A Common-Value Auction with Liquidity Needs

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Testing the Auction Design

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Bidder Instructions for Experiment 1

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Two formats

- Simultaneous uniform-price sealed bid
- Simultaneous descending clock

Each session

- 4-bidder sealed-bid
- 8-bidder sealed-bid
- 4-bidder clock
- 8-bidder clock

4-bidder auction

- Treasury demand is 1000 shares of each security, where each share corresponds to $1 million of face value
- Each bidder has holdings of 1000 shares of each security
- At least 1 winner

8-bidder auction

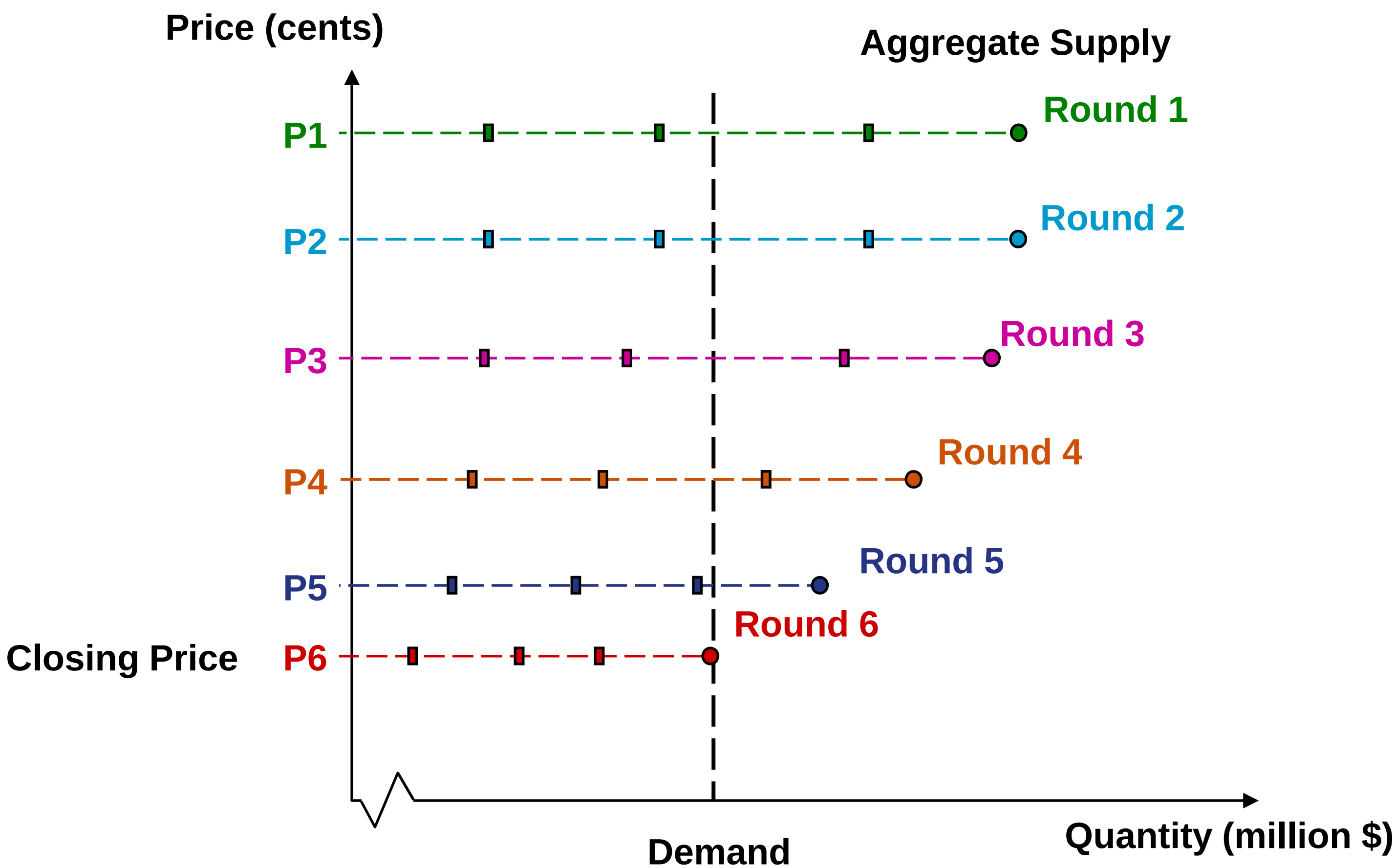
- Treasury demand is 2000 shares of each security, where each share corresponds to $1 million of face value
- Each bidder has holdings of 500 shares of each security
- At least 4 winners

Uniform-price sealed-bid

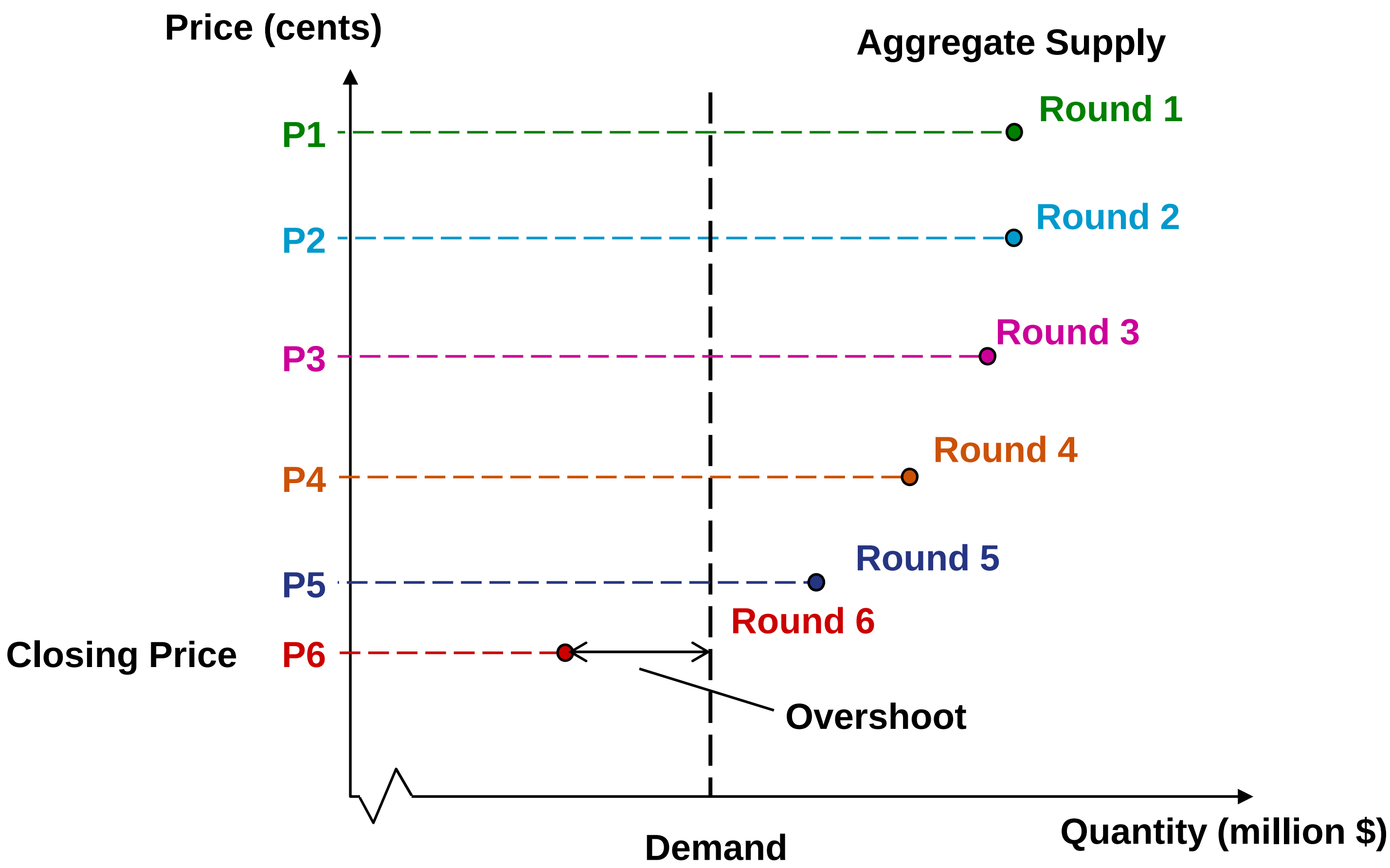
Descending-clock auction

- Since it's an auction to buy rather than sell (a reverse auction), price descends
- Auction is conducted in discrete rounds
- Auctioneer announces price for each security
- Bidders submit quantities for each security
- Activity rule: Quantity cannot increase as the price falls
- Aggregate supply, but not individual bids, announced to bidders
- Auctioneer decrements price for each security
- Process continues until supply equals demand

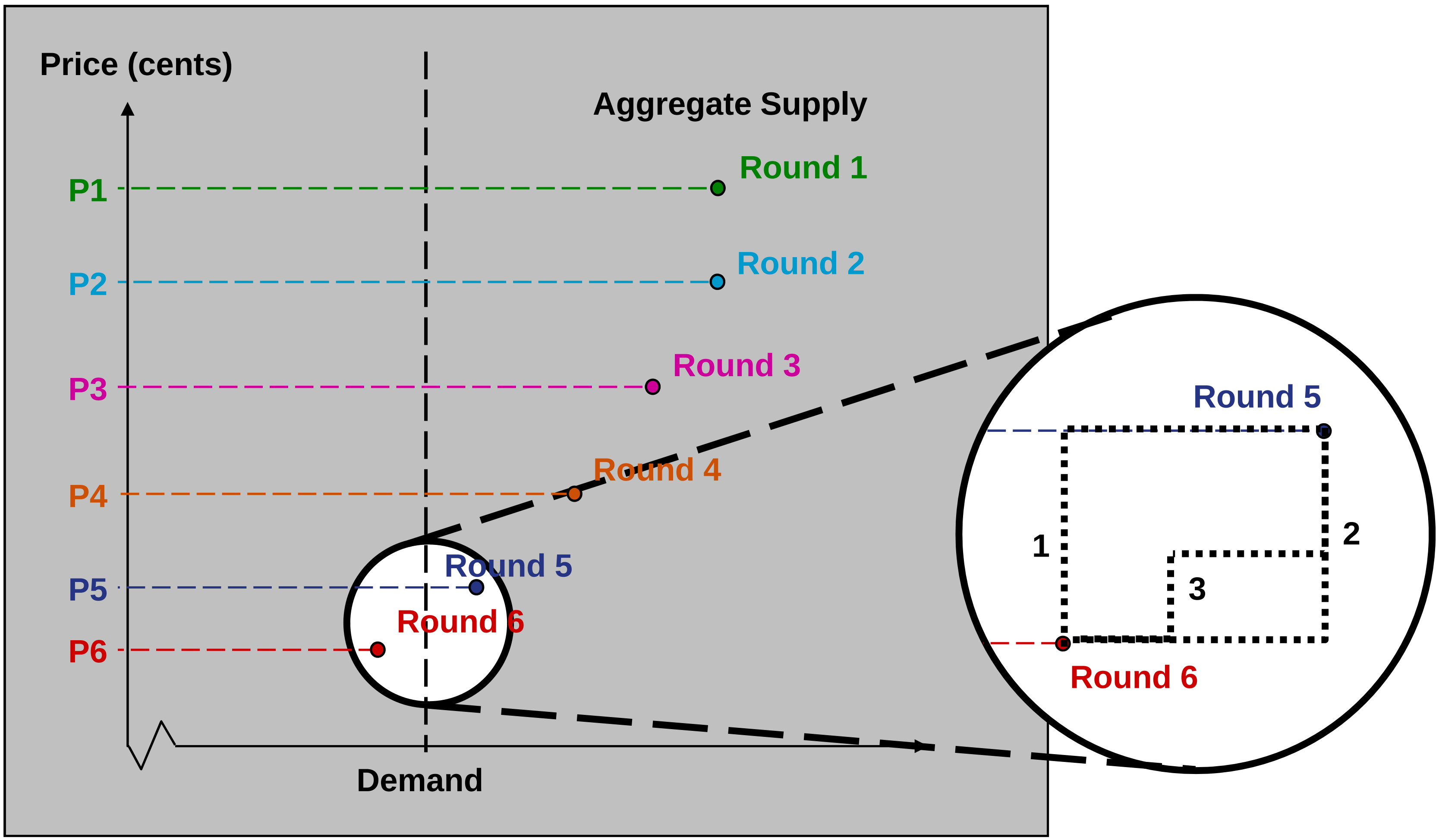
Auction mechanics



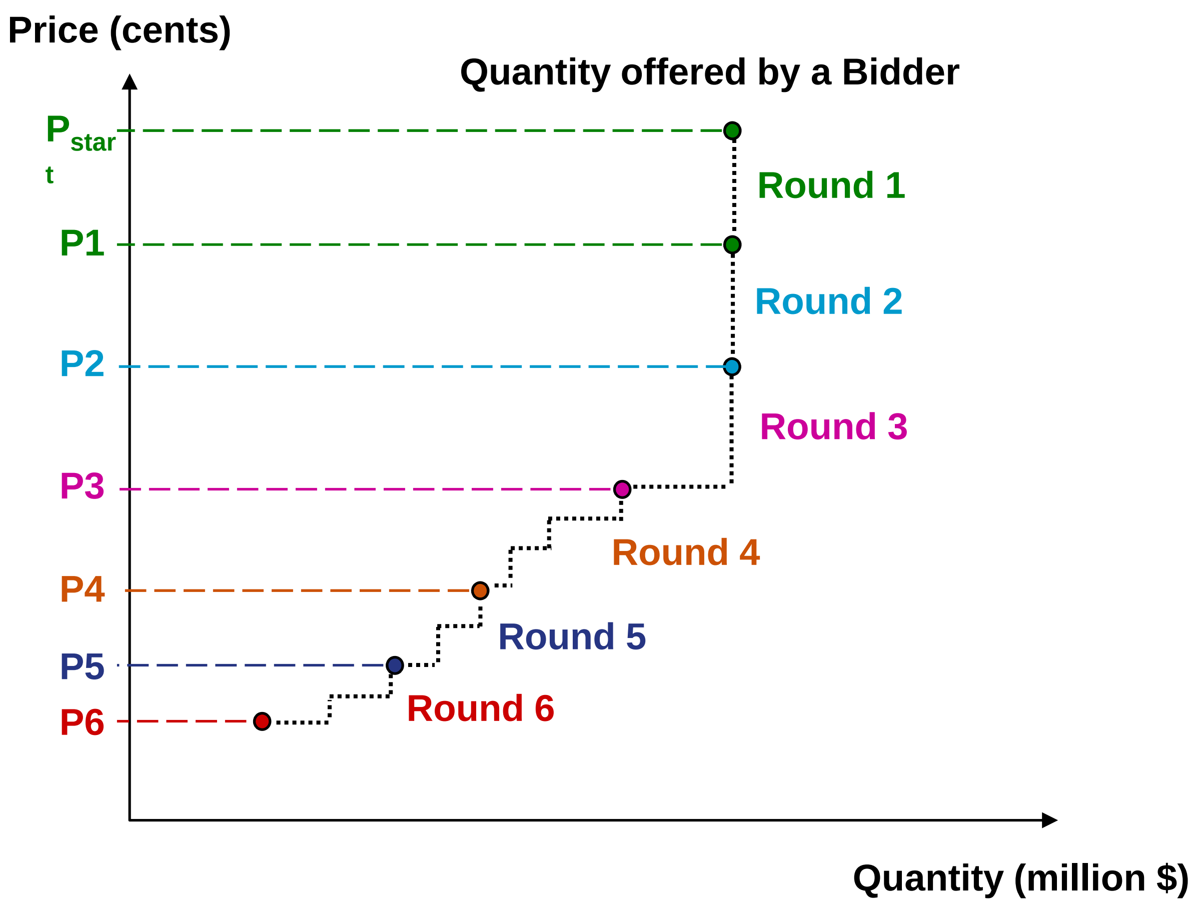
Closing with overshoot



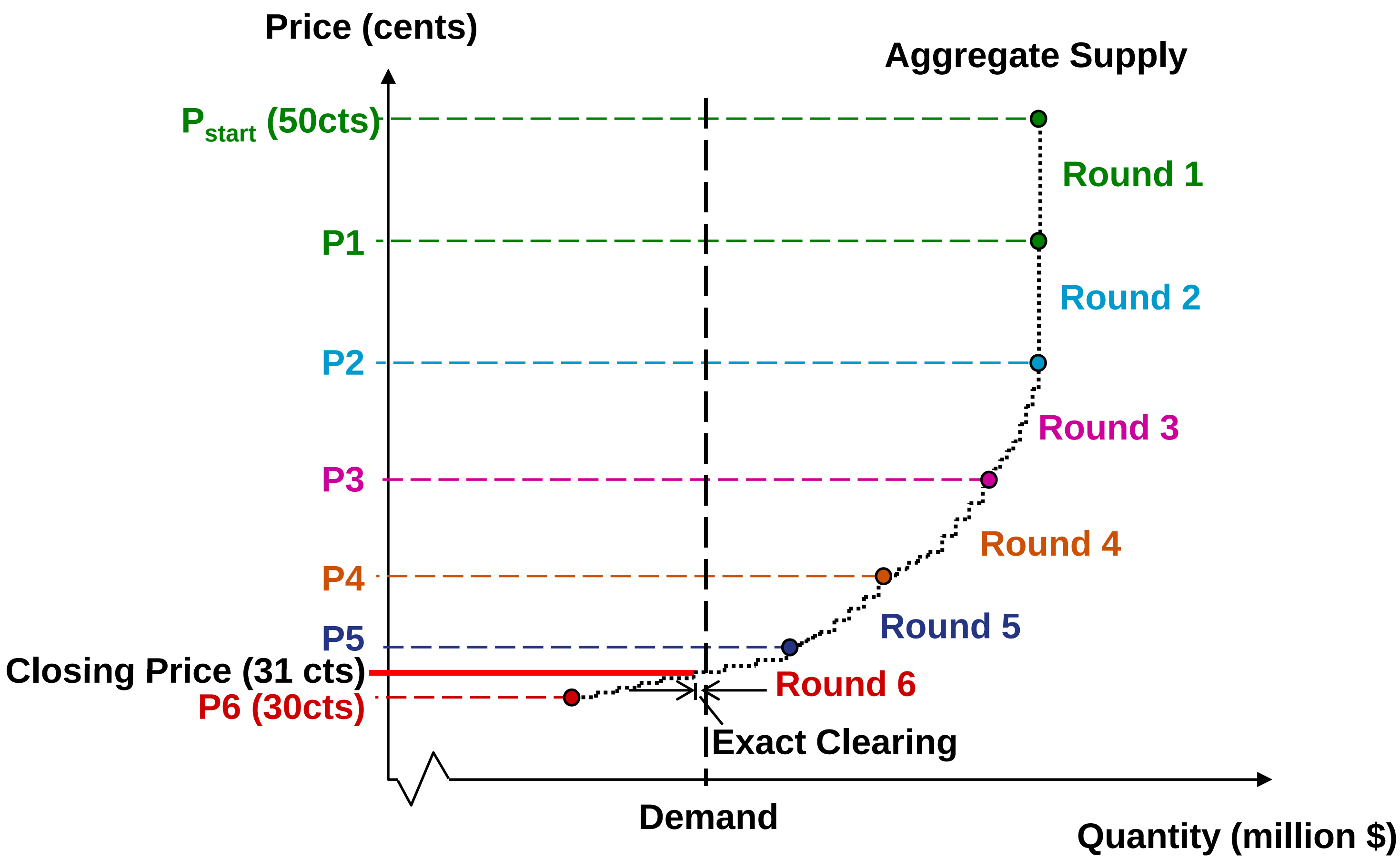
Intraround bids



Intraround bidding – one bidder



Intraround bidding – aggregate supply



An example with 8 securities

Security-by-Security Auction

quantity in $25,000 of face value; price in cents on the dollar

Excess supply
Security clears

Round		Security1	Security2	Security3	Security4	Security5	Security6	Security7	Security8
Reference price		94.35	80.22	72.58	92.11	62.14	54.77	56.11	63.17
Round	Demand	1,000	1,200	2,000	1,500	800	2,500	1,000	1,200
1	Price	98.00	96.00	87.00	98.00	75.00	66.00	67.00	76.00
	Supply	2,300	3,120	6,000	6,000	2,800	5,500	1,500	3,000
2	Price	90.00	88.00	80.00	90.00	69.00	61.00	63.00	70.00
	Supply	2,000	2,160	5,000	4,500	2,400	5,250	1,500	2,400
3	Price	83.00	82.00	74.00	83.00	63.00	56.00	60.00	64.00
	Supply	2,000	1,920	4,400	3,300	1,680	4,000	1,400	1,920
4	Price	76.00	77.00	68.00	76.00	58.00	53.00	57.00	60.00
	Supply	1,700	1,560	3,600	2,850	1,280	4,000	1,200	1,560
5	Price	71.00	74.01	63.00	70.00	55.00	50.00	55.71	57.00
	Supply	1,400	1,200	2,800	2,250	1,040	3,000	1,000	1,320
6	Price	67.00		60.00	66.00	53.24	48.78		55.15
	Supply	1,200		2,600	1,650	800	2,500		1,200
7	Price	64.72		57.32	63.75				
	Supply	1,000		2,000	1,500				

Preferences

- Your payoff depends on your profits and how well your liquidity needs are met

Common value auction

- value of each security in cents on the dollar is the average of eight iid random variables uniformly distributed between 0 and 100

$$v_s = \tfrac{1}{8}\sum_{i=1}^{8} u_{is}, \text{ where } u_{is} \sim_{iid} U[0,100].$$

- u_{is} is bidder i’s private information

Profit

- If you sell the quantity q_s of the security s at the price p_s, then your profit (in million \$) is

$$\pi_i(p, q_i, v) = \frac{1}{100} \sum_{s=1}^{8} (p_s - v_s) q_{is}.$$

Liquidity need

- liquidity need, *L=*, which is drawn iid from the uniform distribution on the interval [250, 750]
- You get a bonus of $1 for every dollar of sales to the Treasury up to your liquidity need of *Li*. You do *not* get any bonus for sales to the Treasury above *Li*. Thus, your bonus is

$$\min\left[L_i, \frac{1}{100}\sum_{s=1}^{8} p_s q_{is} \right].$$

Total payoff

- Combining your profit and your liquidity bonus results in your total payoff

$$U_i(p, q_i, v) = \begin{cases} \frac{1}{100}\sum_{s=1}^{8}(2p_s - v_s)q_{is} & \text{if } \frac{1}{100}\sum_{s=1}^{8} p_s q_{is} < L_i \\ L_i + \frac{1}{100}\sum_{s=1}^{8}(p_s - v_s)q_{is} & \text{otherwise} \end{cases}$$

- Thus, an additional dollar of cash is worth two dollars when your liquidity need is not satisfied, but is worth one dollar when your liquidity need is satisfied.

Bidding strategy

Auction environment has three complicating features:

- *Common value auction*. You have an imperfect estimate of the good's common value.
- *Divisible good auction*. Your bid is a supply curve, specifying the quantity you wish to sell at various prices.
- *Liquidity need*. You have a specific liquidity need that is met through selling shares from your portfolio of eight securities.

Benchmark assumption

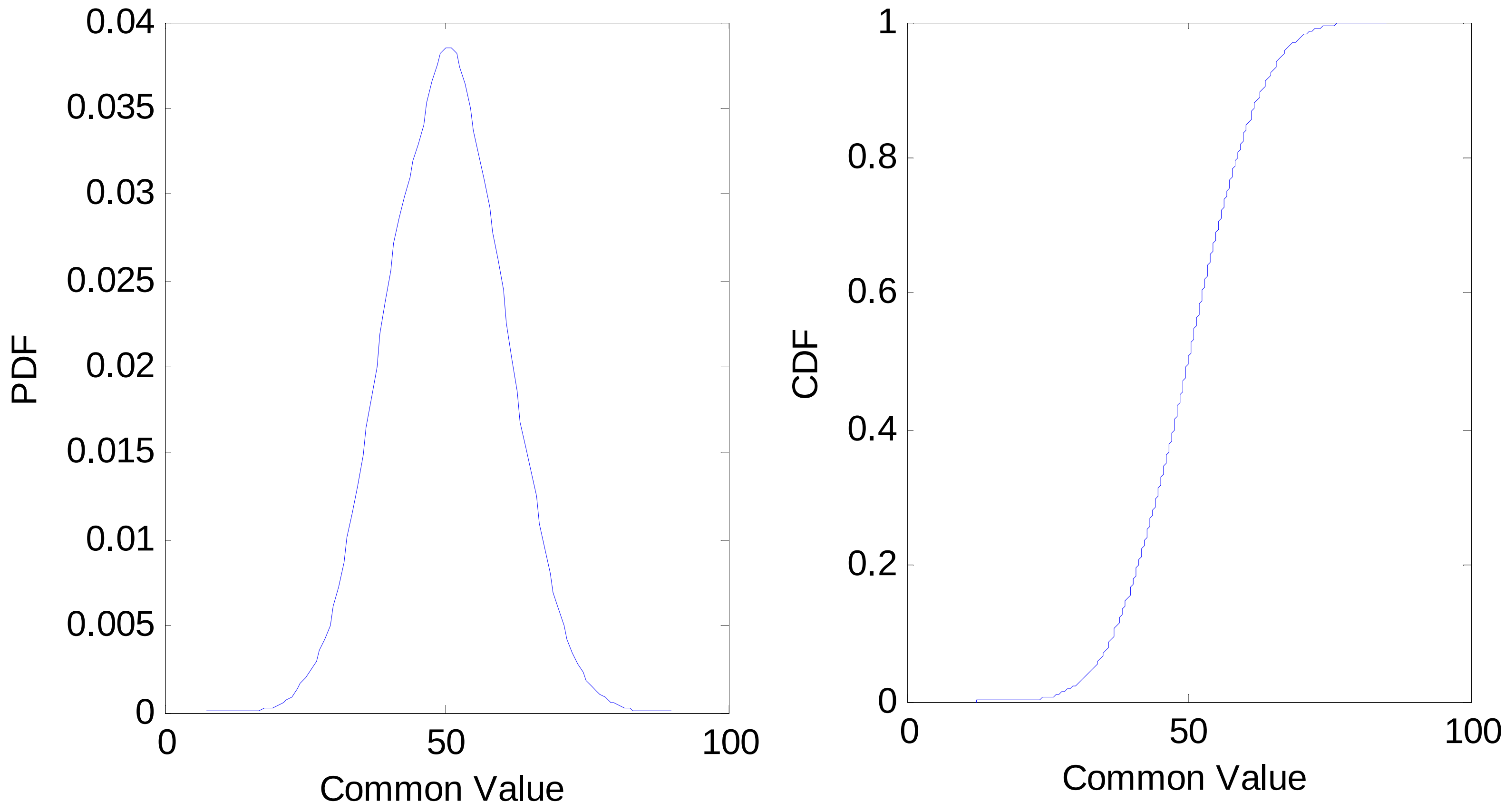
- Each bidder submits a flat supply schedule; that is, the bidder offers to sell all of her holdings of a particular security at a specified price.
- Each bidder ignores her liquidity need, bidding as if Li = 0
- Then we can compute an equilibrium
- Benchmark strategy

Note well

- ***We wish to emphasize that the benchmark strategy focuses on only one element of the auction. Your challenge is to determine your own strategy to maximize your payoff that reflects all aspects of the auction environment.***

Common value distribution

$$v_s = \tfrac{1}{8}\sum_{i=1}^{8} u_{is}, \text{ where } u_{is} \sim_{iid} U[0,100].$$



4-bidder sealed bid

- Your bid is your expected value conditional on your signal being the lowest and on the second-lowest signal being equal to yours

$$b_{is} = E\left[v_s \mid u_1 = u_{is}, u_2 = u_1\right],$$

where u_1 is the lowest signal and u_2 is the second-lowest signal

8-bidder sealed bid

- bid the expected value conditional on your signal being the fourth-lowest signal and on the fifth-lowest signal being equal to yours

$$b_{is} = E\left[v_s \mid u_4 = u_{is}, u_5 = u_4\right],$$

where u_4 is the fourth-lowest signal and u_5 is the fifth-lowest signal

4-bidder sealed bid

- Your bid is your expected value conditional on your signal being the lowest and on the second-lowest signal being equal to yours

$$b_{is} = E\left[v_s \mid u_1 = u_{is}, u_2 = u_1\right],$$

where u_1 is the lowest signal and u_2 is the second-lowest signal

$$b_{is} = \frac{1}{8}\left(2u_{is} + 2\left(\frac{u_{is} + 100}{2}\right) + 4 \cdot 50\right) = \tfrac{3}{8}u_{is} + \tfrac{75}{2}.$$

8-bidder sealed bid

- bid the expected value conditional on your signal being the fourth-lowest signal and on the fifth-lowest signal being equal to yours

$$b_{is} = E\left[v_s \mid u_4 = u_{is}, u_5 = u_4 \right],$$

where u_4 is the fourth-lowest signal and u_5 is the fifth-lowest signal

$$b_{is} = \frac{1}{8}\left(2u_{is} + 3\frac{u_{is}}{2} + 3\left(\frac{u_{is} + 100}{2} \right) \right) = \tfrac{5}{8} u_{is} + \tfrac{75}{4}.$$

Descending clock

- When the first bidder an and 8-bidder auction drops out you can calculated his value

$$u_{8s} = \frac{P_{\text{dropout}} - \text{intercept}}{\text{slope}}$$

8-bidder clock strategy

- No one has dropped out

$$b_{is} = \frac{1}{8}\left(2u_{is} + 3\frac{u_{is}}{2} + 3\left(\frac{u_{is} + 100}{2}\right)\right).$$

- One bidder has dropped out

$$b_{is} = \frac{1}{8}\left(2u_{is} + 3\frac{u_{is}}{2} + u_8 + 2\left(\frac{u_{is} + u_8}{2}\right)\right).$$

8-bidder clock strategy

- Two bidders have dropped out

$$b_{is} = \frac{1}{8}\left(2u_{is} + 3\frac{u_{is}}{2} + u_8 + u_7 + 1\left(\frac{u_{is} + u_7}{2} \right) \right).$$

- Three bidder has dropped out

$$b_{is} = \frac{1}{8}\left(2u_{is} + 3\frac{u_{is}}{2} + u_8 + u_7 + u_6 \right).$$

4-bidder clock auction

- No one has dropped out

$$b_{is} = \frac{1}{8}\left(2u_{is} + 2\left(\frac{u_{is} + 100}{2}\right) + 4 \cdot 50\right)$$

- One bidder has dropped out

$$b_{is} = \frac{1}{8}\left(2u_{is} + u_4 + 1\left(\frac{u_{is} + u_4}{2}\right) + 4 \cdot 50\right).$$

- Two bidders have dropped out

$$b_{is} = \frac{1}{8}\left(2u_{is} + u_4 + u_3 + 4 \cdot 50\right).$$

Moving beyond the benchmark strategy

- Bidding tool is set up to calculate the conditional expected values assuming the benchmark strategy. Of course, you (and others) may well deviate from the benchmark strategy as a result of liquidity needs or other reasons, since these other factors are ignored in the benchmark calculation
- *Remember your overall goal is to maximize your experimental payoff in each auction. You should think carefully about what strategy is best apt to achieve this goal.*

