2.1 Introducing the Total Quantity Supply Schedule (TQSS)



TQSS = Total Quantity Supply Schedule

(Here willing to sell up to 60 of good 1, and willing to sell up to 60 of good 2, but no more than 60 in total.)

demoCombine

2.1 Introducing the Total Quantity Supply Schedule (TQSS) Demand, Supply & Allocations

Supply curves for each good

Supply curve for good 1 ✖ Supply curve

Units	Price
60	0

60 [was 30]

Supply curve for good 2 ✖ Supply curve

Units	Price
60	0

60 [was 30]

TQSS

TQSS enabled

Enabled

Enabled [was Disabled]

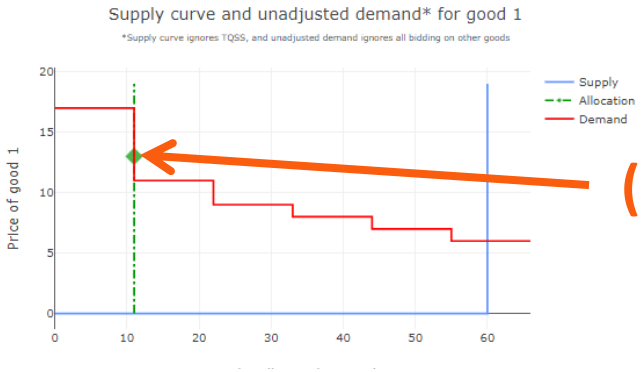
Price normalisation and scaling

Normalised - constrain supply (may constrain quantities below supply cu

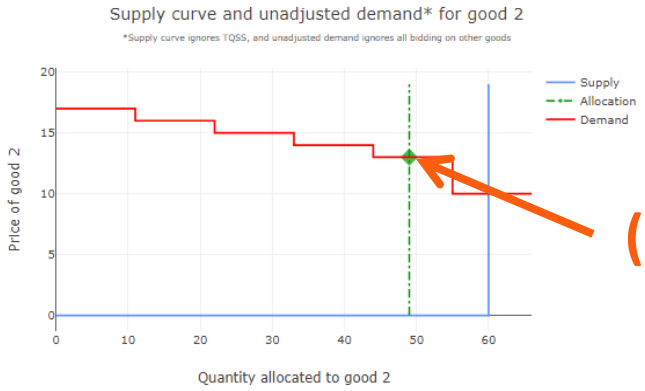
TQSS Steps

Units	Price
60	0

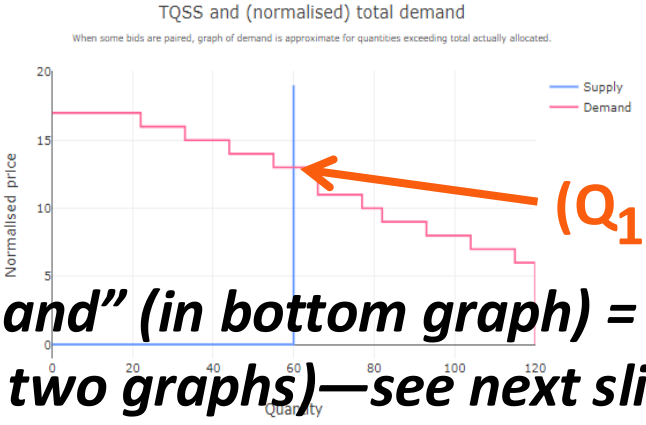
60 0



$(Q_1,P_1) = (11,13)$



$(Q_2,P_2) = (49,13)$



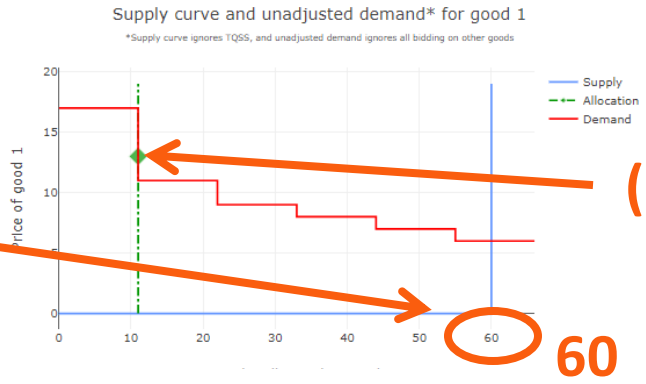
$(Q_1+Q_2,P) = (60,13)$

"total demand" (in bottom graph) = horizontal sum of demands (in top two graphs)—see next slide

demoCombine

2.1 Introducing the Total Quantity Supply Schedule (TQSS)
Demand, Supply & Allocations

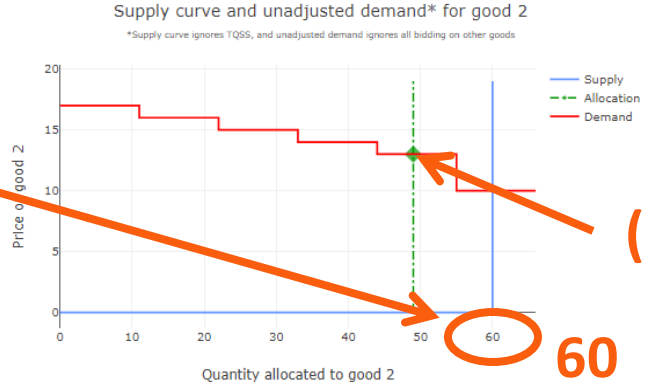
Auctioneer is willing to sell up to 60 of good 1,



$(Q_1,P_1) = (11,13)$

60

and up to 60 of good 2,

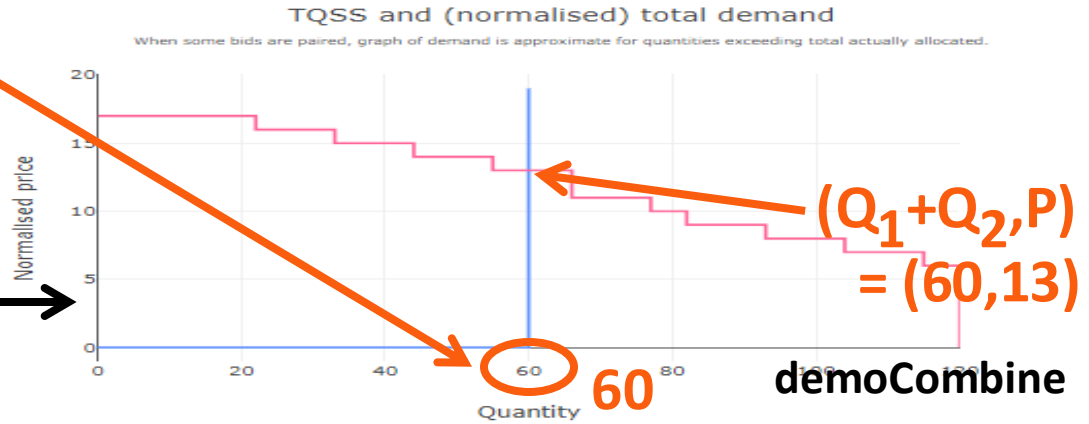


$(Q_2,P_2) = (49,13)$

60

but no more than 60 in total (Total Quantity Supply Schedule)

(This is the previous screenshot, rescaled)



$(Q_1+Q_2,P) = (60,13)$

60

demoCombine

2.1 Introducing the Total Quantity Supply Schedule (TQSS)
Bids in price space & Allocation of bids to goods

demoCombine

Section 2.2

2. Combining the Auctions
2.2 Simple Examples

Supply curves for each good

Supply curve for good 1 ✖ Supply curve

Units	Price
60	0

Supply curve for good 2 ✖ Supply curve

Units	Price
60	0

TQSS

TQSS enabled

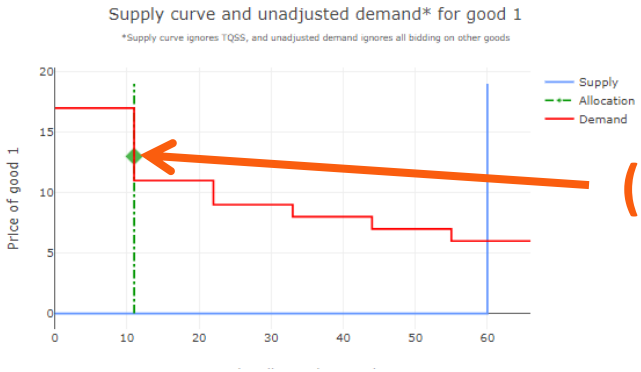
Enabled

Price normalisation and scaling

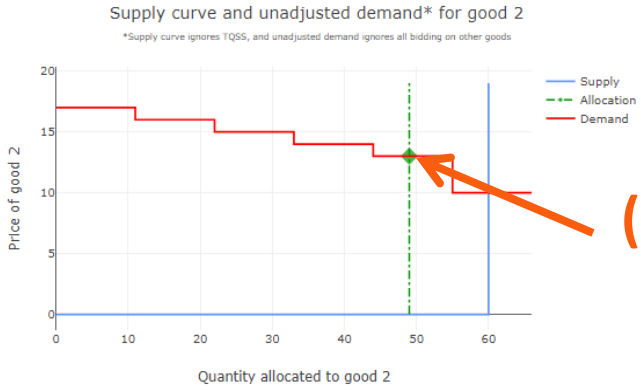
Normalised - constrain supply (may constrain quantities below supply cu

TQSS Steps

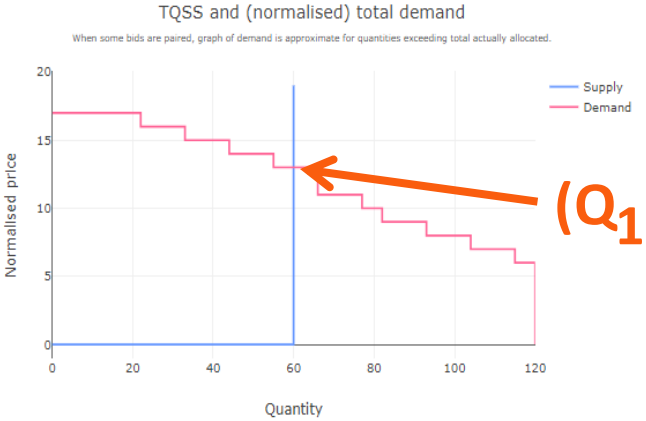
Units	Price
60	0



$(Q_1,P_1) = (11,13)$



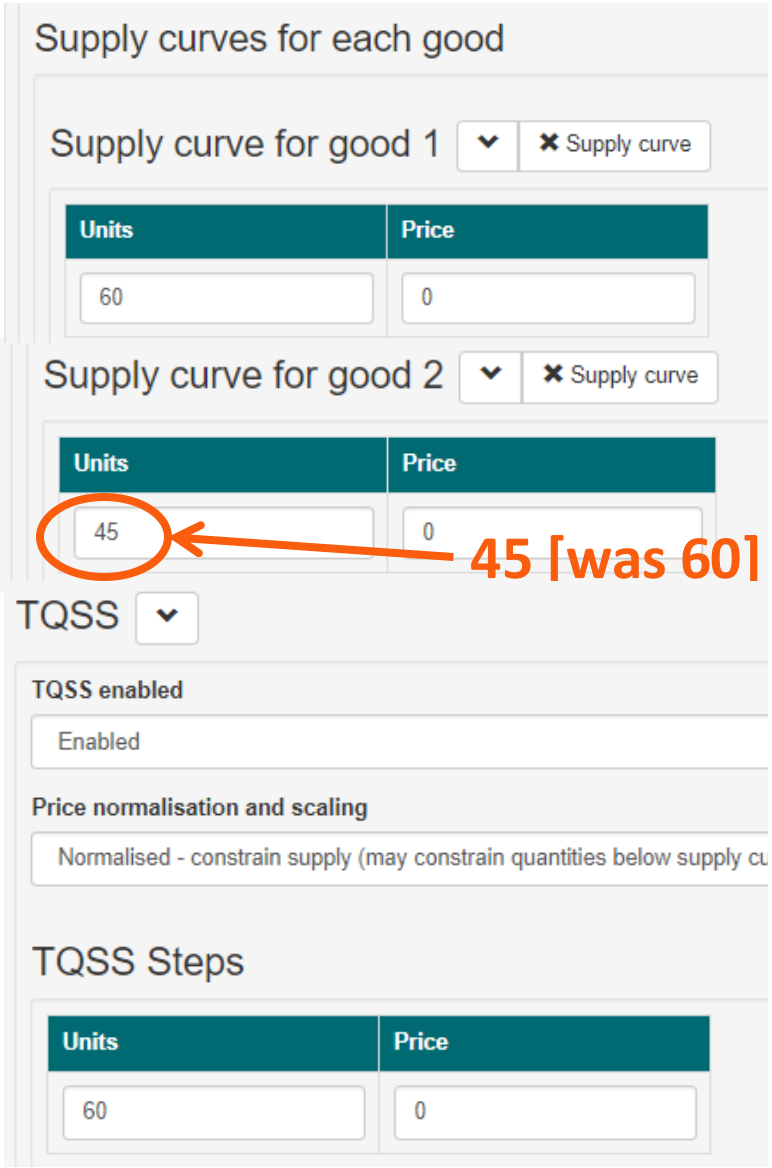
$(Q_2,P_2) = (49,13)$



$(Q_1+Q_2,P) = (60,13)$

demoCombine

2.2 Simple Examples
Constraining maximum quantity of good



demoCombine2

2.2 Simple Examples – Constraining maximum Q of good 2
Demand, supply & allocations

Supply curves for each good

Supply curve for good 1 ✖ Supply curve

Units	Price
60	0

Supply curve for good 2 ✖ Supply curve

Units	Price
45	0

45 [was 60]

TQSS

TQSS enabled

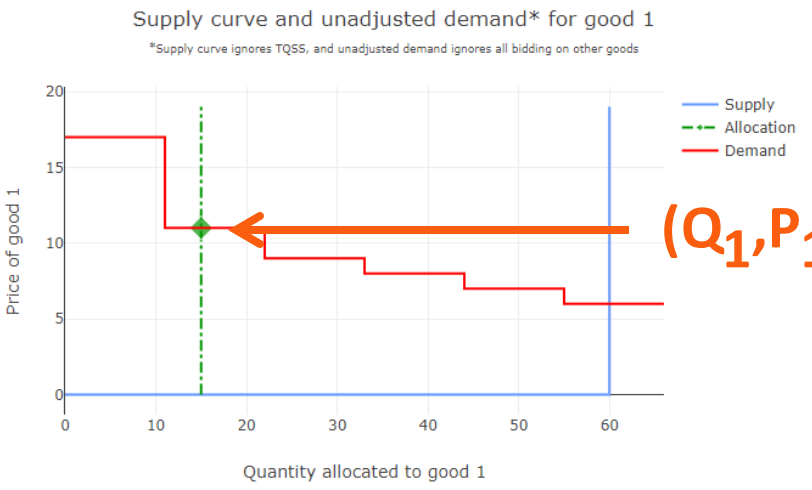
Enabled

Price normalisation and scaling

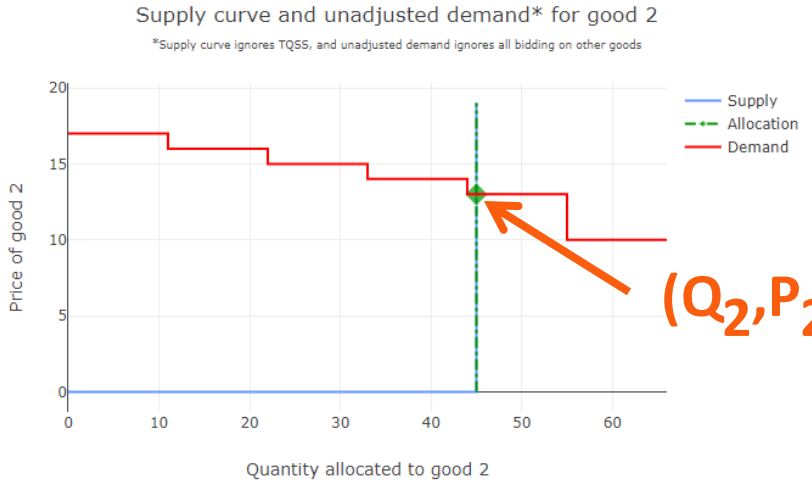
Normalised - constrain supply (may constrain quantities below supply cu

TQSS Steps

Units	Price
60	0



$(Q_1,P_1) = (15,11)$



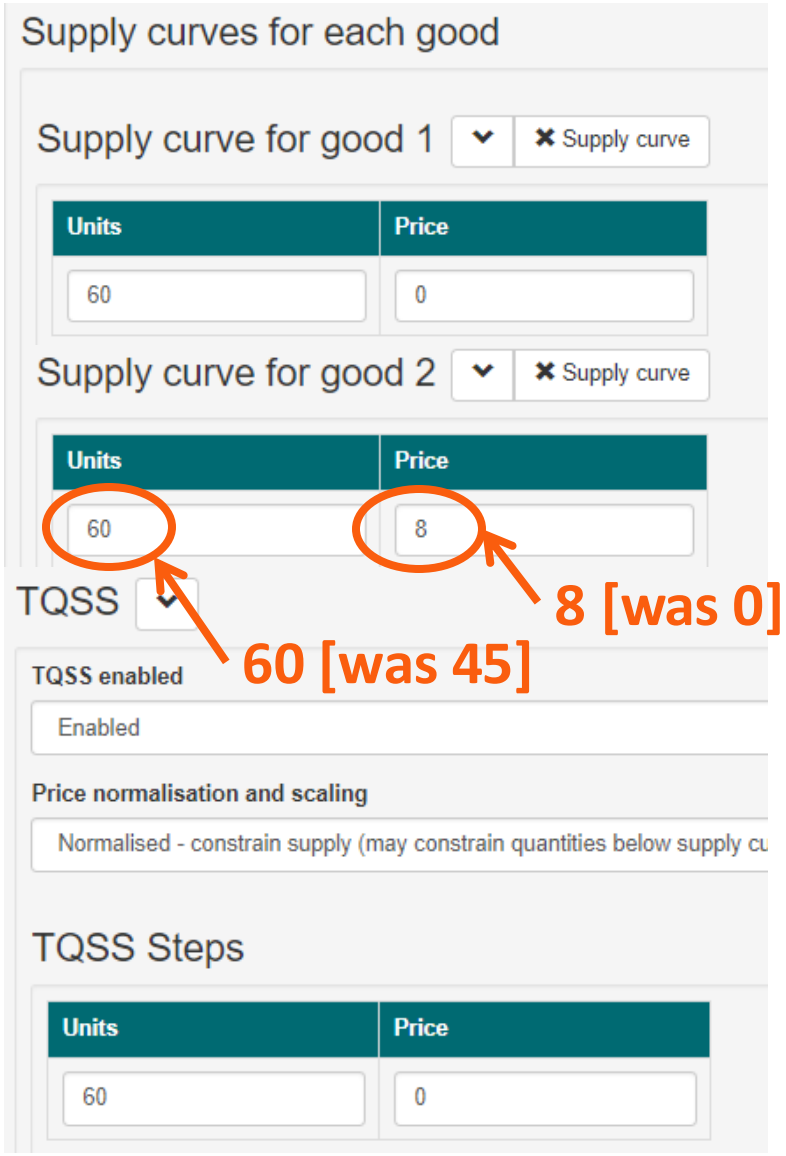
$(Q_2,P_2) = (45,13)$

demoCombine2

2.2 Simple Examples – Constraining maximum Q of good 2
Bids in price space & Allocations of bids to goods

demoCombine2

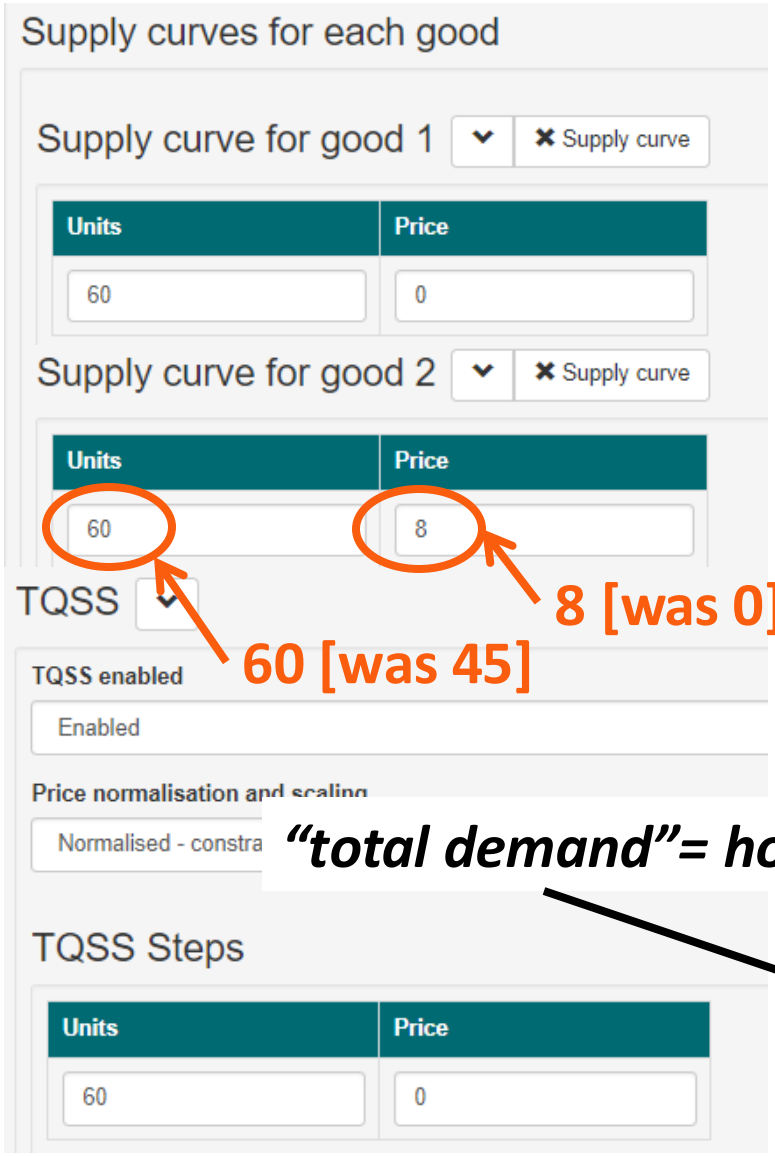
2.2 Simple Examples
Fixing price difference between goods



-> cf. handicapping good 2

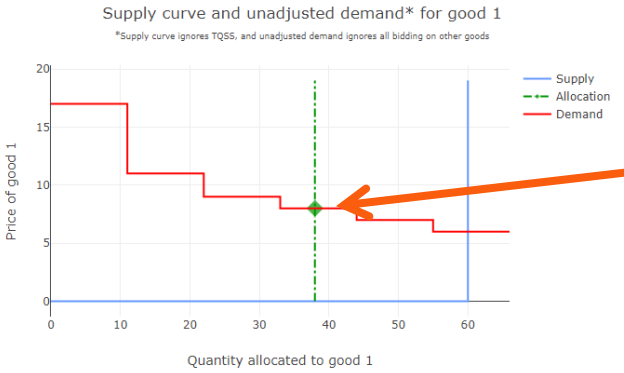
demoCombine3

2.2 Simple Examples – Fixing price difference between goods Demand, Supply & Allocations

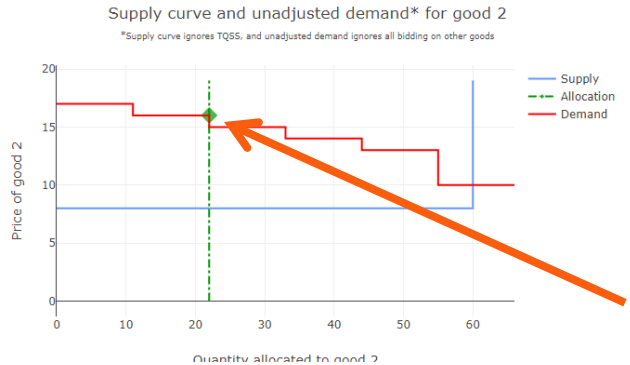


8 [was 0]

60 [was 45]

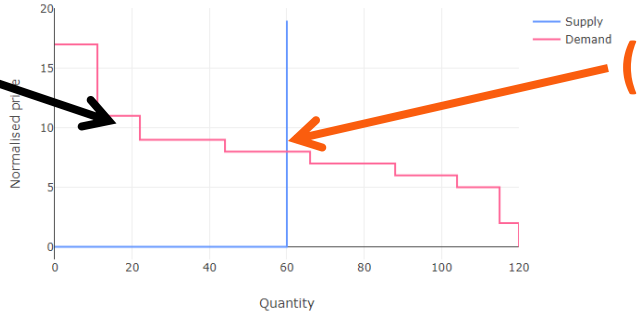


$(Q_1,P_1) = (38,8)$



$(Q_2,P_2) = (22,16)$

"total demand"= horizontal sum of P –"Cost" curves



$(Q_1+Q_2,P$ –"Cost") $= (60,8)$

demoCombine3

2.2 Simple Examples – Fixing price difference between goods
Demand, Supply & Allocations

Supply curves for each good

Supply curve for good 1 ✖ Supply curve

Units	Price
60	0

Supply curve for good 2 ✖ Supply curve

Units	Price
60	8

8 [was 0]

60 [was 45]

TQSS

TQSS enabled

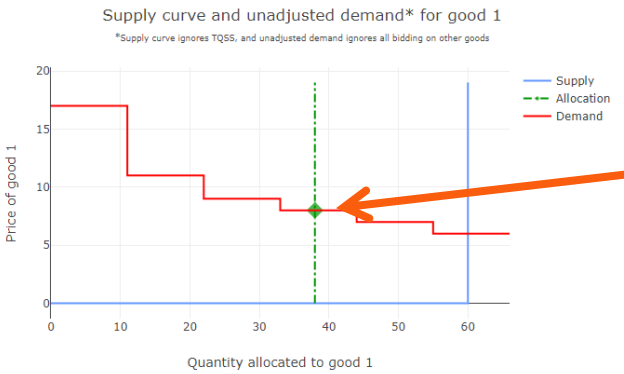
Enabled

Price normalisation and scaling

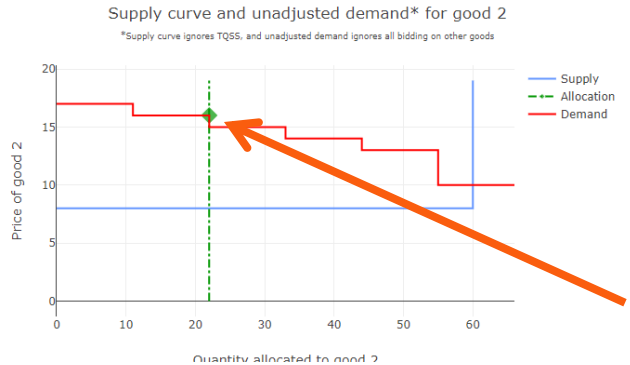
Normalised - constra

TQSS Steps

Units	Price
60	0

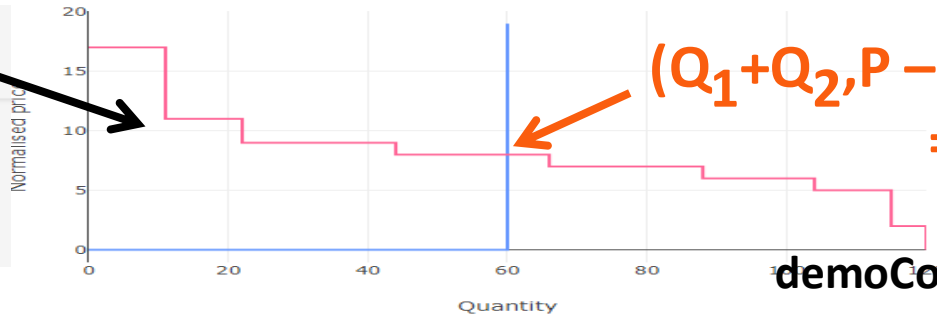


$(Q_1,P_1) = (38,8)$



$(Q_2,P_2) = (22,16)$

"total demand"= horizontal sum of P –"Cost" curves (rescaled)