Bid tool

Auction system

A Common-Value Reference-Price Auction with Liquidity Needs: Bidder Instructions for Experiment 2

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Two pools of securities

- High quality pool
  - Securities H1 to H4
  - Each security has an ex ante expected common value of 75 cents on the dollar of face value
- Low quality pool
  - Securities L1 to L4
  - Each security has an ex ante expected common value of 25 cents on the dollar of face value

Reference price auction

- Each security has a reference price
  - Cents on the dollar of face value
  - Treasury's best estimate of value of each security
- Similar securities are pooled together
- Market clearing price-point is found for each pool
  - Price point = percent of reference price
- Winner's receives for each $ of a security sold
  - price point $\times$ reference price
- Approach allows many securities to be auctioned as one
  - Reference price controls for value differences, limiting adverse selection

Two formats

- Simultaneous uniform-price sealed bid
- Simultaneous descending clock

Setting for each auction

- Two pools of four securities each
- Eight bidders
- Four holders of each security
  - One large (20,000 $k of fv; 50%)
  - One medium (10,000 $k of fv; 25%)
  - Two small (5,000 $k of fv; 12.5% each)

Each session has four auctions; Tue & Thu

1. Sealed-bid with more precise reference prices
2. Clock with more precise reference prices
   - Same signals as in prior sealed-bid
3. Sealed-bid less more precise reference prices
4. Clock with less precise reference prices
   - Same signals as in prior sealed-bid

Each session has four auctions; Wed & Fri

1. Sealed-bid less more precise reference prices
2. Clock with less precise reference prices
   - Same signals as in prior sealed-bid
3. Sealed-bid with more precise reference prices
4. Clock with more precise reference prices
   - Same signals as in prior sealed-bid

Proportionate rationing at clearing price

- If multiple bidders make reductions at clearing price, reductions are accepted in proportion to size of reduction
- Example with two bidders, A and B
  - Reduction of 300 needed to clear market
  - A drops 400 and B drops 200
  - A is reduced by 200 and B is reduced by 100, yielding total reduction of 300
  - A’s reduction is twice as large as B’s, since A’s drop at the clearing price is twice as large as B’s
- Only relevant if multiple reductions at clearing price
  - Ties can be avoided by selecting price points that are not round numbers (e.g., 98.34 percent)

Activity rule

- Activity rule applies to each pool of securities
- Activity points = reference price $\times$ quantity, summed over all securities in pool
- Activity points for pool cannot increase as price point falls
- Allows lots of switching within pool of securities

Holdings in thousand $ of face value

		High-Quality Securities				Low-Quality Securities				
		H1	H2	H3	H4	L1	L2	L3	L4	Total
Bidder	1	20,000					5,000	5,000	10,000	40,000
	2		20,000			10,000		5,000	5,000	40,000
	3			20,000		5,000	10,000		5,000	40,000
	4				20,000	5,000	5,000	10,000		40,000
	5		5,000	5,000	10,000	20,000				40,000
	6	10,000		5,000	5,000		20,000			40,000
	7	5,000	10,000		5,000			20,000		40,000
	8	5,000	5,000	10,000					20,000	40,000
	Total	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	
	Expected price	75	75	75	75	25	25	25	25	
	Expected value	30,000	30,000	30,000	30,000	10,000	10,000	10,000	10,000	
	Total value	120,000				40,000				

Treasury budget: 30,000 10,000

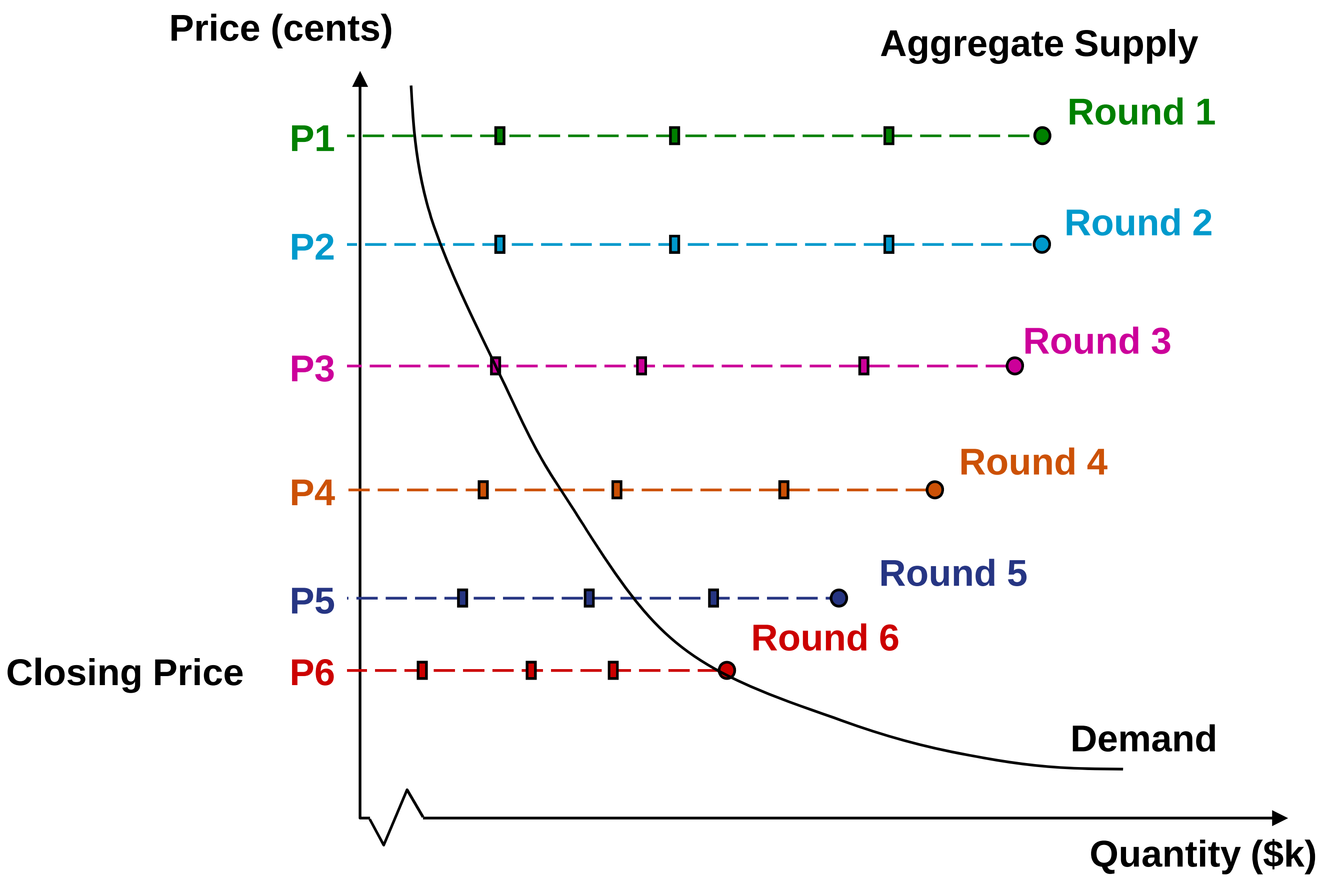
Treasury buys about ¼ of each pool at expected price

Uniform-price sealed-bid

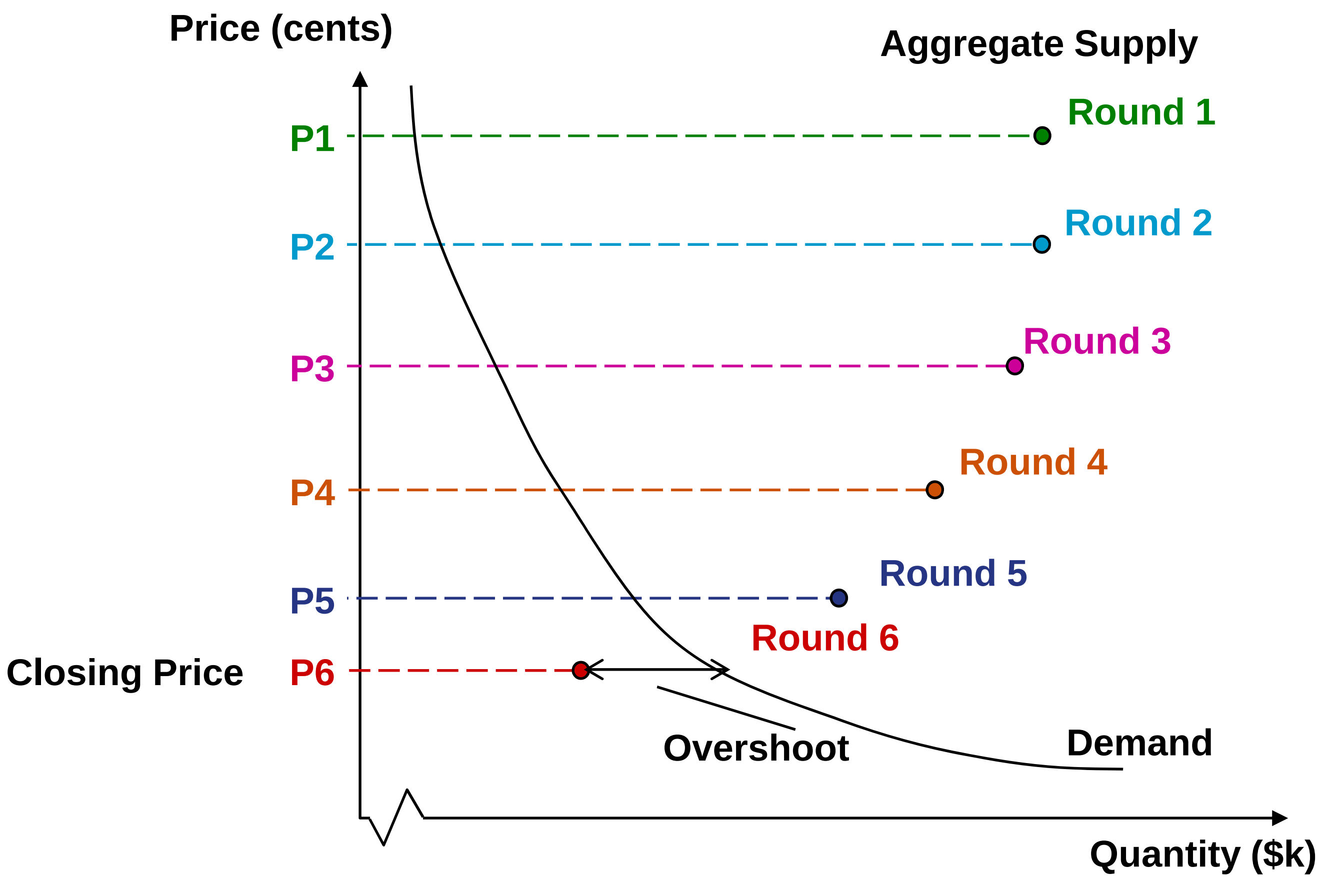
Descending-clock auction

- Since it's an auction to buy rather than sell (a reverse auction), price point descends
- Auction is conducted in discrete rounds
- Auctioneer announces price point for each pool
- Bidders submit quantities for each security in each pool
- Activity rule: Activity points for pool cannot increase as the price falls
  - Activity points = reference price × quantity,
    summed over securities in pool
- Aggregate supply of each security, but not individual bids, announced to bidders
- Auctioneer decrements price for each pool with excess spend
  - Treasury has a fixed budget for each pool
- Process continues until supply equals demand (spend = budget)

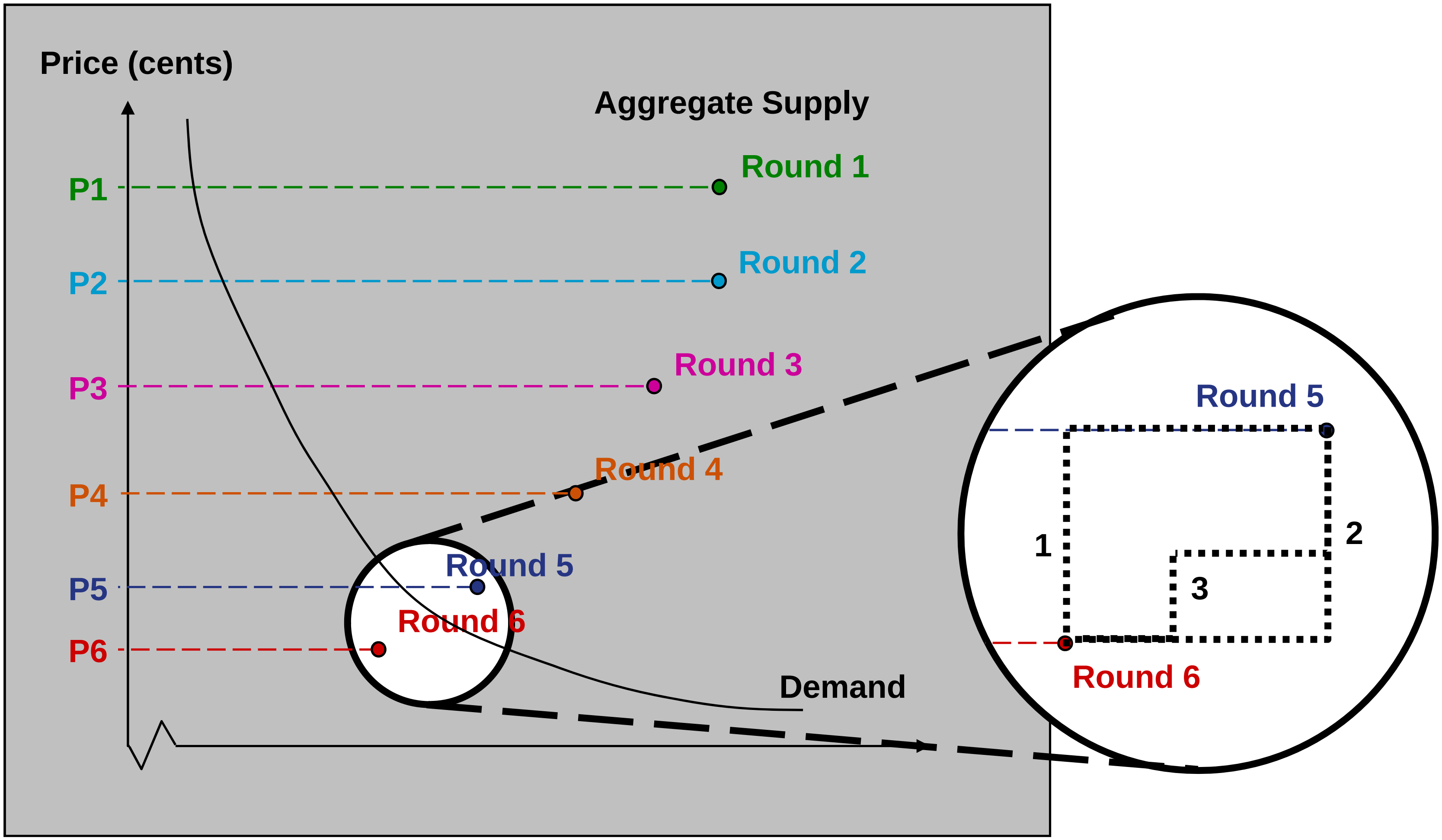
Auction mechanics



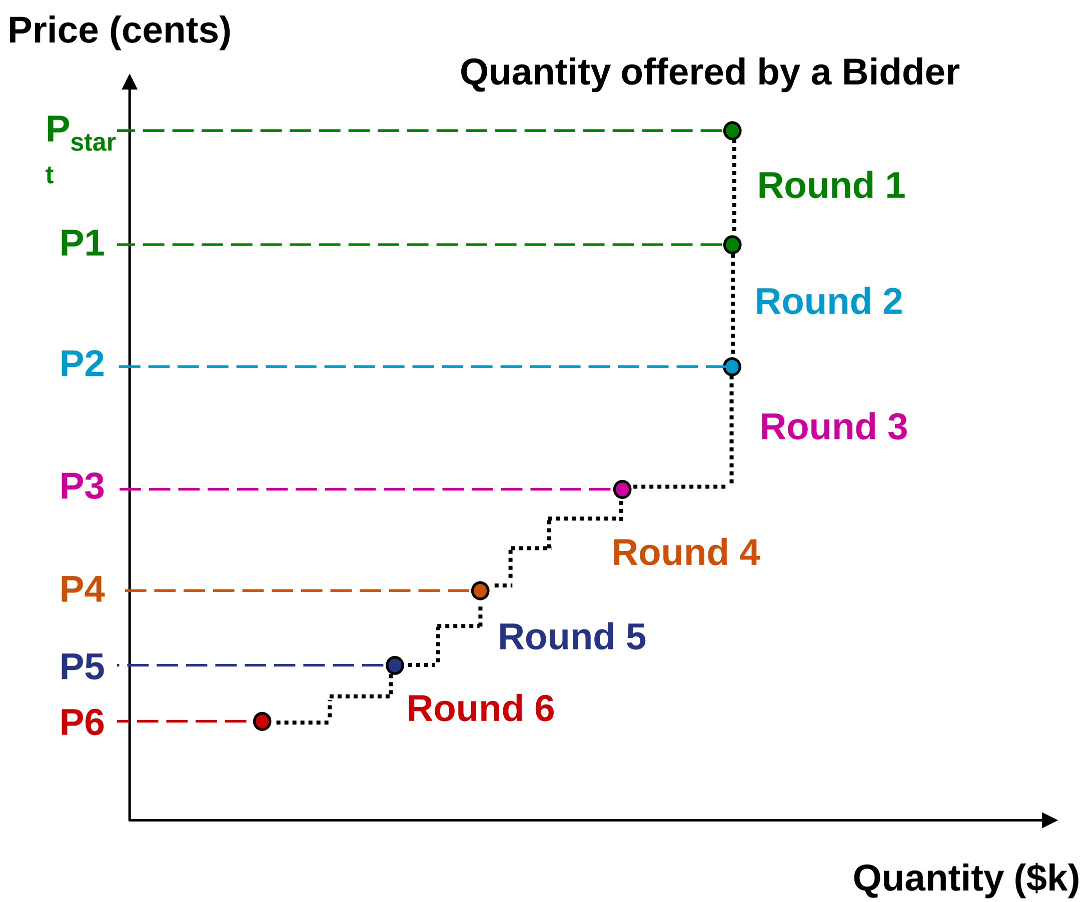
Closing with overshoot



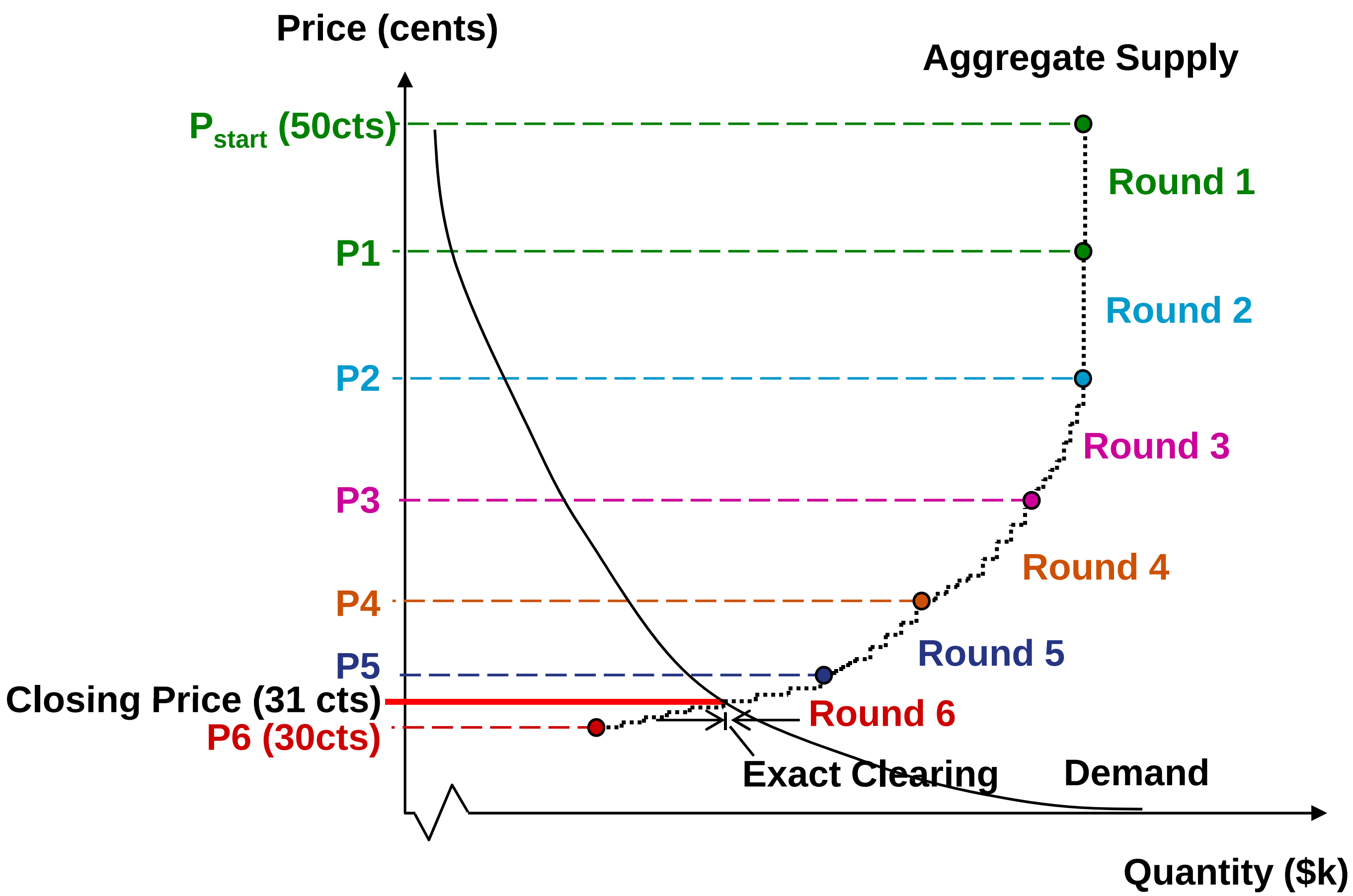
Intraround bids



Intraround bidding – one bidder



Intraround bidding – aggregate supply



An example with 2 pools and 8 securities

Pooled Auction

quantity in $k of face value; price in % of reference price; spend in $k

Excess supply

Pool clears

		High-Quality Pool					Low-Quality Pool				
		HQ Pool	H1	H2	H3	H4	LQ Pool	L1	L2	L3	L4
Reference price			79.34	66.52	62.89	83.12		26.45	31.42	21.36	27.98
Round	Budget	$30,000					$10,000				
1	Price	110%	87.27	73.17	69.18	91.43	110%	29.10	34.56	23.50	30.78
	Spend	$44,095	12,773	17,573	14,835	10,748	$14,887	9,233	20,558	11,115	8,070
2	Price	107%	84.89	71.18	67.29	88.94	106%	28.04	33.31	22.64	29.66
	Spend	$38,766	12,353	16,088	13,778	8,498	$13,547	8,918	19,290	10,553	7,530
3	Price	104%	82.51	69.18	65.41	86.44	102%	26.98	32.05	21.79	28.54
	Spend	$36,392	12,023	15,908	13,508	7,673	$12,398	8,250	18,165	10,253	7,418
4	Price	102%	80.93	67.85	64.15	84.78	100%	26.45	31.42	21.36	27.98
	Spend	$33,936	11,408	14,588	13,328	7,380	$11,971	8,018	18,008	10,050	7,313
5	Price	100%	79.34	66.52	62.89	83.12	97%	25.66	30.48	20.72	27.14
	Spend	$32,701	11,168	14,415	12,998	7,313	$11,390	7,688	17,745	9,900	7,215
6	Price	98.22%	77.93	65.34	61.77	81.64	94%	24.86	29.53	20.08	26.30
	Spend	$30,000	11,063	13,080	11,408	7,088	$10,720	7,463	17,333	9,420	7,050
7	Price						91.44%	24.19	28.73	19.53	25.59
	Spend						$10,000	7,163	16,920	8,588	6,758

Preferences

- Your payoff depends on your profits and how well your liquidity needs are met

Common value auction

- value of each high-quality security in cents on the dollar is the average of *n* iid random variables uniformly distributed between 50 and 100

$$v_s = \frac{1}{n}\sum_{j=1}^{n} u_{js}, \text{ where } u_{js} \sim_{iid} U[50,100].$$

- More precise case *n* = 16 (ref. price is average of last 8)
- Less precise case *n* = 12 (ref. price is average of last 4)

$$r_s = \frac{1}{n-8}\sum_{j=9}^{n} u_{js}.$$

Common value auction

- value of each low-quality security in cents on the dollar is the average of *n* iid random variables uniformly distributed between 0 and 50

$$v_s = \tfrac{1}{n} \sum_{j=1}^{n} u_{js}, \text{ where } u_{js} \sim_{iid} U[0,50].$$

- More precise case *n* = 16 (ref. price is average of last 8)
- Less precise case *n* = 12 (ref. price is average of last 4)

$$r_s = \tfrac{1}{n-8} \sum_{j=9}^{n} u_{js}.$$

Private information

- Each bidder receives 1 iid signal as private information for each 5,000 of security holdings
  - Bidder with 20,000 receives 4 private signals
  - Bidder with 10,000 receives 2 private signals
  - Bidder with 5,000 receives 1 private signal
- Thus, there are 8 private signals in addition to the 8 (more precise) or 4 (less precise) signals in the reference price

Prices

- Pool price points of p_H and p_L implies security prices of
  - $p_s = p_H \, r_s$ for $s \in \{H1,H2,H3,H4\}$
  - $p_s = p_L \, r_s$ for $s \in \{L1,L2,L3,L4\}$

Profit

- If you sell the quantity q_s of the security s at the price p_s, then your profit (in \$k) is

$$\pi_i(p, q_i, v) = \frac{1}{100} \sum_s (p_s - v_s) q_{is}.$$

Liquidity need

- liquidity need, *L*=, which is drawn iid from the uniform distribution on the interval [2500, 7500]
- You get a bonus of $1 for every dollar of sales to the Treasury up to your liquidity need of *Li*. You do *not* get any bonus for sales to the Treasury above *Li*. Thus, your bonus is

$$\min\left[L_i , \frac{1}{100} \sum_s p_s q_{is} \right].$$

Total payoff

- Combining your profit and your liquidity bonus results in your total payoff

$$U_i(p, q_i, v) = \begin{cases} \frac{1}{100}\sum_s (2p_s - v_s)q_{is} & \text{if } \frac{1}{100}\sum_s p_s q_{is} < L_i \\ L_i + \frac{1}{100}\sum_s (p_s - v_s)q_{is} & \text{otherwise} \end{cases}$$

- Thus, an additional dollar of cash is worth two dollars when your liquidity need is not satisfied, but is worth one dollar when your liquidity need is satisfied.

Bidding strategy

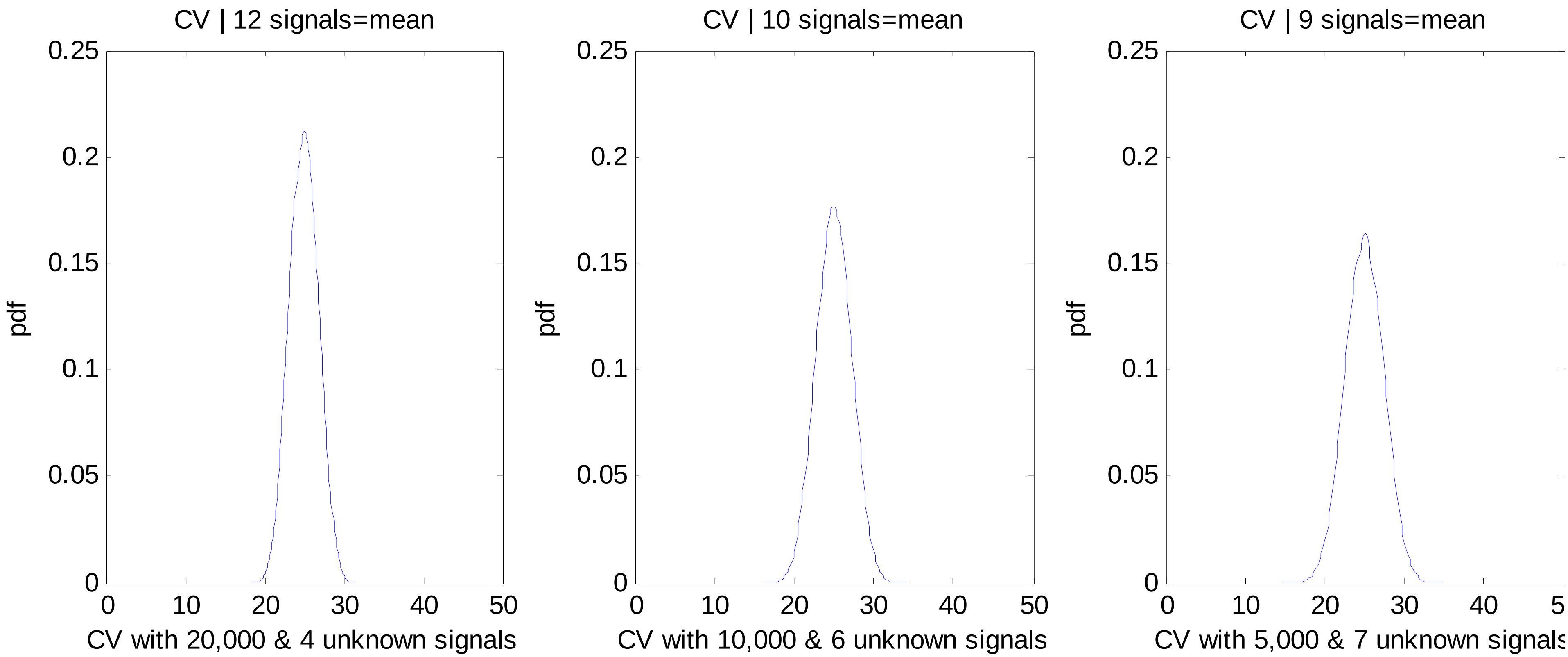
Auction environment has five complicating features:

- *Common value auction*. You have an imperfect estimate of the good's common value.
- *Divisible good auction*. Your bid is a supply curve, specifying the quantity you wish to sell at various prices.
- *Demand for pool of securities*. Treasury does not have a demand for individual securities, but for pools of securities (high- and low-quality pools)
- *Asymmetric holdings*. Bidders have different holdings of securities.
- *Liquidity need*. You have a specific liquidity need that is met through selling shares from your portfolio of eight securities.

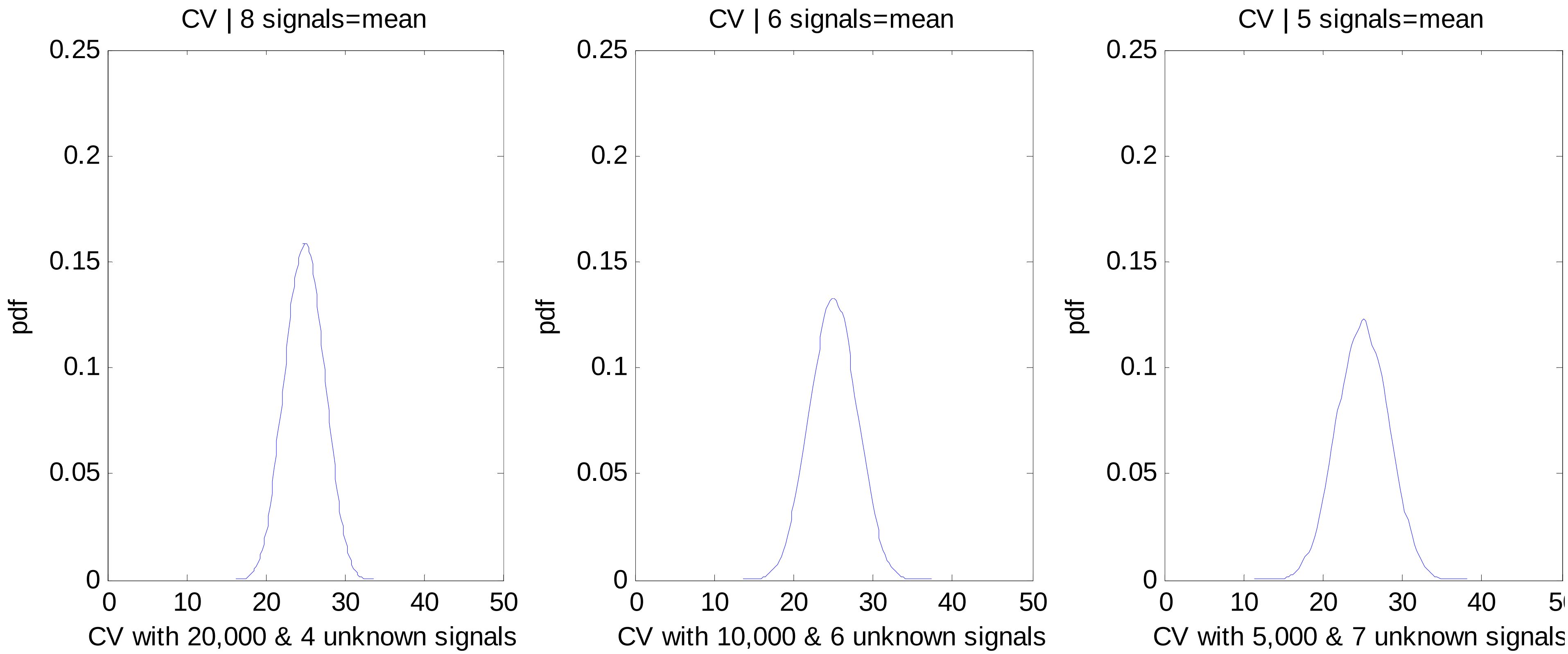
Goal

Your challenge is to determine your own strategy to maximize your payoff that reflects all aspects of the auction environment. The best response in this auction, as in any auction is a best response to what the other bidders are actually doing.

Common value density: more precise case



Common value density: less precise case



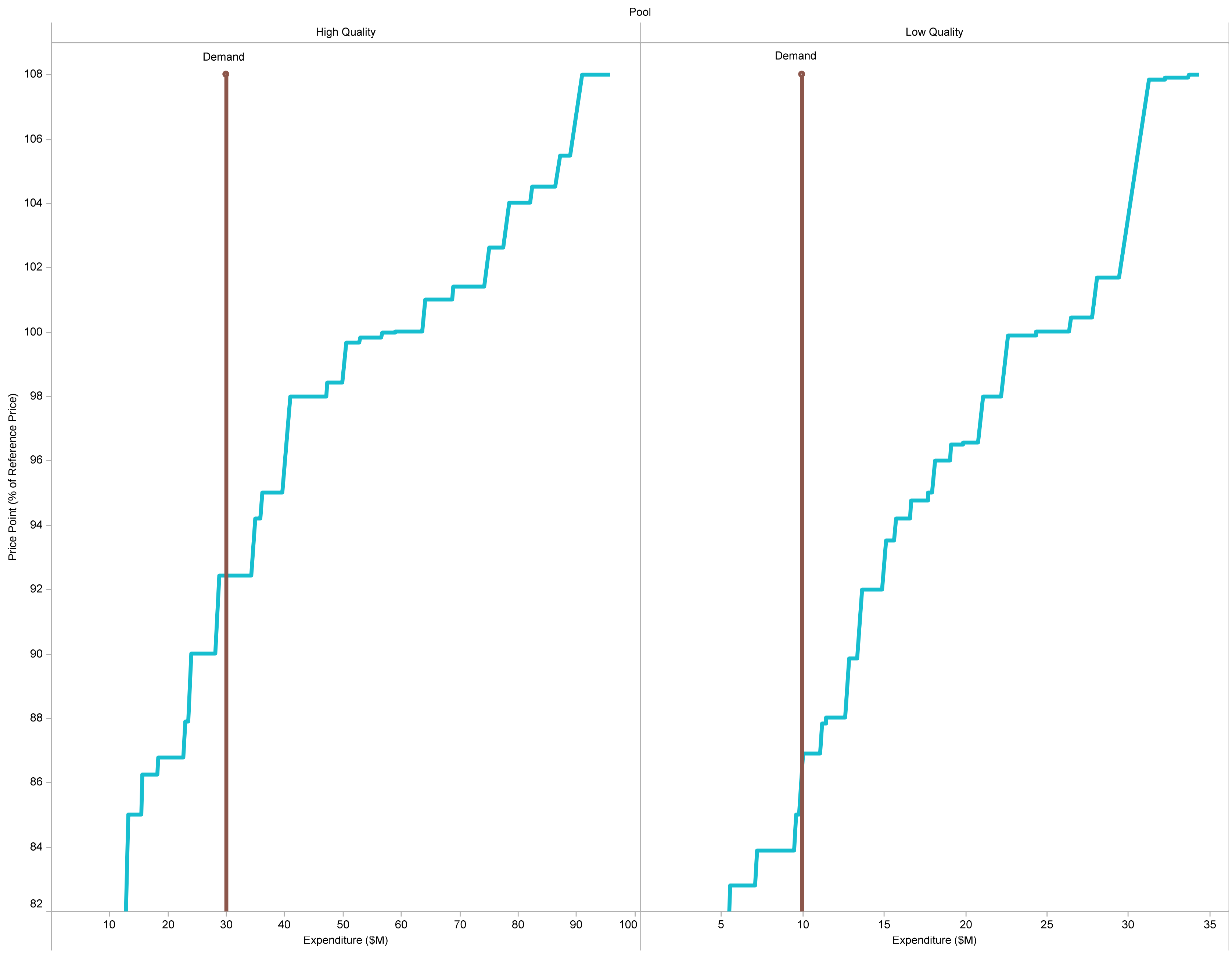
Bidding tool

- Bidding tool is set up to calculate the conditional expected values assuming what you know and guesses of what you don't know
- *Remember your overall goal is to maximize your experimental payoff in each auction. You should think carefully about what strategy is best apt to achieve this goal.*
- Take-home pay is $1 per 100 $k of experimental payoff

Bidding tool

Auction system

Experiment 2
Reference-Price Auction


Pool
High Quality
Low Quality
Demand
Demand
Price Point (% of Reference Price)
108
106
104
102
100
98
96
94
92
90
88
86
84
82
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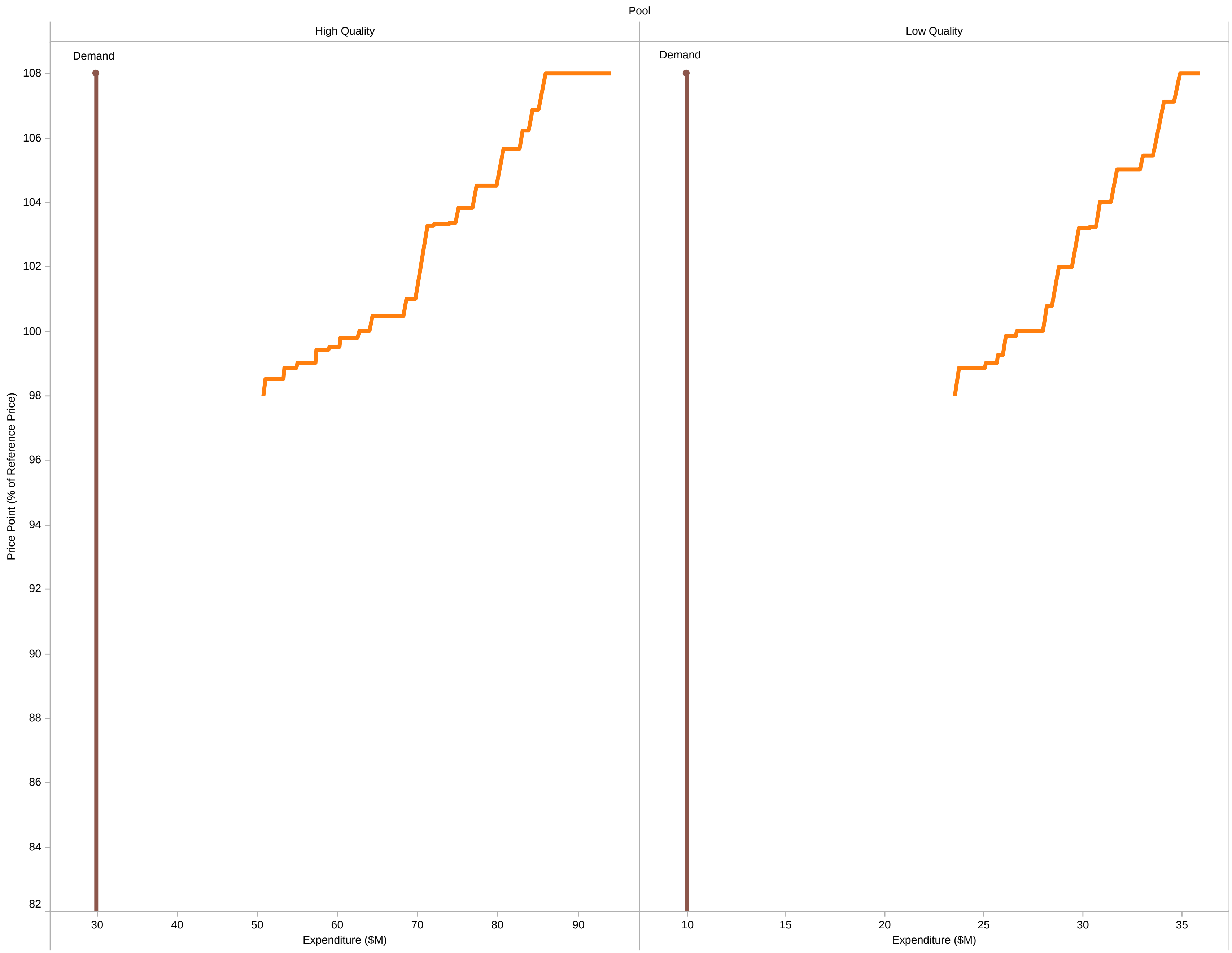
80
90
100
Expenditure ($M)
5
10
15
20
25
30
35
Expenditure ($M)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108
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86
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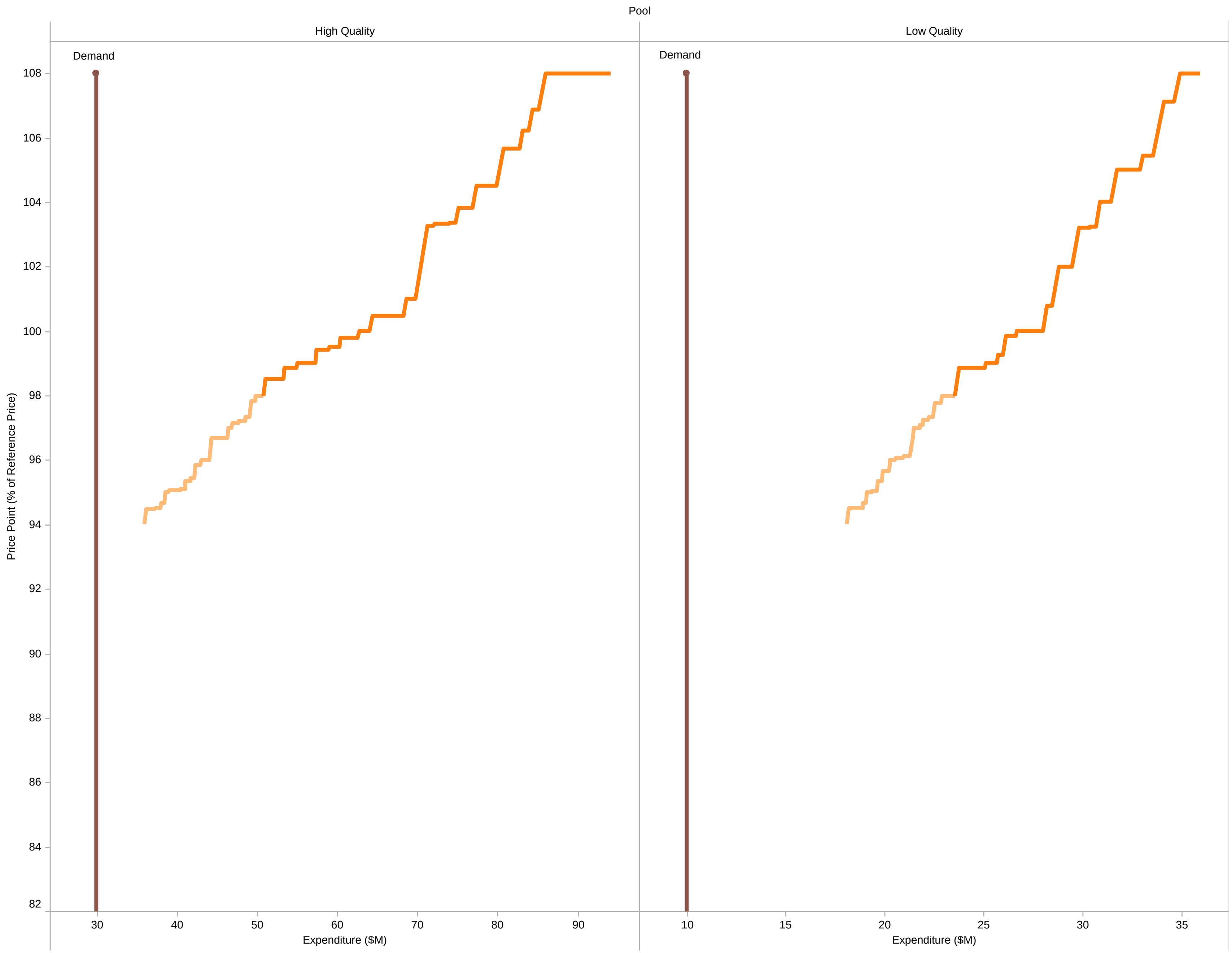
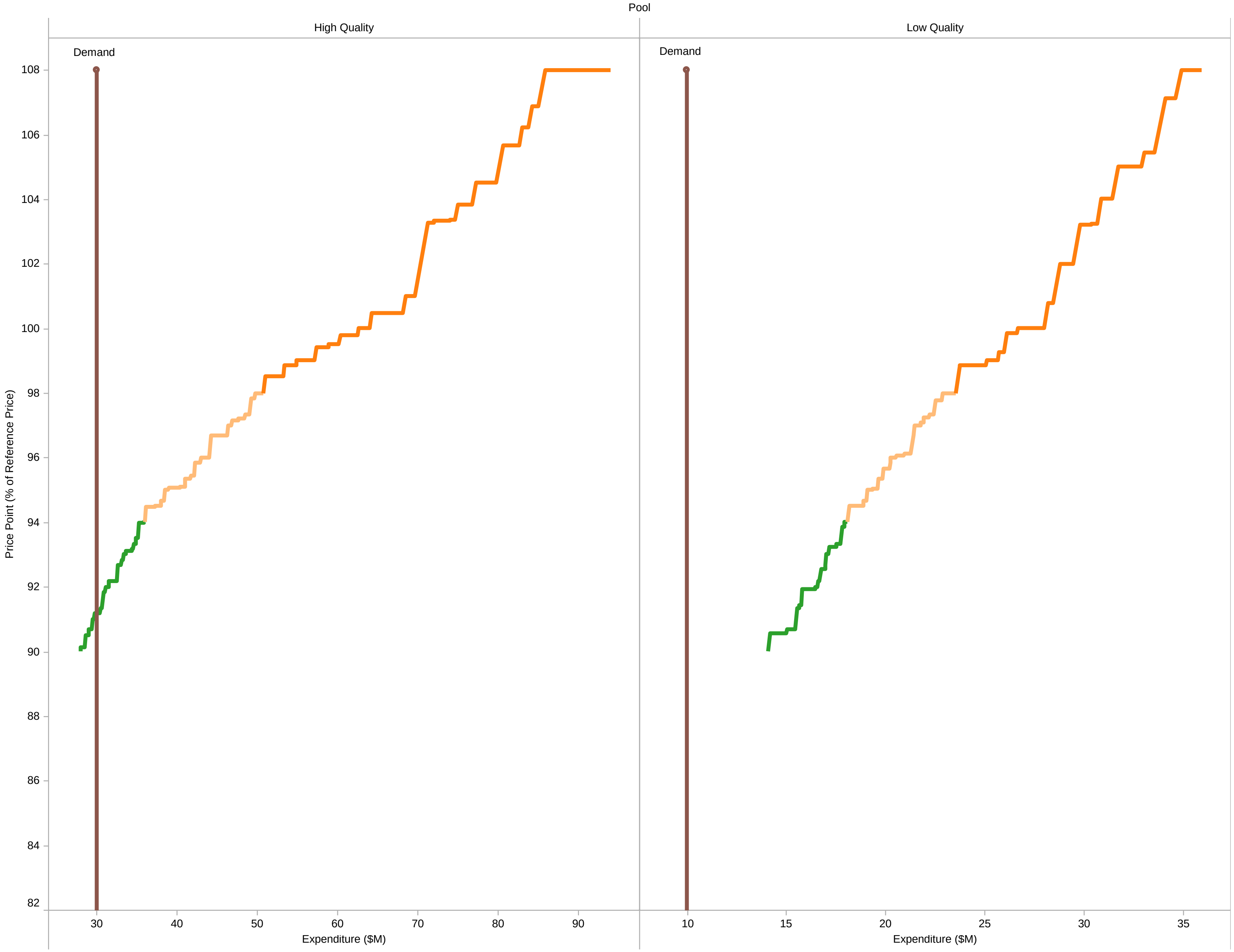
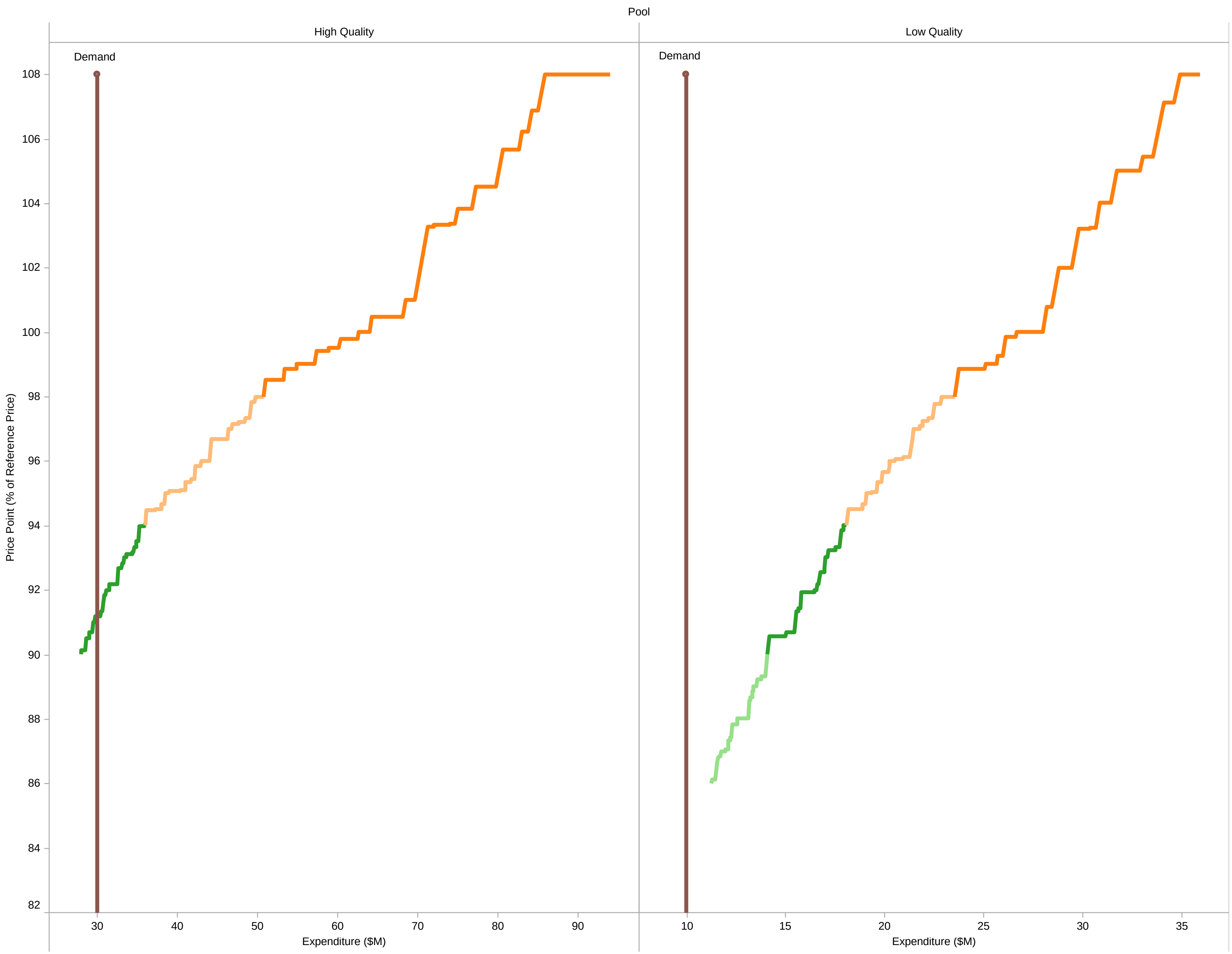
80
90
Expenditure ($M)
10
15
20
25
30
35
Expenditure ($M)

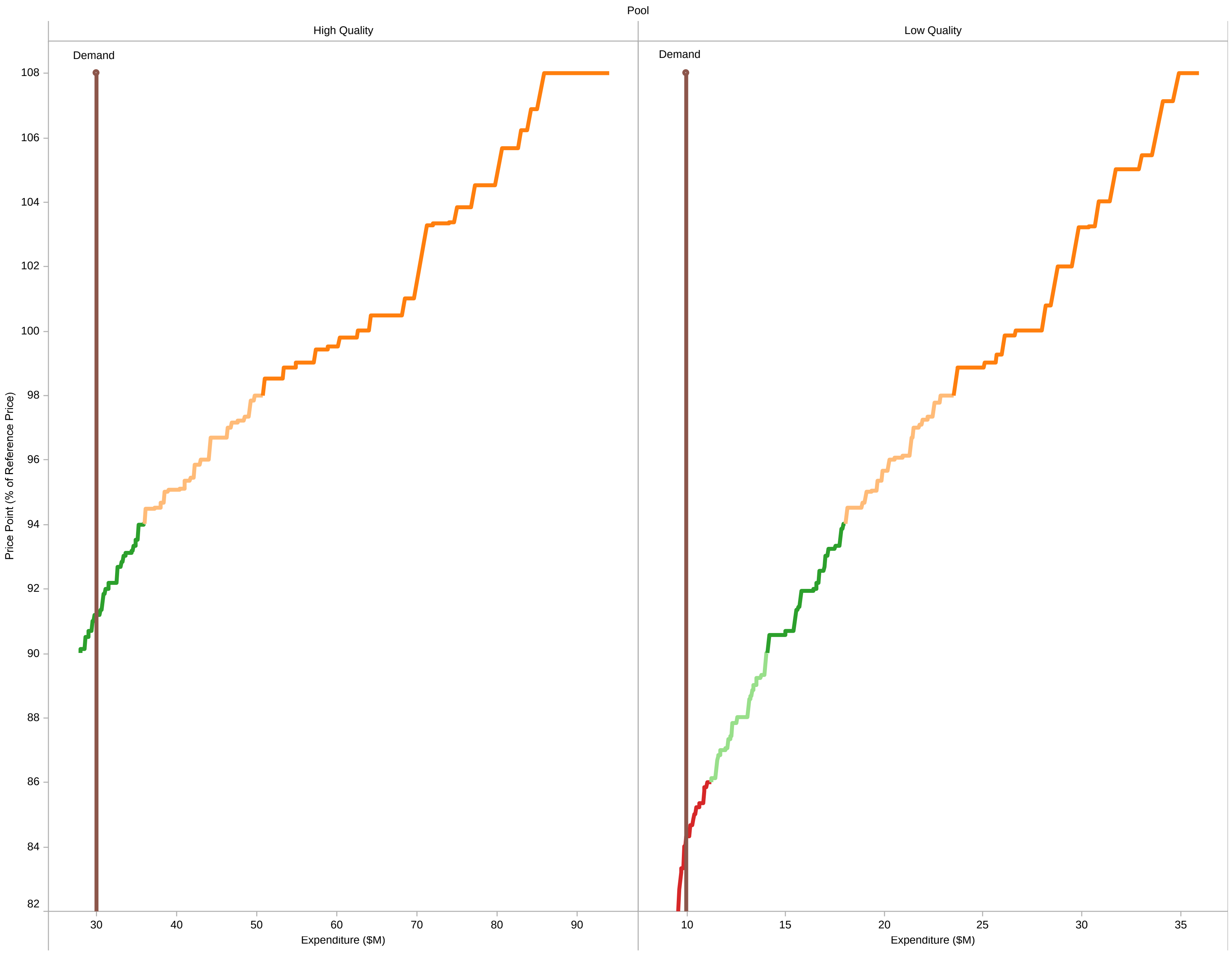


Pool
High Quality
Low Quality
Demand
Demand
Price Point (% of Reference Price)
Expenditure ($M)
Expenditure ($M)
108
106
104
102
100
98
96
94
92
90
88
86
84
82
30
40
50
60
70
80
90
10
15
20
25
30
35

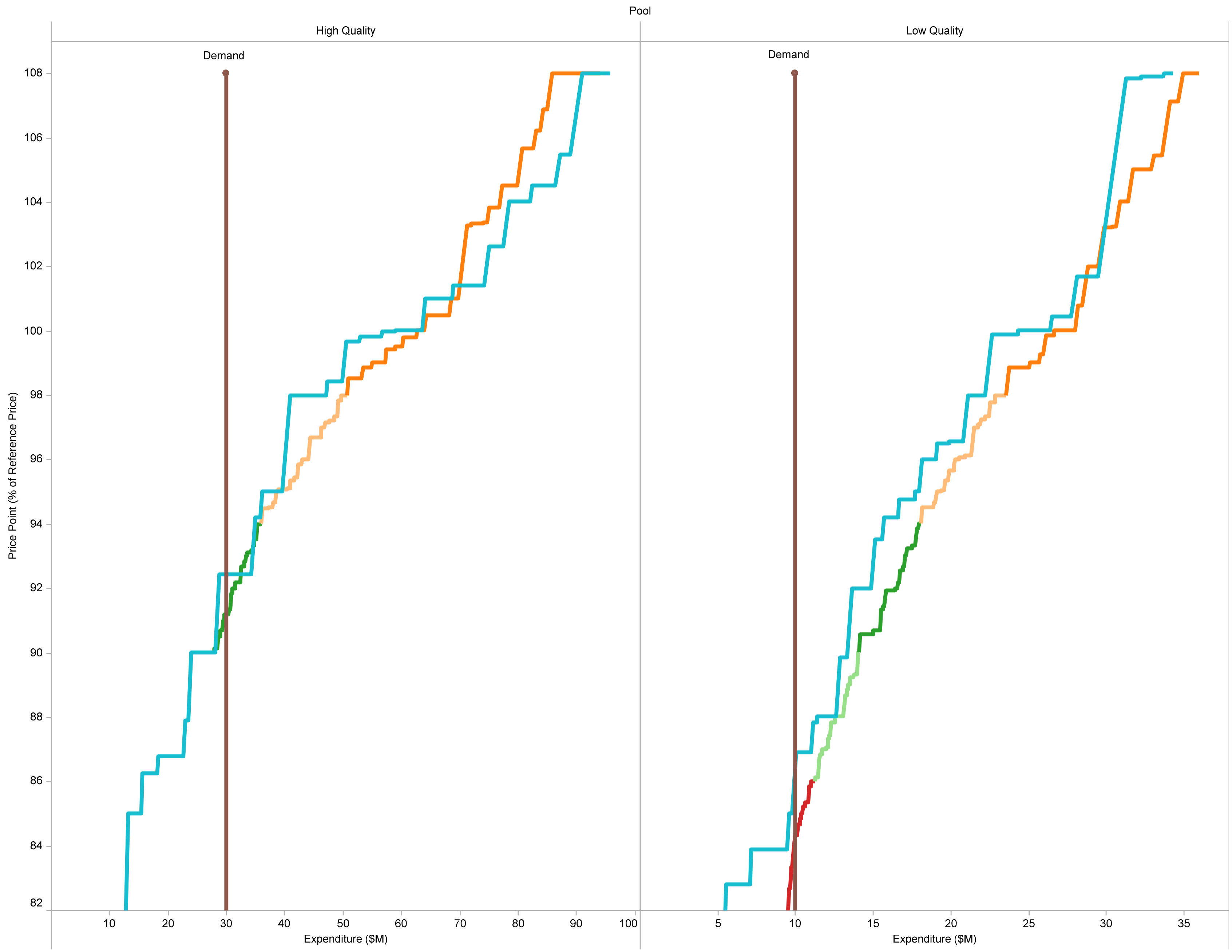

Pool
High Quality
Low Quality
Demand
Demand
Price Point (% of Reference Price)
108
106
104
102
100
98
96
94
92
90
88
86
84
82
30
40
50
60
70
80
90
Expenditure ($M)
10
15
20
25
30
35
Expenditure ($M)



Pool
High Quality
Low Quality
Demand
Demand
Price Point (% of Reference Price)
108
106
104
102
100
98
96
94
92
90
88
86
84
82
30
40
50
60
70
80
90
Expenditure ($M)
10
15
20
25
30
35
Expenditure ($M)



Pool
High Quality
Low Quality
Demand
Demand
Price Point (% of Reference Price)
108
106
104
102
100
98
96
94
92
90
88
86
84
82
30
40
50
60
70
80
90
Expenditure ($M)
10
15
20
25
30
35
Expenditure ($M)