$(Q_1+Q_2,P-\text{"Cost"}) = (60,8)$

demoCombine3

2.2 Simple Examples – Fixing price difference between goods
Bids in price space & Allocations of bids to goods

demoCombine3

2.2 Simple Examples
Upward sloping supply curve for good 2

Supply curve for good 1 | ✖ Supply curve for good

Units	Price
60	0

Supply curve for good 2 | ✖ Supply curve for good

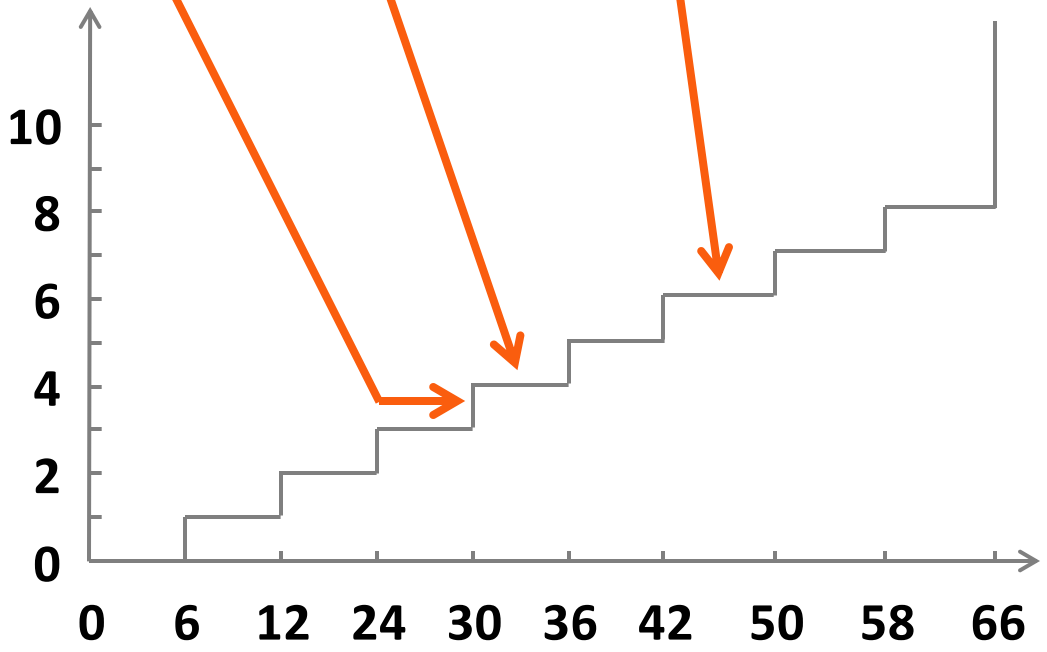
Units		Price	
6	6	0	0
6	6	1	1
6	6	2	2
6	6	3	3
6	6	4	4
6	6	5	5
8	8	6	6
8	8	7	7
8	8	8	8

TQSS Steps

Units	Price
60	0

-> Price difference is increasing in quantity of good 2

Construction of supply curve for good 2: steps of length 6 and length 8 and of height 1



demoUpwardSloping

2.2 Simple Examples – Upward sloping supply curve for good 2
Demand, Supply & Allocations

Supply curve for good 1 ✖ Supply curve for good

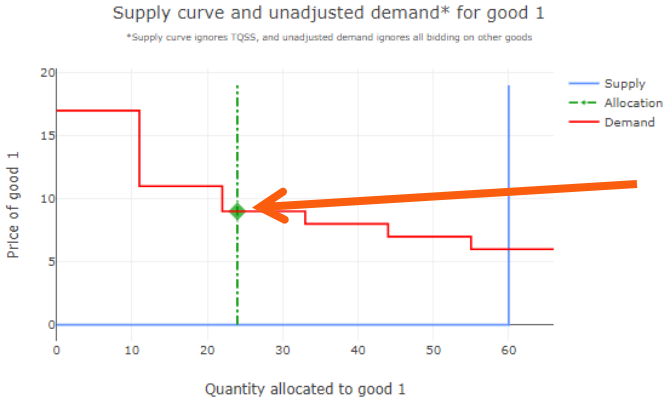
Units	Price
60	0

Supply curve for good 2 ✖ Supply curve for good

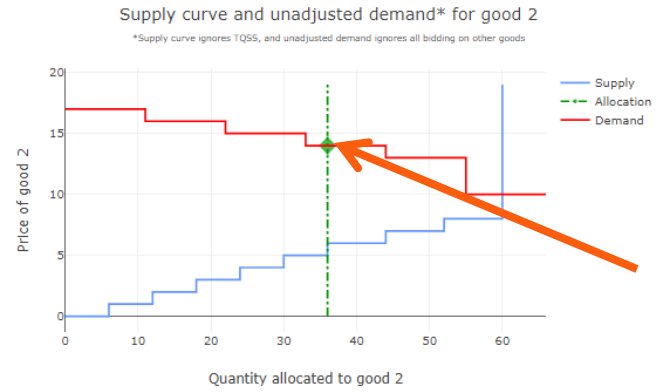
Units	Price	
6 6	0 0	✖
6 6	1 1	✖
6 6	2 2	✖
6 6	3 3	✖
6 6	4 4	✖
6 6	5 5	✖
8 8	6 6	✖
8 8	7 7	✖
8 8	8 8	✖

TQSS Steps

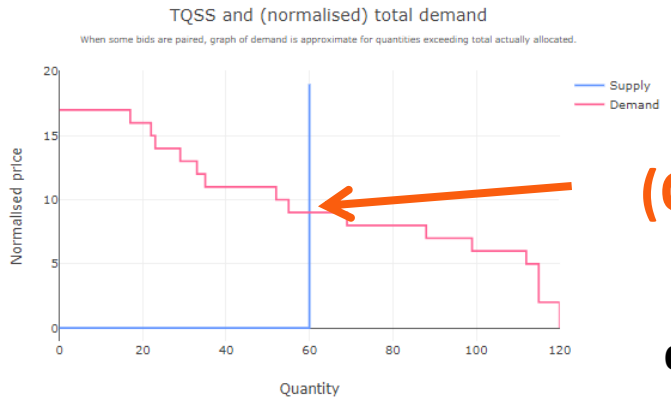
Units	Price
60	0



$(Q_1,P_1) = (24,9)$



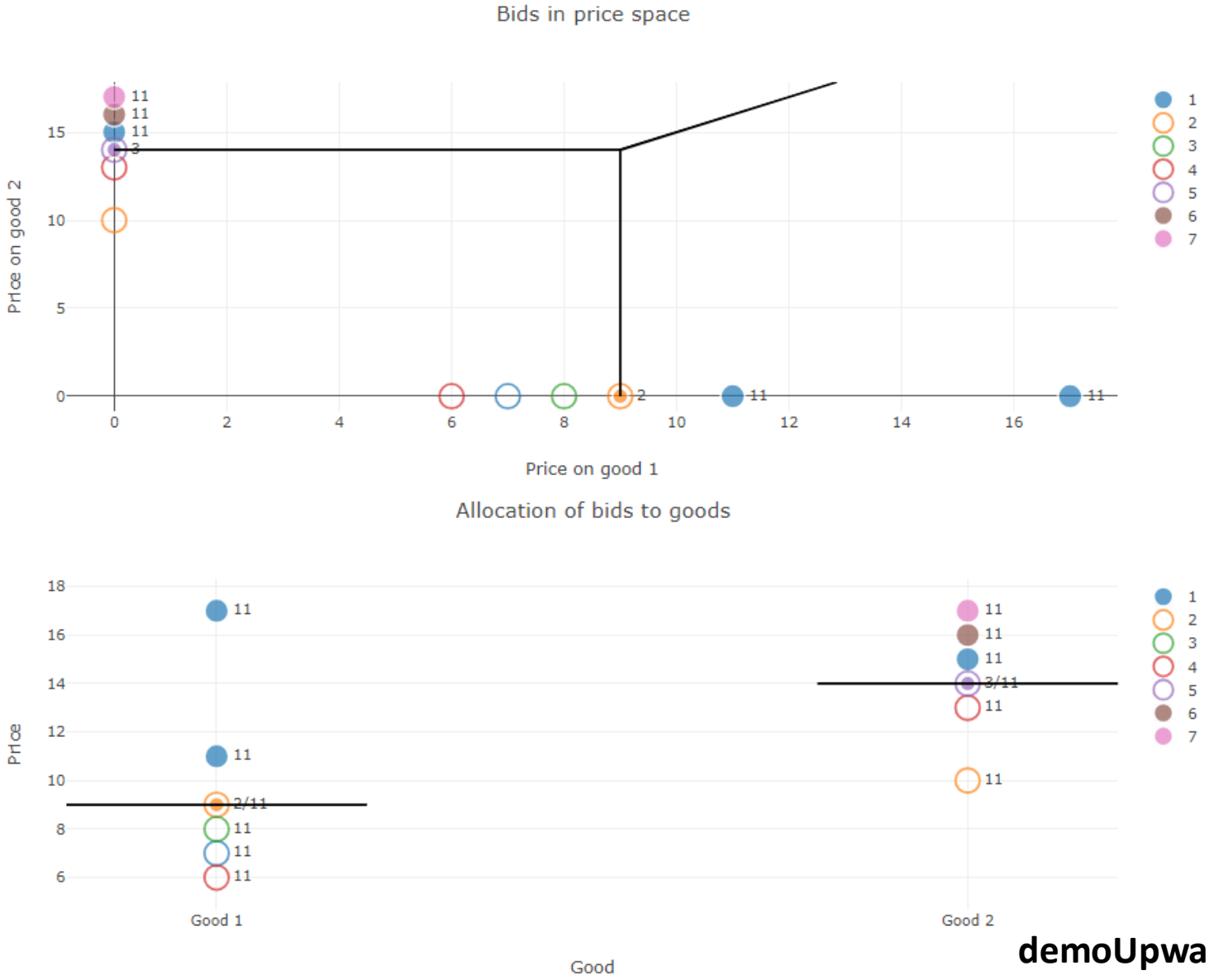
$(Q_2,P_2) = (36,14)$



$(Q_1+Q_2,P$ –"Cost"$)$
$= (60,9)$

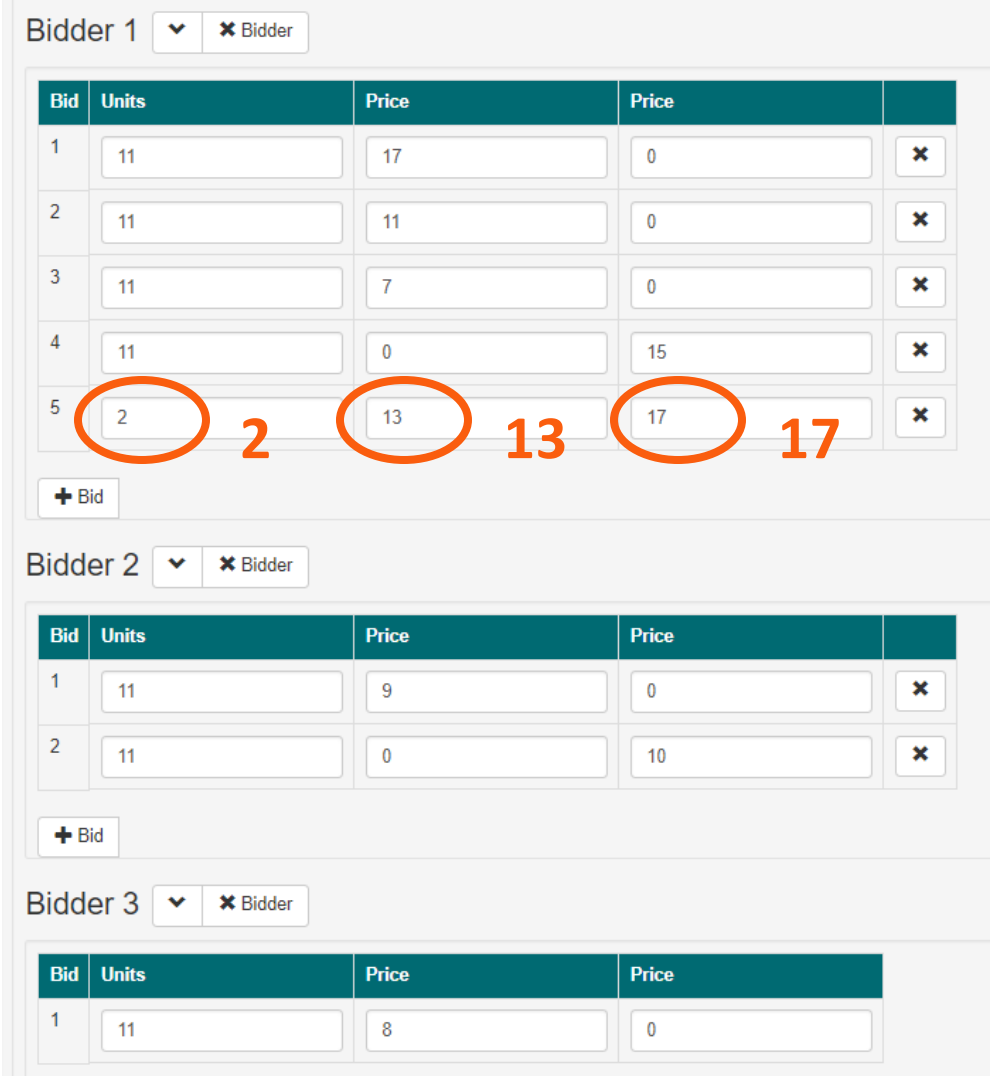
demoUpwardSloping

2.2 Simple Examples – Upward sloping supply curve for good 2
Bids in price space & Allocations of bids to goods



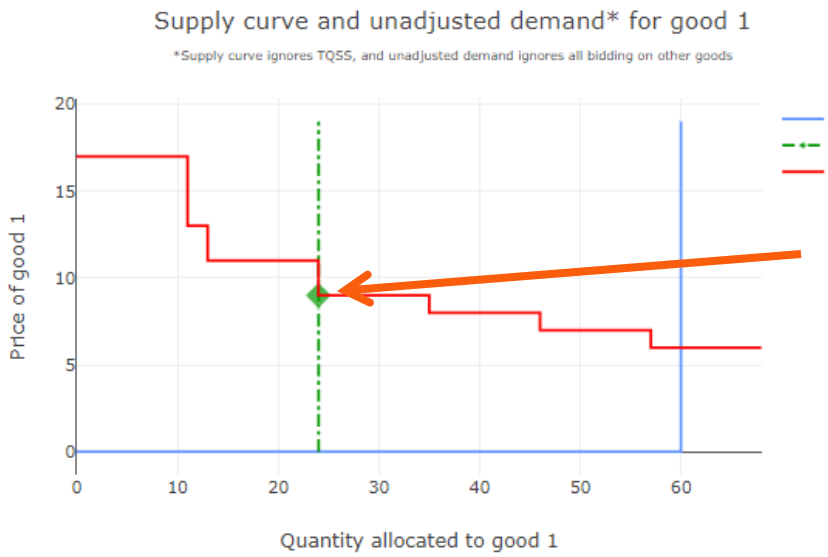
demoUpwardSloping

2.2 Simple Examples
Example of a “Paired Bid”

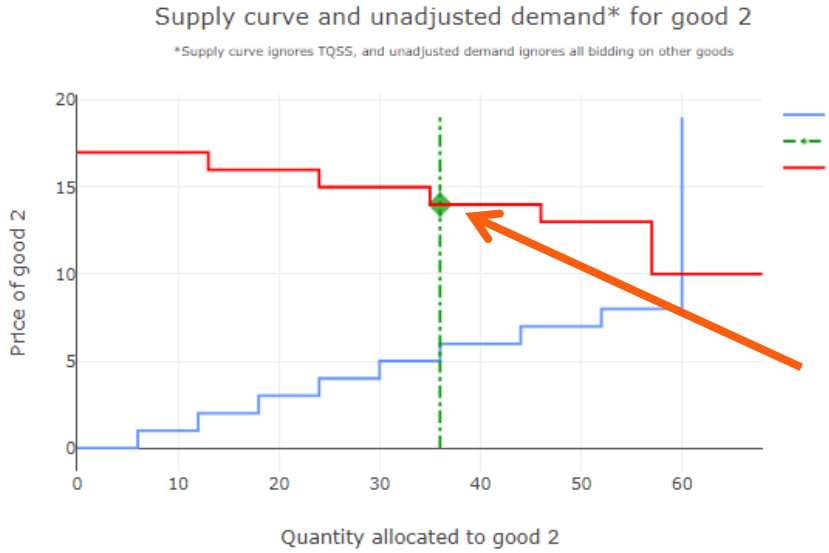


demoPaired

2.2 Simple Examples – Example of a "Paired Bid" Demand, Supply & Allocations



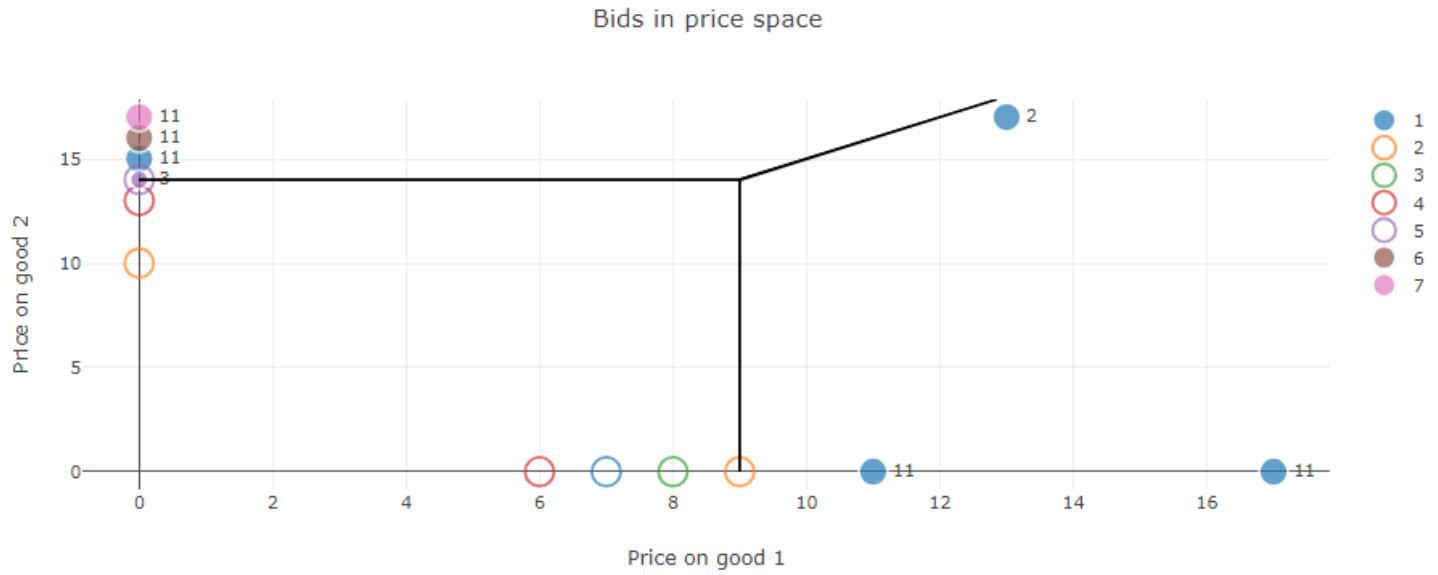
$(Q_1,P_1) = (24,9)$



$(Q_2,P_2) = (36,14)$

demoPaired

2.2 Simple Examples – Example of a “Paired Bid”
Bids in price space & Allocations of bids to goods

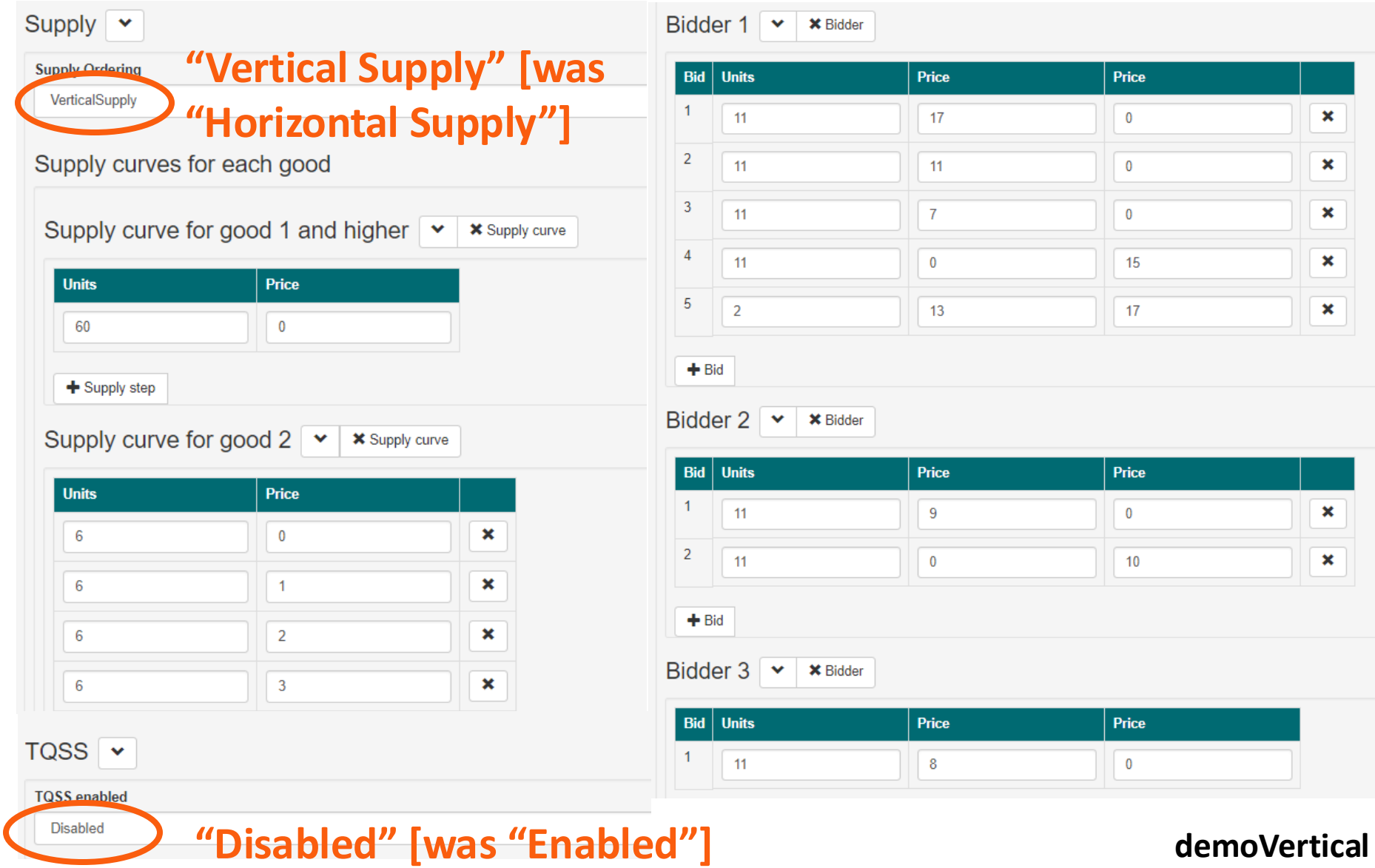


demoPaired

Section 3
Section 3.1

3. The "Vertical" Representation, and the Bank of England's Auction

3.1 Vertical representation



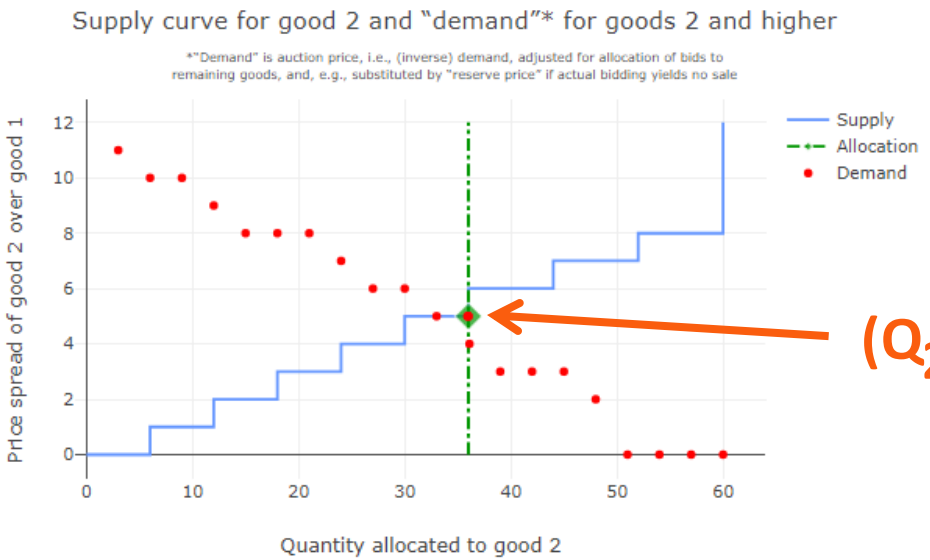
demoVertical

3.1 Vertical representation
Demand, Supply & Allocations

$(Q_1+Q_2,P_1) = (60,\ 9)$

$(Q_1,P_1) = (24,\ 9)$

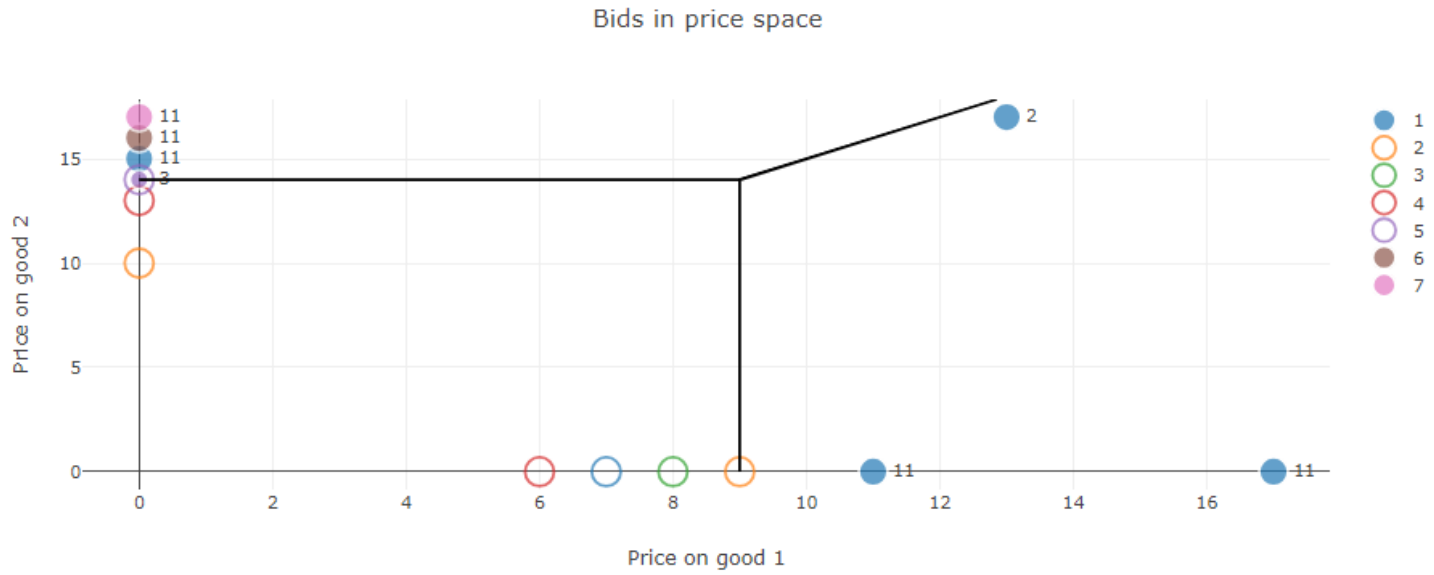
$(Q_2,P_2) = (36,14)$



$(Q_2,P_2-P_1) = (36,\ 5)$

demoVertical

3.1 Vertical representation
Bids in price space & Allocations of bids to goods



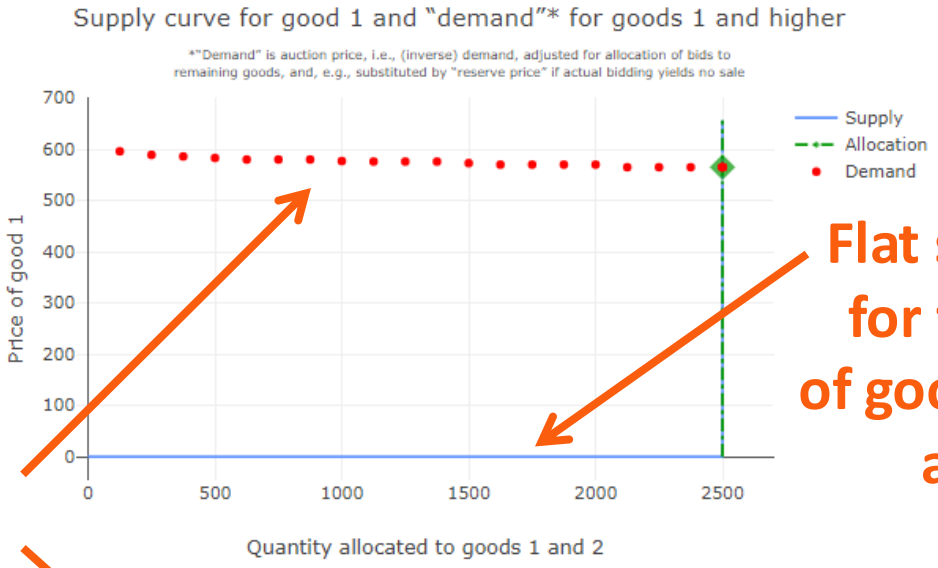
demoVertical

Section 3.2

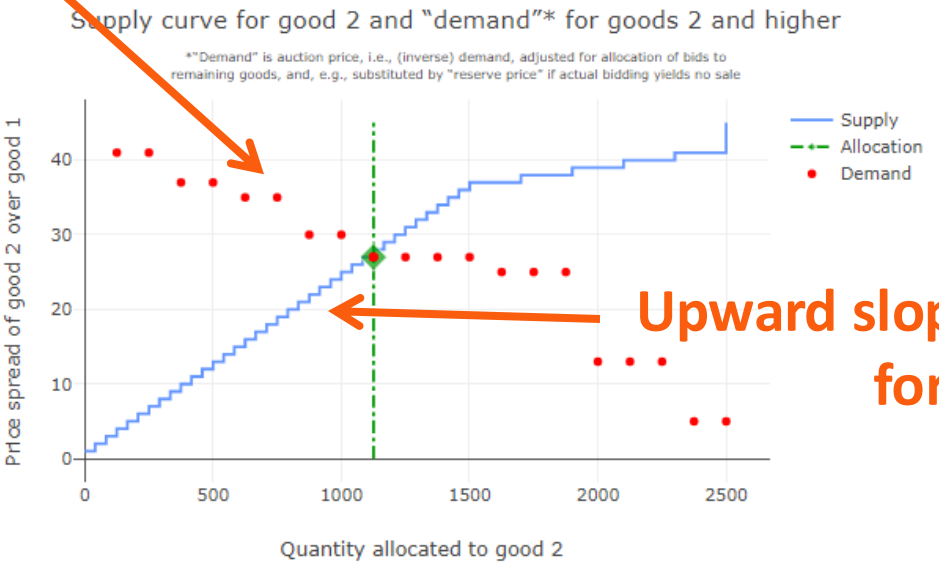
3. The "Vertical" Representation, and the Bank of England's Auction