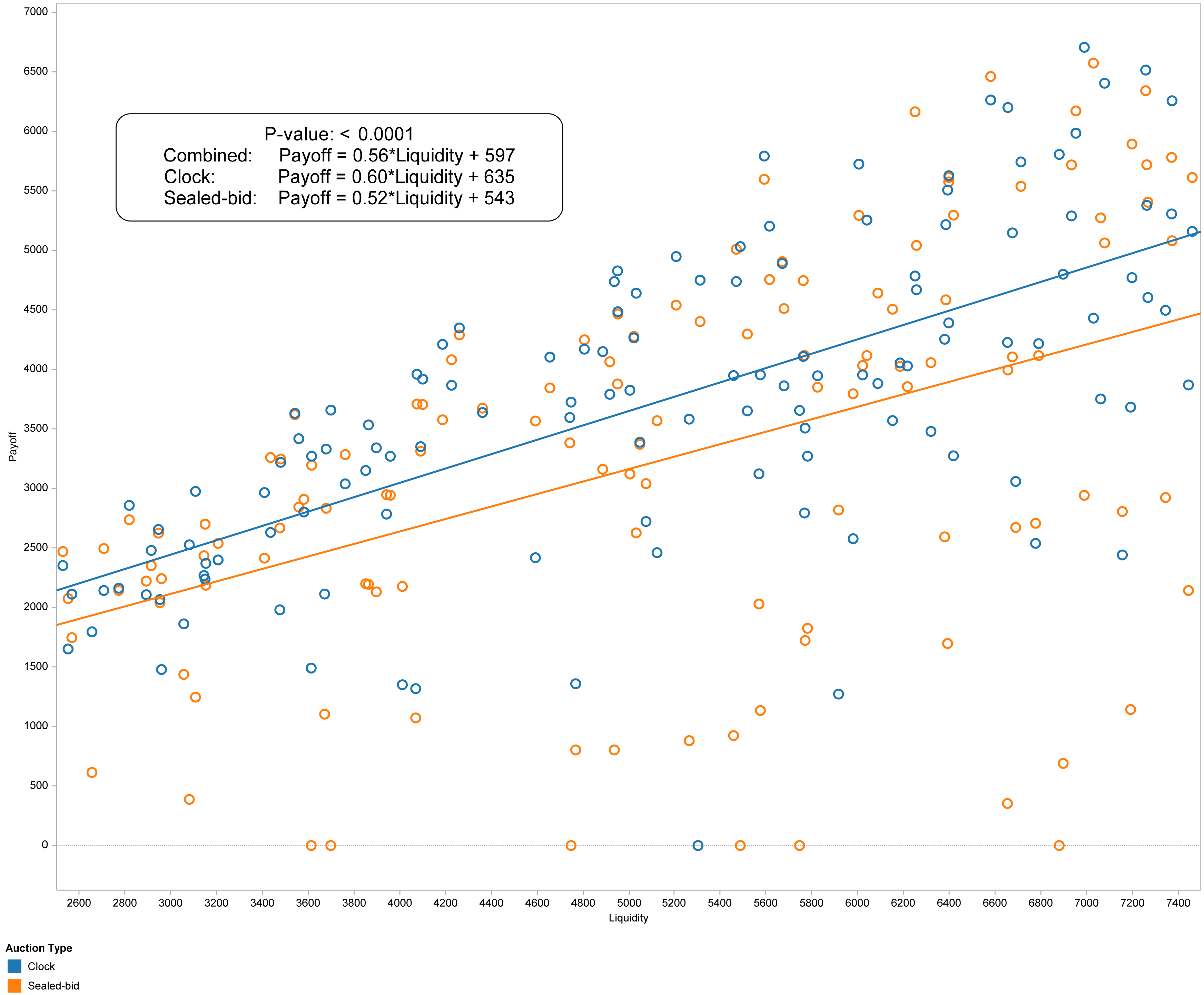


Pool
High Quality
Low Quality
Demand
Demand
Price Point (% of Reference Price)
108
106
104
102
100
98
96
94
92
90
88
86
84
82
10
20
30
40
50
60
70
80
90
100
Expenditure ($M)
5
10
15
20
25
30
35
Expenditure ($M)

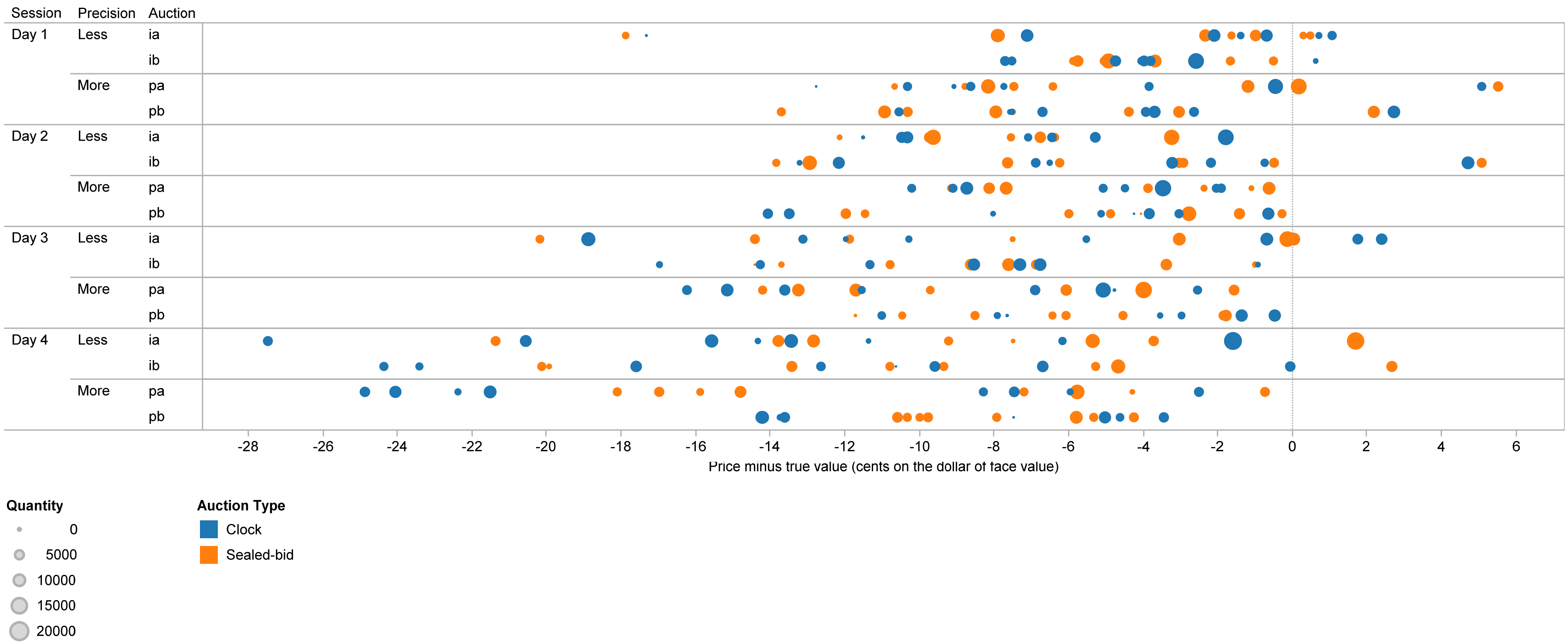
- Does it work?
- Can it be implemented quickly?

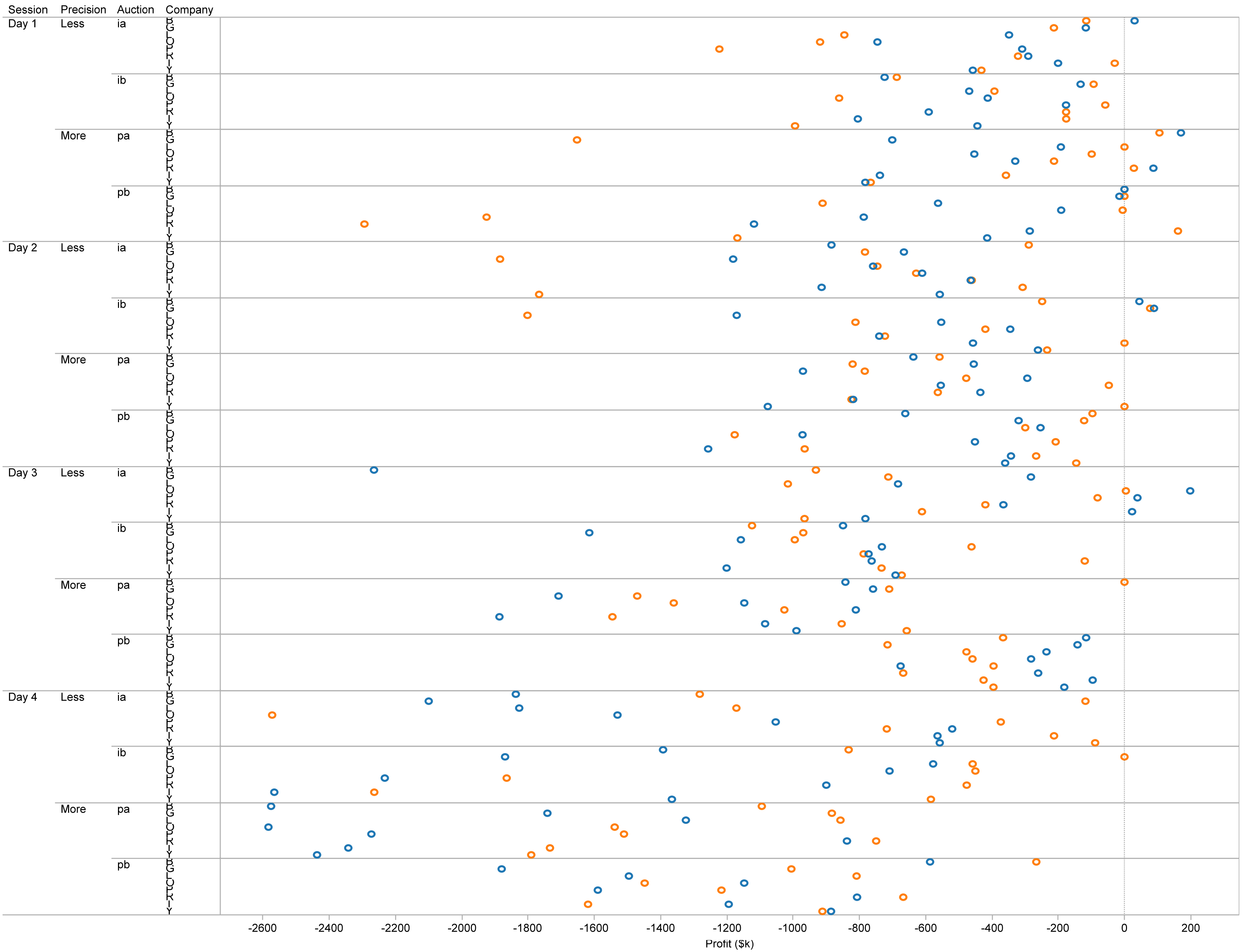
- No difference in clearing price
- Treasury buys securities at below true value, as banks seek cash
- Clock lets banks better manage liquidity needs
- Banks have higher payoff with clock
- Bank payoff is less variable with clock

Dynamic auction is win-win for banks and taxpayers

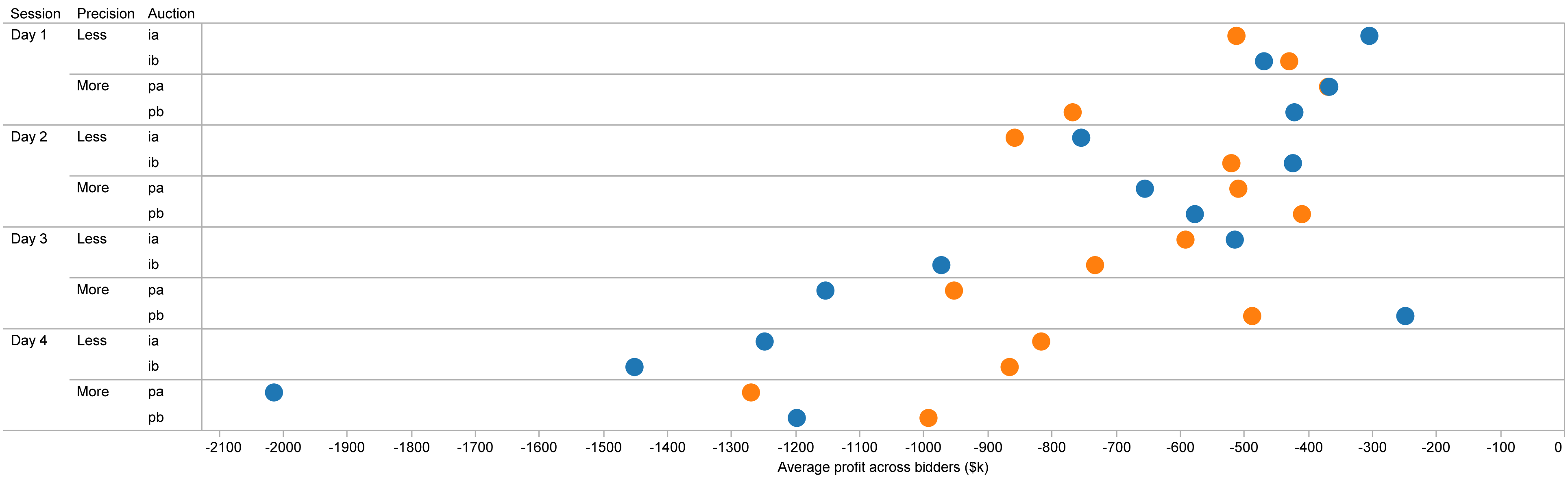


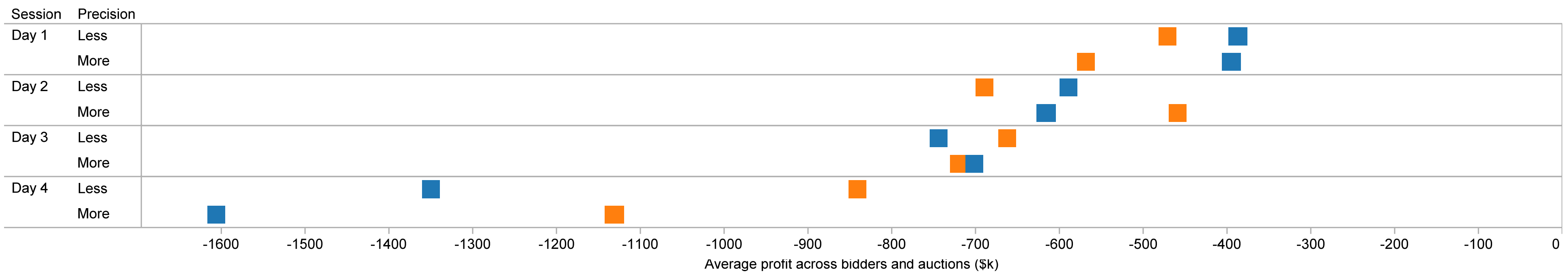
P-value: < 0.0001
Combined: Payoff = 0.56*Liquidity + 597
Clock: Payoff = 0.60*Liquidity + 635
Sealed-bid: Payoff = 0.52*Liquidity + 543
Payoff
Liquidity
7000
6500
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
2600 2800 3000 3200 3400 3600 3800 4000 4200 4400 4600 4800 5000 5200 5400 5600 5800 6000 6200 6400 6600 6800 7000 7200 7400
Auction Type
Clock
Sealed-bid


Session
Precision
Auction
Day 1
Less
ia
ib
More
pa
pb
Day 2
Less
ia
ib
More
pa
pb
Day 3
Less
ia
ib
More
pa
pb
Day 4
Less
ia
ib
More
pa
pb
-28
-26
-24
-22
-20
-18
-16
-14
-12
-10
-8
-6
-4
-2
0
2
4
6
Price minus true value (cents on the dollar of face value)
Quantity
0
5000
10000
15000
20000
Auction Type
Clock
Sealed-bid

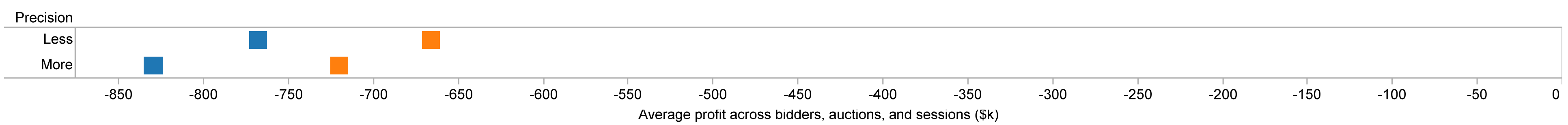


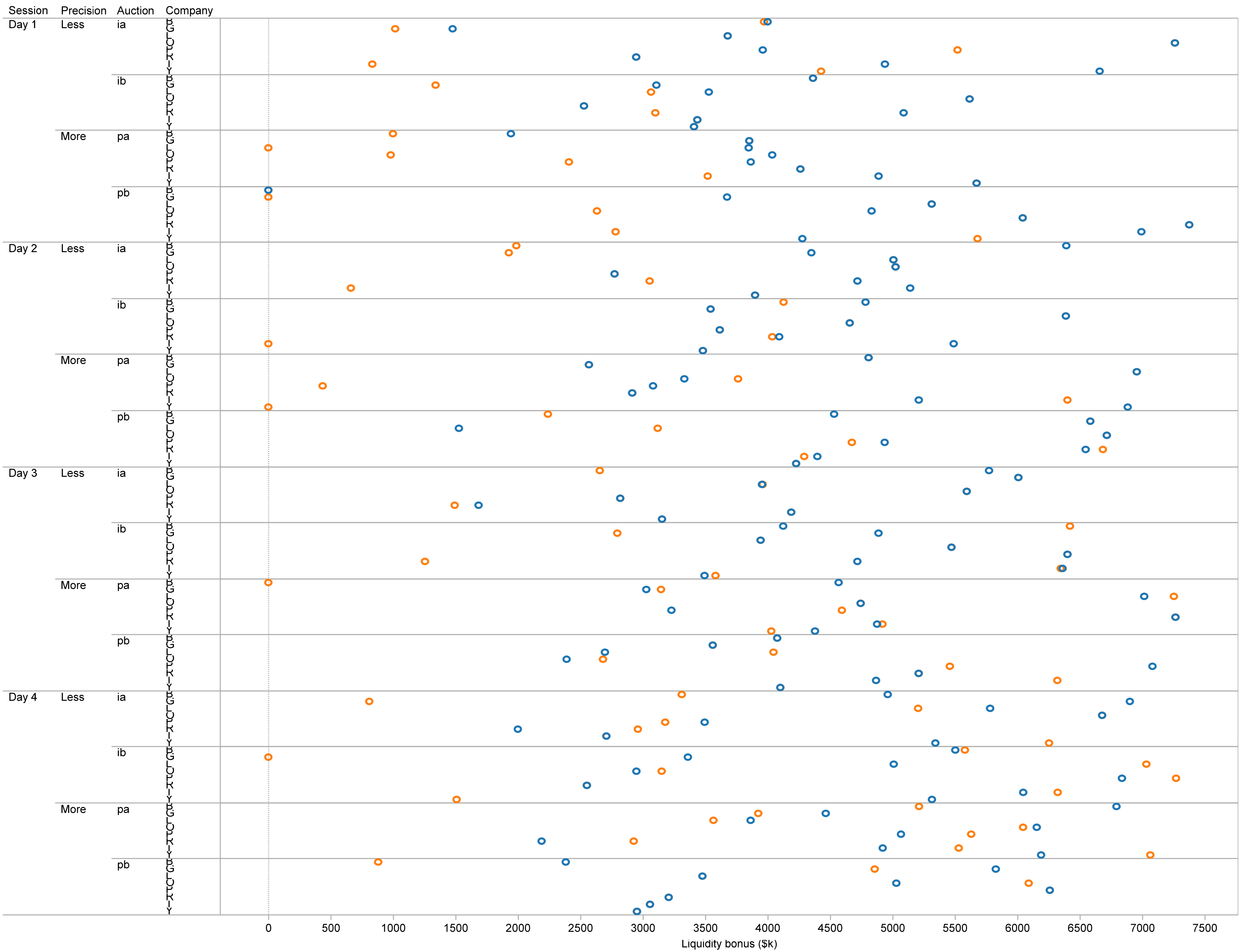
Session
Precision
Auction
Company
Day 1
Day 2
Day 3
Day 4
Less
More
ia
ib
pa
pb
B
G
L
O
P
R
T
Y
-2600
-2400
-2200
-2000
-1800
-1600
-1400
-1200
-1000
-800
-600
-400
-200
0
200
Profit ($k)


Session
Precision
Auction
Day 1
Day 2
Day 3
Day 4
Less
More
ia
ib
pa
pb
-2100
-2000
-1900
-1800
-1700
-1600
-1500
-1400
-1300
-1200
-1100
-1000
-900
-800
-700
-600
-500
-400
-300
-200
-100
0
Average profit across bidders ($k)

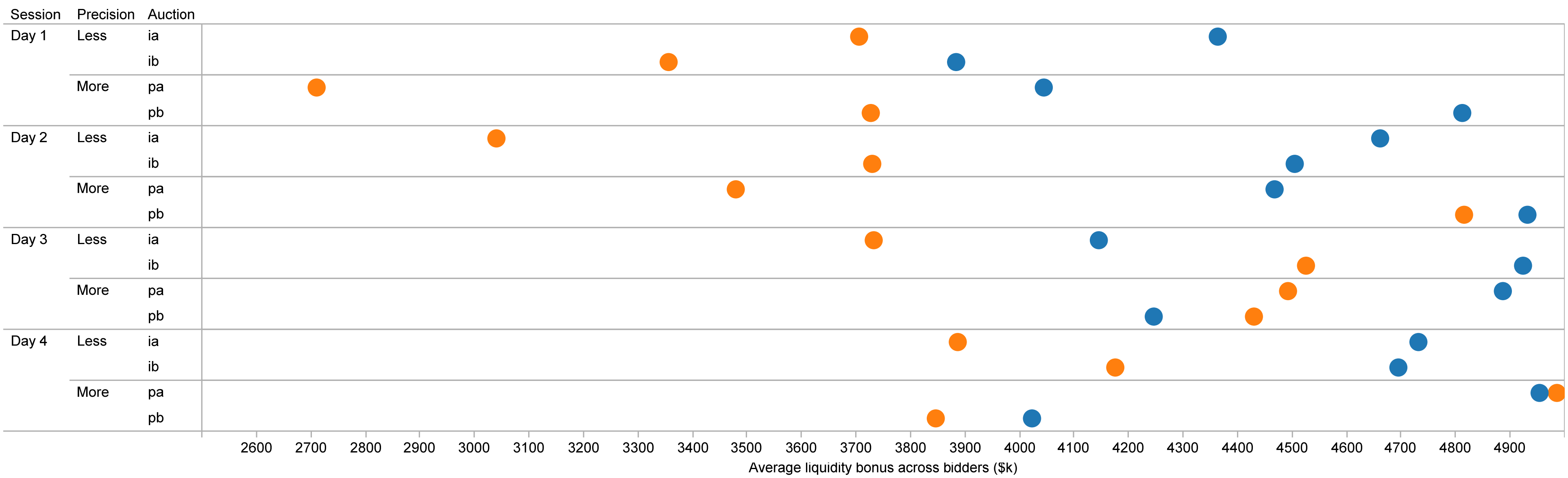


Session
Precision
Day 1
Less
More
Day 2
Less
More
Day 3
Less
More
Day 4
Less
More
-1600
-1500
-1400
-1300
-1200
-1100
-1000
-900
-800
-700
-600
-500
-400
-300
-200
-100
0
Average profit across bidders and auctions ($k)

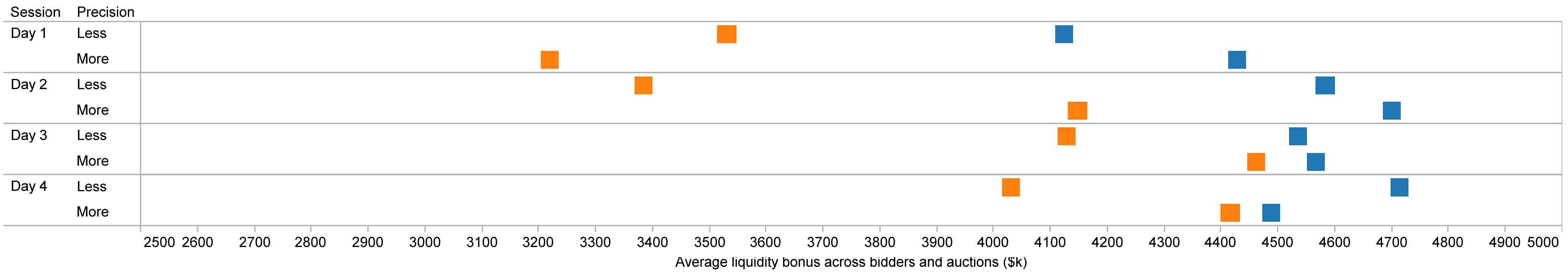

Precision
Less
More
-850
-800
-750
-700
-650
-600
-550
-500
-450
-400
-350
-300
-250
-200
-150
-100
-50
0
Average profit across bidders, auctions, and sessions ($k)



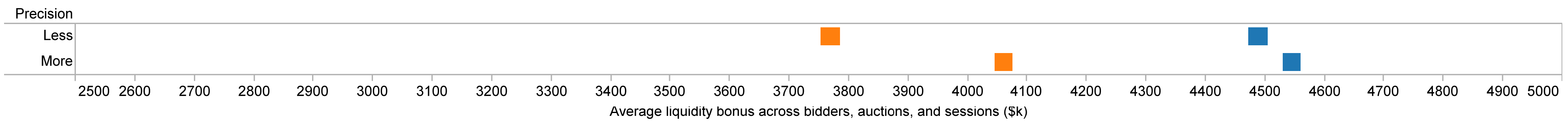
Session
Precision
Auction
Company
Day 1
Day 2
Day 3
Day 4
Less
More
ia
ib
pa
pb
B
G
L
O
P
R
I
Y
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
Liquidity bonus ($k)

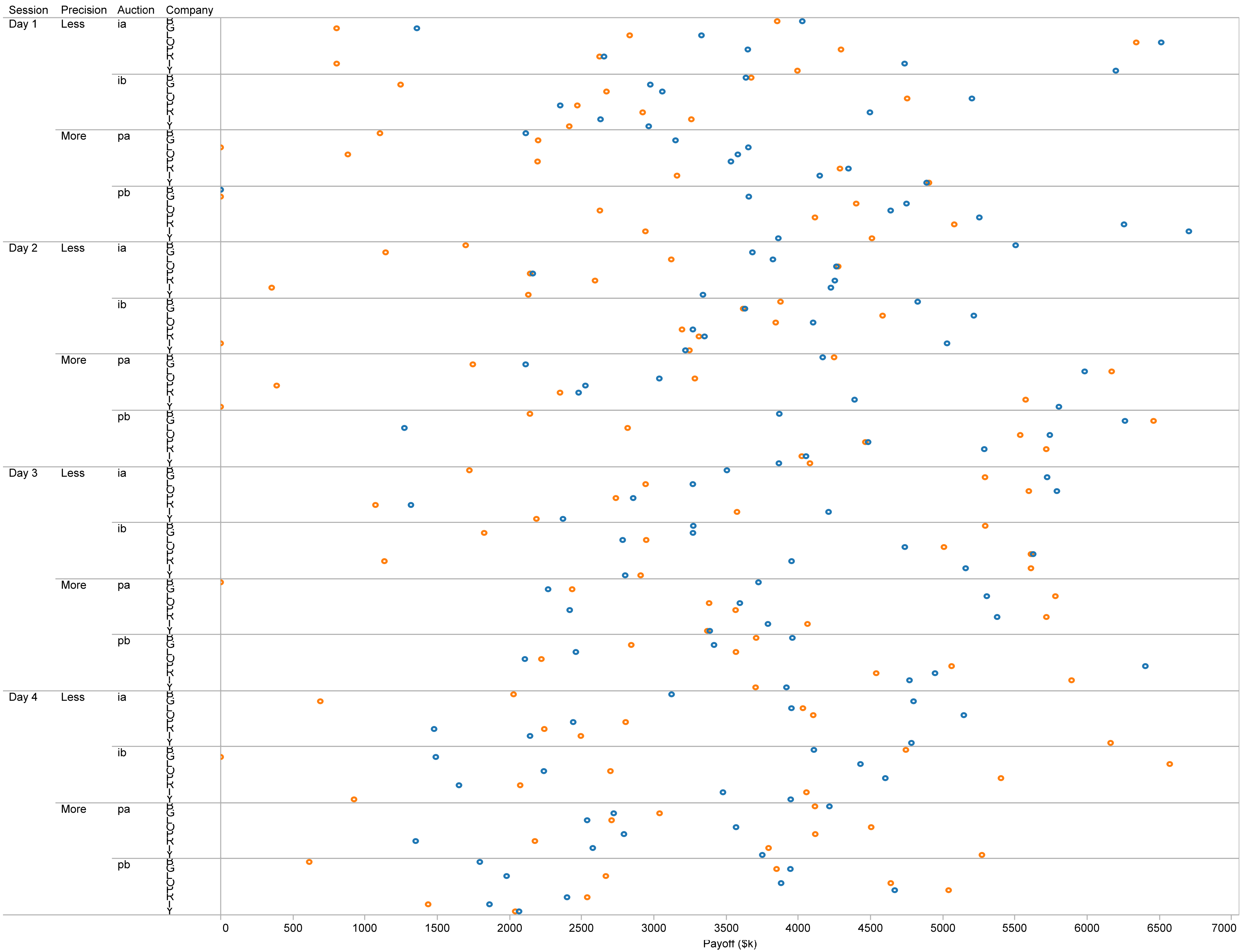


Session
Precision
Auction
Day 1
Less
ia
ib
More
pa
pb
Day 2
Less
ia
ib
More
pa
pb
Day 3
Less
ia
ib
More
pa
pb
Day 4
Less
ia
ib
More
pa
pb
2600
2700
2800
2900
3000
3100
3200
3300
3400
3500
3600
3700
3800
3900
4000
4100
4200
4300
4400
4500
4600
4700
4800
4900
Average liquidity bonus across bidders ($k)