3.2 The Bank of England's Indexed Long-Term Repo Auction

Demand curves are created by various paired and single bids for good 1 OR good 2



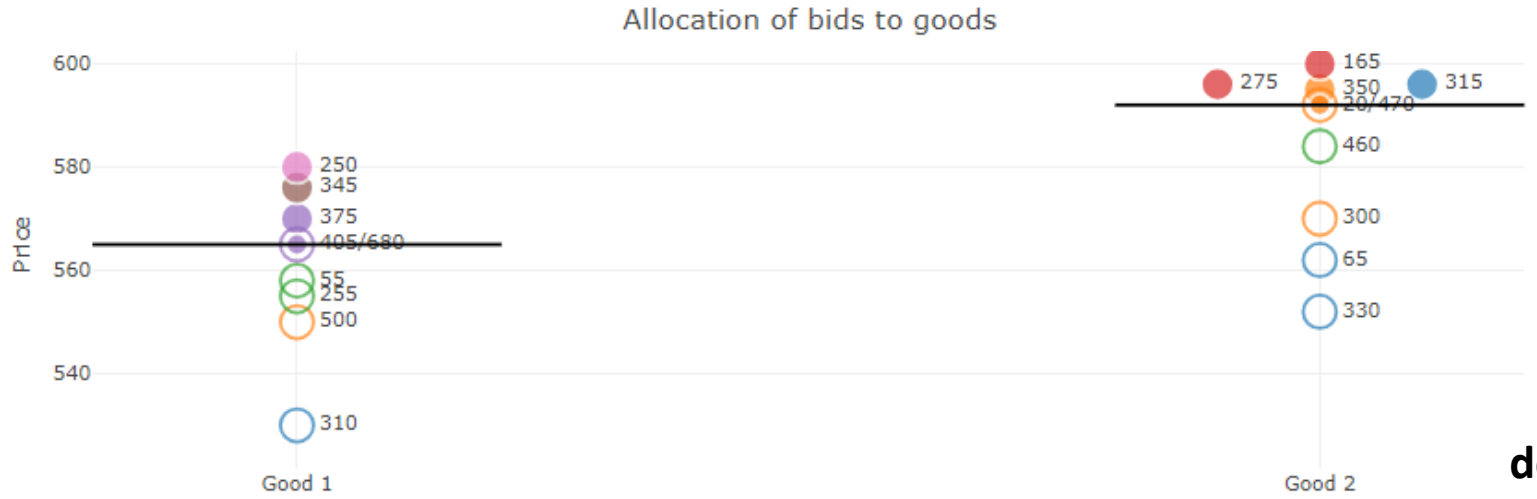
Flat supply of 2500 for total quantity of good 1 and good 2 at zero cost



Upward sloping supply curve for good 2

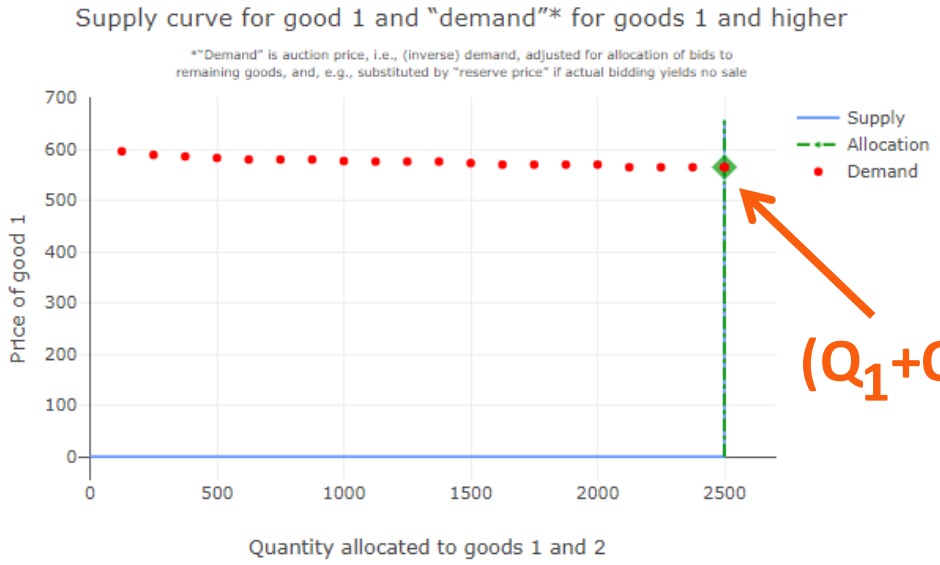
demoBoE

3.2 The Bank of England's ILTR Auction (Initial Implementation)
Bids in price space & Allocations of bids to goods



demoBoE

3.2 The Bank of England's ILTR Auction (Initial Implementation) Demand, Supply, & Allocations



$(Q_1+Q_2,P_1) = (2500,565)$

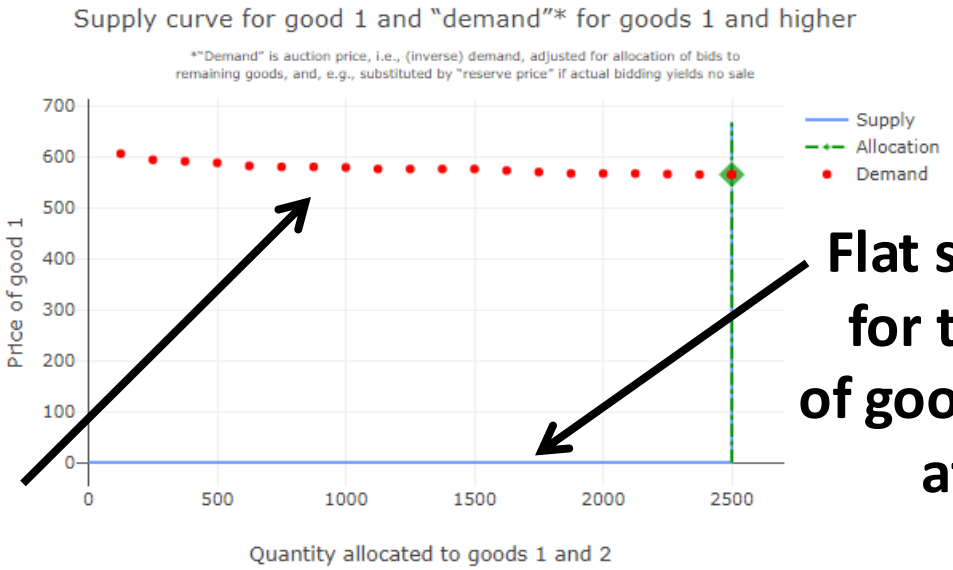
$(Q_1,P_1) = (1375,565)$

$(Q_2,P_2) = (1125,592)$

$(Q_2,P_2-P_1) = (1125, 27)$

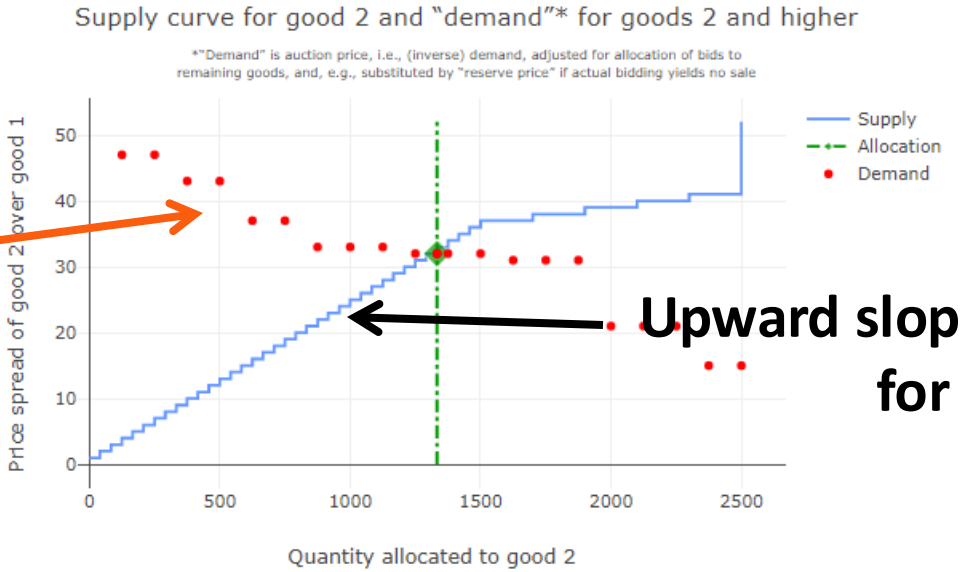
demoBoE

3.2 The Bank of England's ILTR Auction (Initial Implementation) More Stressed Demand



Various paired and single bids for good 1 OR good 2

Flat supply of 2500 for total quantity of good 1 and good 2 at zero cost

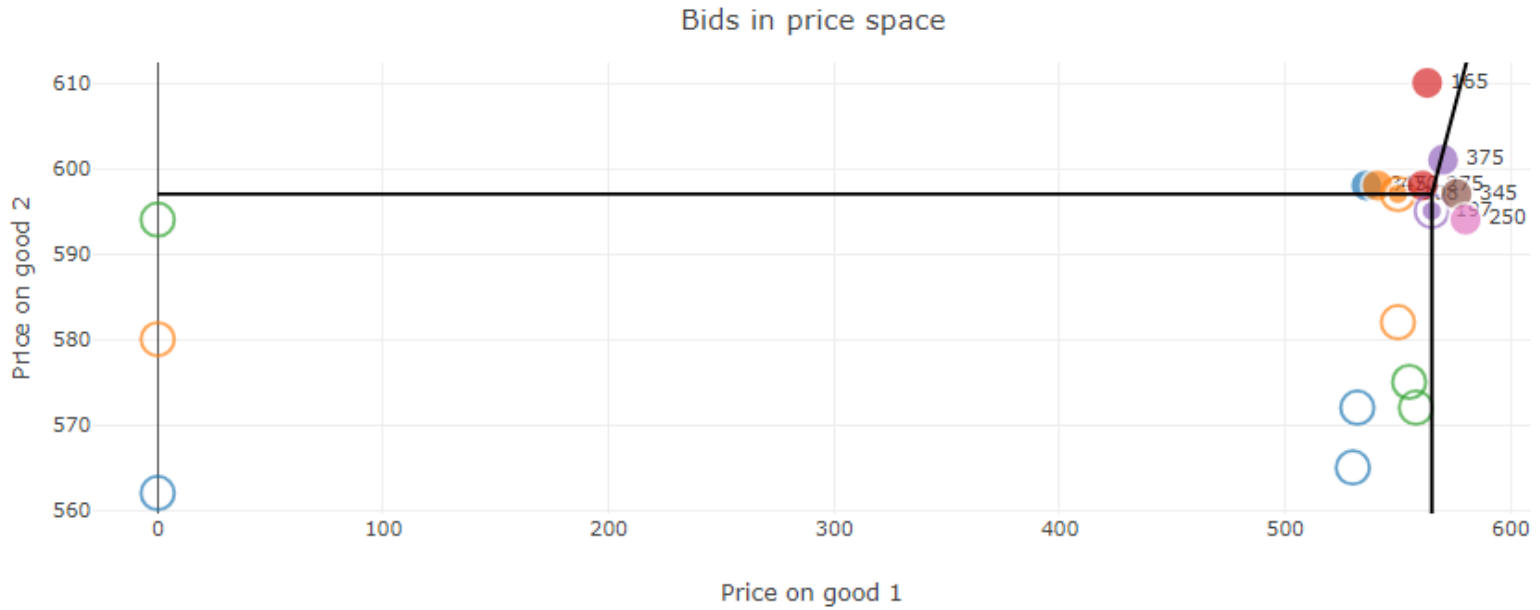


Increased prices for bids on good 2

Upward sloping supply curve for good 2

demoBoEstressed

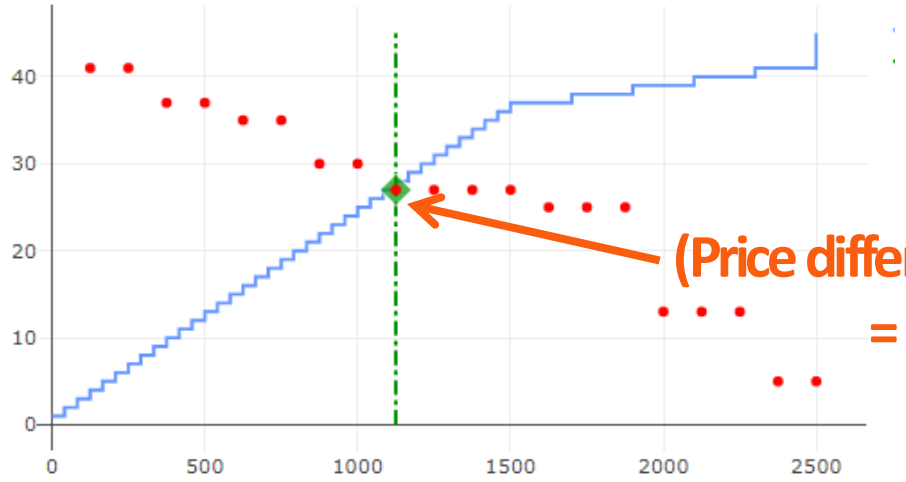
3.2 The Bank of England's ILTR Auction (Initial Implementation) More Stressed Demand



demoBoEstressed

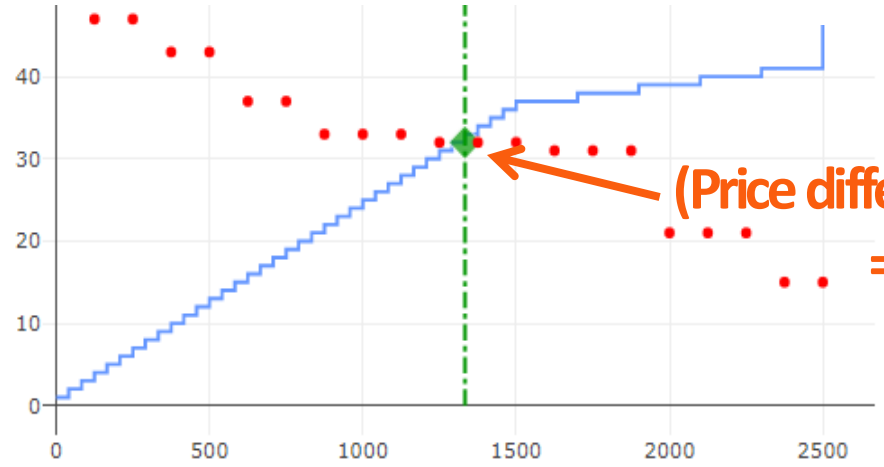
3.2 The Bank of England's ILTR Auction (Initial Implementation)
Total allocation capped at £2,500m

Less Stressed Demand



(Price difference, % alloc. to good 2)
= (27bps, 45%)

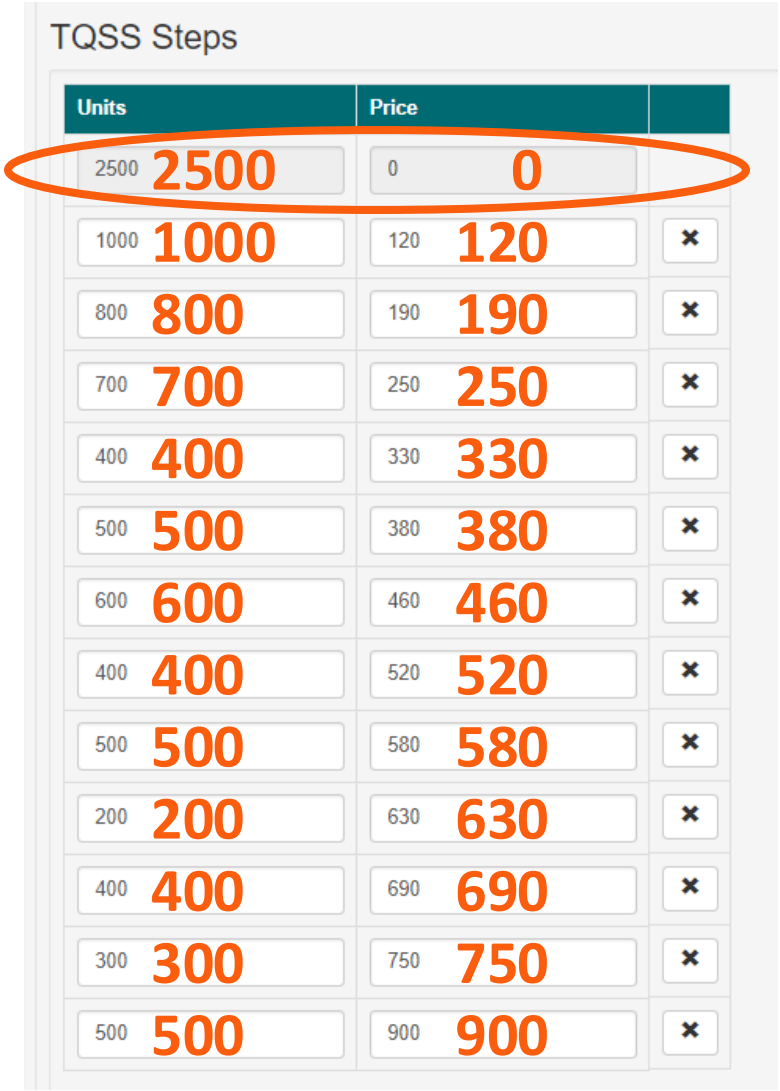
More Stressed Demand



(Price difference, % alloc. to good 2)
= (32bps, 53%)

demoBoE
demoBoEstressed

3.2 The Bank of England's Indexed Long-Term Repo Auction
BoE's Current Implementation with (Flexible) TQSS



Without TQSS, Quantity Cap = 2500

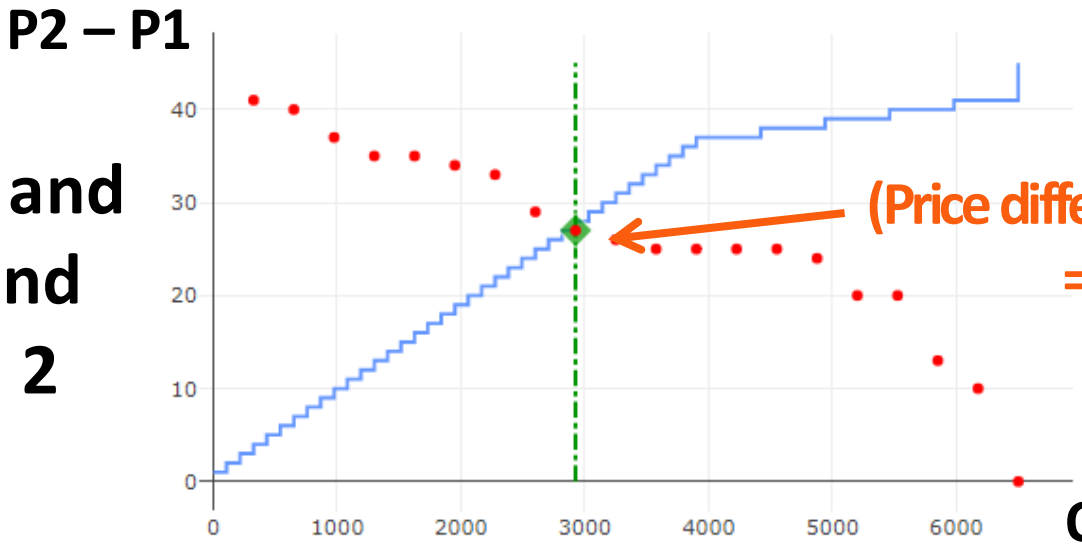
Implicit TQSS step with
length = Supply curve of good 1 and higher

With additional steps above TQSS,
Quantity Sold is
function of price measure
(here, function of price of good 2)

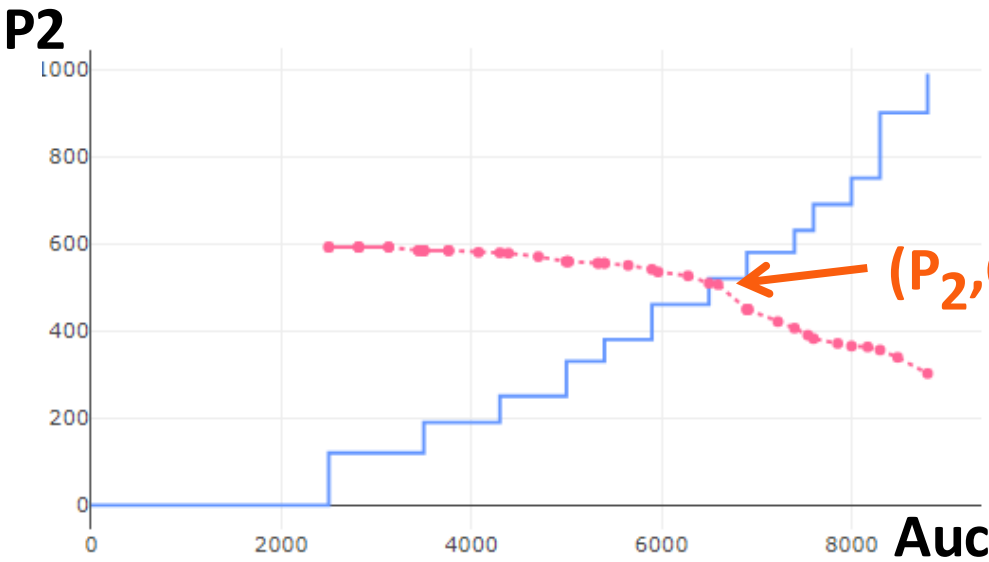
When demand is high,
supply curves are scaled up until
auction prices coincide with the
TQSS,
i.e. total demand and TQSS intersect

3.2 The Bank of England's ILTR Auction (Current Implementation)
Demand, Supply & Allocations & TQSS

Supply and demand good 2



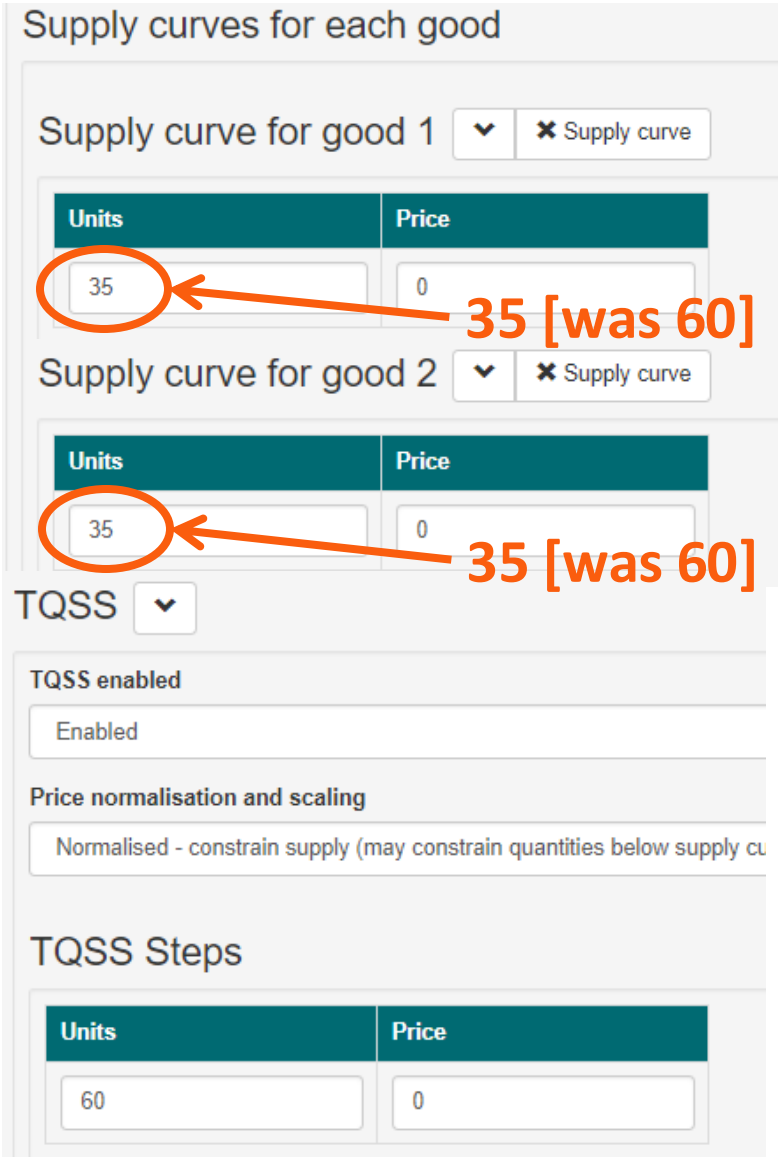
TQSS and total demand



demoBoETQSS

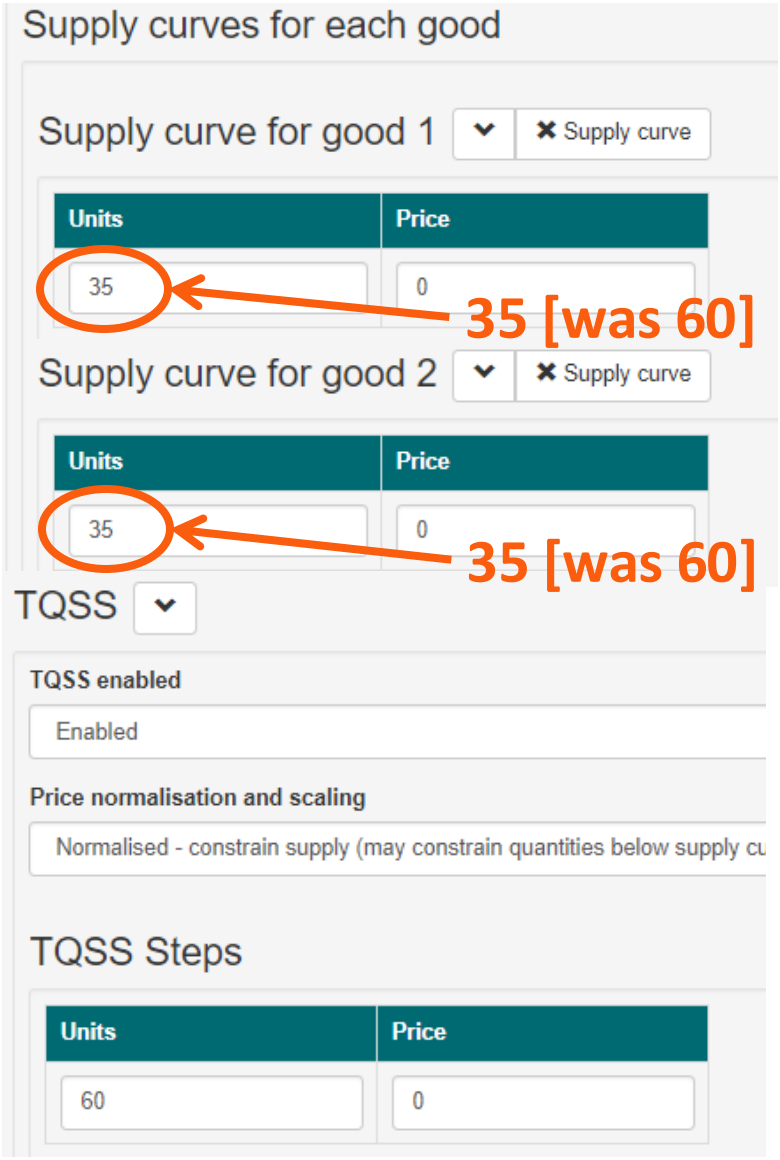
Section 4

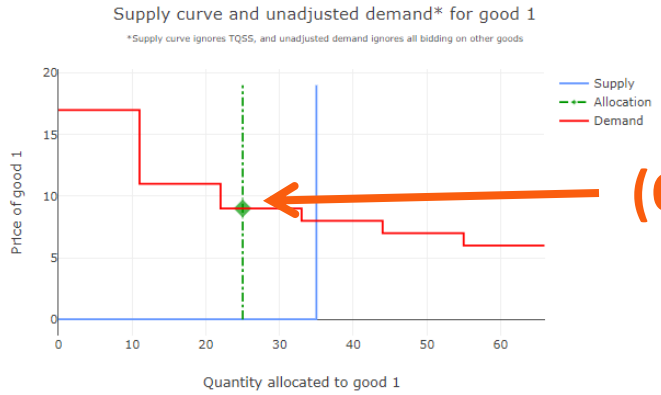
4. More Examples for Horizontal Applications, e.g., Related Bonds – Limited Flexibility Between Varieties



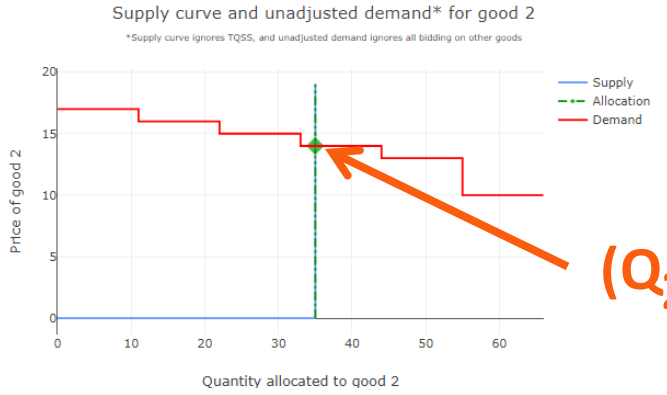
demoBonds

4. Limited Flexibility Between Varieties
Demand, Supply & Allocations

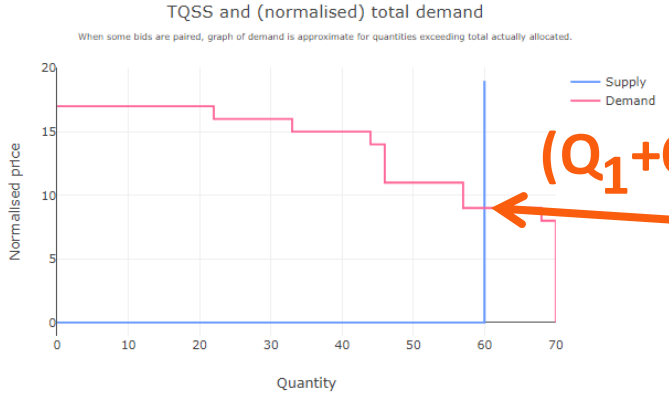




$(Q_1,P_1) = (25,9)$



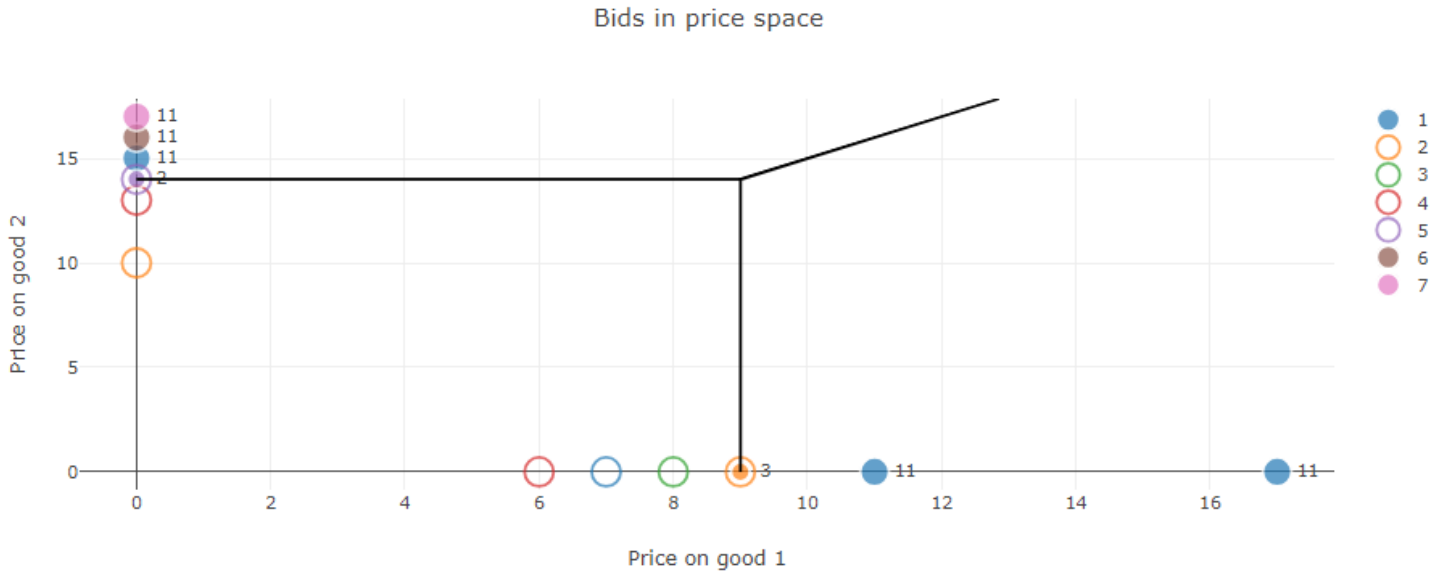
$(Q_2,P_2) = (35,14)$



$(Q_1+Q_2, P$ –" Cost") $= (60,9)$

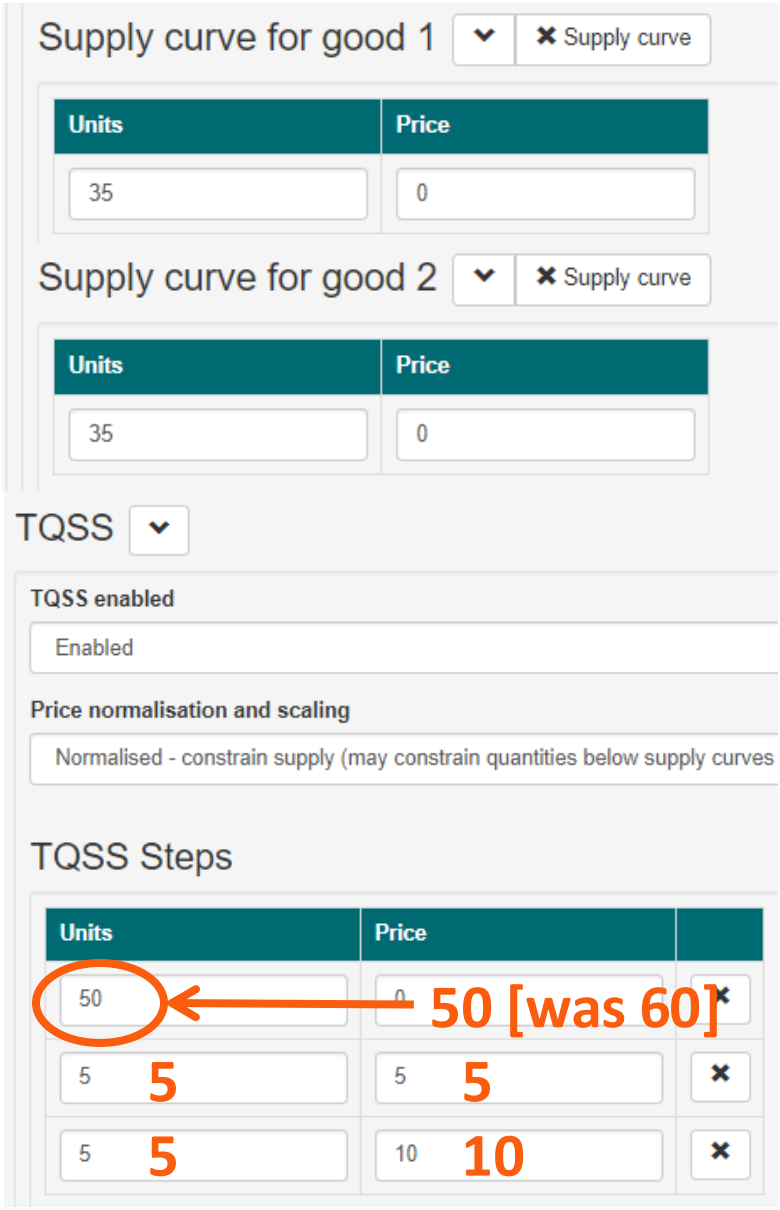
demoBonds

4. Limited Flexibility Between Varieties
Bids in price space & Allocations of bids to goods



demoBonds

4. More Examples for Horizontal Applications, e.g., Related Bonds – Additional Flexibility on Total Sales



demoBonds2

4. More Examples for Horizontal Applications, e.g., Closely Related Bonds – Additional Flexibility on Total Sales

Supply curve for good 1 ✖ Supply curve

Units	Price
35	0

Supply curve for good 2 ✖ Supply curve

Units	Price
35	0

TQSS

TQSS enabled

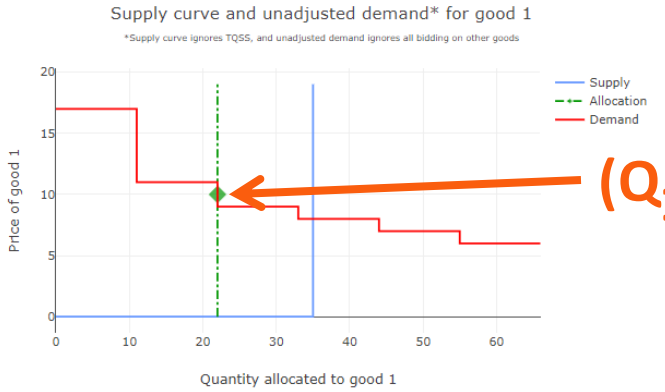
Enabled

Price normalisation and scaling

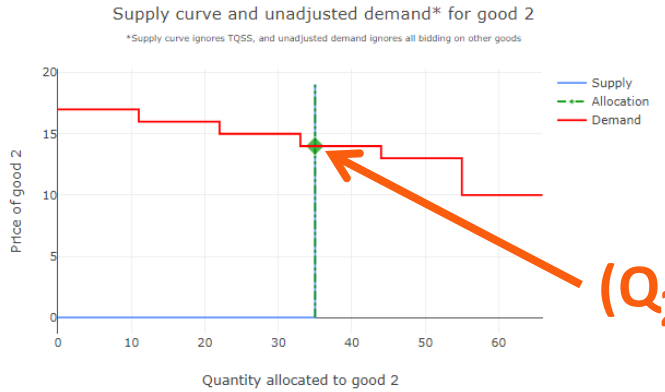
Normalised - constrain supply (may constrain quantities below supply curves

TQSS Steps

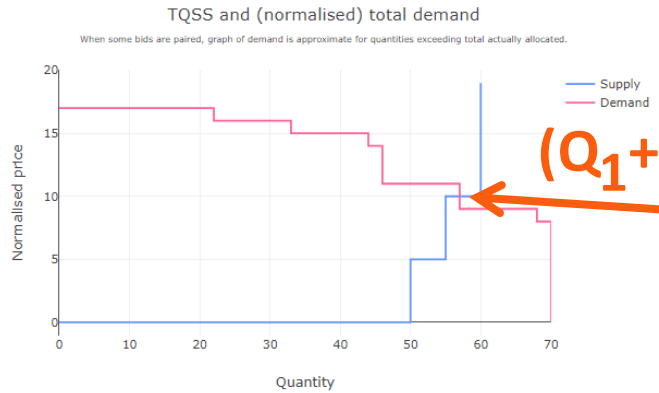
Units	Price	
50 (50 [was 60])	0	✖
5 (5)	5 (5)	✖
5 (5)	10 (10)	✖