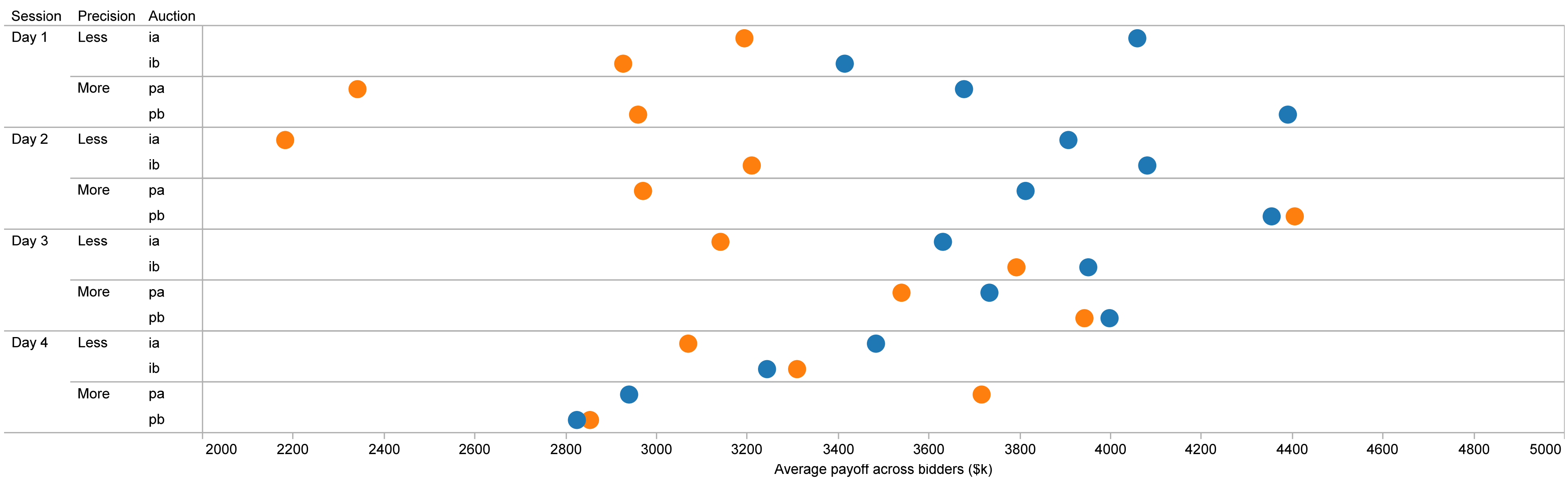


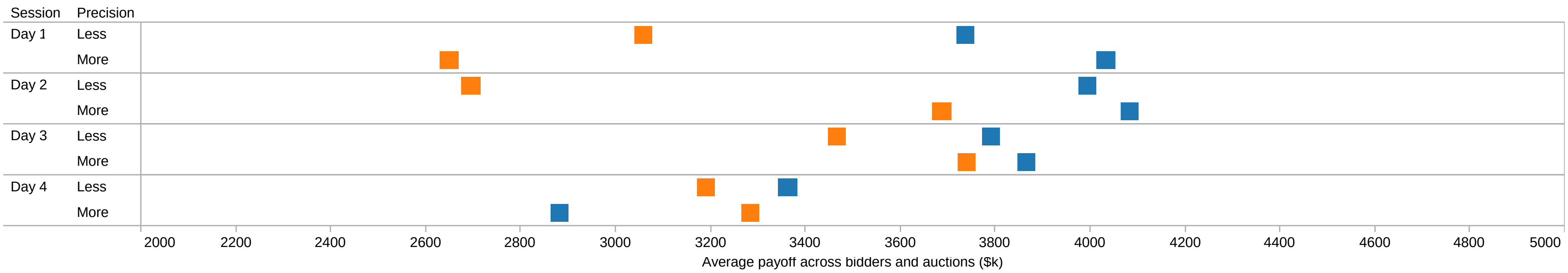
Session
Precision
Day 1
Less
More
Day 2
Less
More
Day 3
Less
More
Day 4
Less
More
2500
2600
2700
2800
2900
3000
3100
3200
3300
3400
3500
3600
3700
3800
3900
4000
4100
4200
4300
4400
4500
4600
4700
4800
4900
5000
Average liquidity bonus across bidders and auctions ($k)

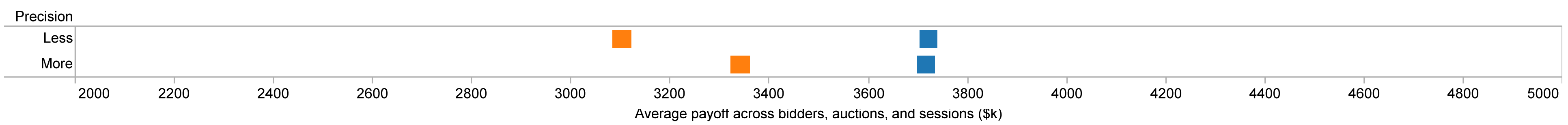

Precision
Less
More
2500
2600
2700
2800
2900
3000
3100
3200
3300
3400
3500
3600
3700
3800
3900
4000
4100
4200
4300
4400
4500
4600
4700
4800
4900
5000
Average liquidity bonus across bidders, auctions, and sessions ($k)

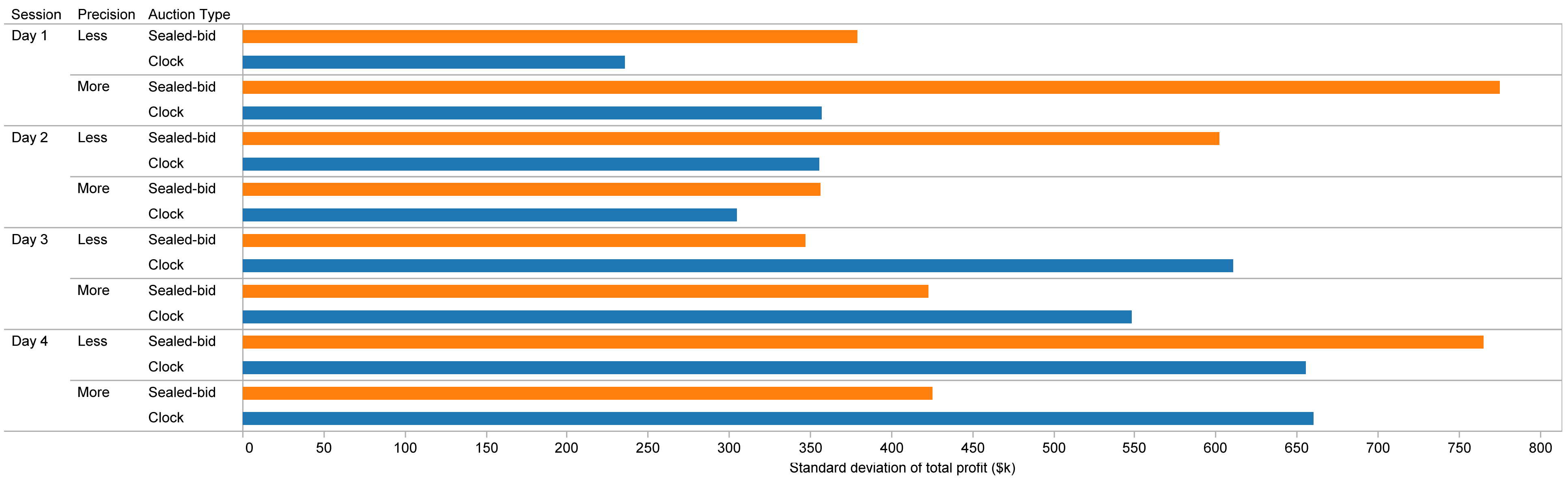


Session
Precision
Auction
Company
Day 1
Day 2
Day 3
Day 4
Less
More
ia
ib
pa
pb
B
G
L
O
P
R
I
Y
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
Payoff ($k)

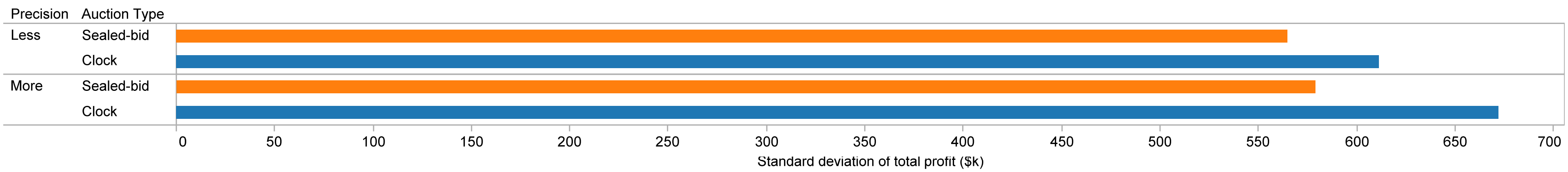

Session
Precision
Auction
Day 1
Less
ia
ib
More
pa
pb
Day 2
Less
ia
ib
More
pa
pb
Day 3
Less
ia
ib
More
pa
pb
Day 4
Less
ia
ib
More
pa
pb
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
4000
4200
4400
4600
4800
5000
Average payoff across bidders ($k)

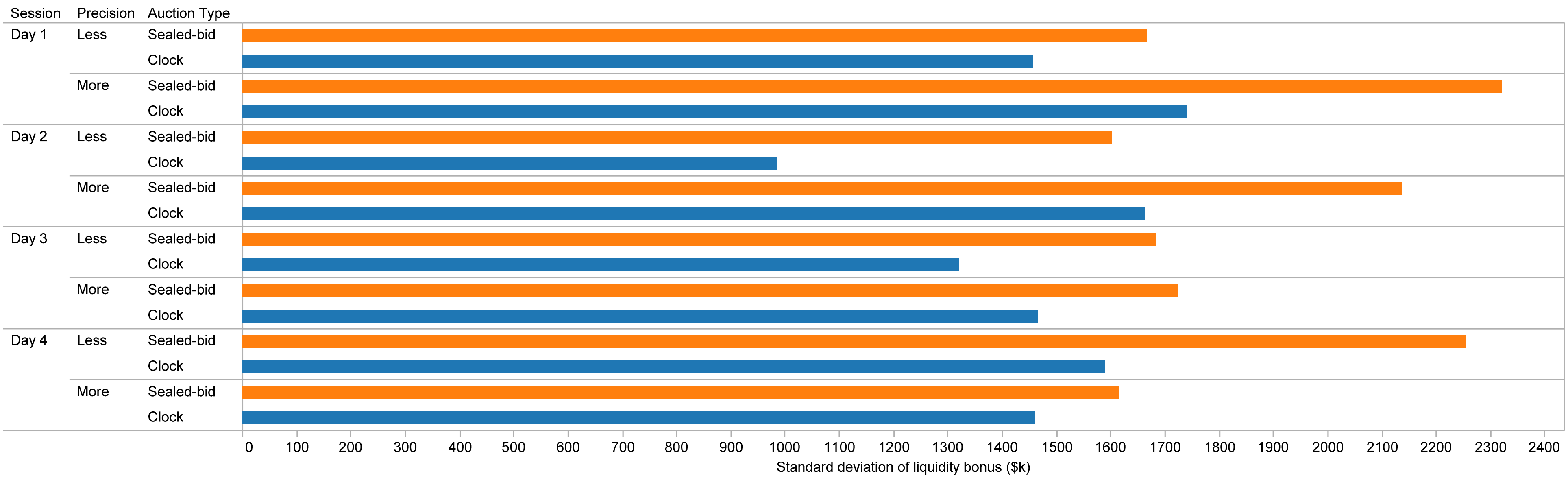

Session
Precision
Day 1
Less
More
Day 2
Less
More
Day 3
Less
More
Day 4
Less
More
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
4000
4200
4400
4600
4800
5000
Average payoff across bidders and auctions ($k)

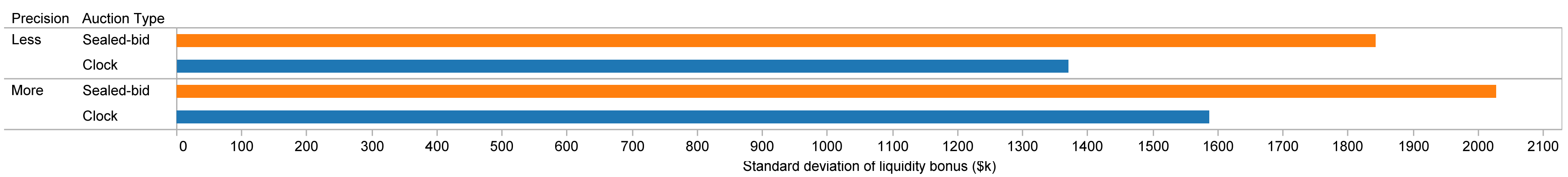

Precision
Less
More
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
4000
4200
4400
4600
4800
5000
Average payoff across bidders, auctions, and sessions ($k)

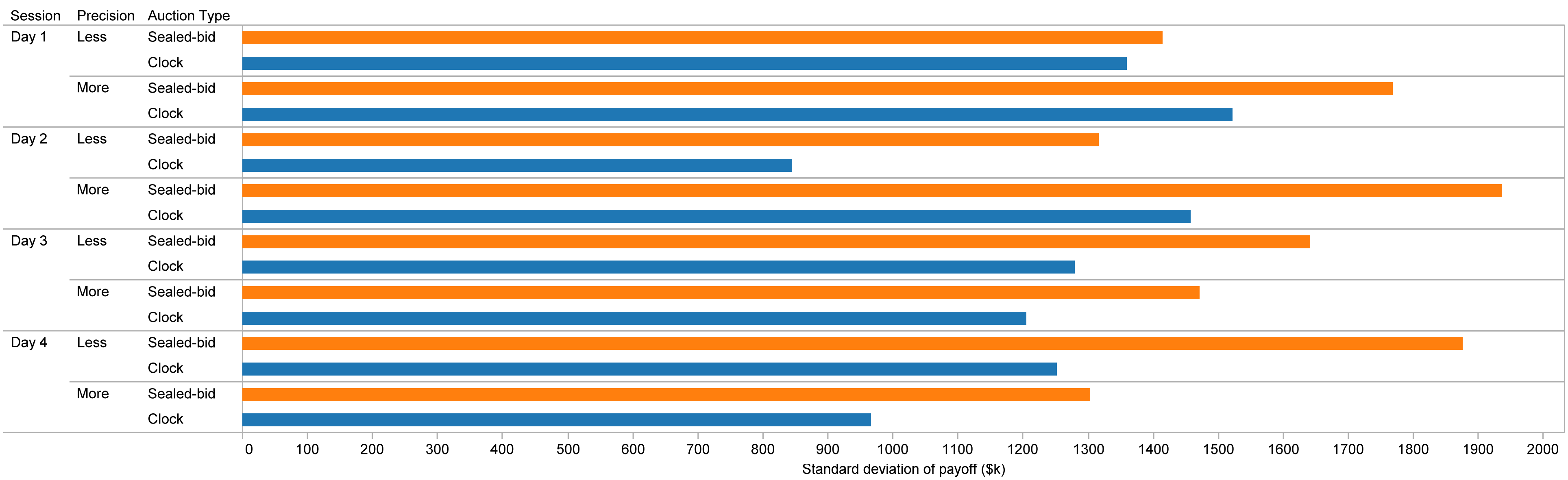


Session
Precision
Auction Type
Day 1
Less
Sealed-bid
Clock
More
Sealed-bid
Clock
Day 2
Less
Sealed-bid
Clock
More
Sealed-bid
Clock
Day 3
Less
Sealed-bid
Clock
More
Sealed-bid
Clock
Day 4
Less
Sealed-bid
Clock
More
Sealed-bid
Clock
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Standard deviation of total profit ($k)

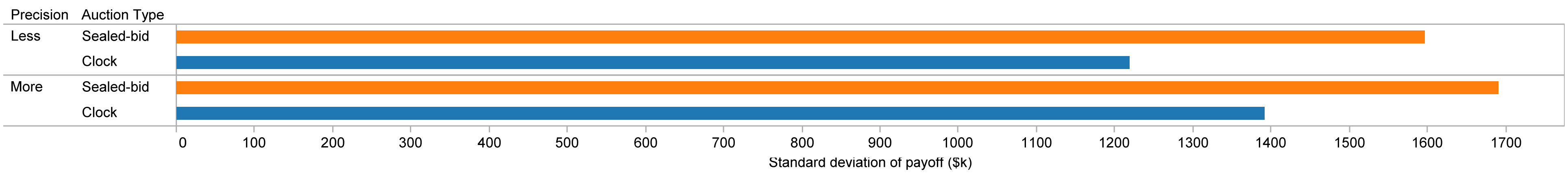

Precision
Auction Type
Less
Sealed-bid
Clock
More
Sealed-bid
Clock
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
Standard deviation of total profit ($k)


Session
Precision
Auction Type
Day 1
Day 2
Day 3
Day 4
Less
More
Sealed-bid
Clock
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
2200
2300
2400
Standard deviation of liquidity bonus ($k)

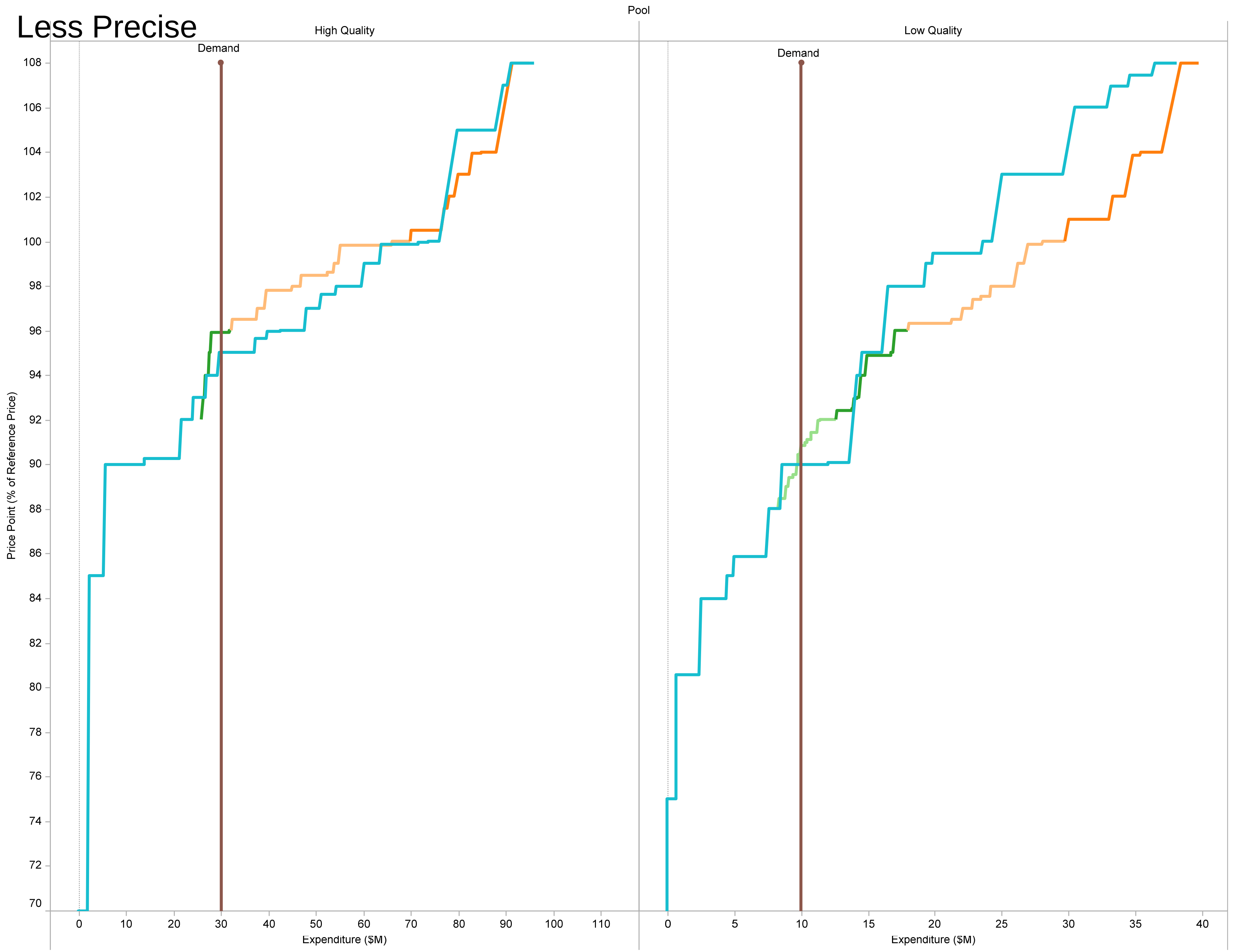

Precision
Auction Type
Less
Sealed-bid
Clock
More
Sealed-bid
Clock
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
Standard deviation of liquidity bonus ($k)



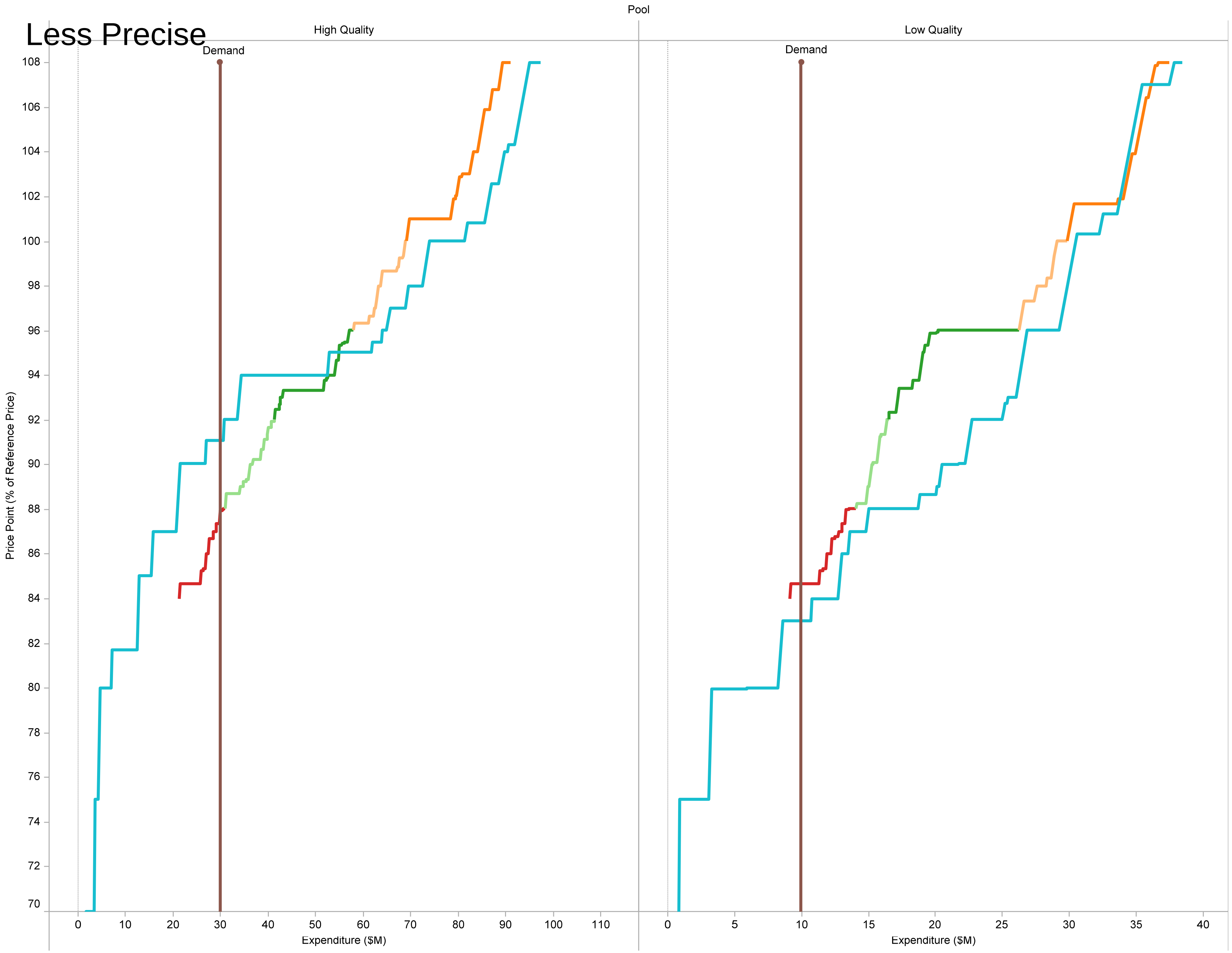
Session
Precision
Auction Type
Day 1
Day 2
Day 3
Day 4
Less
More
Sealed-bid
Clock
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Standard deviation of payoff ($k)



Precision
Auction Type
Less
Sealed-bid
Clock
More
Sealed-bid
Clock
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
Standard deviation of payoff ($k)

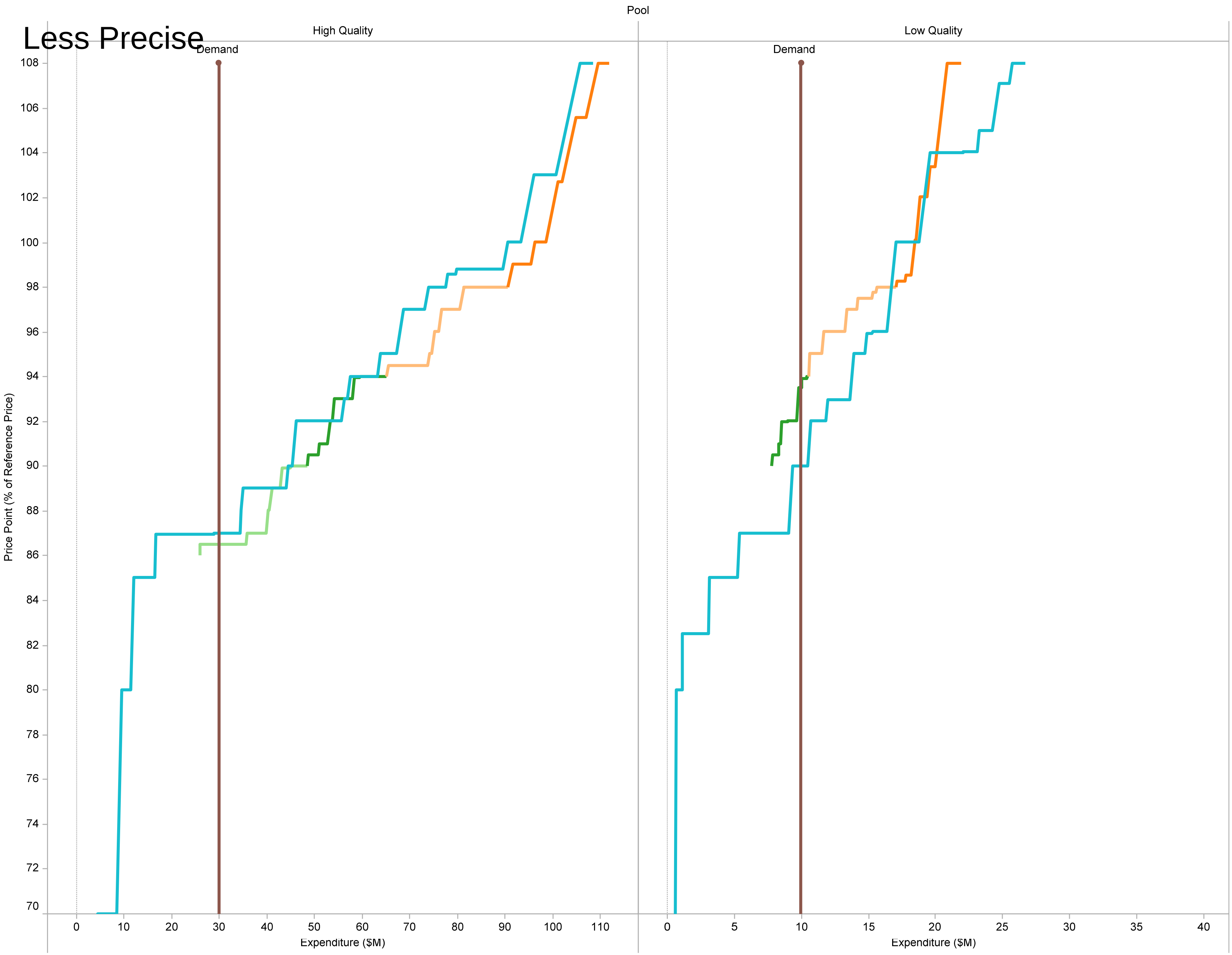


Less Precise
Pool
High Quality
Low Quality
Demand
Demand
Price Point (% of Reference Price)
108
106
104
102
100
98
96
94
92
90
88
86
84
82
80
78
76
74
72
70
0
10
20
30
40
50
60
70
80
90
100
110
Expenditure ($M)
0
5
10
15
20
25
30
35
40
Expenditure ($M)