$(Q_1,P_1) = (22,10)$



$(Q_2,P_2) = (35,14)$



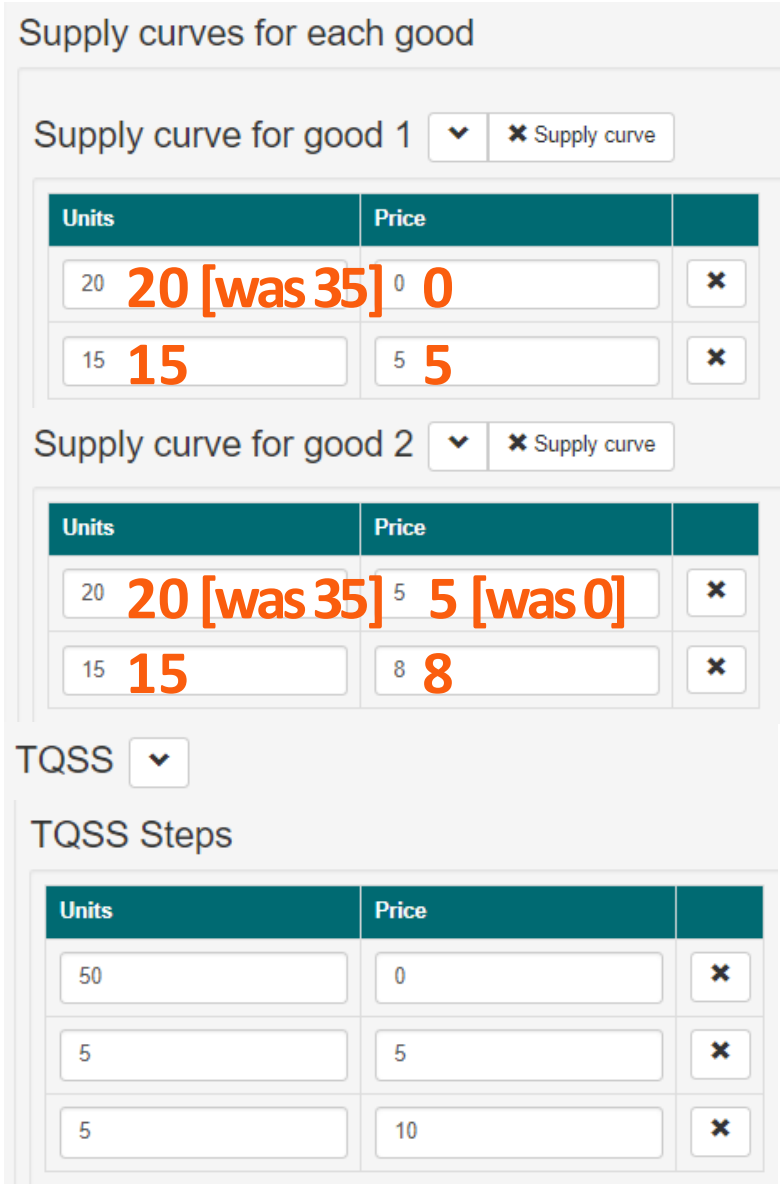
$(Q_1+Q_2, P$ –" Cost") $= (57,10)$

demoBonds2

4. Additional Flexibility on Total Sales
Bids in price space & Allocations of bids to goods

demoBonds2

4. More Examples for Horizontal Applications, e.g., Related Bonds – More Flexible Auctioneer



demoBonds3

4. More Examples for Horizontal Applications, e.g., Related Bonds – More Flexible Auctioneer

Supply curves for each good

Supply curve for good 1 ✖ Supply curve

Units	Price	
20 20 [was 35]	0 0	✖
15 15	5 5	✖

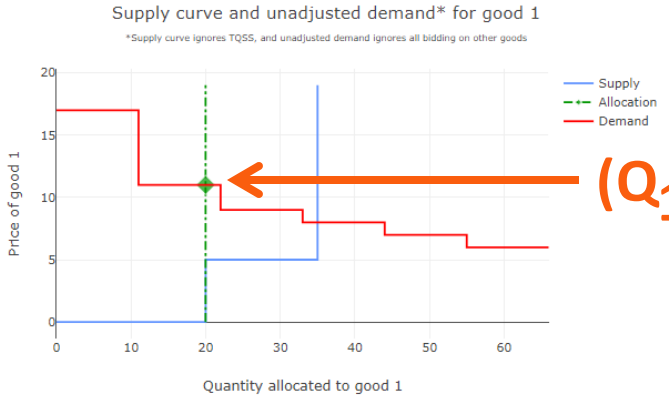
Supply curve for good 2 ✖ Supply curve

Units	Price	
20 20 [was 35]	5 5 [was 0]	✖
15 15	8 8	✖

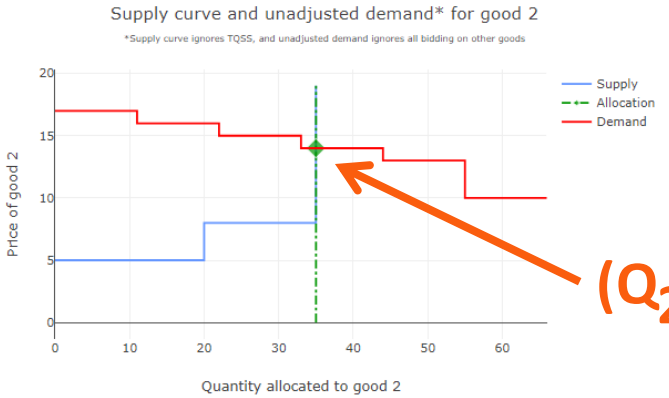
TQSS

TQSS Steps

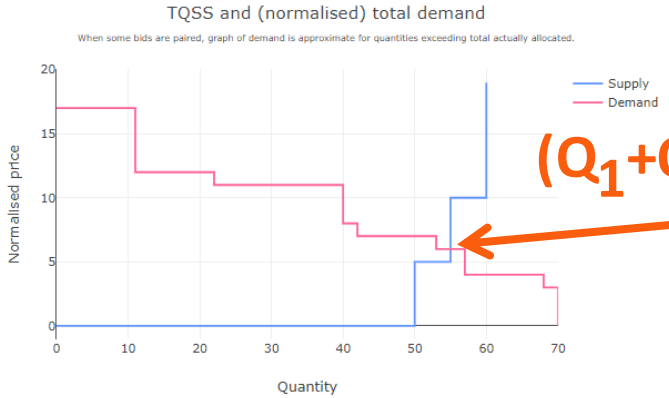
Units	Price	
50	0	✖
5	5	✖
5	10	✖



$(Q_1,P_1) = (20,11)$



$(Q_2,P_2) = (35,14)$



$(Q_1+Q_2, P$ –" Cost") $= (55,6)$

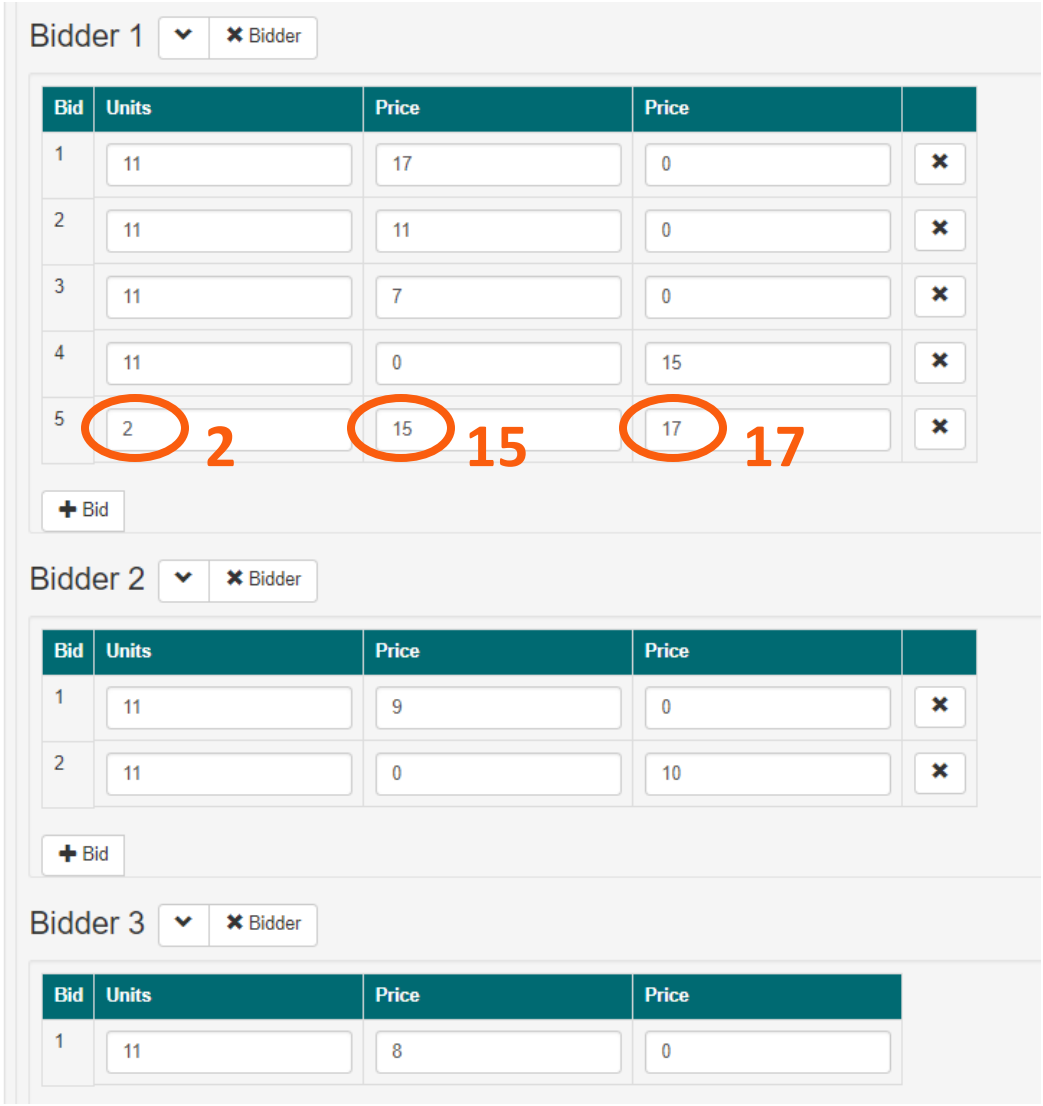
demoBonds3

4. More Flexible Auctioneer
Bids in price space & Allocations of bids to goods

demoBonds3

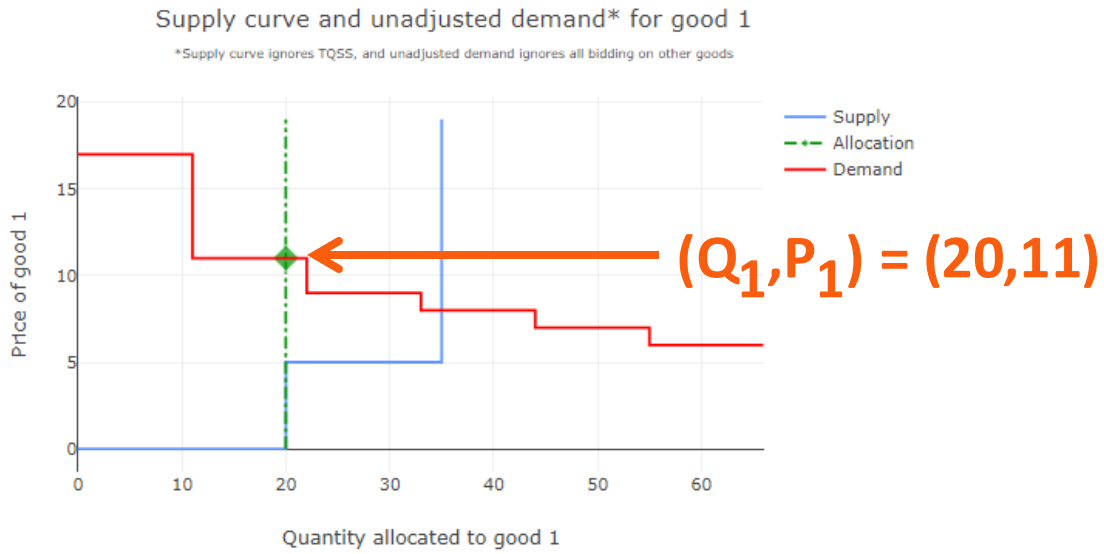
Section 5

5. More Examples of Paired Bids



demoPairedHoriz

5. More Examples of Paired Bids Demand, Supply & Allocations

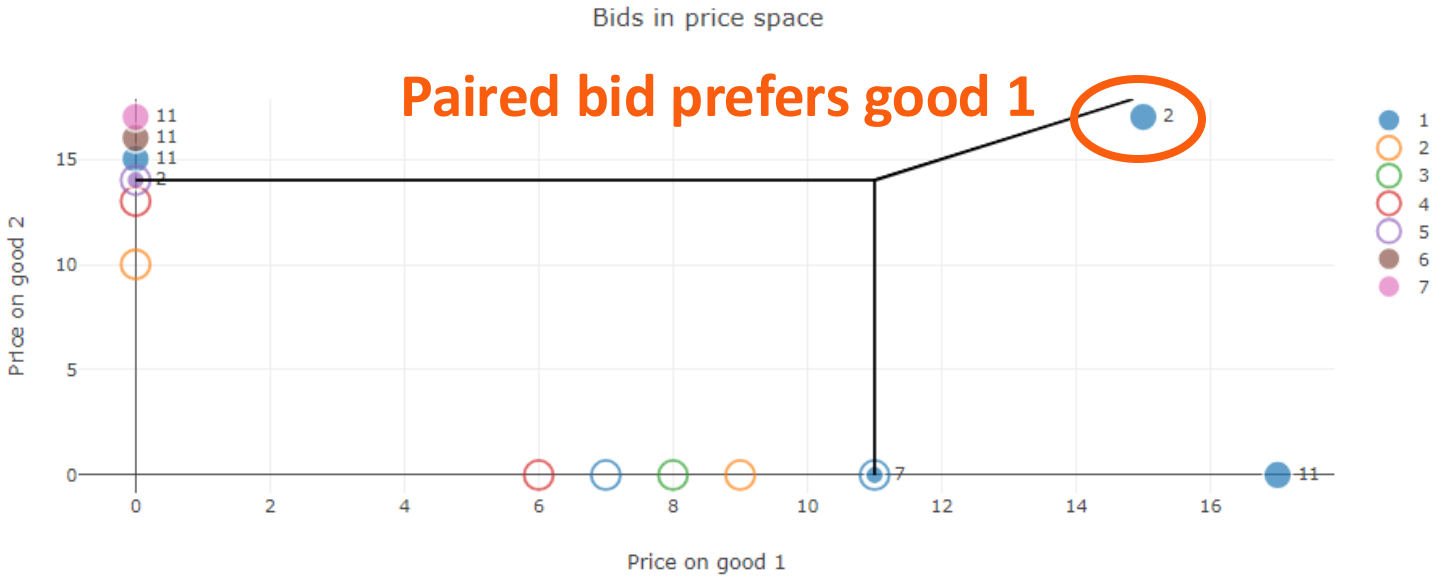


$(Q_1,P_1) = (20,11)$

$(Q_2,P_2) = (35,14)$

demoPairedHoriz

5. More Examples of Paired Bids
Bids in price space & Allocations of bids to goods

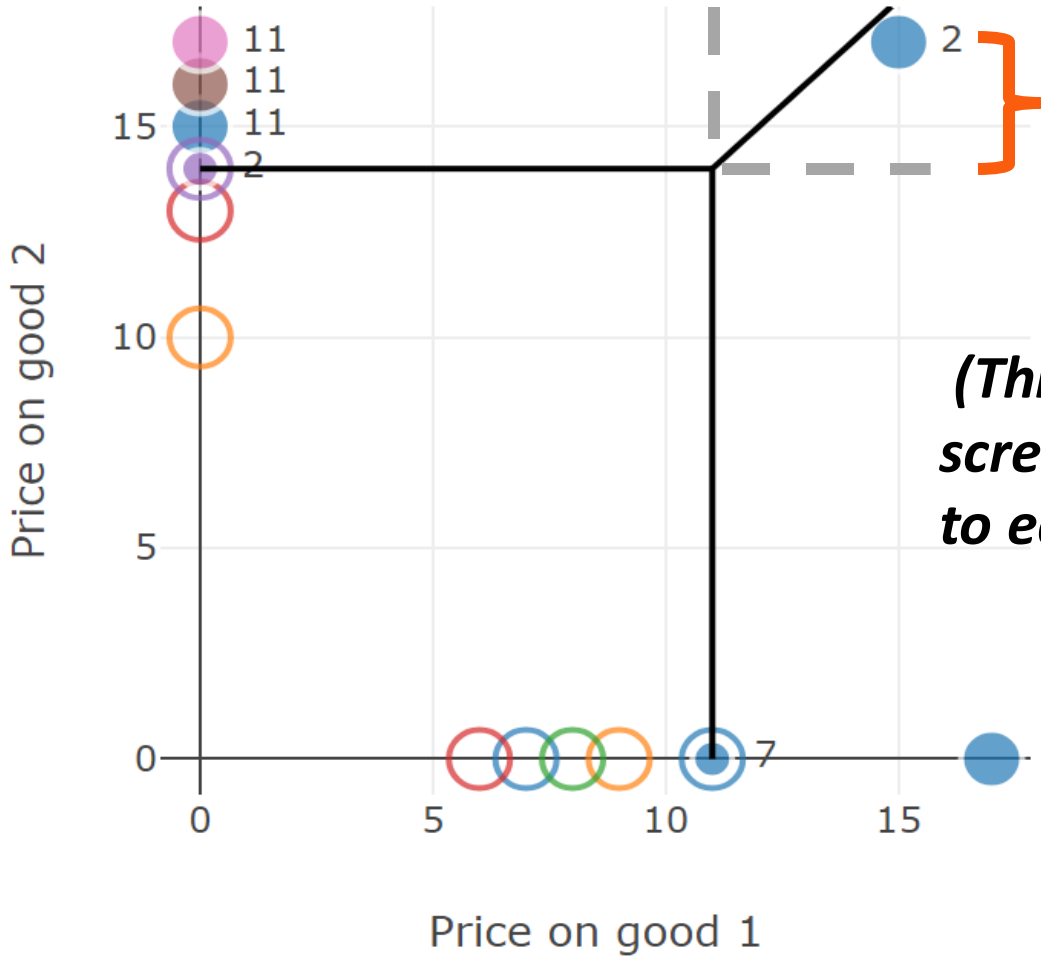


demoPairedHoriz

5. More Examples of Paired Bids
Bids in price space

Bidder's surplus = 15 – 11 = 4

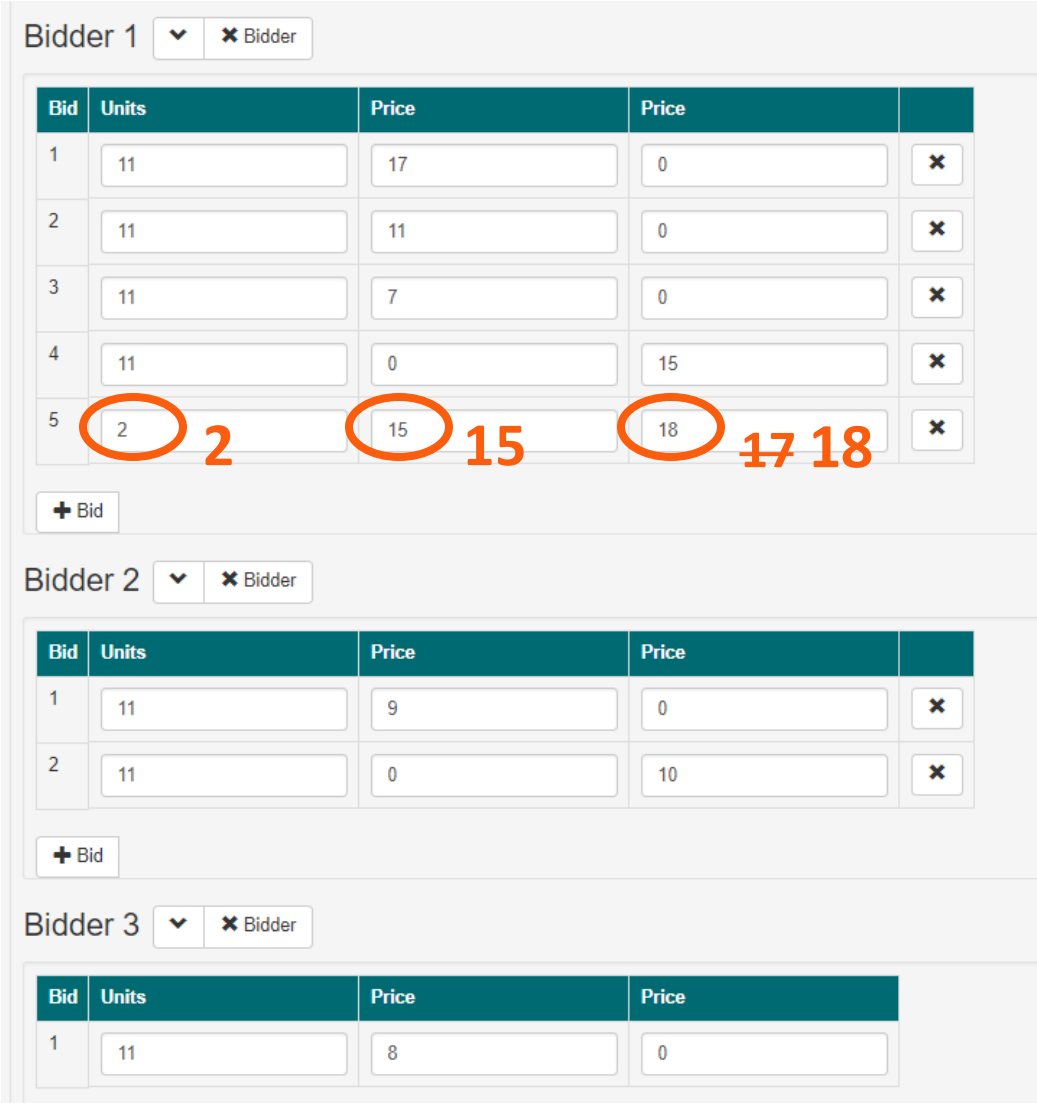
Bidder's surplus = 17 – 14 = 3



(This is the previous screenshot, axes rescaled to equal proportions)

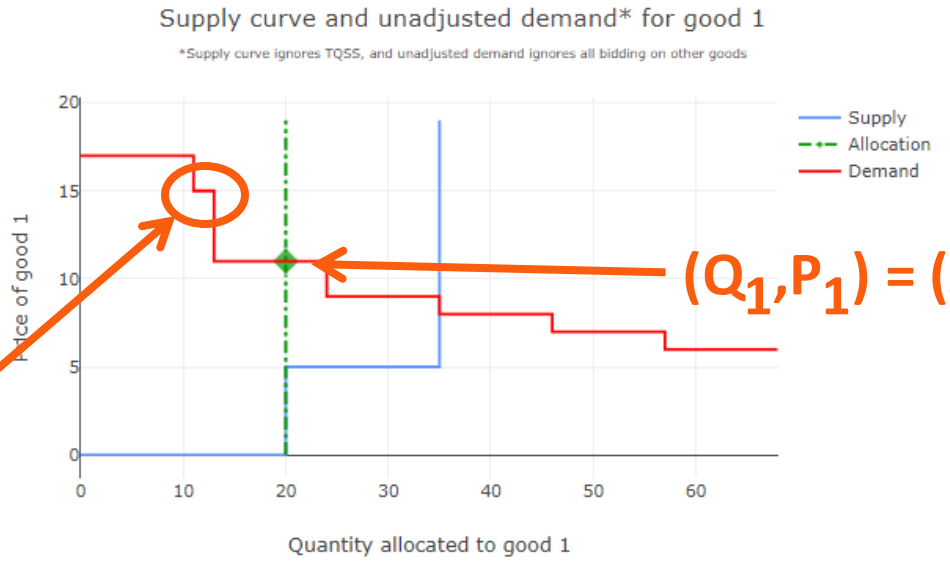
demoPairedHoriz

5. More Examples of Paired Bids
Paired bid is indifferent between goods



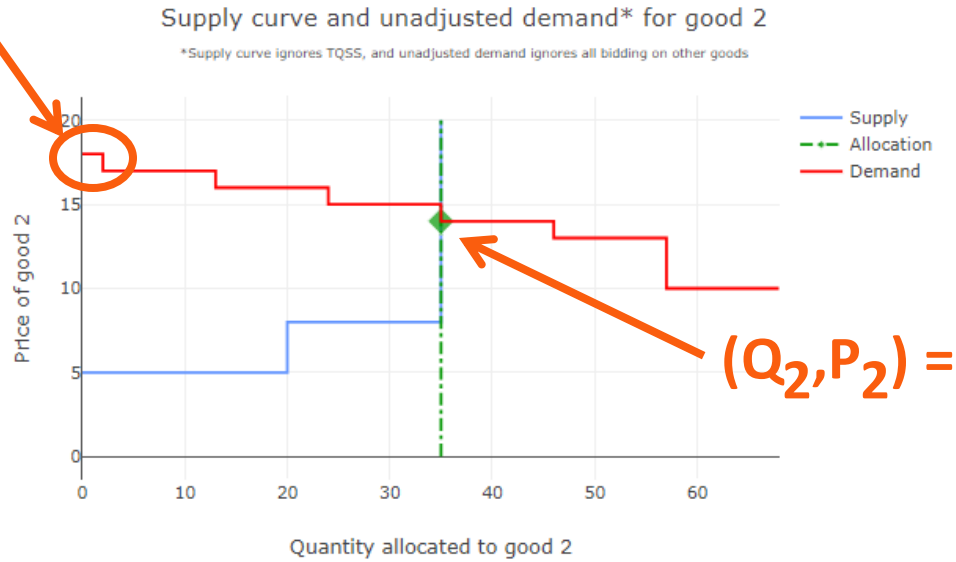
demoPairedHoriz2

5. Paired bid is indifferent between goods
Demand, Supply & Allocations



Paired bid [2,15,18]

$(Q_1,P_1) = (20,11)$



$(Q_2,P_2) = (35,14)$

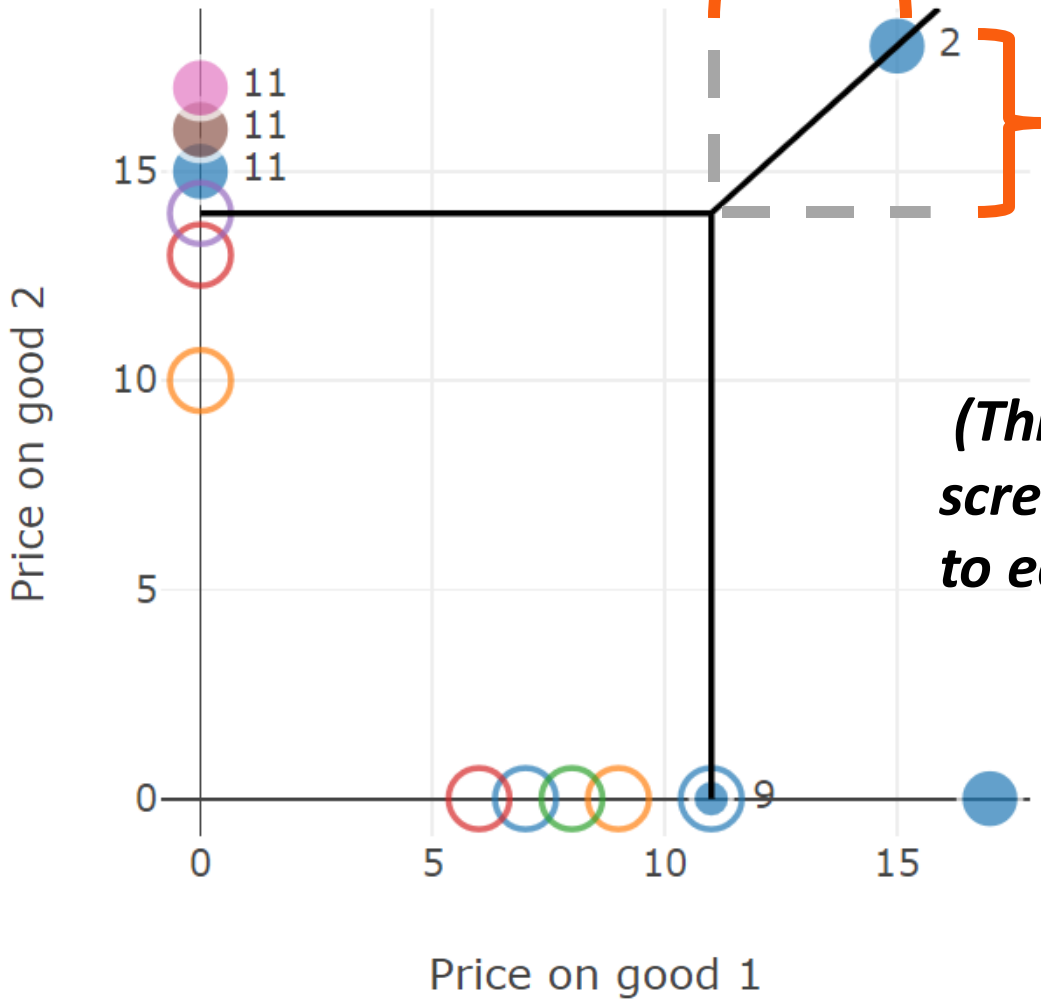
demoPairedHoriz2

5. Paired bid is indifferent between goods
Bids in price space & Allocations of bids to goods

demoPairedHoriz2

5. Paired bids is indifferent between goods
Bids in price space

Bidder's surplus = 15 – 11 = 4

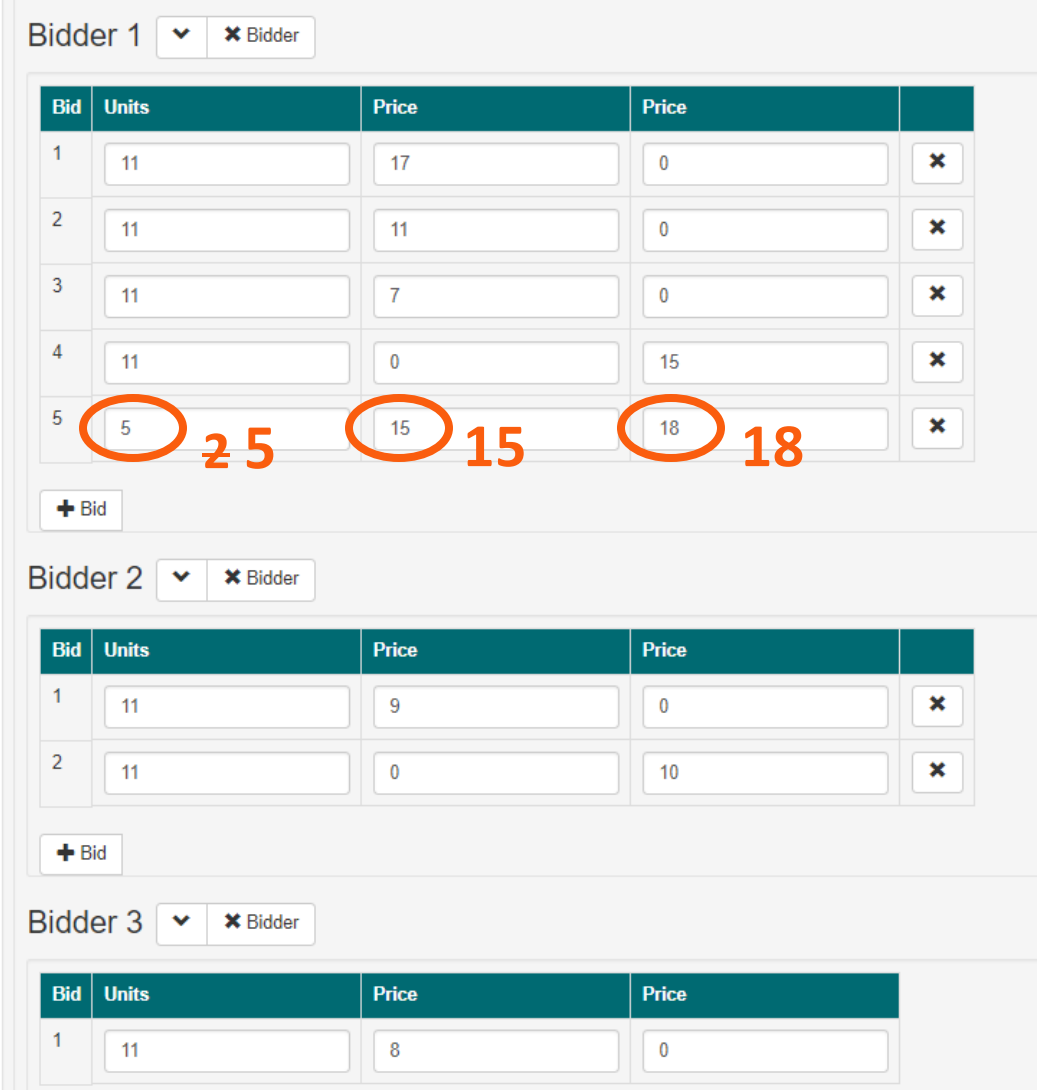


Bidder's surplus
= 18 – 14
= 4

(This is the previous screenshot, axes rescaled to equal proportions)

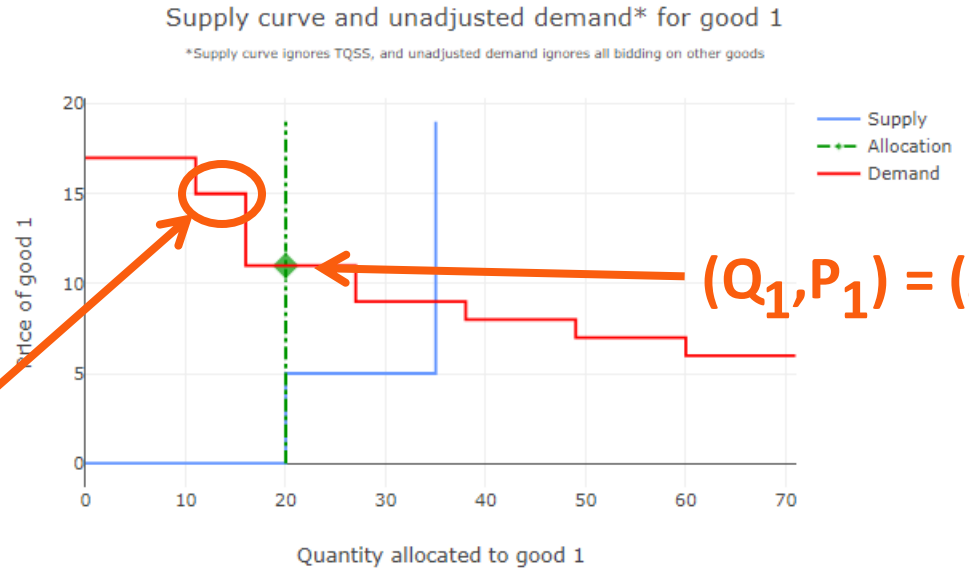
demoPairedHoriz2

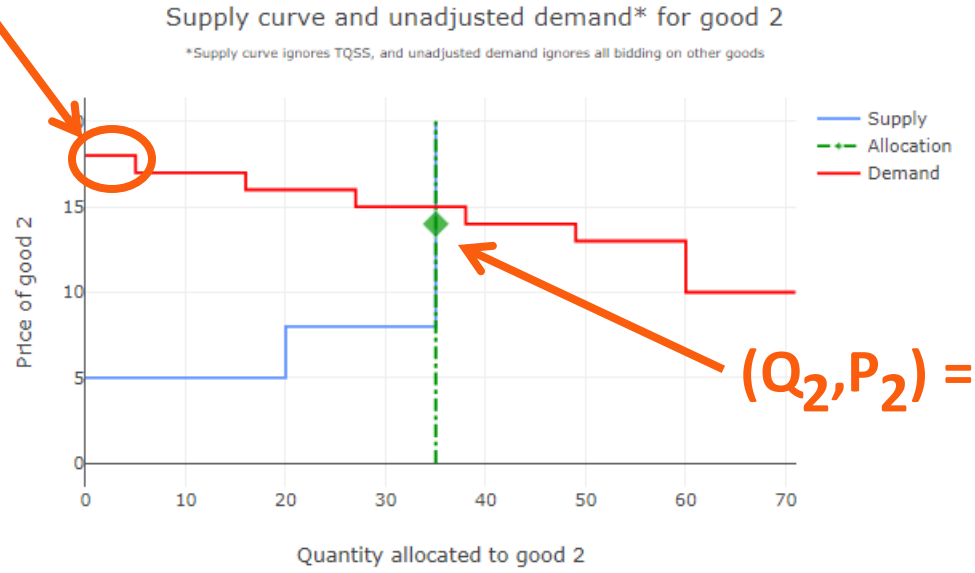
5. More Examples of Paired Bids
Paired bid is rationed between goods



demoPairedHoriz3

5. Paired bid is rationed between goods
Demand, Supply & Allocations





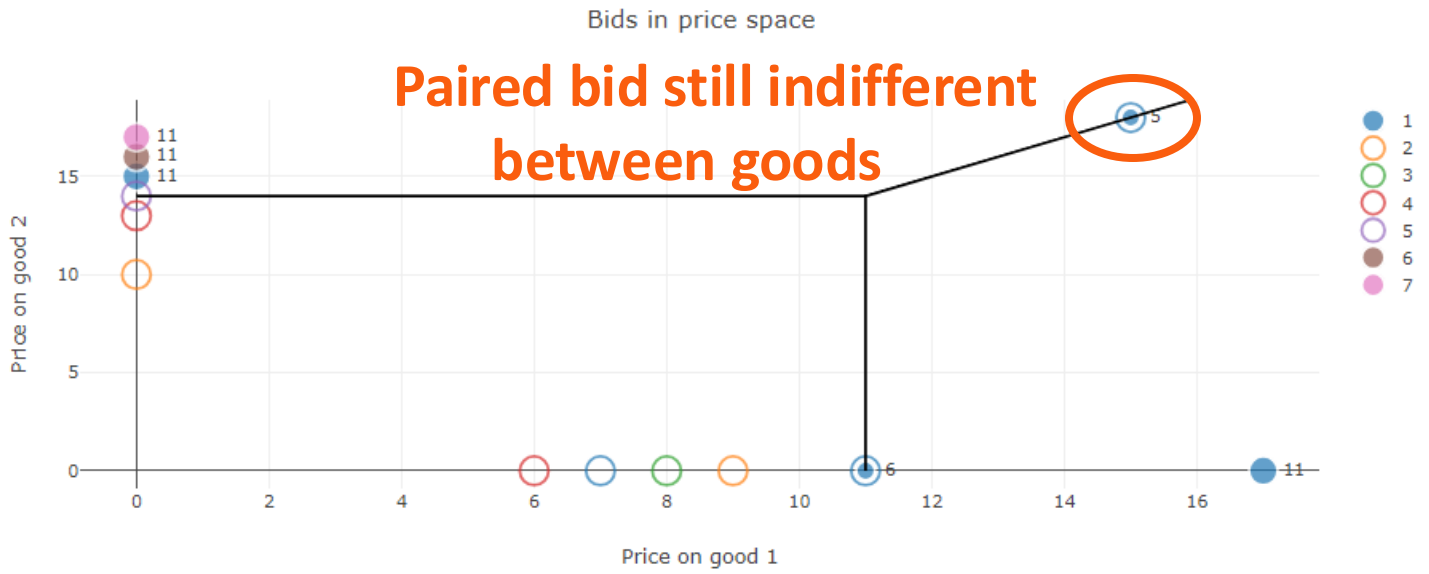
Paired bid [5,15,18]

$(Q_1,P_1) = (20,11)$

$(Q_2,P_2) = (35,14)$

demoPairedHoriz3

5. Paired bid is rationed between goods
Bids in price space & Allocations of bids to goods

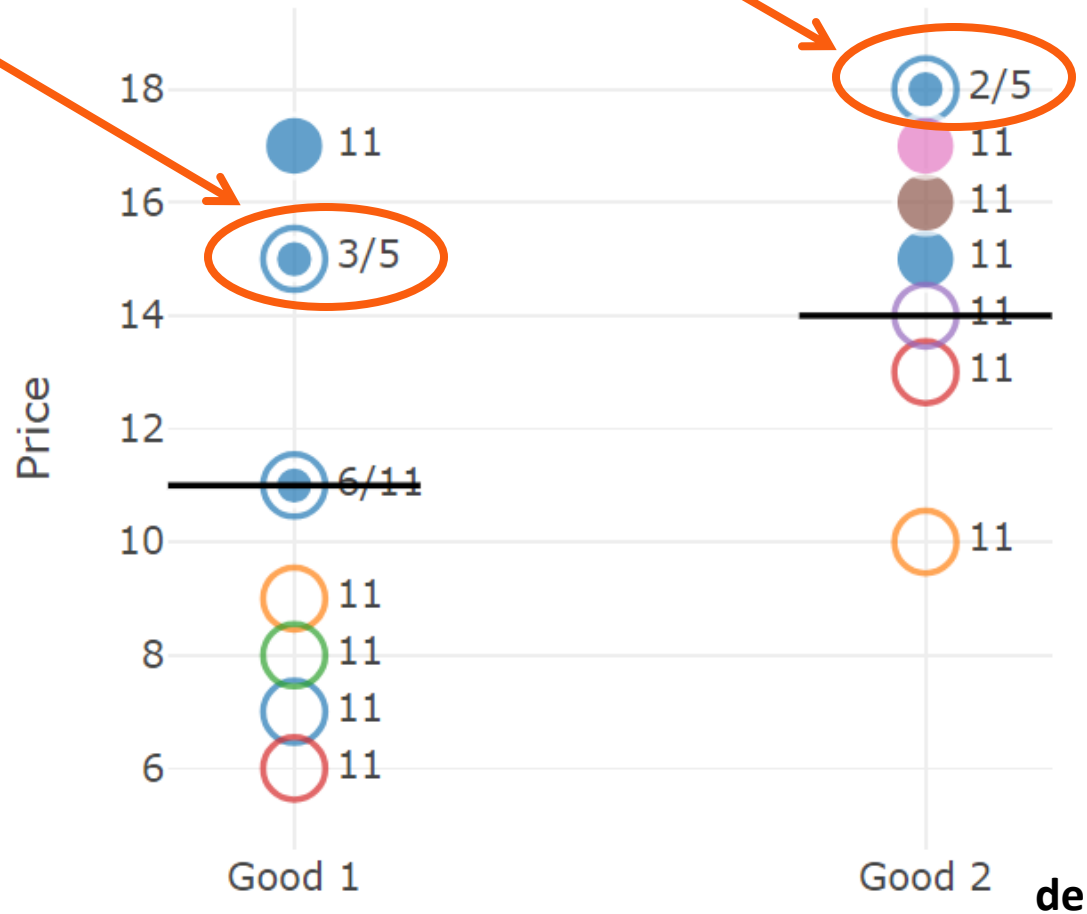


demoPairedHoriz3

5. Paired bid is rationed between goods
Allocations of bids to goods

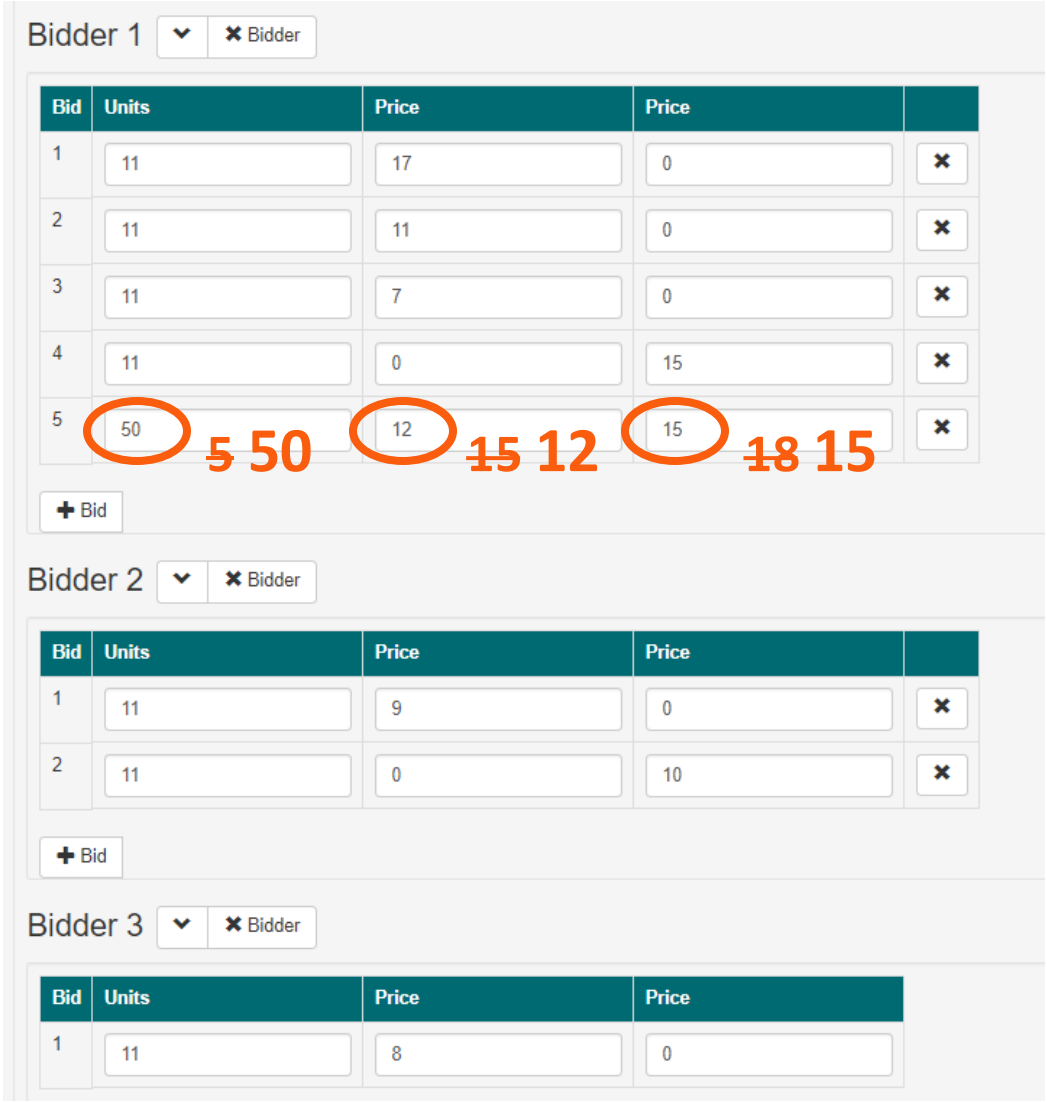
Paired bid (for 5 units in total) receives

3 units of good 1 AND 2 units of good 2



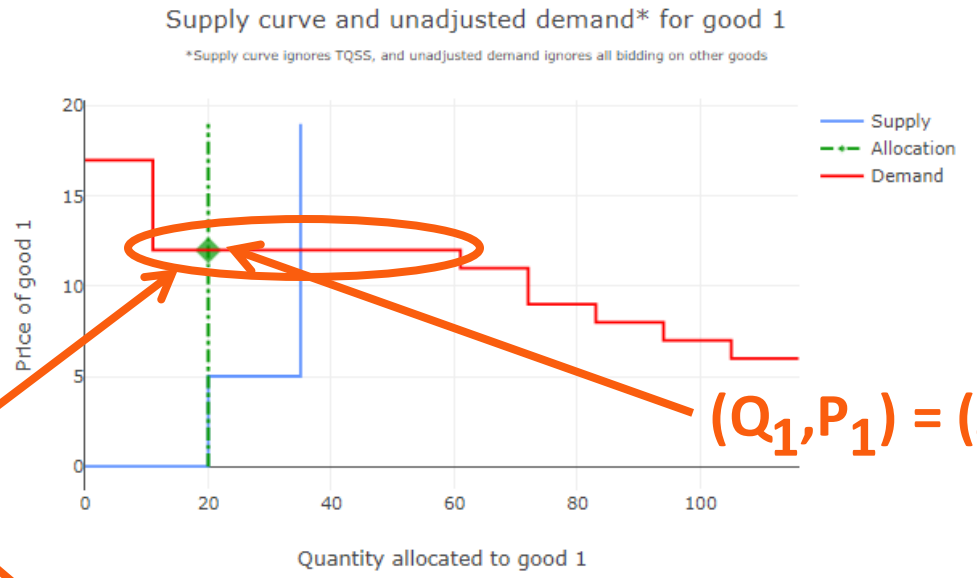
demoPairedHoriz3

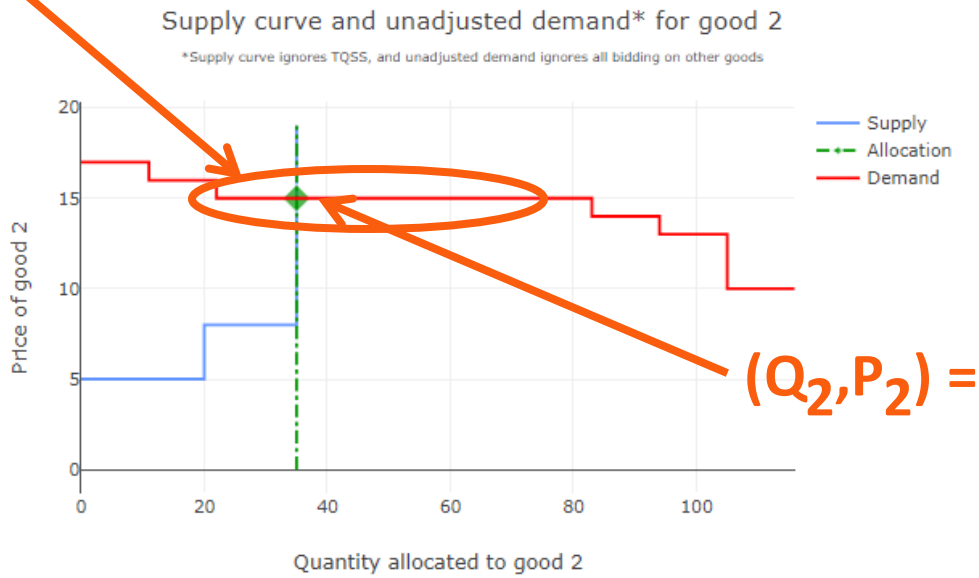
5. More Examples of Paired Bids
Paired bid is rationed between goods and no sale



demoPairedHoriz4

5. Paired bid is rationed between goods and no sale
Demand, Supply & Allocations





Paired bid [50,12,15]

$(Q_1,P_1) = (20,12)$

$(Q_2,P_2) = (35,15)$

demoPairedHoriz4

5. Paired bid is rationed between goods and no sale
Bids in price space & Allocations of bids to goods

demoPairedHoriz4

5. Paired bid is rationed between goods and no sale
Allocations of bids to goods

Paired bid (for 50 units in total) receives

9 units of good 1 AND 13 units of good 2

demoPairedHoriz4

Section 6

6. More Than Two Varieties

Quantity bid for

Good 1 Price bid

Good 2 Price bid

Good 3 Price bid

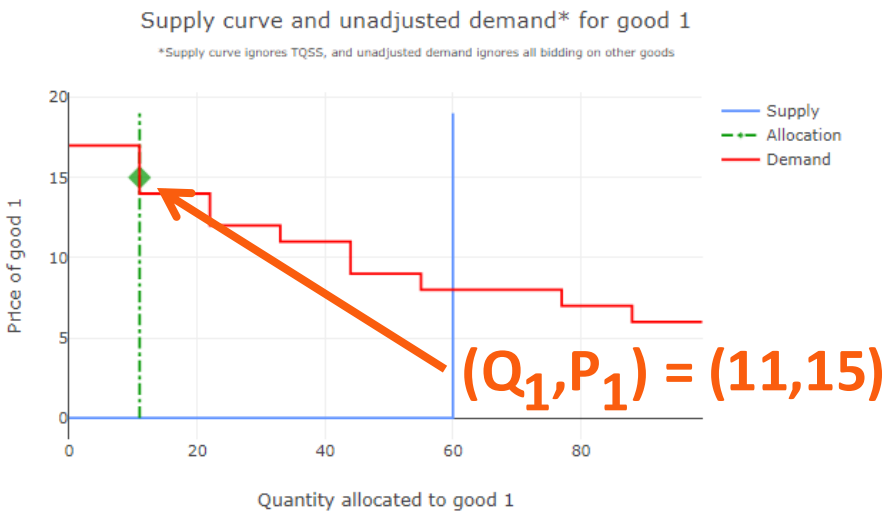
Good 4 Price bid

Bidder 8 ✖ Bidder

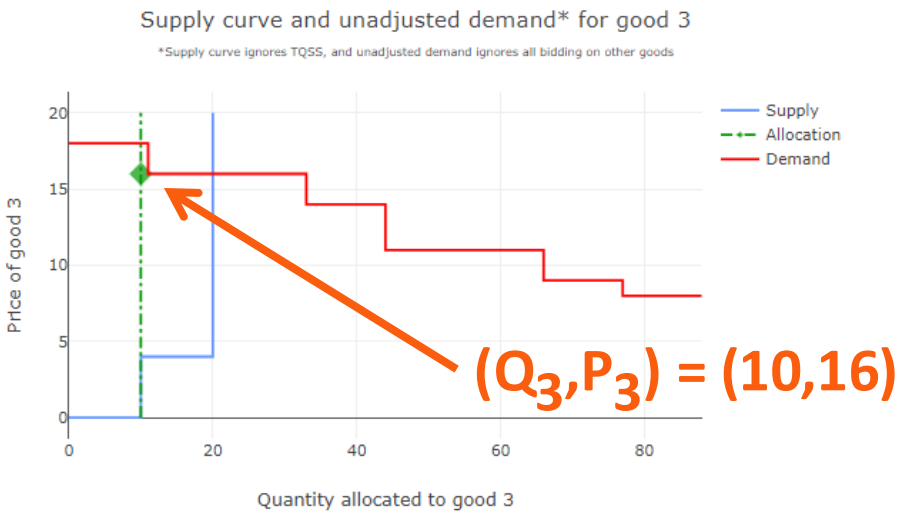
Bid	Units	Price	Price	Price	Price	
1	11	14	13	11	0	✖
2	11	12	14	9	0	✖
3	11	8	11	8	0	✖
4	11	0	0	11	12	✖
5	11	0	0	14	16	✖
6	11	0	14	16	16	✖
7	11	0	12	16	0	✖
8	11	0	0	18	19	✖

demoMoreHorizGoods

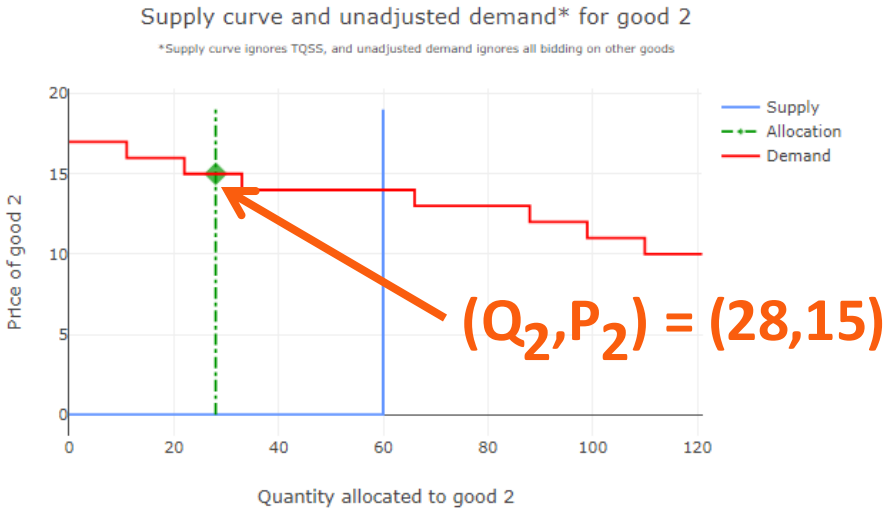
6. More Than Two Varieties
Demand, Supply & Allocations



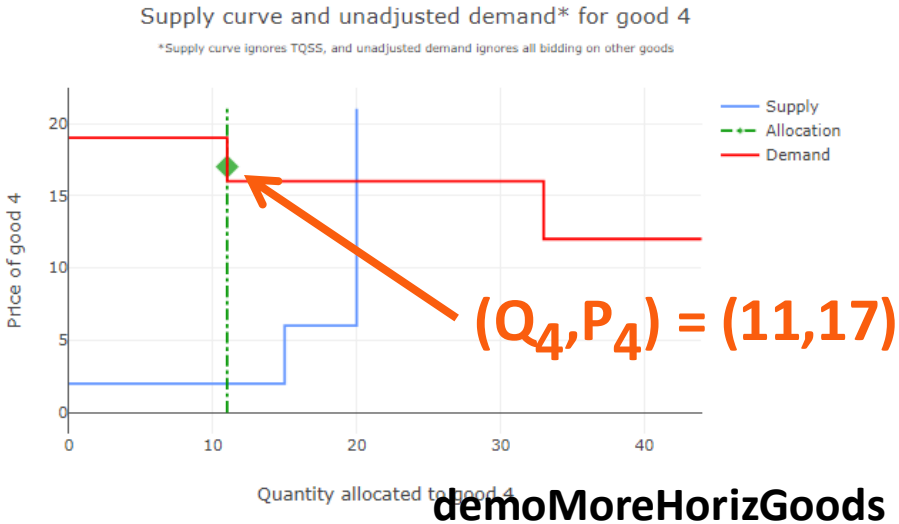
$(Q_1,P_1) = (11,15)$



$(Q_3,P_3) = (10,16)$



$(Q_2,P_2) = (28,15)$



$(Q_4,P_4) = (11,17)$

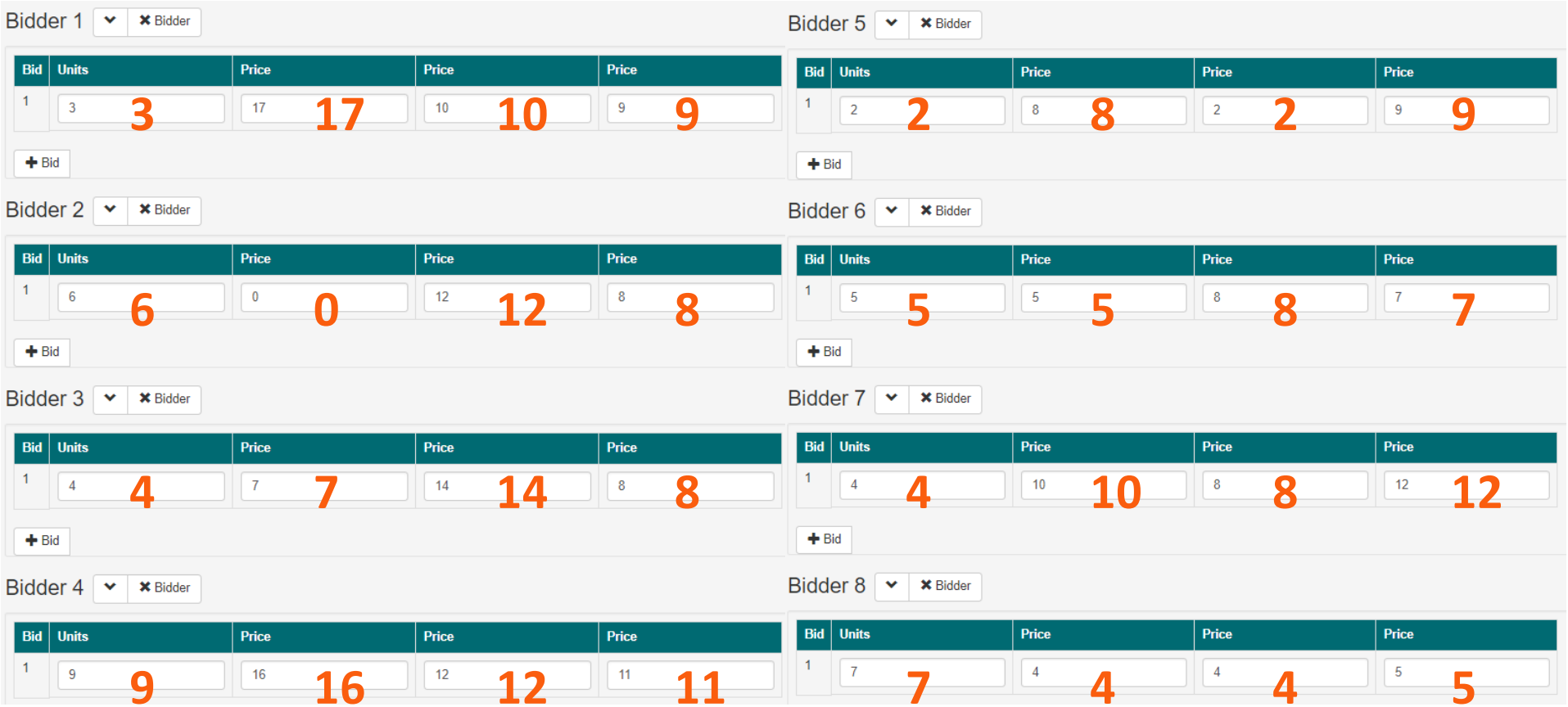
demoMoreHorizGoods

6. More Than Two Varieties
Allocations of bids to goods

demoMoreHorizGoods

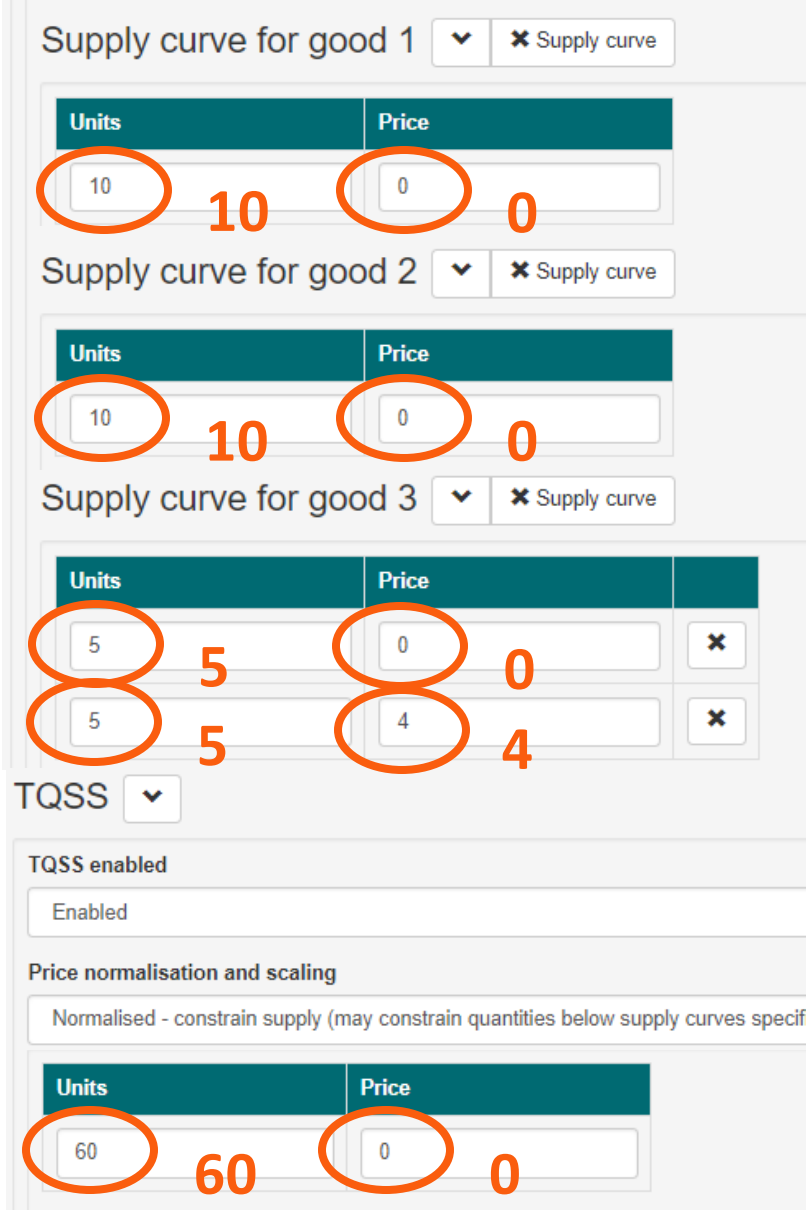
6. More Than Two Varieties
Bidders/Bids

Various bids for different quantities, specifying prices for up to 3 goods



demo3GoodsHoriz

6. Three Varieties
Supply Curves



demo3GoodsHoriz

6. Three Varieties
Demand, Supply & Allocations

Supply curve for good 1 ✖ Supply curve

Units	Price
10	0

10 0

Supply curve for good 2 ✖ Supply curve

Units	Price
10	0

10 0

Supply curve for good 3 ✖ Supply curve

Units	Price	
5	0	✖
5	4	✖

5 0

5 4

TQSS

TQSS enabled

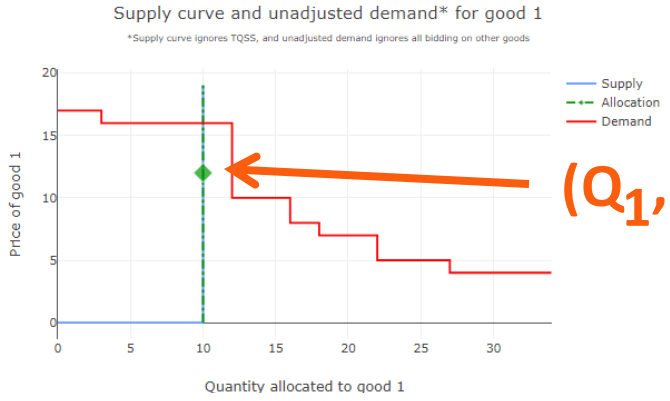
Enabled

Price normalisation and scaling

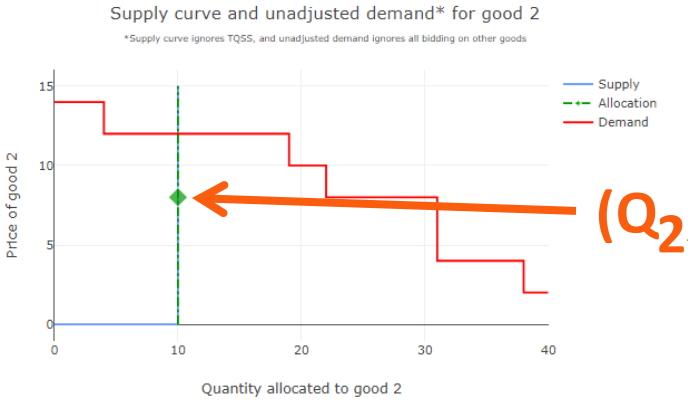
Normalised - constrain supply (may constrain quantities below supply curves specif