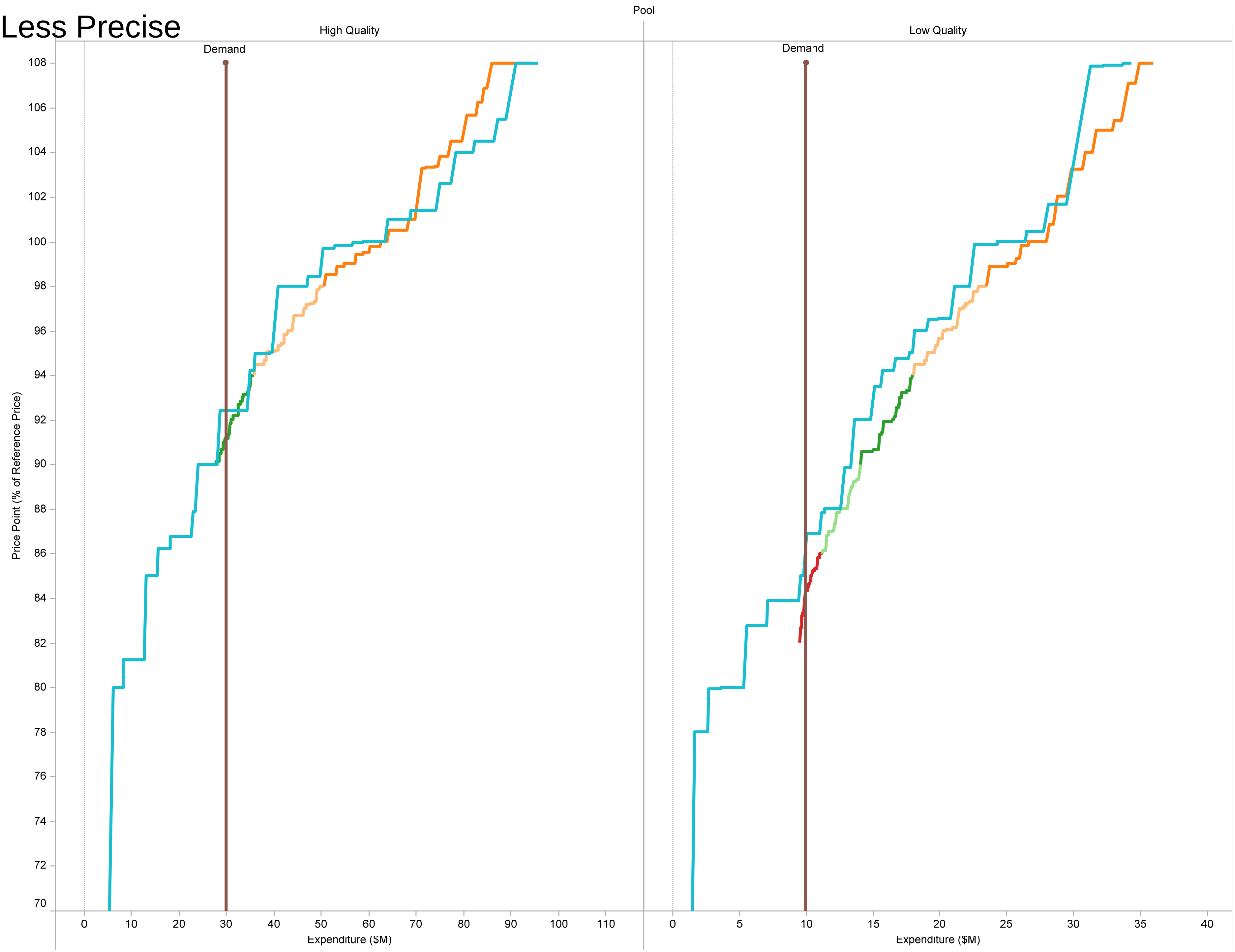


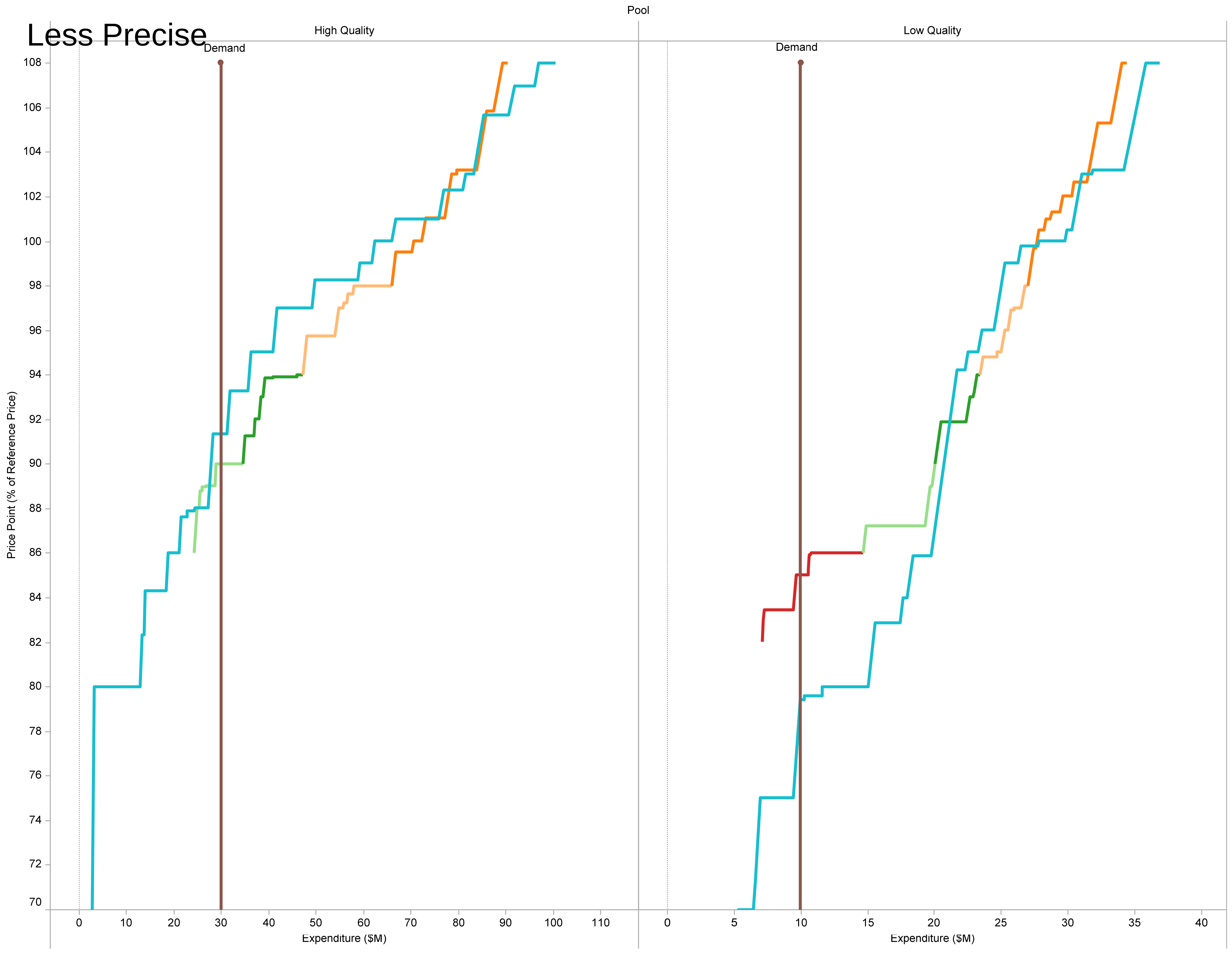
Less Precise
Pool
High Quality
Low Quality
Demand
Demand
Price Point (% of Reference Price)
108
106
104
102
100
98
96
94
92
90
88
86
84
82
80
78
76
74
72
70
0
10
20
30
40
50
60
70
80
90
100
110
Expenditure ($M)
0
5
10
15
20
25
30
35
40
Expenditure ($M)

Less Precise



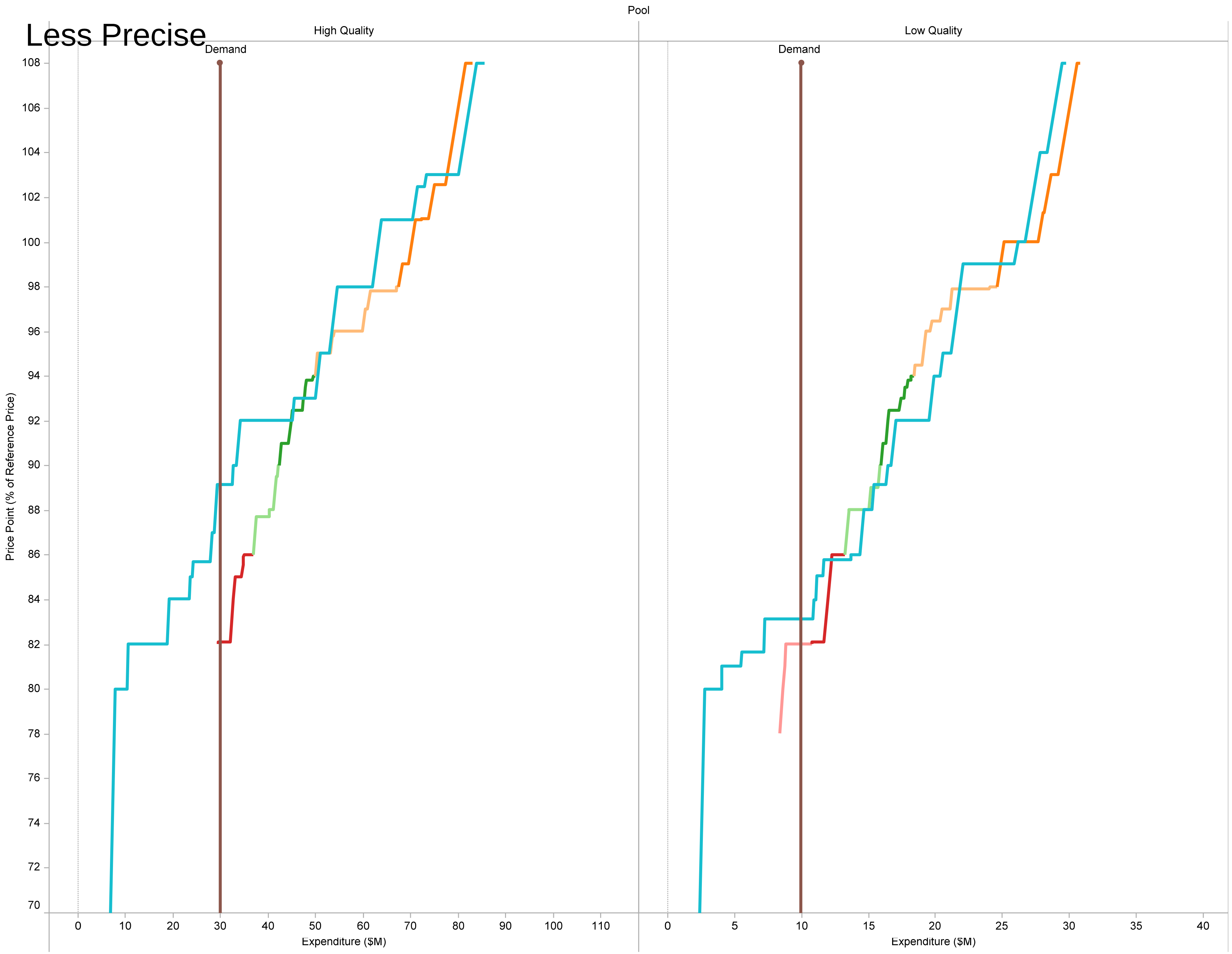
Less Precise



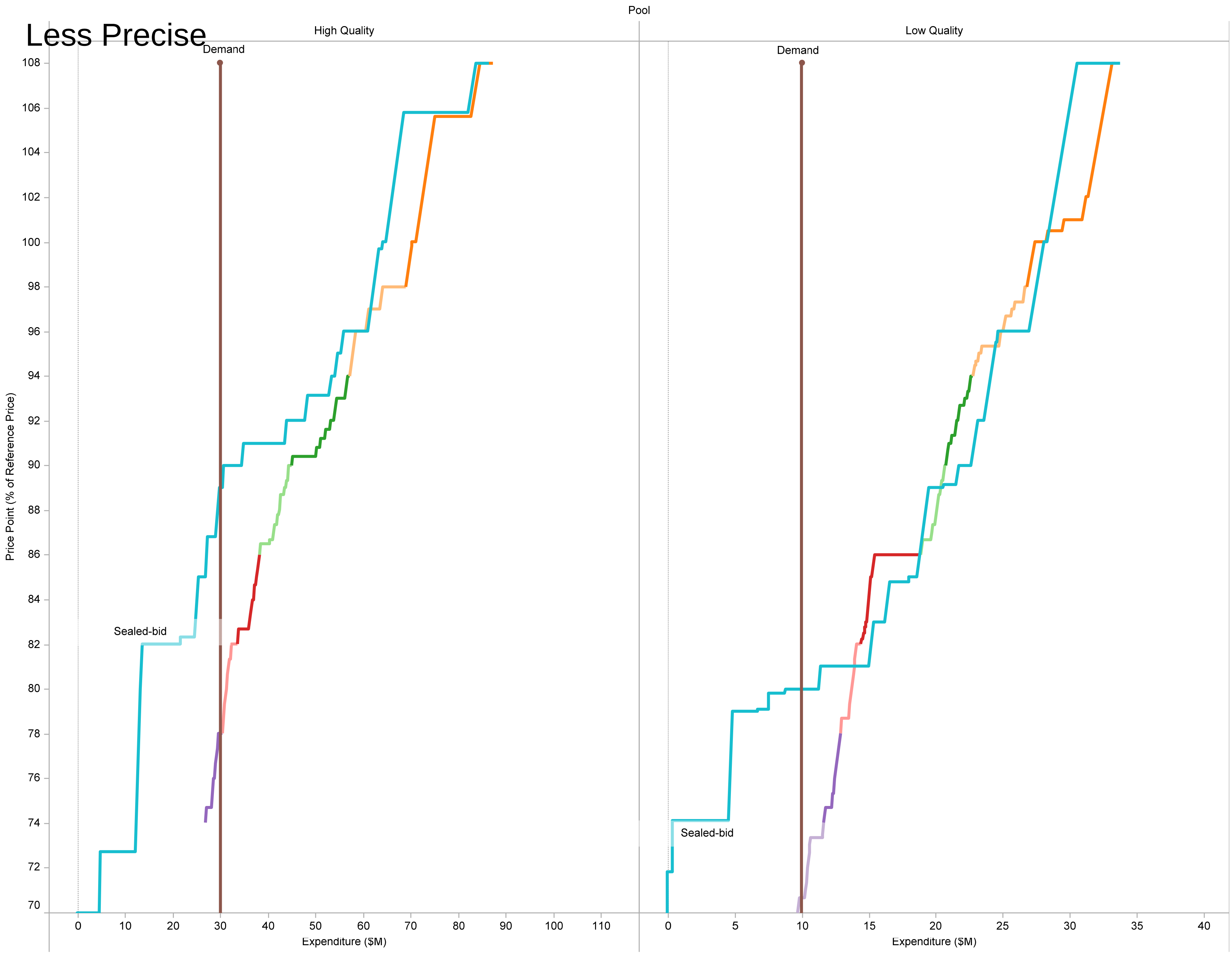


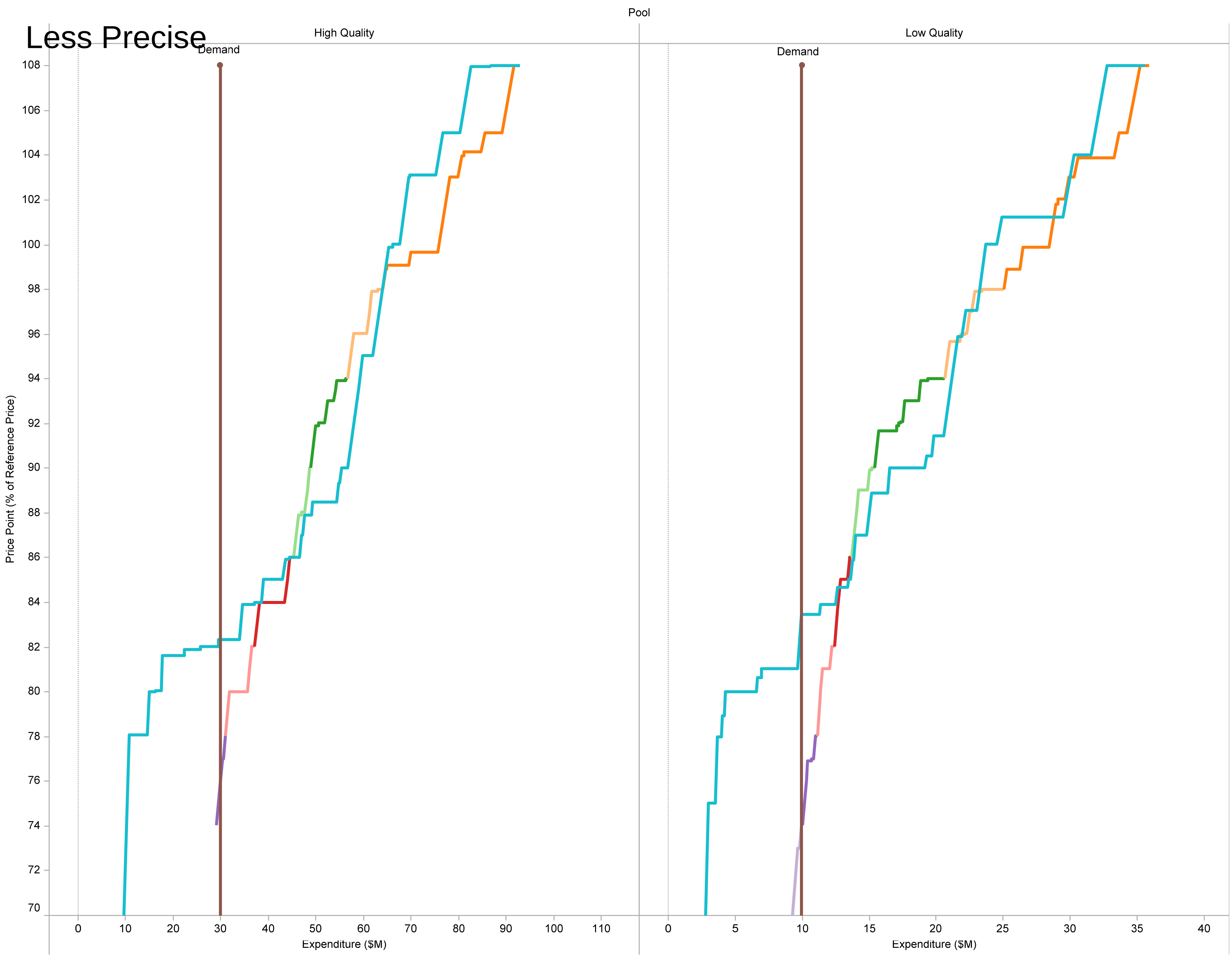
Less Precise
Pool
High Quality
Low Quality
Demand
Demand
Price Point (% of Reference Price)
108
106
104
102
100
98
96
94
92
90
88
86
84
82
80
78
76
74
72
70
0
10
20
30
40
50
60
70
80
90
100
110
0
5
10
15
20
25
30
35
40
Expenditure ($M)
Expenditure ($M)

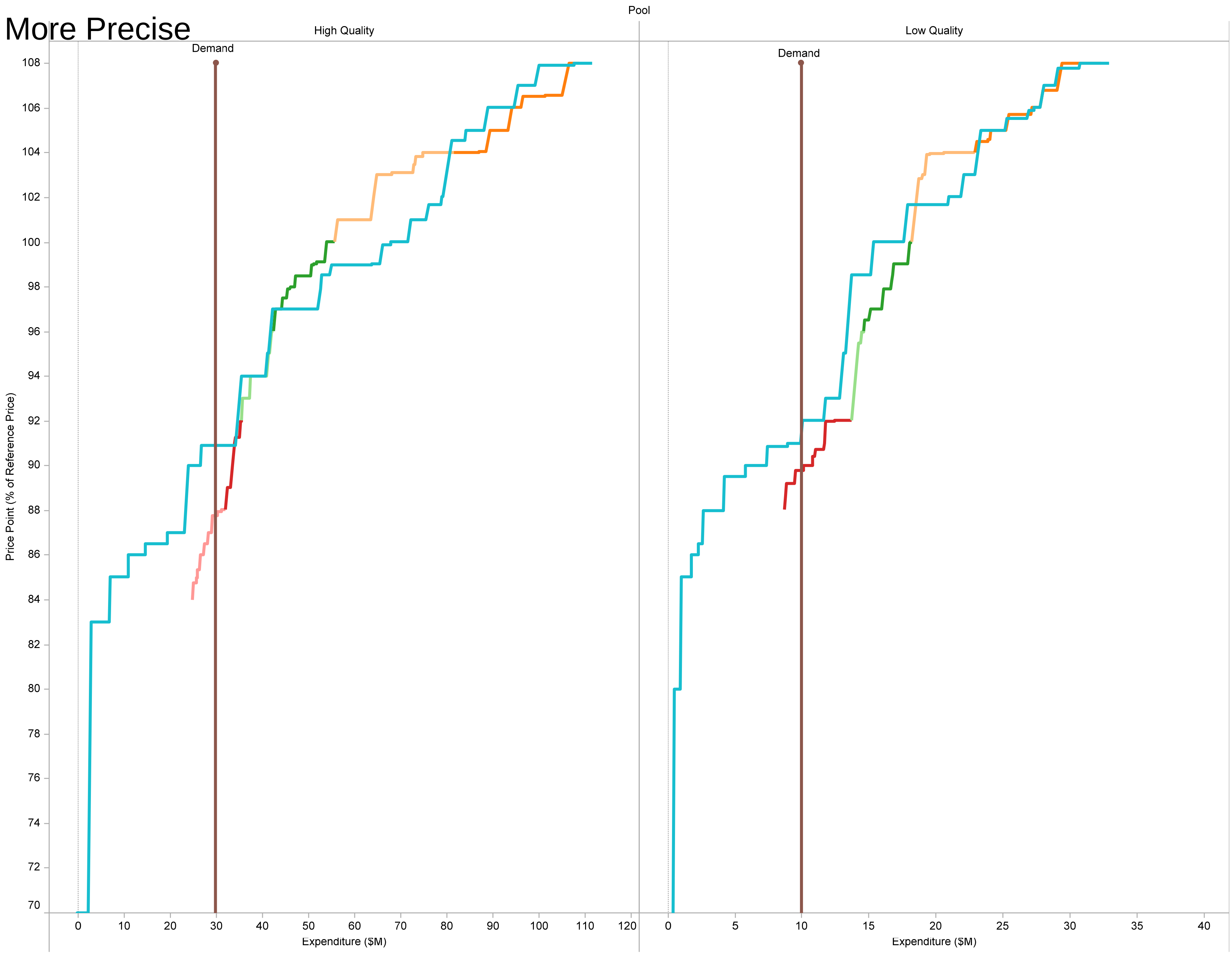
Less Precise



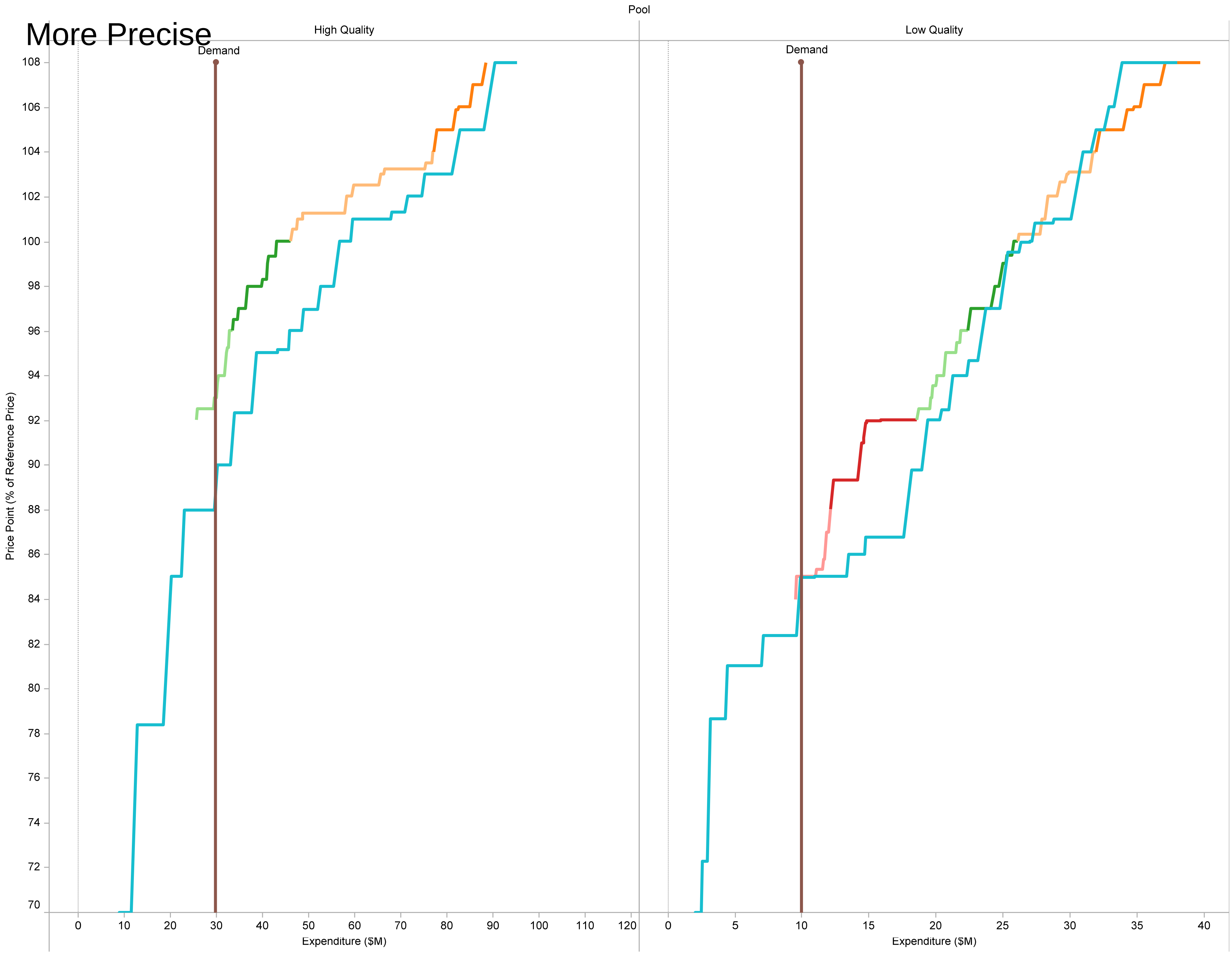
Less Precise



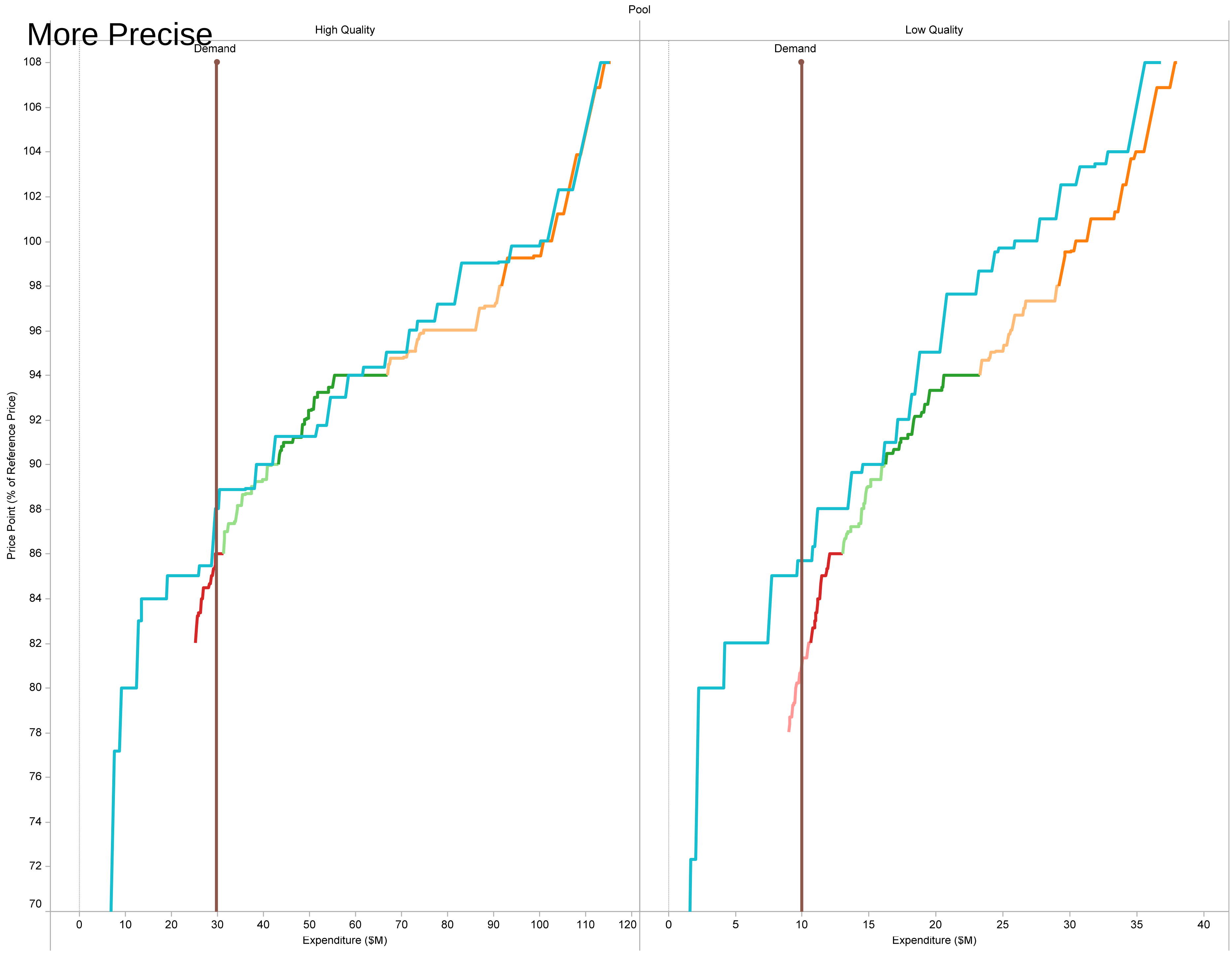

Less Precise
Pool
High Quality
Low Quality
Demand
Demand
Price Point (% of Reference Price)
Expenditure ($M)
Expenditure ($M)
108
106
104
102
100
98
96
94
92
90
88
86
84
82
80
78
76
74
72
70
0
10
20
30
40
50
60
70
80
90
100
110
0
5
10
15
20
25
30
35
40


More Precise
Pool
High Quality
Low Quality
Demand
Demand
Price Point (% of Reference Price)
108
106
104
102
100
98
96
94
92
90
88
86
84
82
80
78
76
74
72
70
0
10
20
30
40
50
60
70
80
90
100
110
120
Expenditure ($M)
0
5
10
15
20
25
30
35
40
Expenditure ($M)