Units	Price
60	0

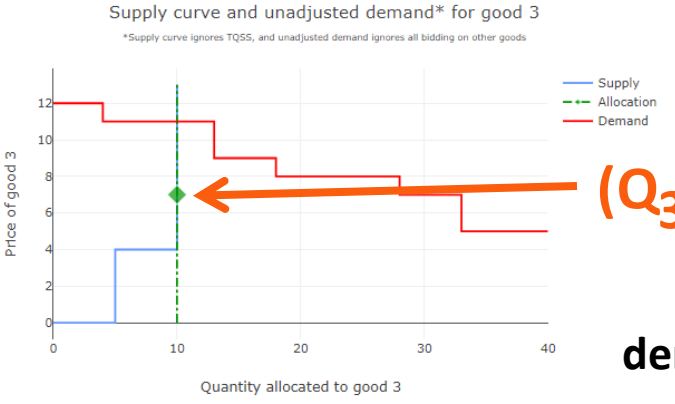
60 0



$(Q_1,P_1) = (10,12)$



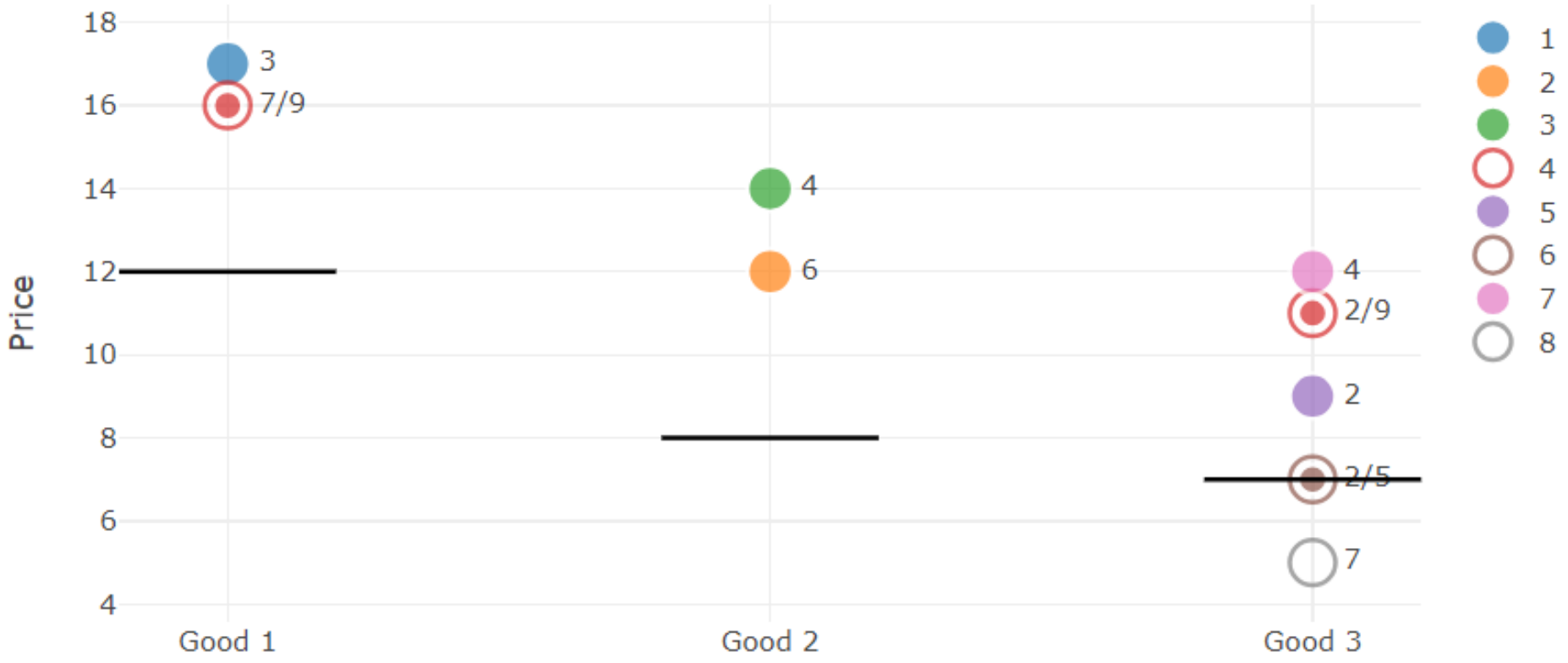
$(Q_2,P_2) = (10,8)$



$(Q_3,P_3) = (10,7)$

demo3GoodsHoriz

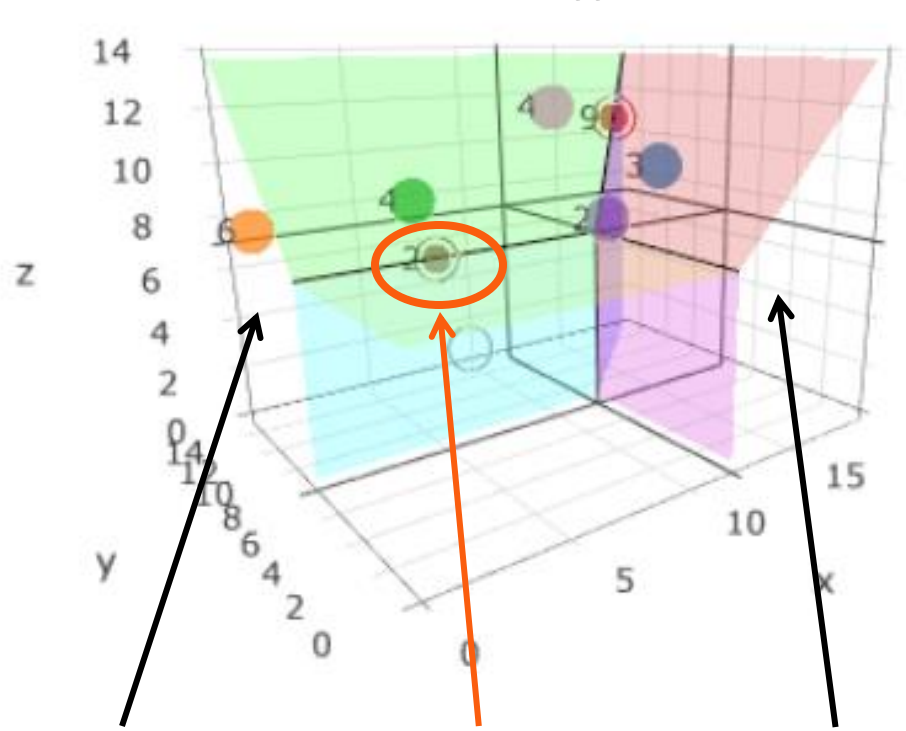
6. More Than Two Varieties
Allocations of bids to goods

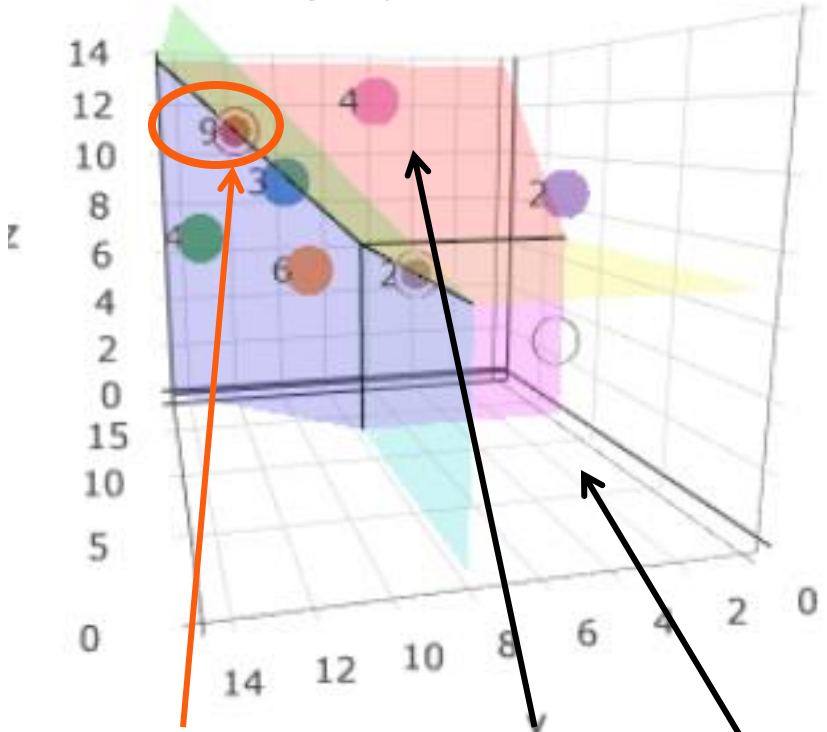


demo3GoodsHoriz

6. More Than Two Varieties
Bids in price space

Two different views of the same 3D-graph





Bids allocated to good 2, e.g. incl.

Bid indifferent between good 2 *and* good 3 *and* no purchase

Bids allocated to good 1, e.g. incl.

Bid indifferent between good 2 *and* good 3

Bids allocated to good 3, e.g. incl.

No sale

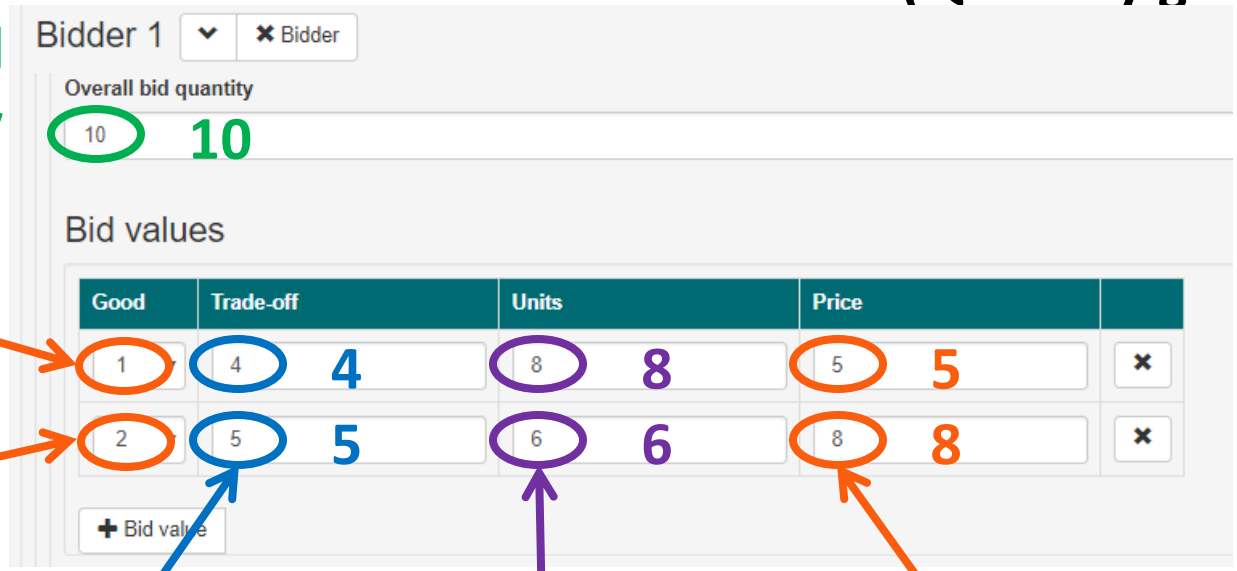
Section 7
Section 7.2

7.2 General Trade-offs and Additional Constraints Bidders/Bids

Overall bid quantity constraint **4×(Quantity good 1) + 5×(Quantity good 2) ≤ 10**

Good 1 constraint **4×(Quantity good 1) ≤ 8**

Good 2 constraint **5×(Quantity good 2) ≤ 6**



Overall bid quantity

Good 1

Good 2

Trade-off good 1 : good 2

Maximum quantities for good 1 / good 2

Bid prices for good 1 / good 2

[Generalised paired bid with 4:5 trade-off]

demoGenTradeoffs

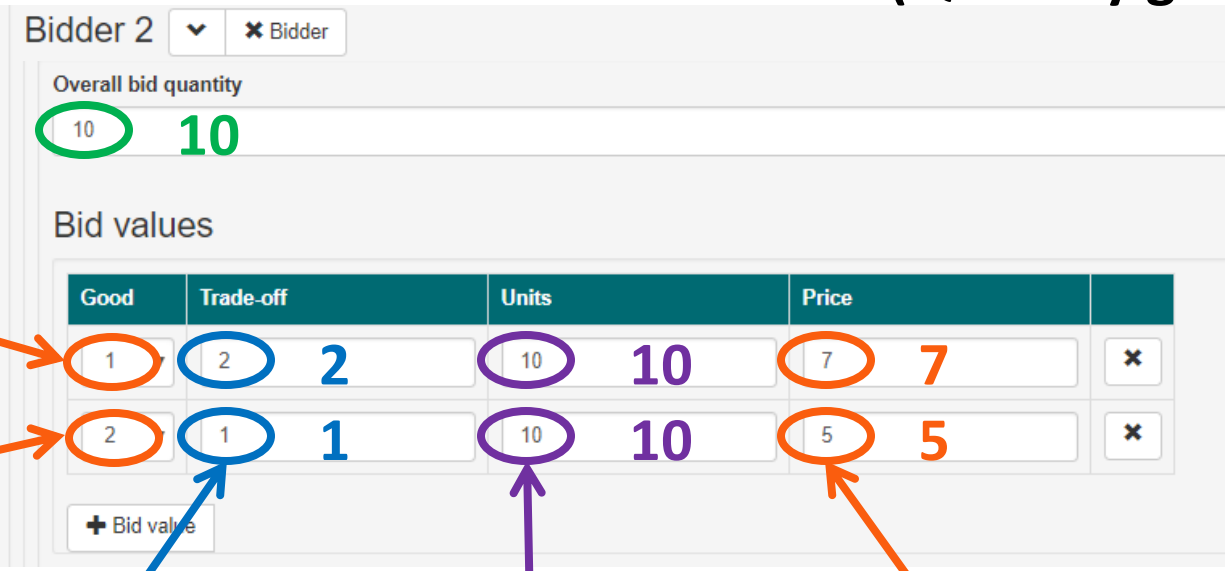
7.2 General Trade-offs and Additional Constraints Bidders/Bids

Overall bid quantity constraint **2×(Quantity good 1) + 1×(Quantity good 2) ≤ 10**

Good 1 constraint **2×(Quantity good 1) ≤ 10**

Good 2 constraint **1×(Quantity good 2) ≤ 10**

Overall bid quantity



Good 1

Good 2

[Generalised paired bid with 2:1 trade-off]

Trade-off good 1 : good 2

Maximum quantities for good 1 / good 2

(= overall bid quantity)

Bid prices for good 1 / good 2

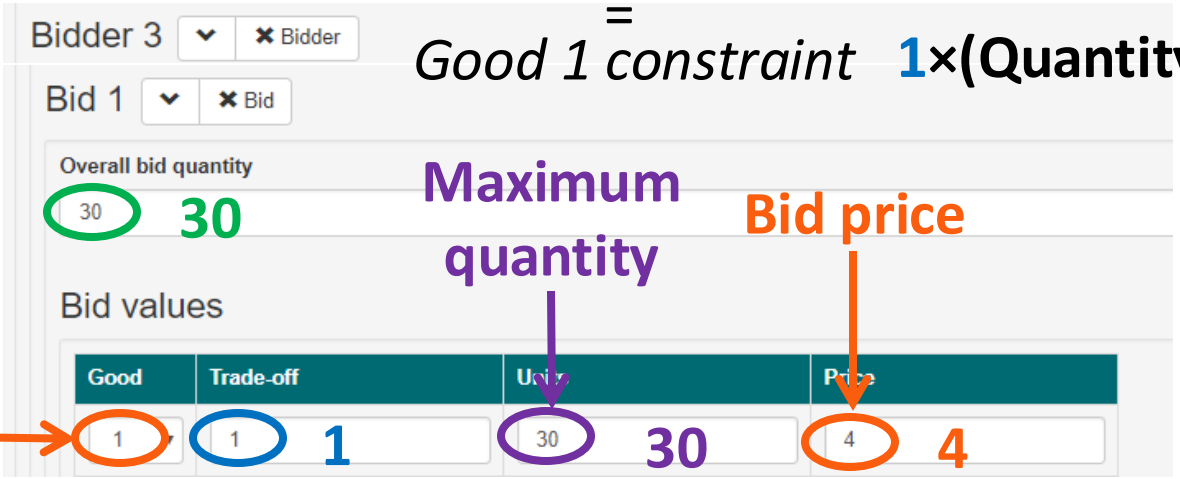
demoGenTradeoffs

7.2 General Trade-offs and Additional Constraints Bidders/Bids

Overall bid quantity constraint 1×(Quantity good 1) ≤ 30

=

Good 1 constraint 1×(Quantity good 1) ≤ 30



Overall bid quantity

Maximum quantity

Bid price

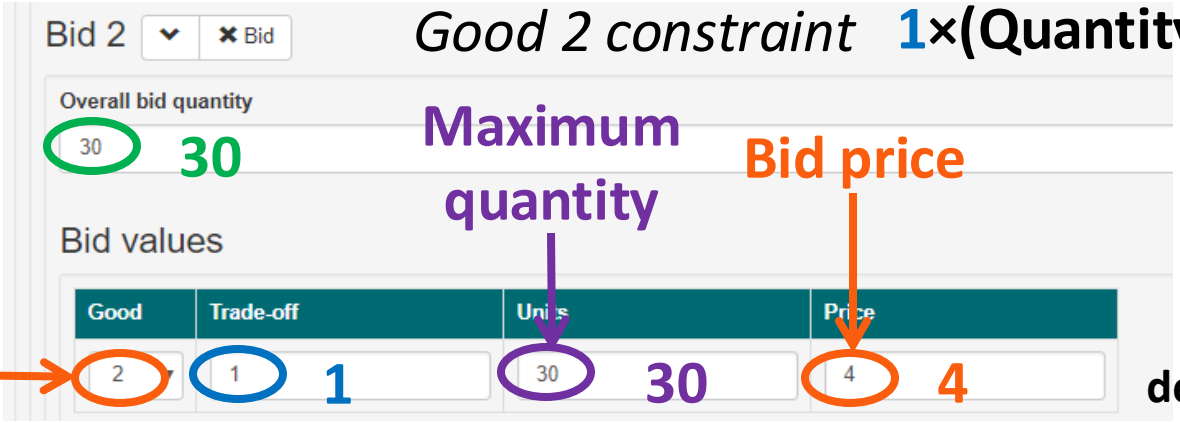
Good 1

[Standard bid for good 1 only]

Overall bid quantity constraint 1×(Quantity good 2) ≤ 30

=

Good 2 constraint 1×(Quantity good 2) ≤ 30



Overall bid quantity

Maximum quantity

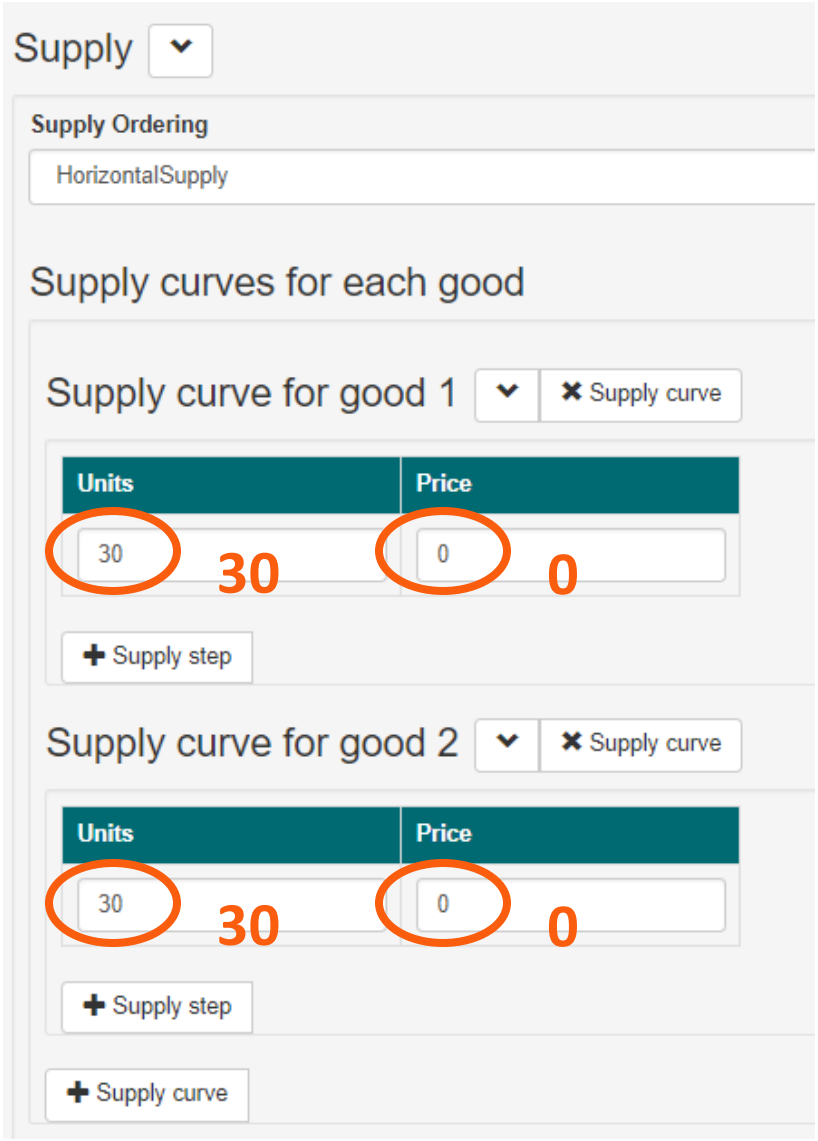
Bid price

Good 2

[Standard bid for good 2 only]

demoGenTradeoffs

7.2 General Trade-offs and Additional Constraints
Supply Curves



demoGenTradeoffs

7.2 General Trade-offs and Additional Constraints
Demand, Supply & Allocations

Supply

Supply Ordering

HorizontalSupply

Supply curves for each good

Supply curve for good 1 ✖ Supply curve

Units	Price
30	0

30 0

✚ Supply step

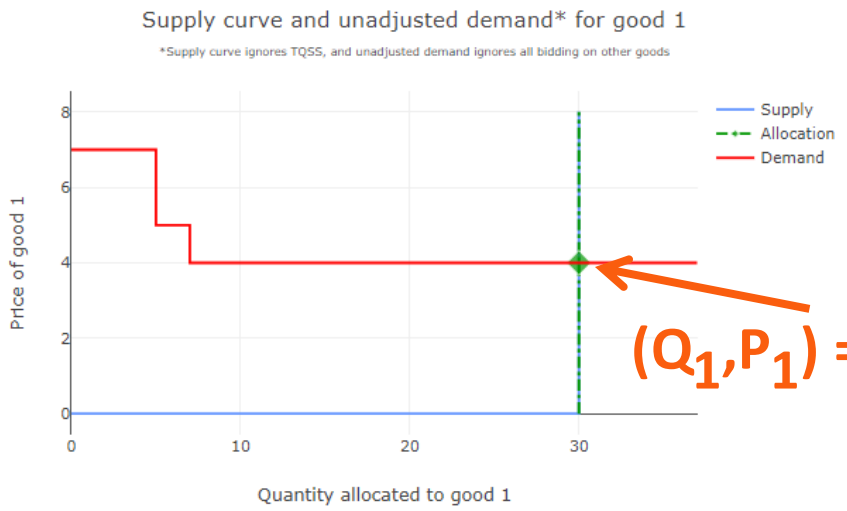
Supply curve for good 2 ✖ Supply curve

Units	Price
30	0

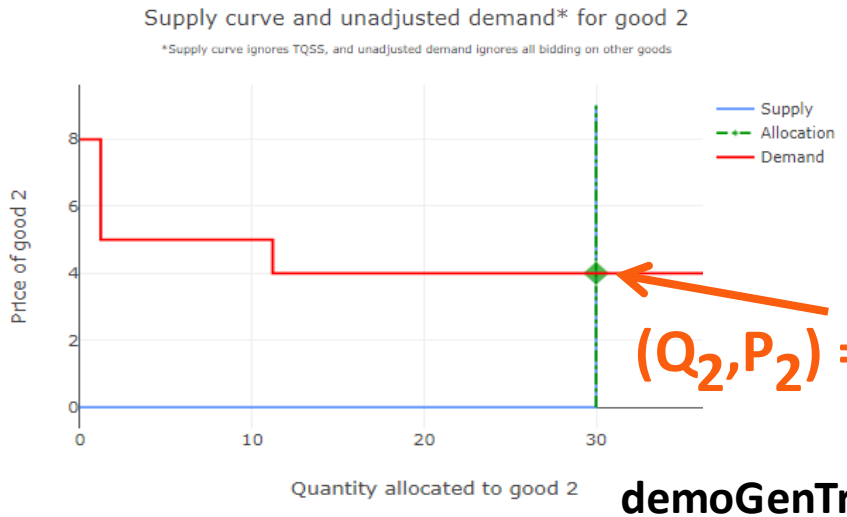
30 0

✚ Supply step

✚ Supply curve



$(Q_1,P_1) = (30,4)$



$(Q_2,P_2) = (30,4)$

demoGenTradeoffs

7.2 General Trade-offs and Additional Constraints
Prices & Allocation of Bids to Goods

$4 \times (\ Q_1 = 1\ ) + 5 \times (\ Q_2 = 1.2\ ) = 10$

Bidder 1's allocation + constraints

$4 \times (\ Q_1 = 1\ ) \leq 8$

$5 \times (\ Q_2 = 1.2\ ) = 6$

Auction output

Prices and total allocations

	Good 1		Good 2	
Price	4	4	4	4
Allocation	30	30	30	30

Allocations

Bidder	Good 1		Good 2	
1	1	1	1.2	1.2
2	5	5	0	0
3	24	24	28.8	28.8

demoGenTradeoffs

7.2 General Trade-offs and Additional Constraints
Prices & Allocation of Bids to Goods

$2 \times (\ Q_1 = 5\ ) + 1 \times (\ Q_2 = 0\ ) = 10$

Bidder 2's allocation + constraints

$2 \times (\ Q_1 = 5\ ) = 10$

$1 \times (\ Q_2 = 0\ ) = 10$

Auction output

Prices and total allocations

	Good 1	Good 2
Price	4 4	4 4
Allocation	30 30	30 30

Allocations

Bidder	Good 1	Good 2
1	1 1	1.2 1.2
2	5 5	0 0
3	24 24	28.8 28.8

demoGenTradeoffs

7.2 General Trade-offs and Additional Constraints
Prices & Allocation of Bids to Goods

$1 \times (\ Q_1 = 24\ ) \leq 30$
$1 \times (\ Q_1 = 24\ ) \leq 30$

Bidder 3's allocation + constraints

$1 \times (\ Q_2 = 28.8\ ) \leq 30$
$1 \times (\ Q_2 = 28.8\ ) \leq 30$

Auction output

Prices and total allocations

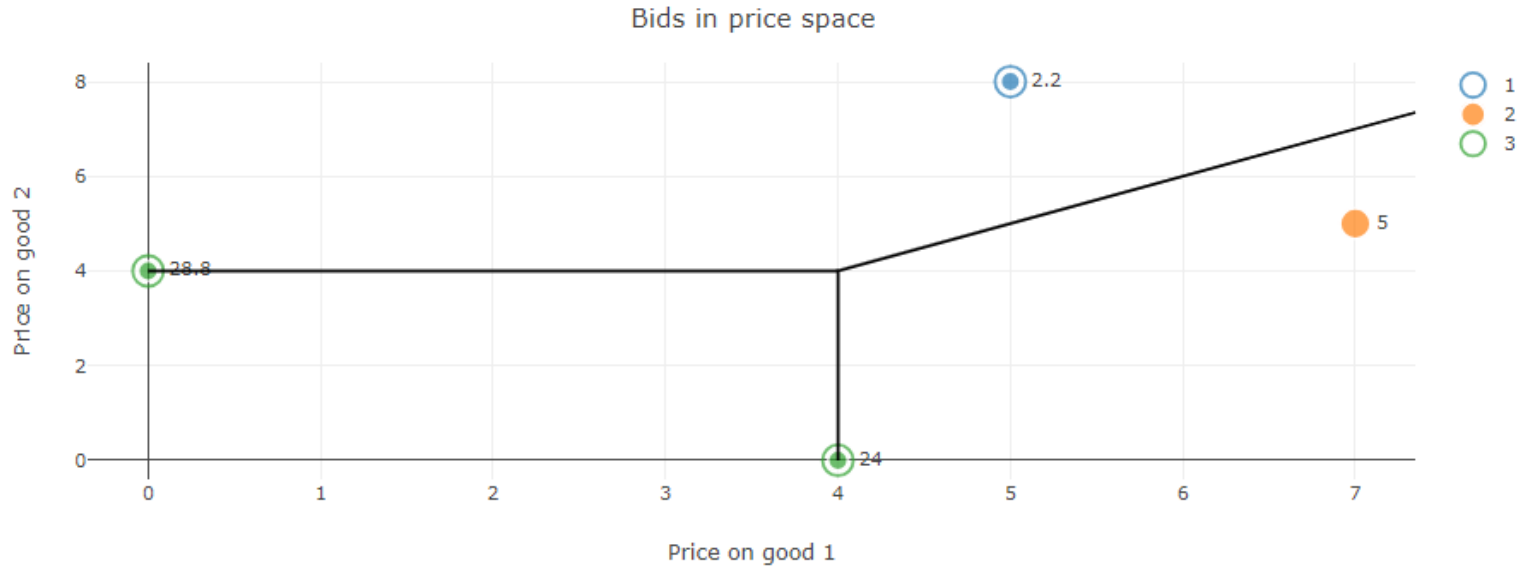
	Good 1	Good 2
Price	4 4	4 4
Allocation	30 30	30 30