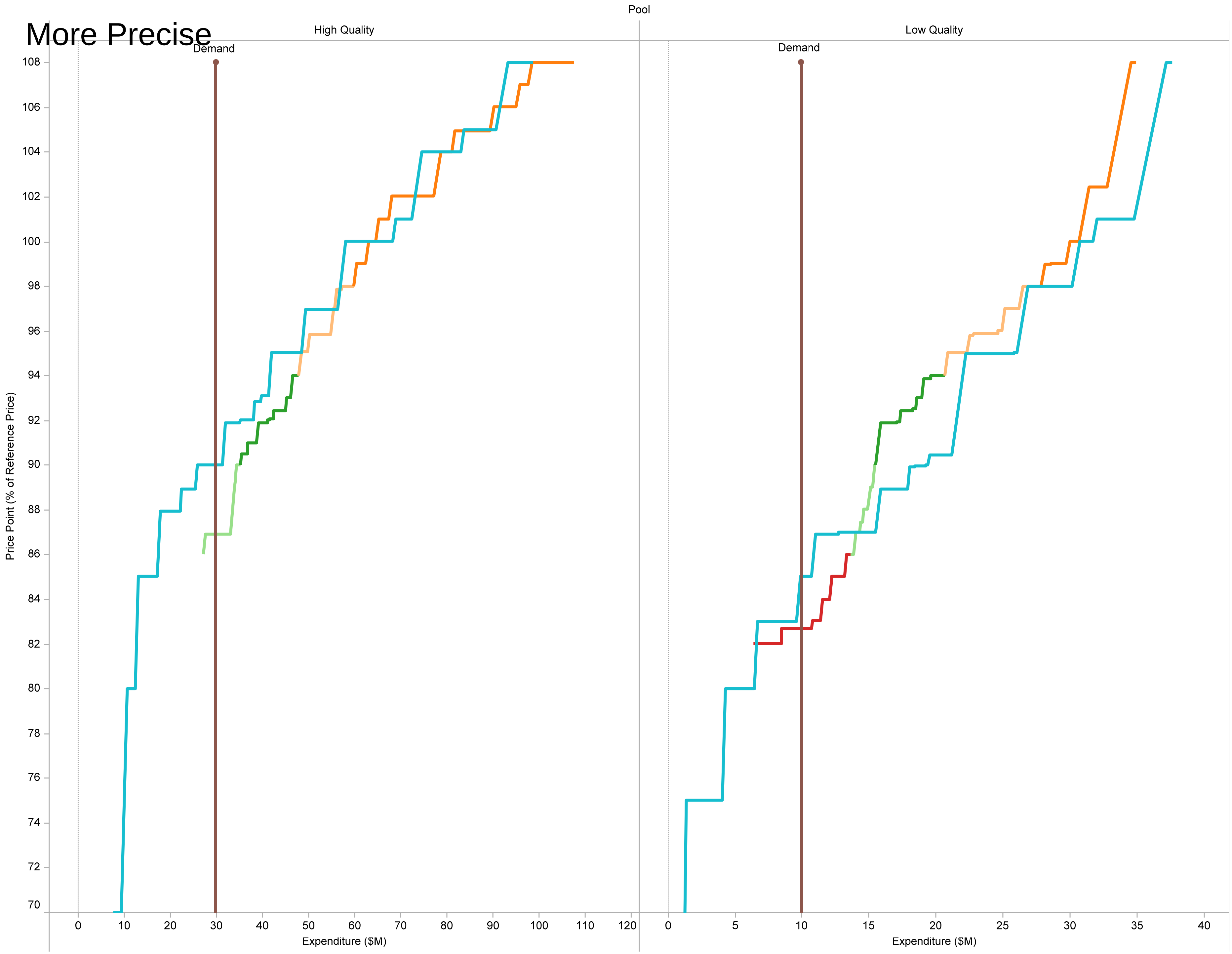
More Precise

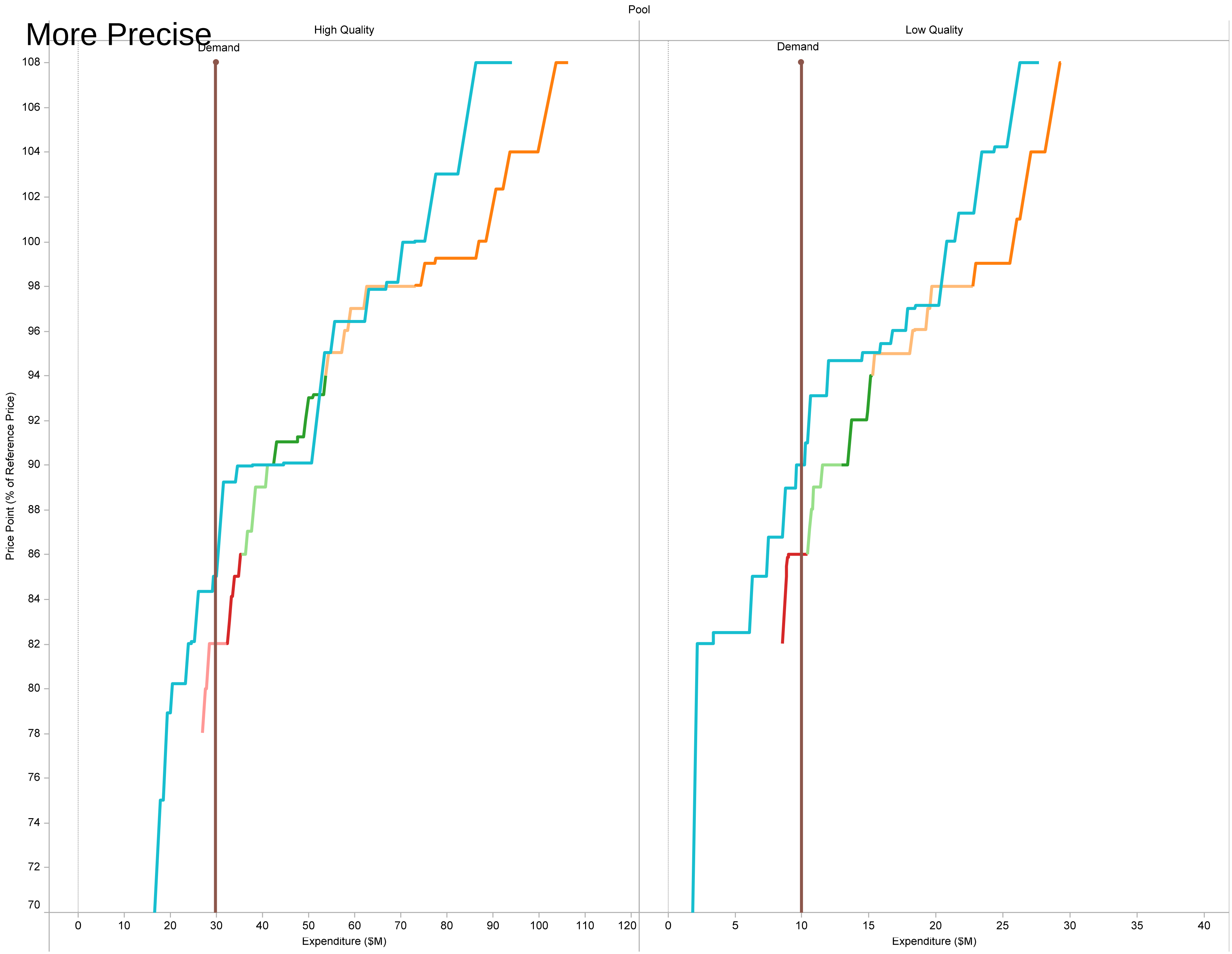


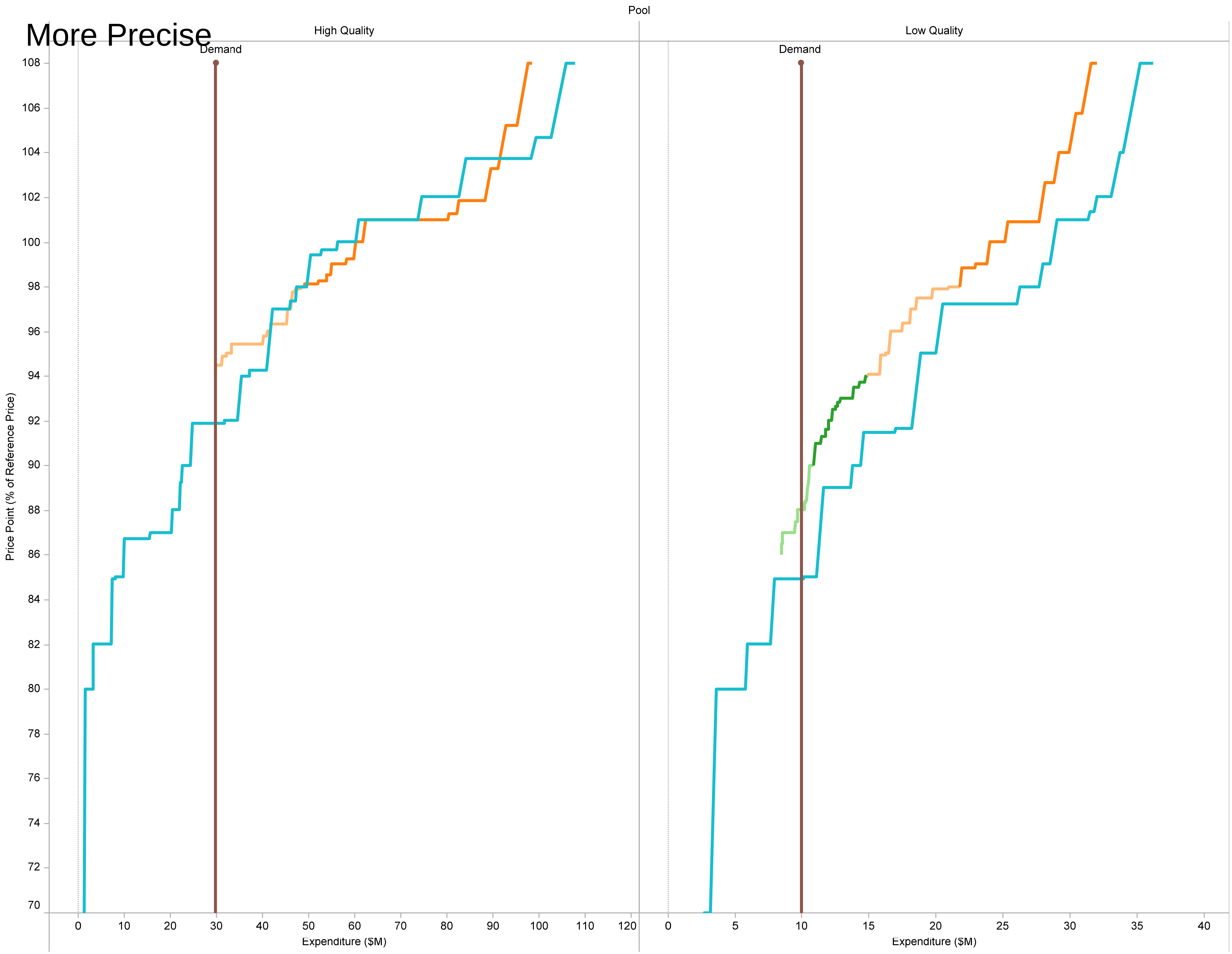
More Precise



More Precise

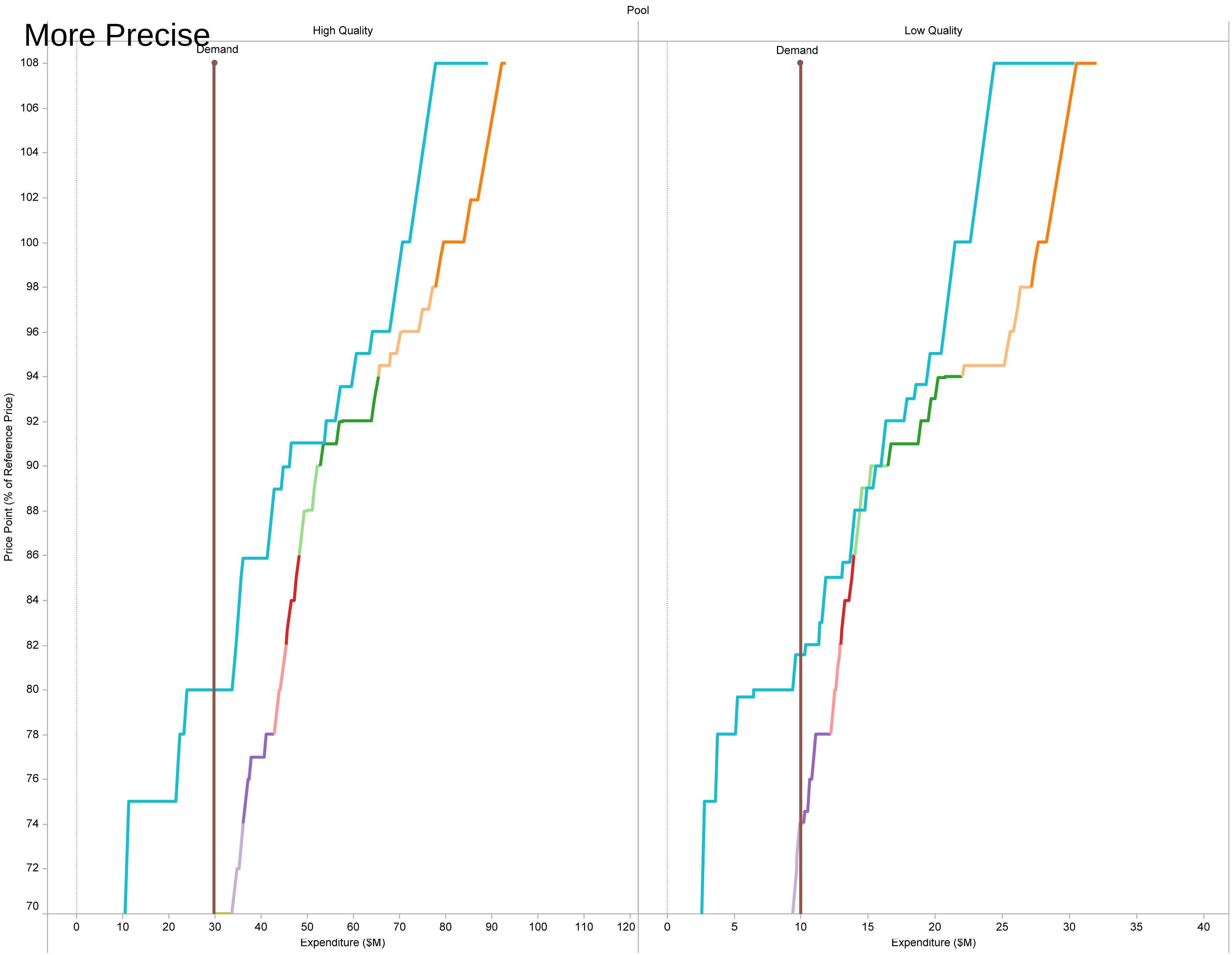



More Precise
Pool
High Quality
Low Quality
Demand
Demand
Price Point (% of Reference Price)
108
106
104
102
100
98
96
94
92
90
88
86
84
82
80
78
76
74
72
70
0
10
20
30
40
50
60
70
80
90
100
110
120
Expenditure ($M)
0
5
10
15
20
25
30
35
40
Expenditure ($M)

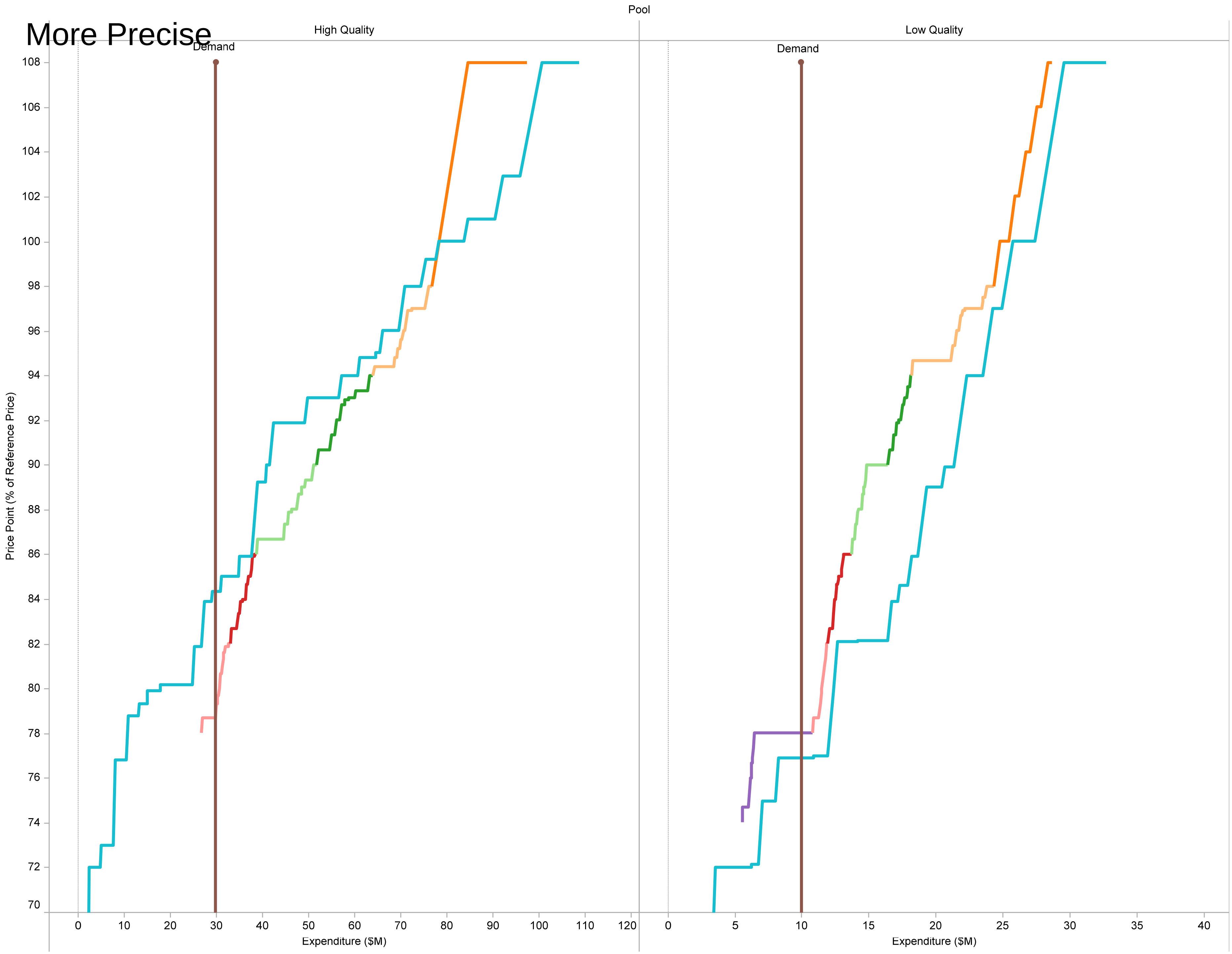


More Precise
Pool
High Quality
Low Quality
Demand
Demand
Price Point (% of Reference Price)
108
106
104
102
100
98
96
94
92
90
88
86
84
82
80
78
76
74
72
70
0
10
20
30
40
50
60
70
80
90
100
110
120
Expenditure ($M)
0
5
10
15
20
25
30
35
40
Expenditure ($M)

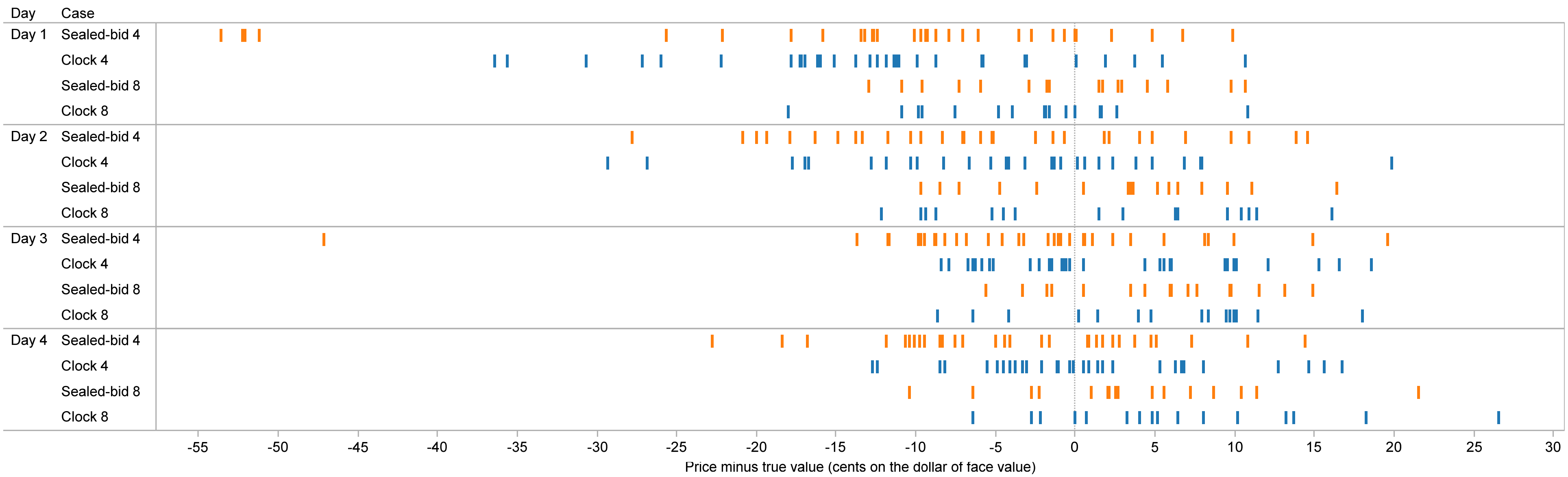
More Precise



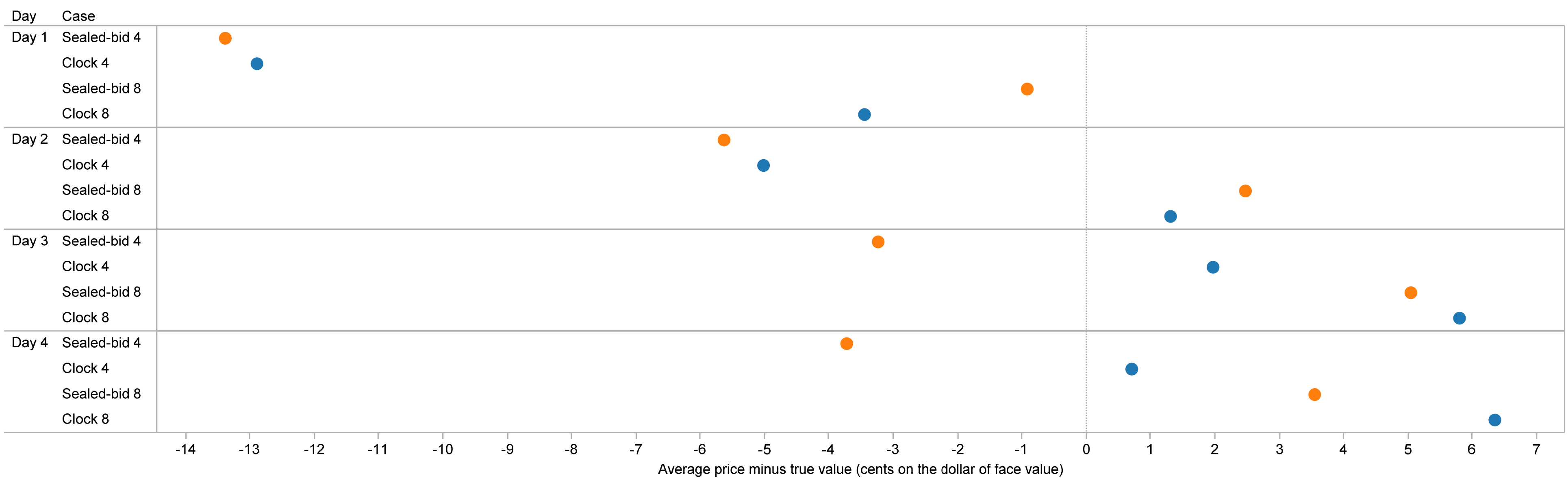
More Precise

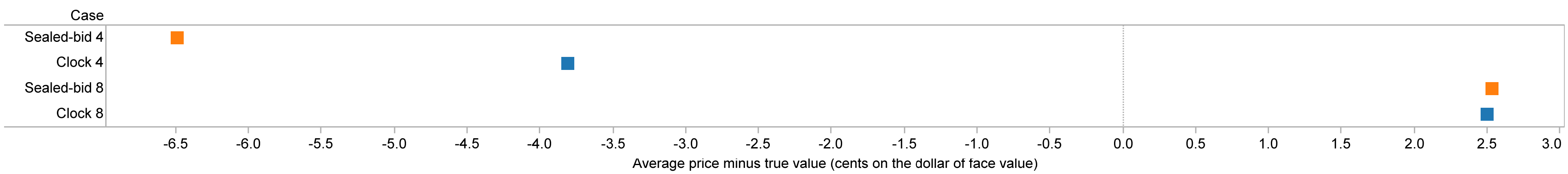


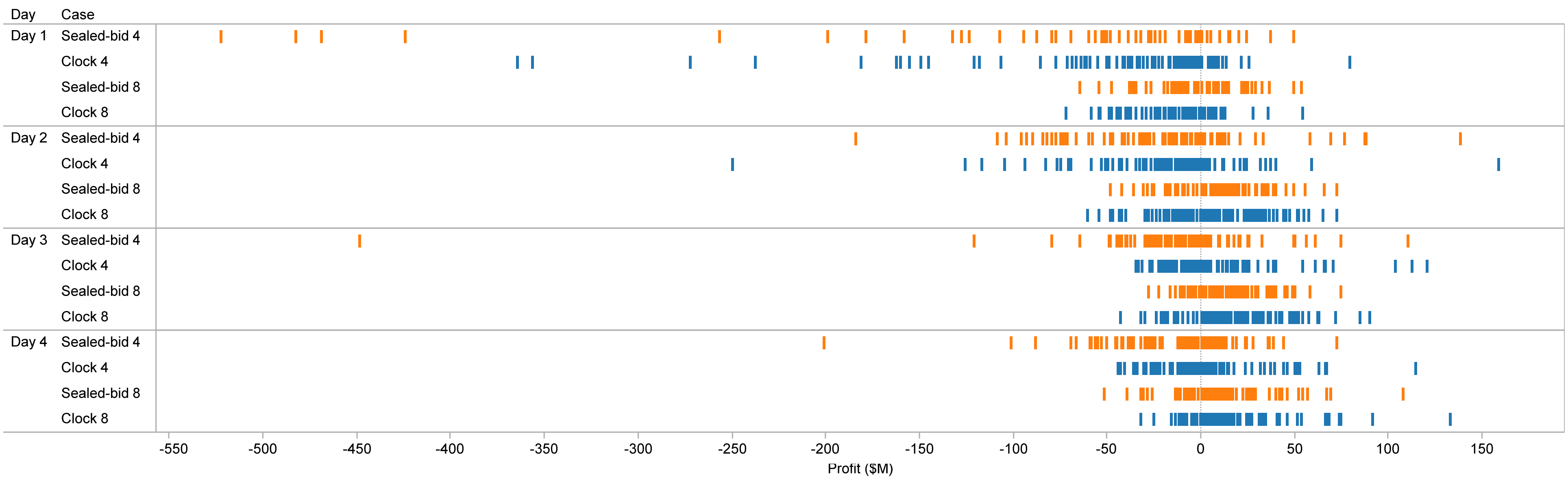
Experiment 1



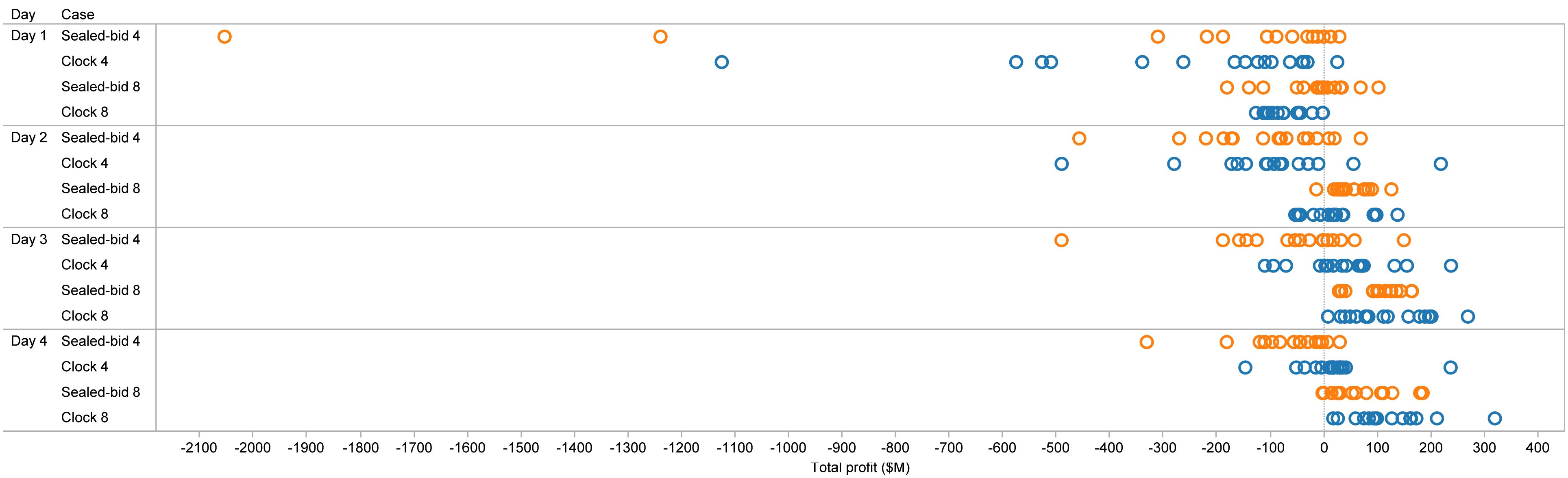
Day
Case
Day 1
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 2
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 3
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 4
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
-55 -50 -45 -40 -35 -30 -25 -20 -15 -10 -5 0 5 10 15 20 25 30
Price minus true value (cents on the dollar of face value)

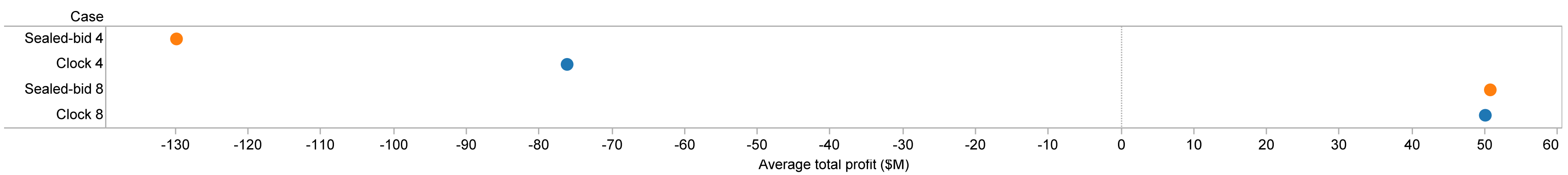

Day
Case
Day 1
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 2
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 3
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 4
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
-14 -13 -12 -11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7
Average price minus true value (cents on the dollar of face value)

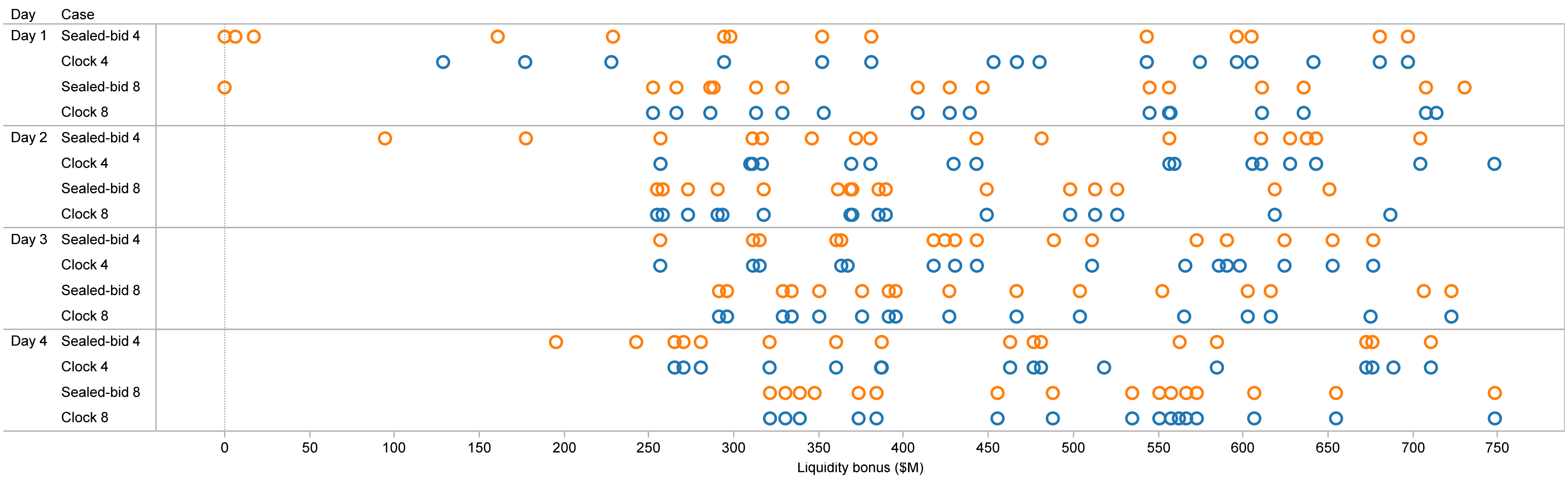

Case
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
-6.5
-6.0
-5.5
-5.0
-4.5
-4.0
-3.5
-3.0
-2.5
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Average price minus true value (cents on the dollar of face value)