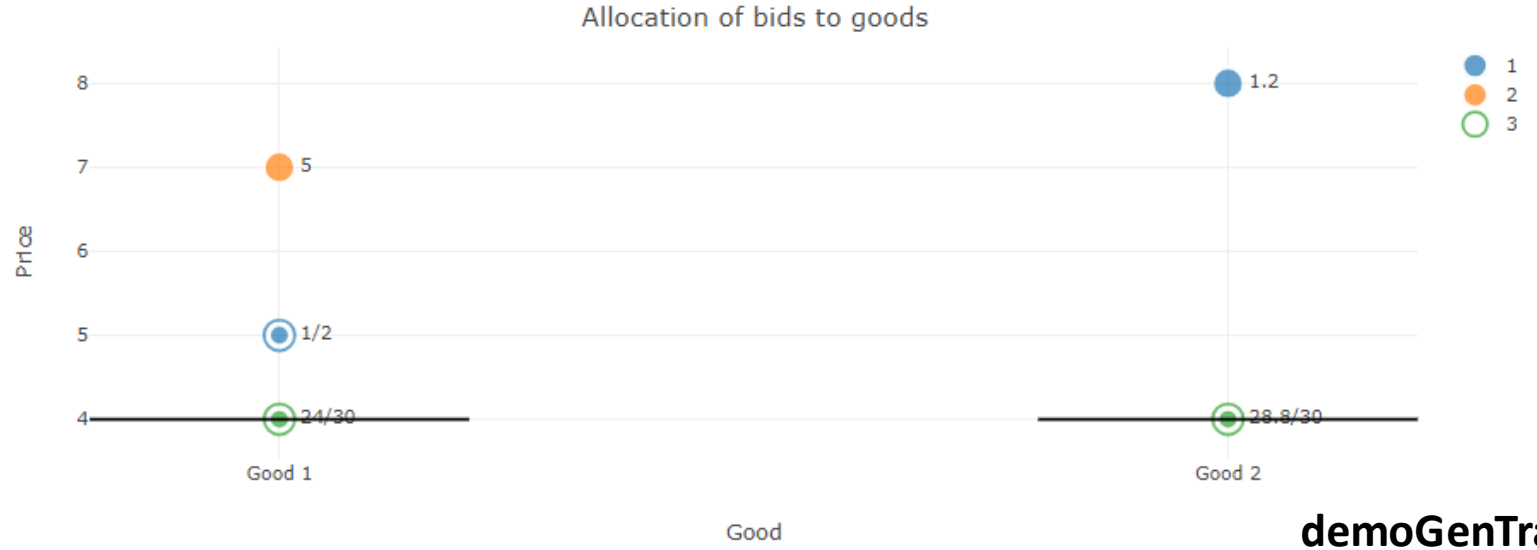
Allocations

Bidder	Good 1	Good 2
1	1 1	1.2 1.2
2	5 5	0 0
3	24 24	28.8 28.8

demoGenTradeoffs

7.2 General Trade-offs and Additional Constraints
Bids in price space & Allocations of bids to goods

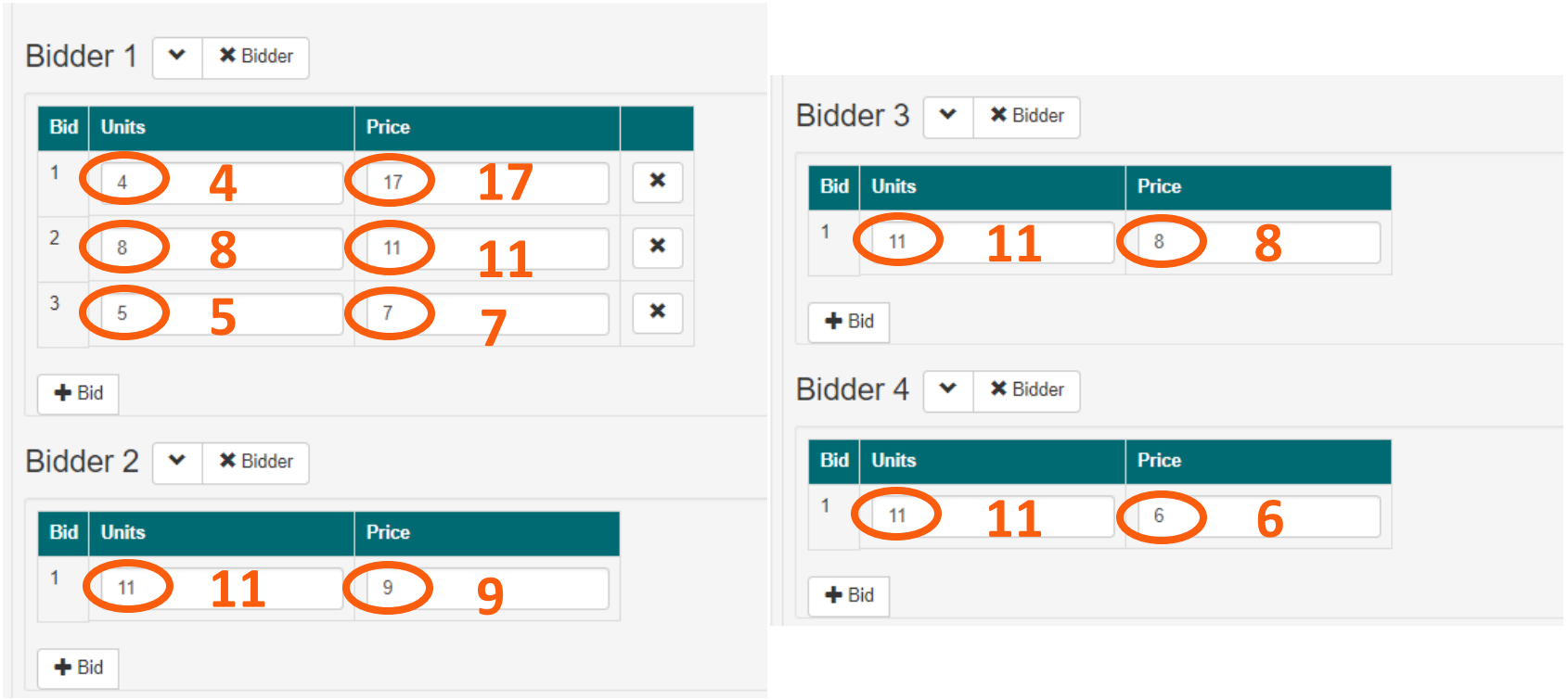




demoGenTradeoffs

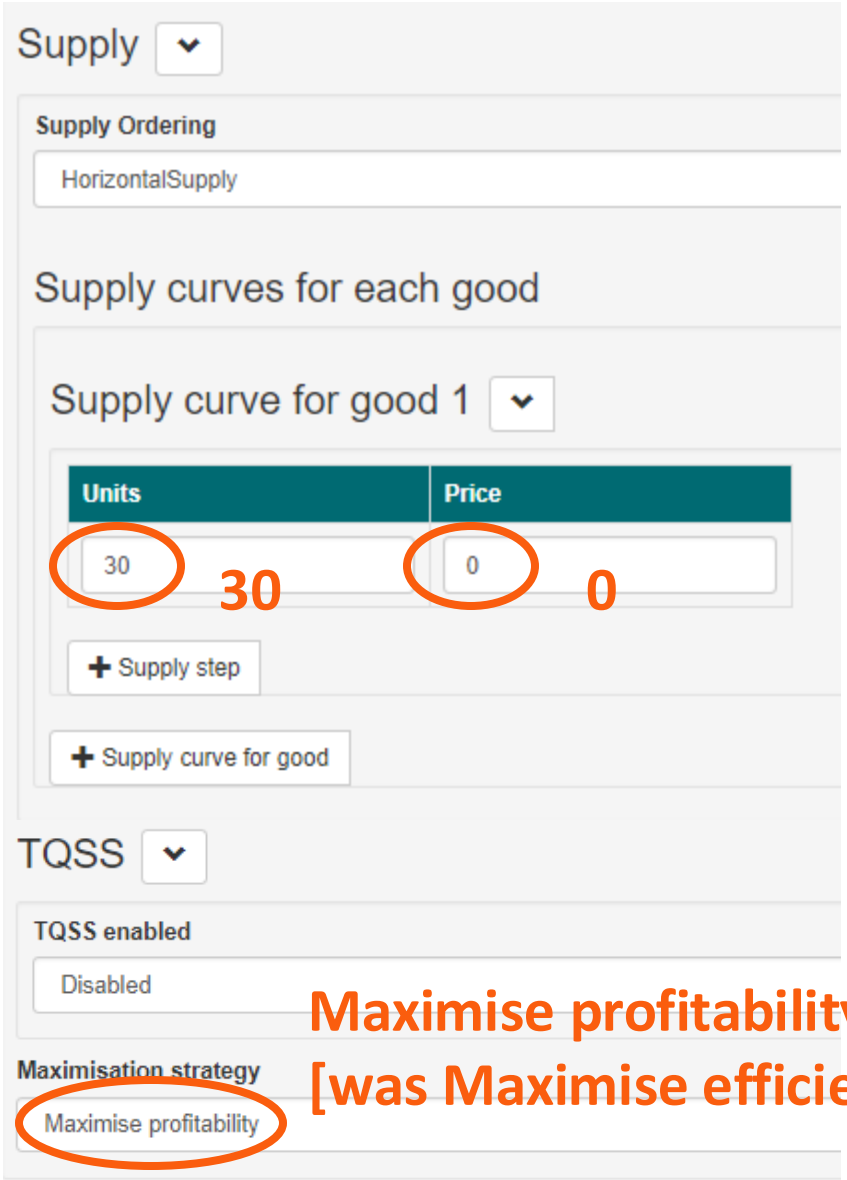
Section 7.3

7.3 Profit Maximisation
Bidders/Bids



demoProfitmax

7.3 Profit Maximisation Supply Curves



demoProfitmax

7.3 Profit Maximisation
Prices & Allocation of Bids to Goods

Auctioneer's profit

Auction output

Auctioneer's profit: 240 — 240

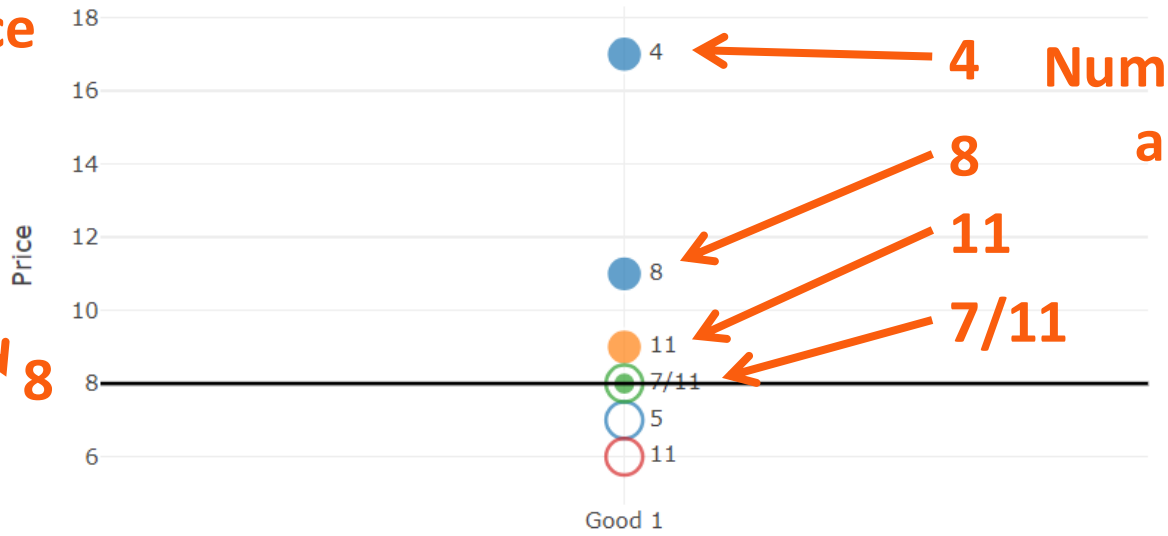
Prices and total allocations

	Good 1
Price	8 — 8
Allocation	30 — 30

Allocations

Bidder	Good 1
1	12
2	11
3	7

Uniform Price



8

4

8

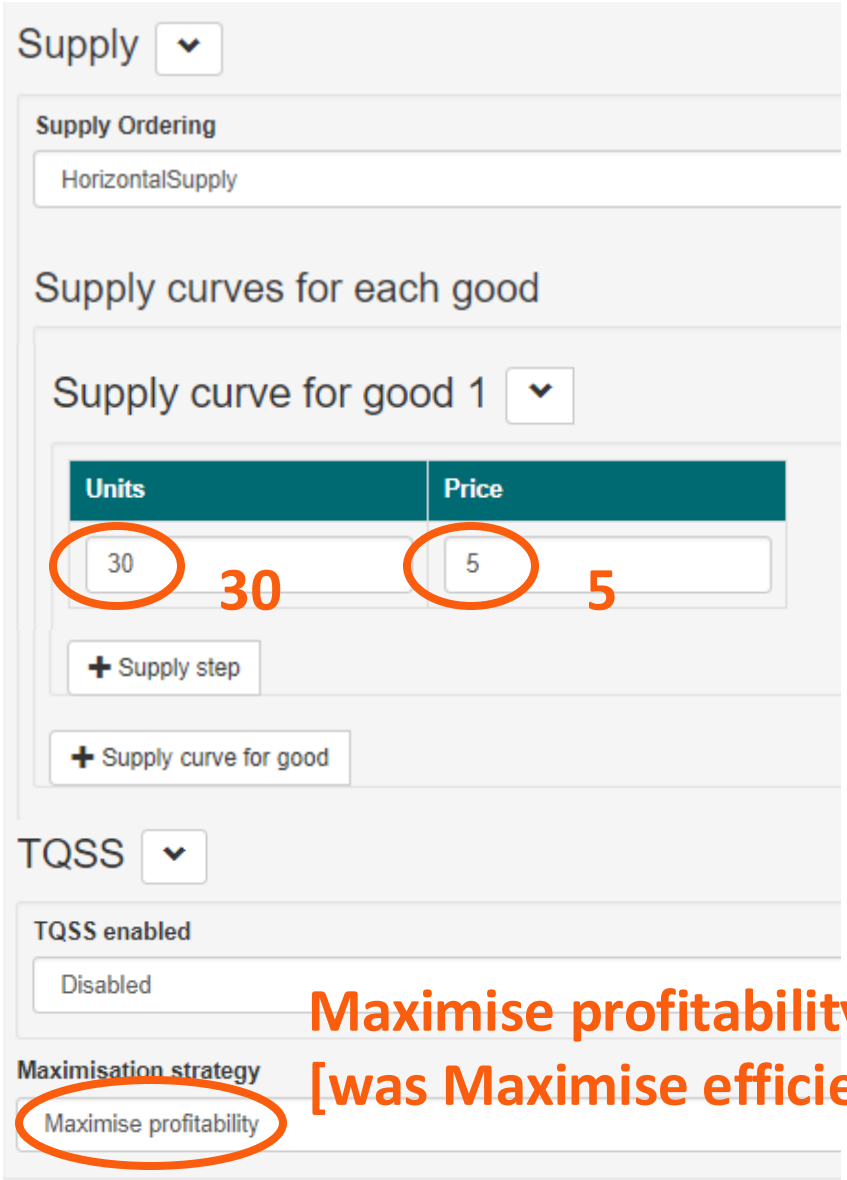
11

7/11

Number of units allocated

demoProfitmax

7.3 Profit Maximisation Supply Curves



demoProfitmax2

7.3 Profit Maximisation
Prices & Allocation of Bids to Goods

Auctioneer's profit

Auction output

Auctioneer's profit: 92

92 (= 23×(9-5) > 30×(8-5) = 90)

Prices and total allocations

	Good 1
Price	9
Allocation	23

9

23

Allocations

Bidder	Good 1
1	12
2	11

Uniform Price

9

4

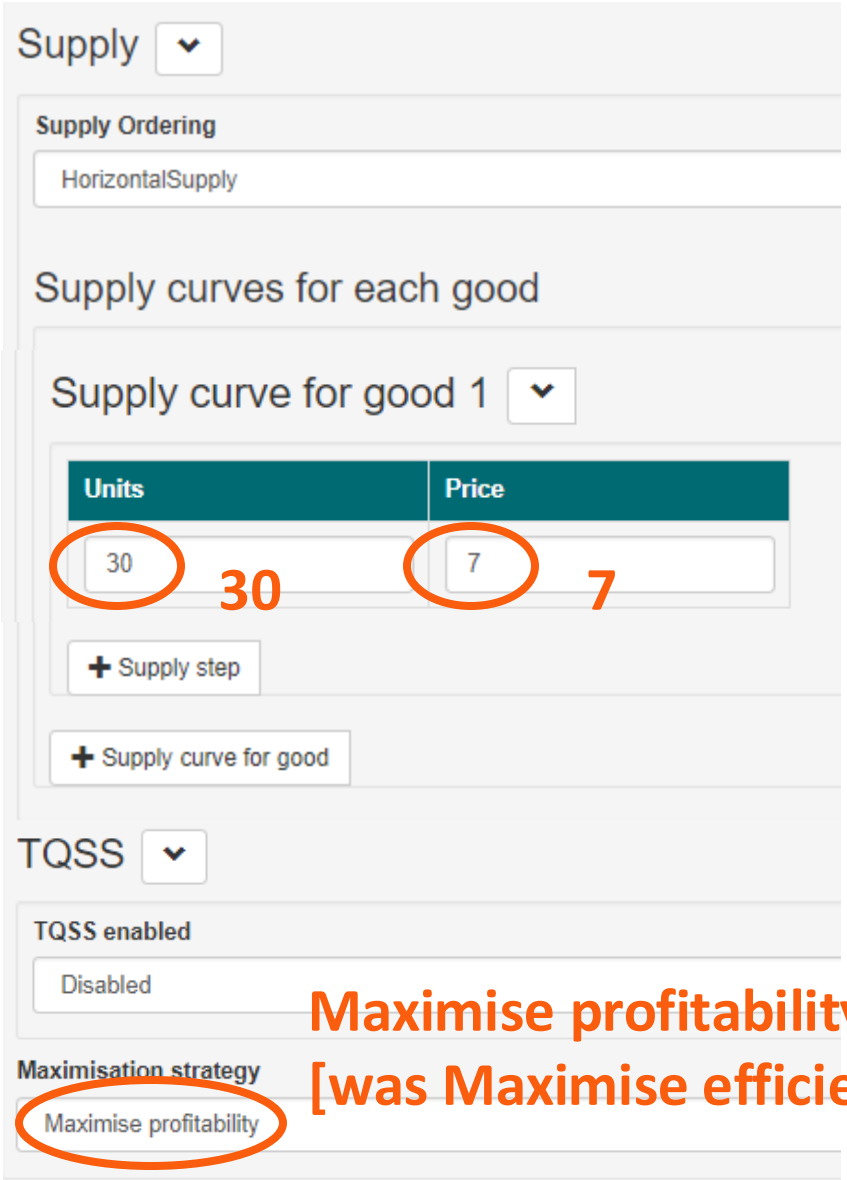
8

11

Number of units allocated

demoProfitmax2

7.3 Profit Maximisation Supply Curves



demoProfitmax3

7.3 Profit Maximisation
Prices & Allocation of Bids to Goods

Auctioneer's profit

Auction output

Auctioneer's profit: 48

48 (= 12×(11-7) > 23×(9-7) = 46)

Prices and total allocations

	Good 1
Price	11
Allocation	12

11

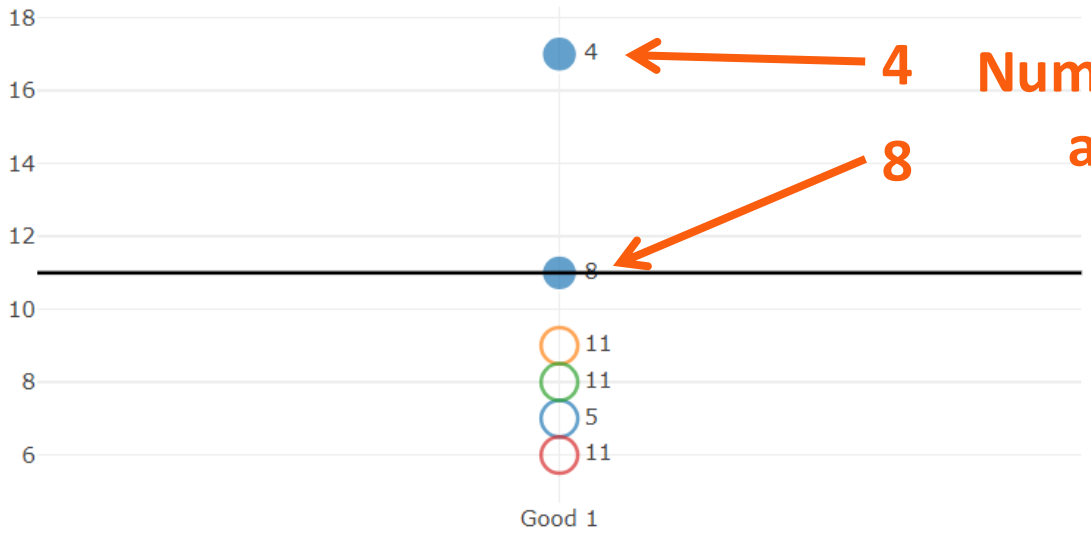
12

Allocations

Bidder	Good 1
1	12

Uniform Price

11



4

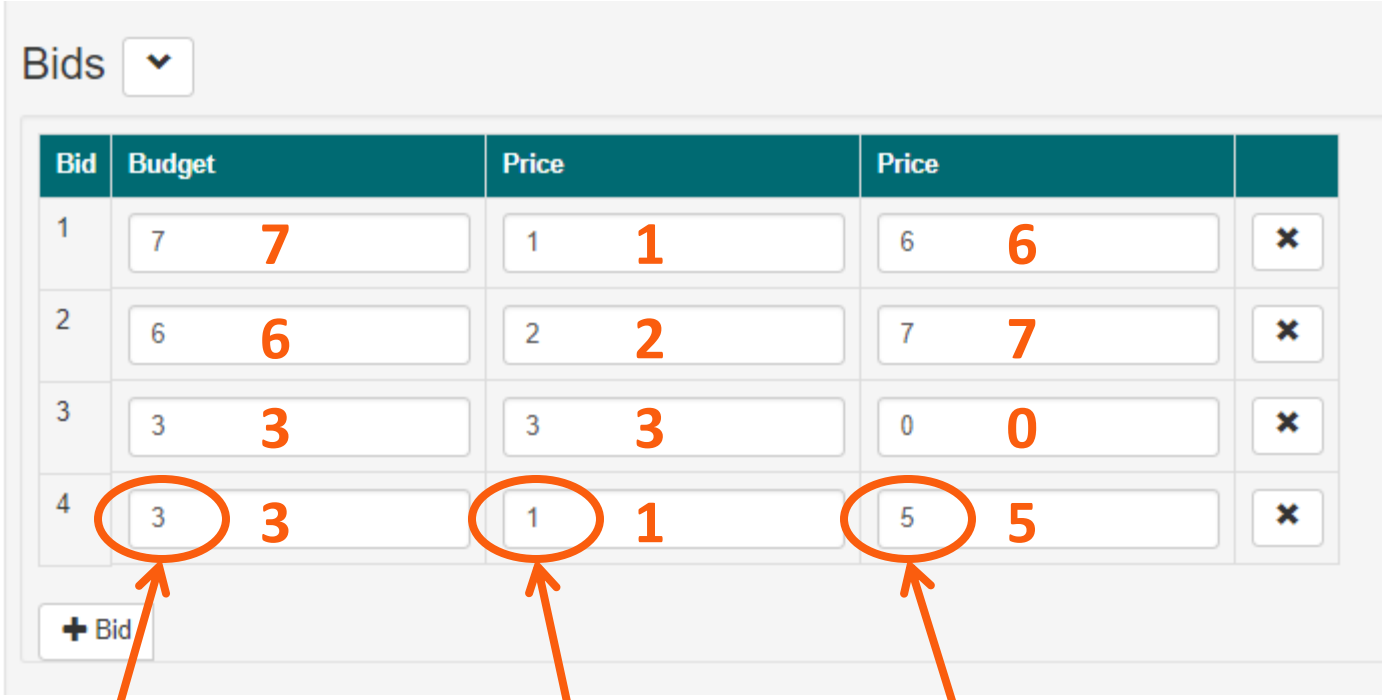
8

Number of units allocated

demoProfitmax3

Section 7.4

7.4 Budget-Constrained Version: Iceland's Auction Bidders/Bids



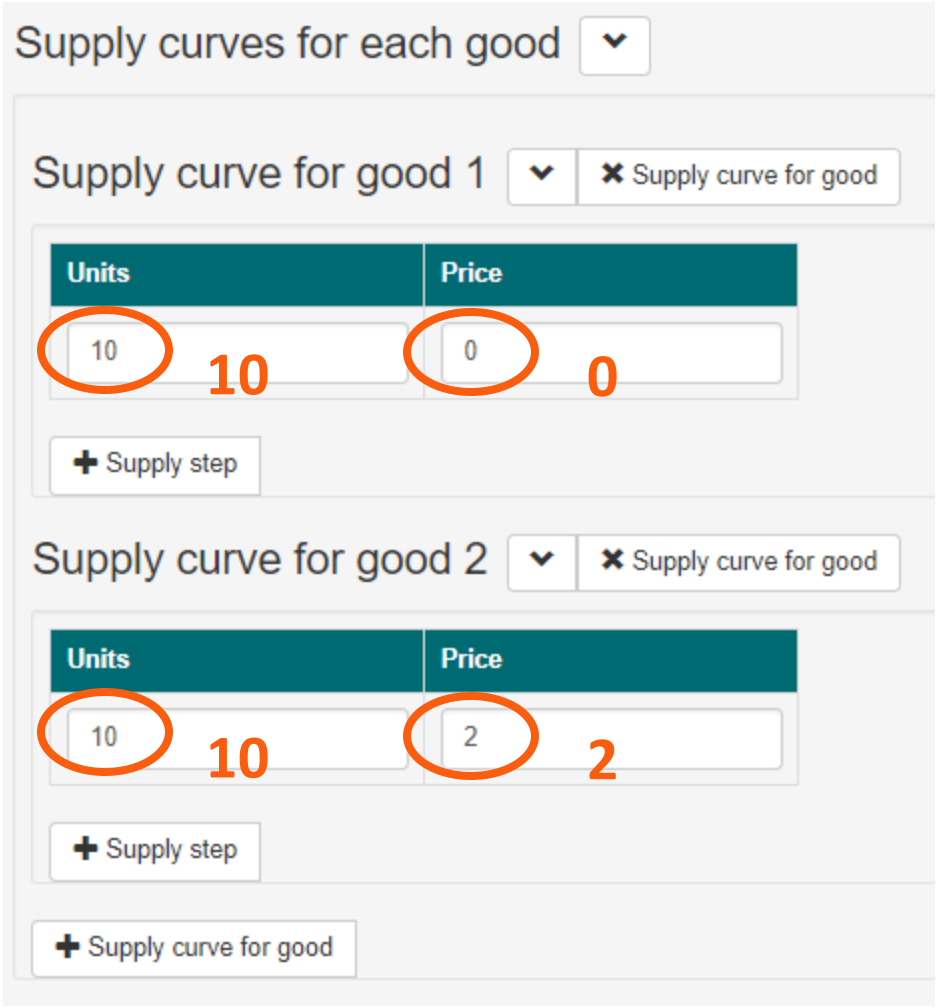
Budget: Maximum total spend on good 1 *or* good 2

Maximum unit price good 1

Maximum unit price good 2

demoIceland

7.4 Budget-Constrained Version: Iceland's Auction Supply Curves



demoIceland

7.4 Budget-Constrained Version: Iceland's Auction Prices & Allocation of Bids to Goods

Auction output

Auctioneer's profit: 15.4 **15.4 Auctioneer's profit**

Prices and total allocations

	Good 1	Good 2
Price	1 **1**	5 **5**
Allocation	10 **10**	1.8 **1.8**

Allocations

Bid	Good 1	Good 2
1	0	1.4
2	6 **6**	0 **0**
3	3	0
4	1	0.4

Bidder 2's surplus on good 1: 6/1×(2-1) = 6

Bidder 2's surplus on good 2: 6/5×(7-5) = 2.4

i.e. allocated only good 1

demoIceland