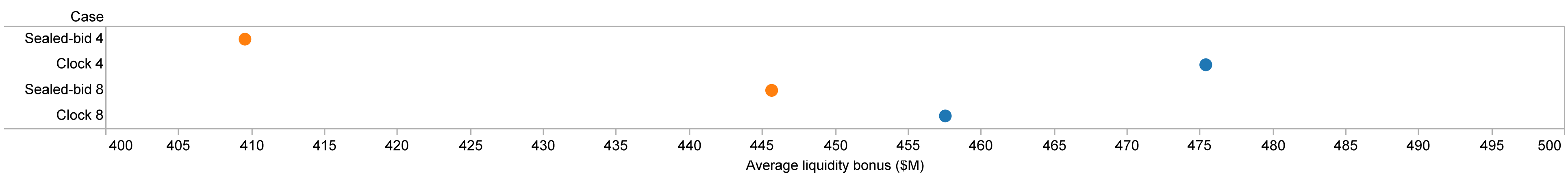


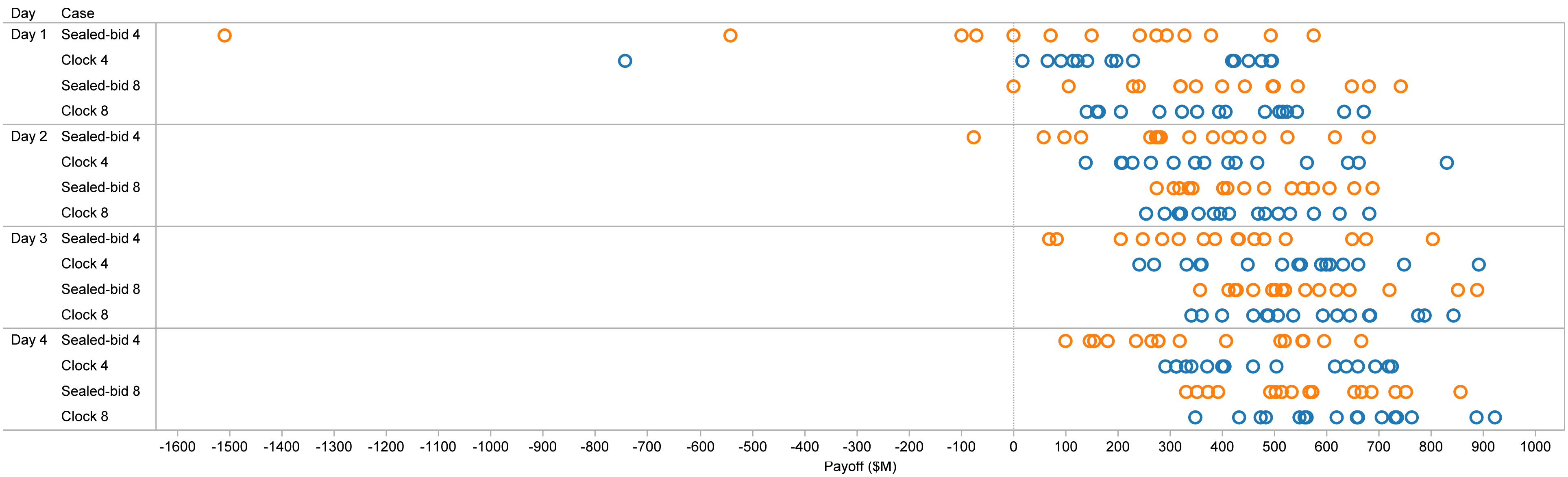
Day
Case
Day 1
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 2
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 3
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 4
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
-550
-500
-450
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
Profit ($M)


Day
Case
Day 1
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 2
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 3
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 4
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
-2100 -2000 -1900 -1800 -1700 -1600 -1500 -1400 -1300 -1200 -1100 -1000 -900 -800 -700 -600 -500 -400 -300 -200 -100 0 100 200 300 400
Total profit ($M)

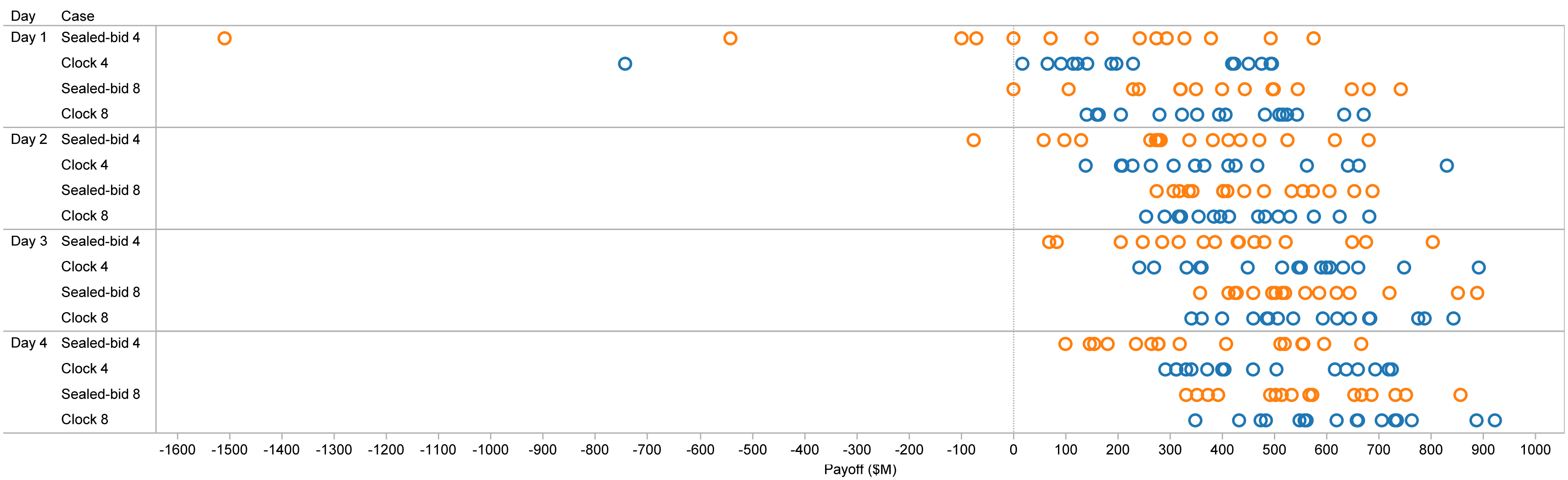

Case
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
-130
-120
-110
-100
-90
-80
-70
-60
-50
-40
-30
-20
-10
0
10
20
30
40
50
60
Average total profit ($M)


Day
Case
Day 1
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 2
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 3
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 4
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
Liquidity bonus ($M)

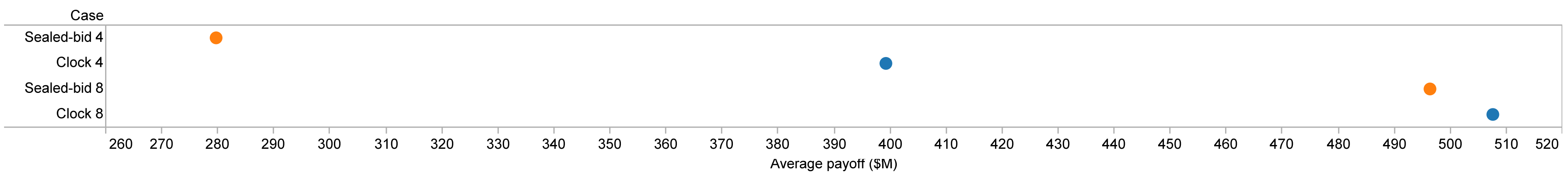

Case
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
400
405
410
415
420
425
430
435
440
445
450
455
460
465
470
475
480
485
490
495
500
Average liquidity bonus ($M)

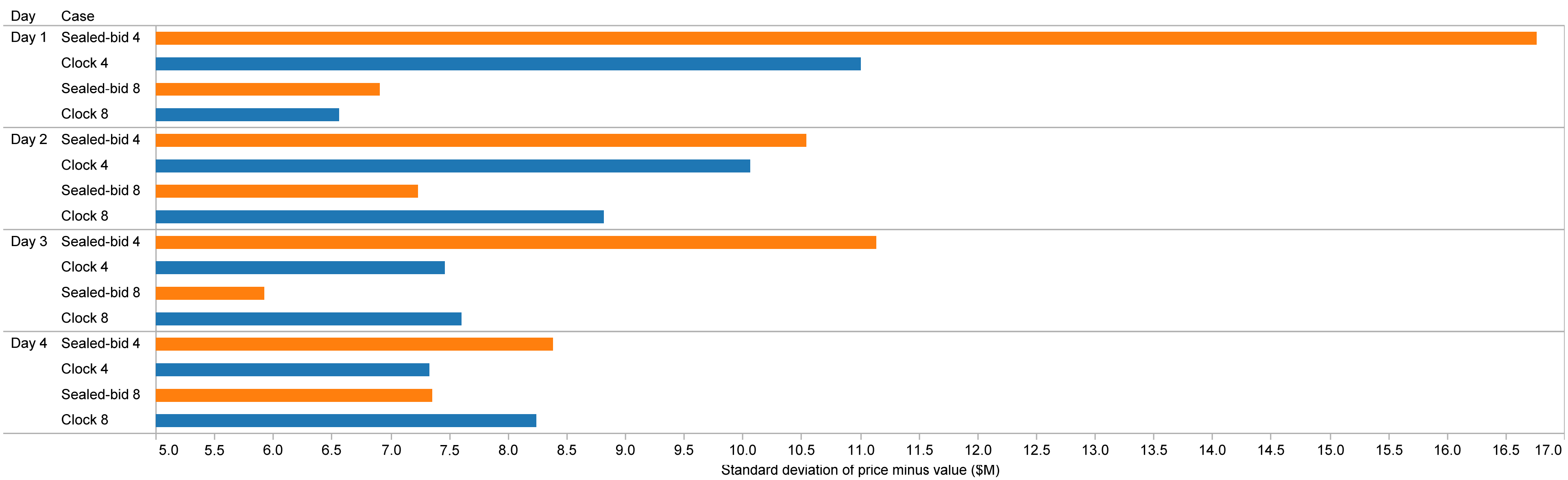


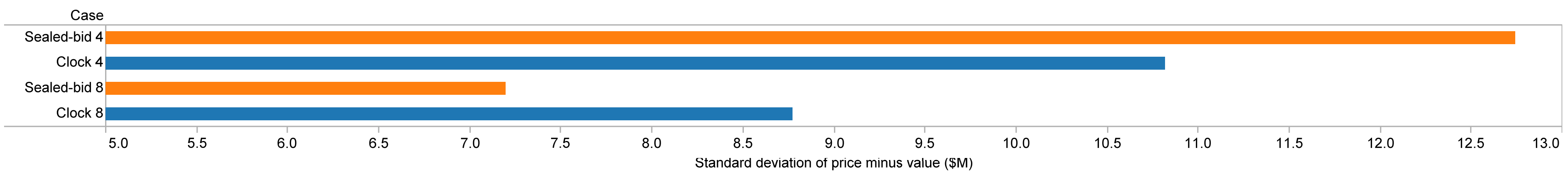
Day
Case
Day 1
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 2
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 3
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 4
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
-1600 -1500 -1400 -1300 -1200 -1100 -1000 -900 -800 -700 -600 -500 -400 -300 -200 -100 0 100 200 300 400 500 600 700 800 900 1000
Payoff ($M)

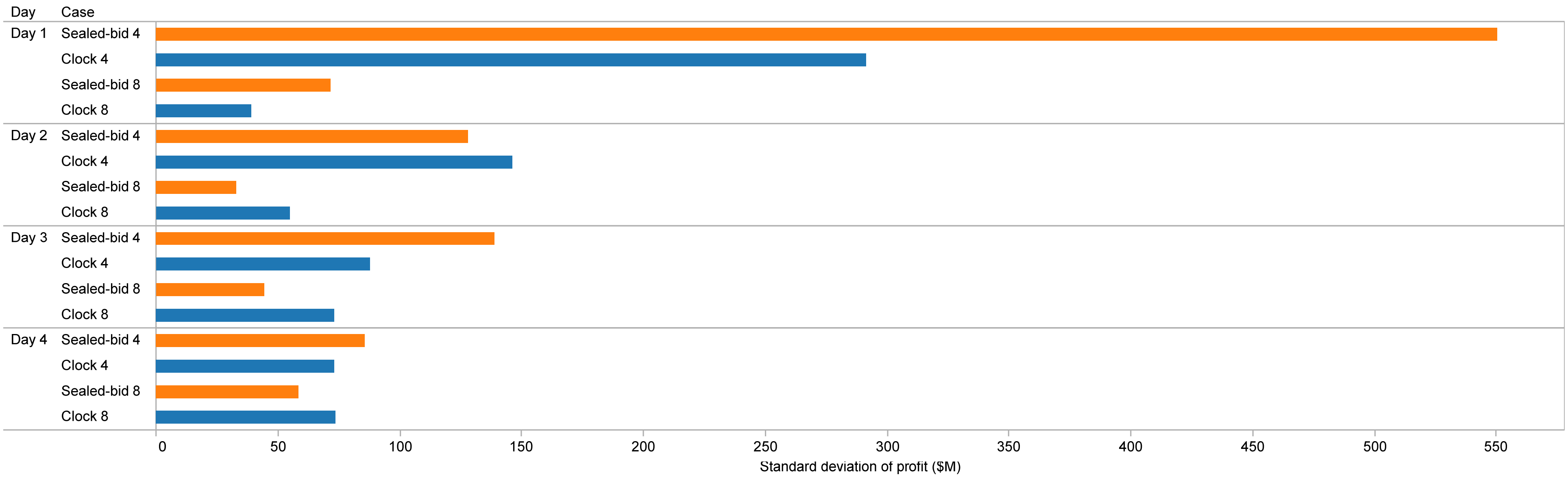


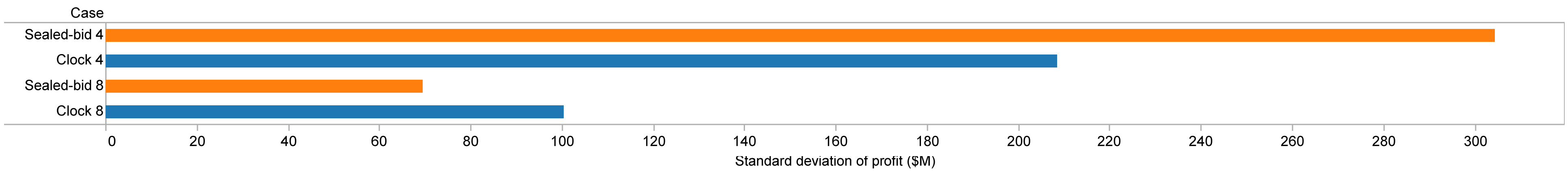
Day
Case
Day 1
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 2
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 3
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 4
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
-1600 -1500 -1400 -1300 -1200 -1100 -1000 -900 -800 -700 -600 -500 -400 -300 -200 -100 0 100 200 300 400 500 600 700 800 900 1000
Payoff ($M)


Case
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
260 270 280 290 300 310 320 330 340 350 360 370 380 390 400 410 420 430 440 450 460 470 480 490 500 510 520
Average payoff ($M)

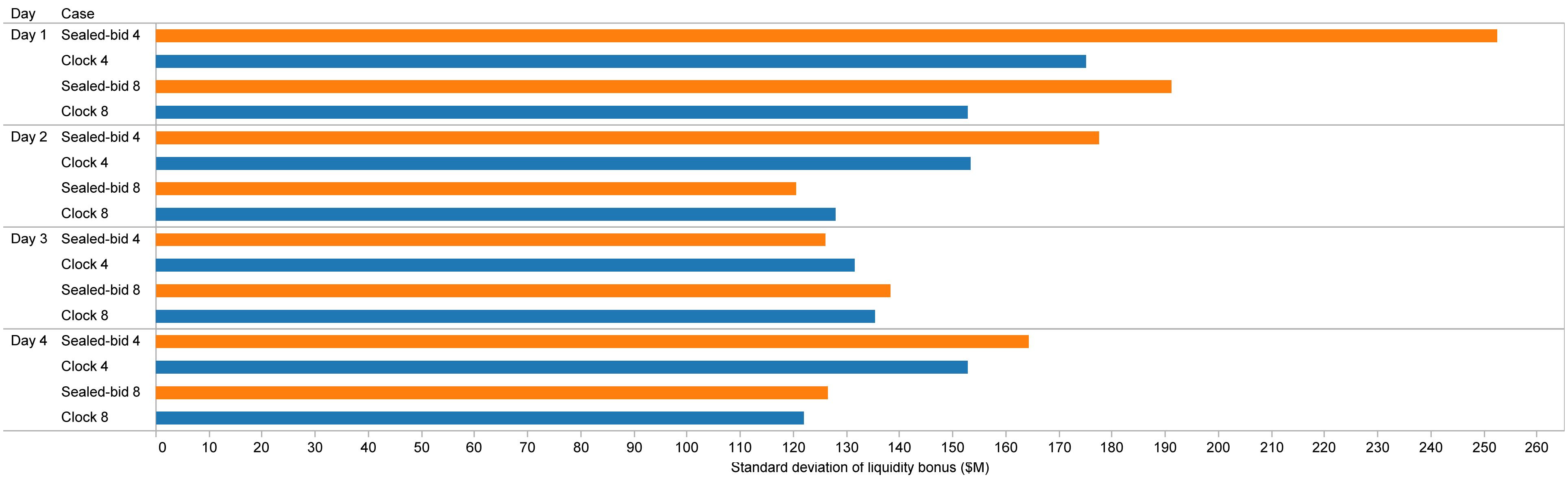

Day
Case
Day 1
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 2
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 3
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 4
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 10.0 10.5 11.0 11.5 12.0 12.5 13.0 13.5 14.0 14.5 15.0 15.5 16.0 16.5 17.0
Standard deviation of price minus value ($M)

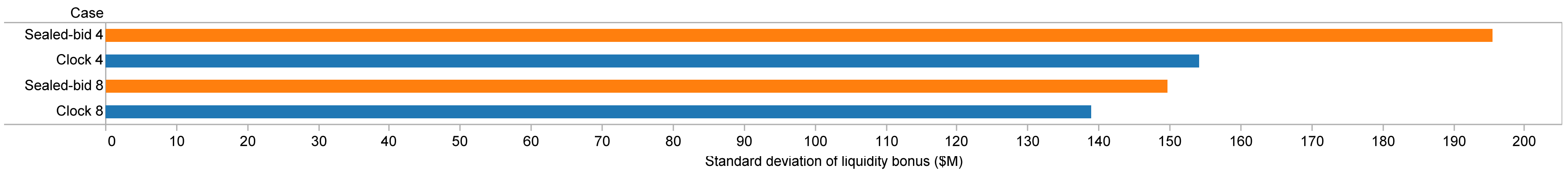

Case
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10.0
10.5
11.0
11.5
12.0
12.5
13.0
Standard deviation of price minus value ($M)

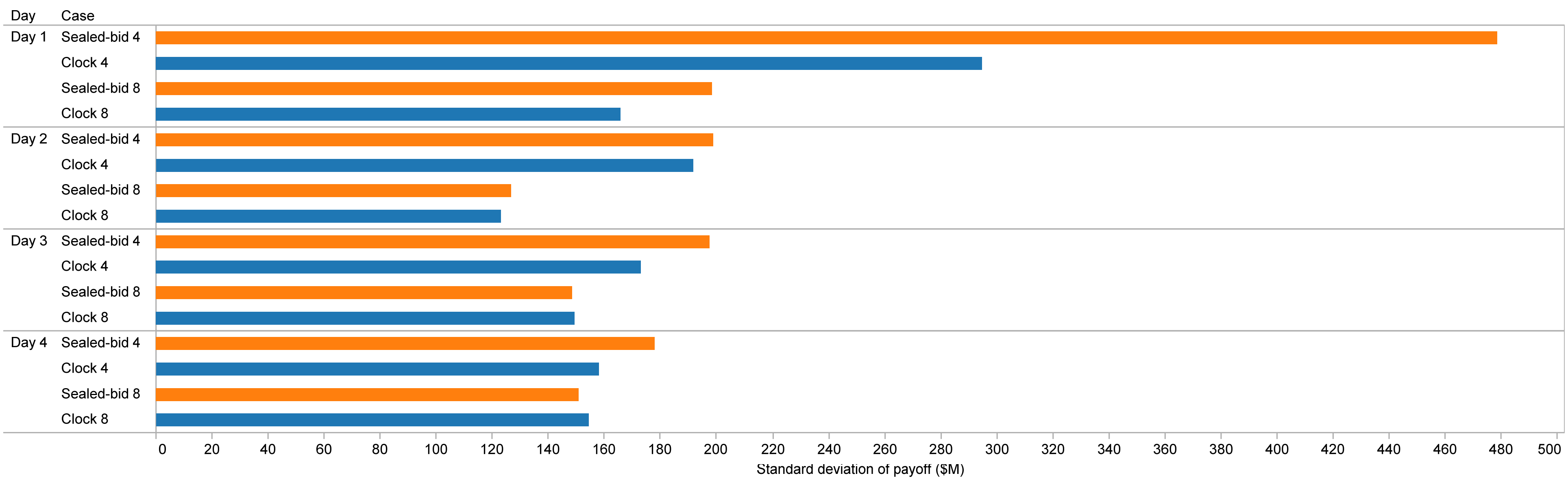

Day
Case
Day 1
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 2
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 3
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 4
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
0
50
100
150
200
250
300
350
400
450
500
550
Standard deviation of profit ($M)

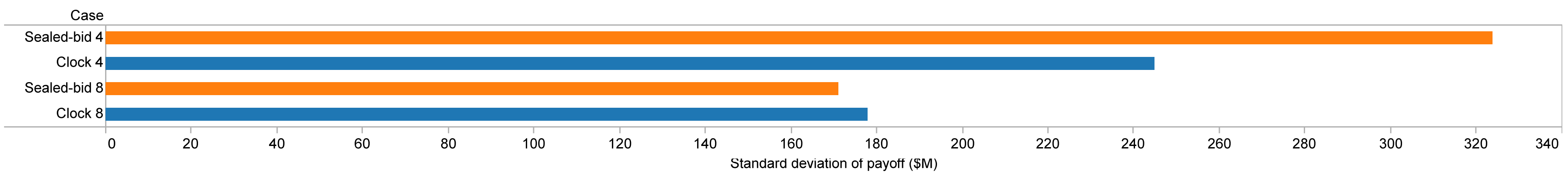


Case
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
Standard deviation of profit ($M)

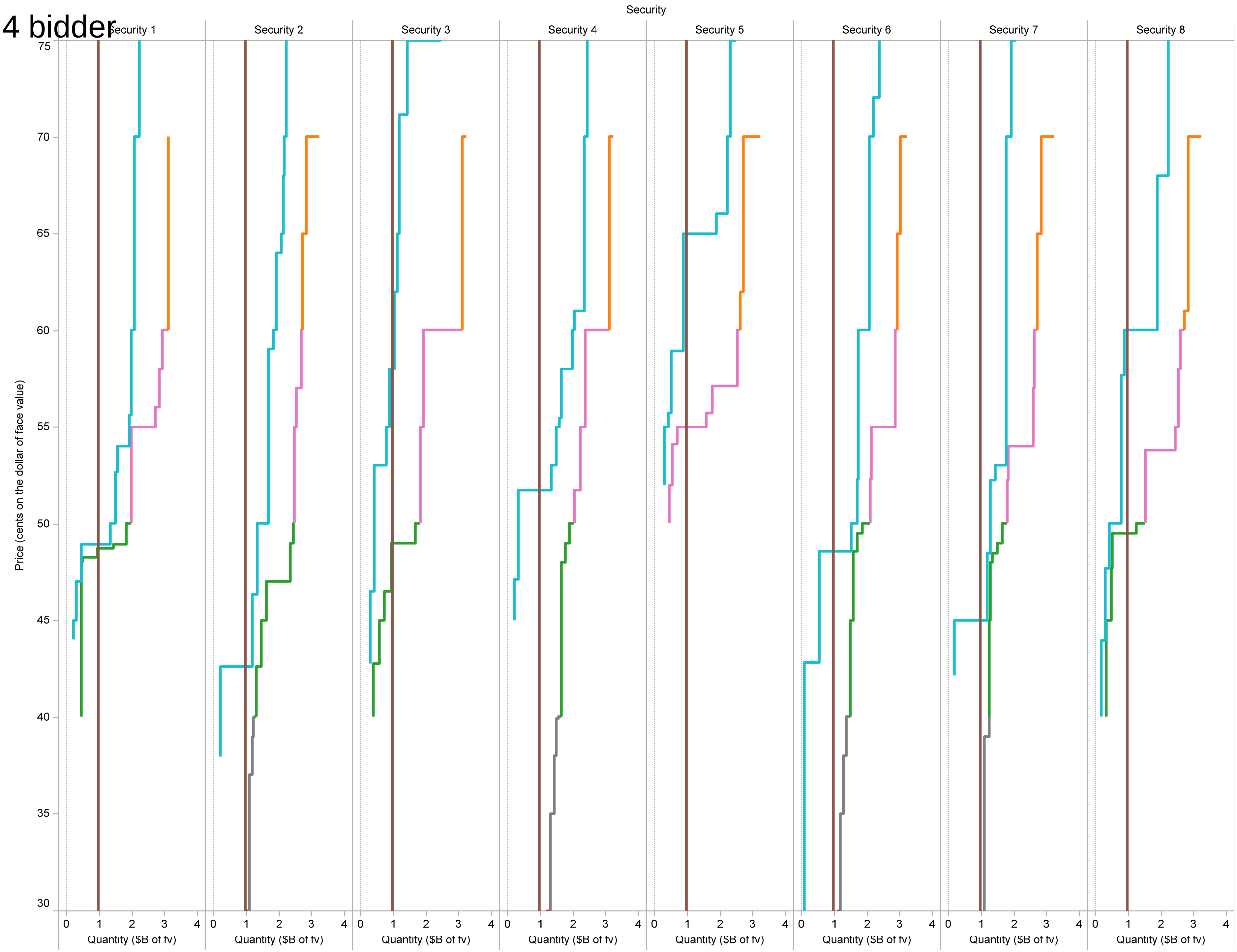

Day
Case
Day 1
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 2
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 3
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 4
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260
Standard deviation of liquidity bonus ($M)


Case
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
Standard deviation of liquidity bonus ($M)

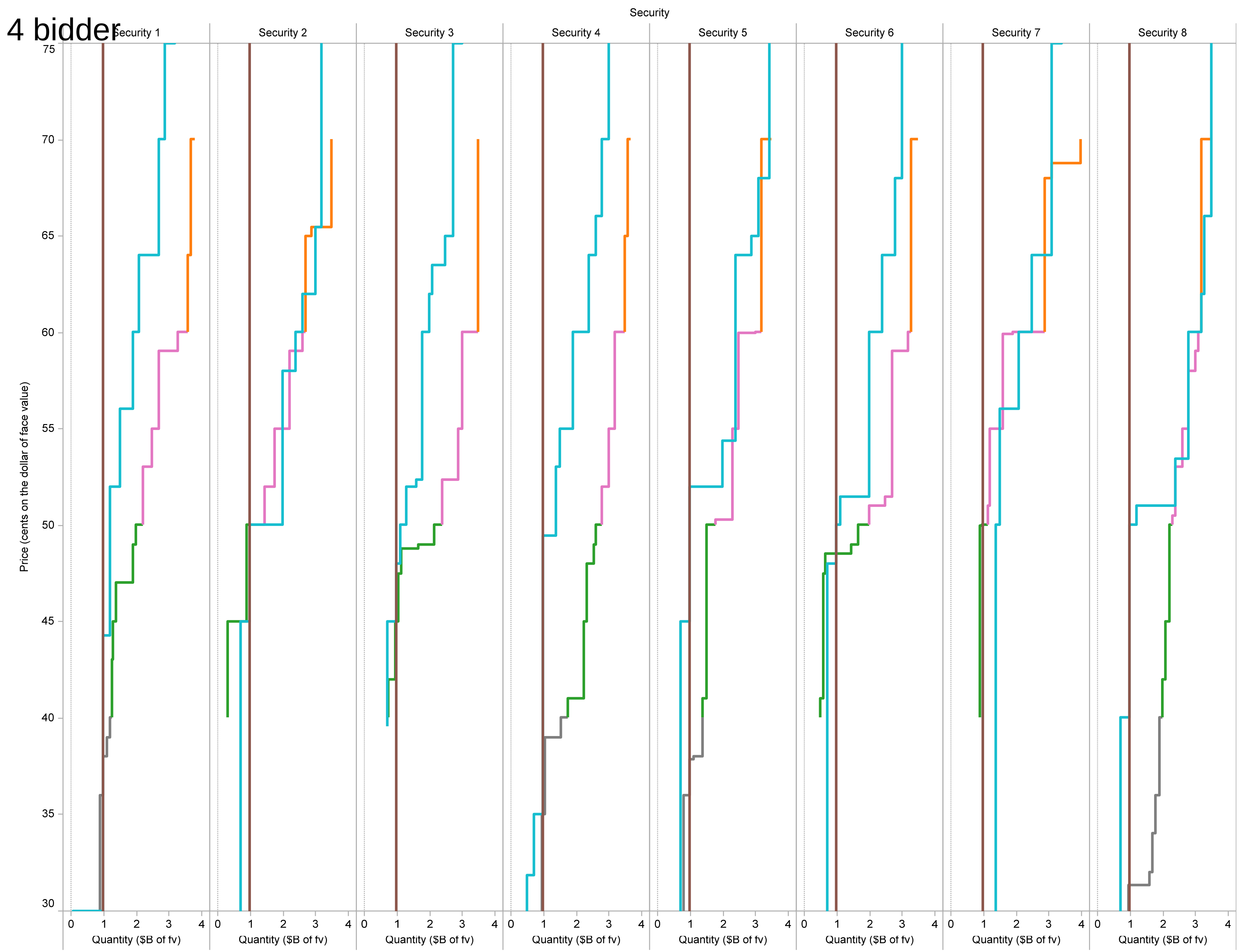

Day
Case
Day 1
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 2
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 3
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
Day 4
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
Standard deviation of payoff ($M)


Case
Sealed-bid 4
Clock 4
Sealed-bid 8
Clock 8
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
Standard deviation of payoff ($M)

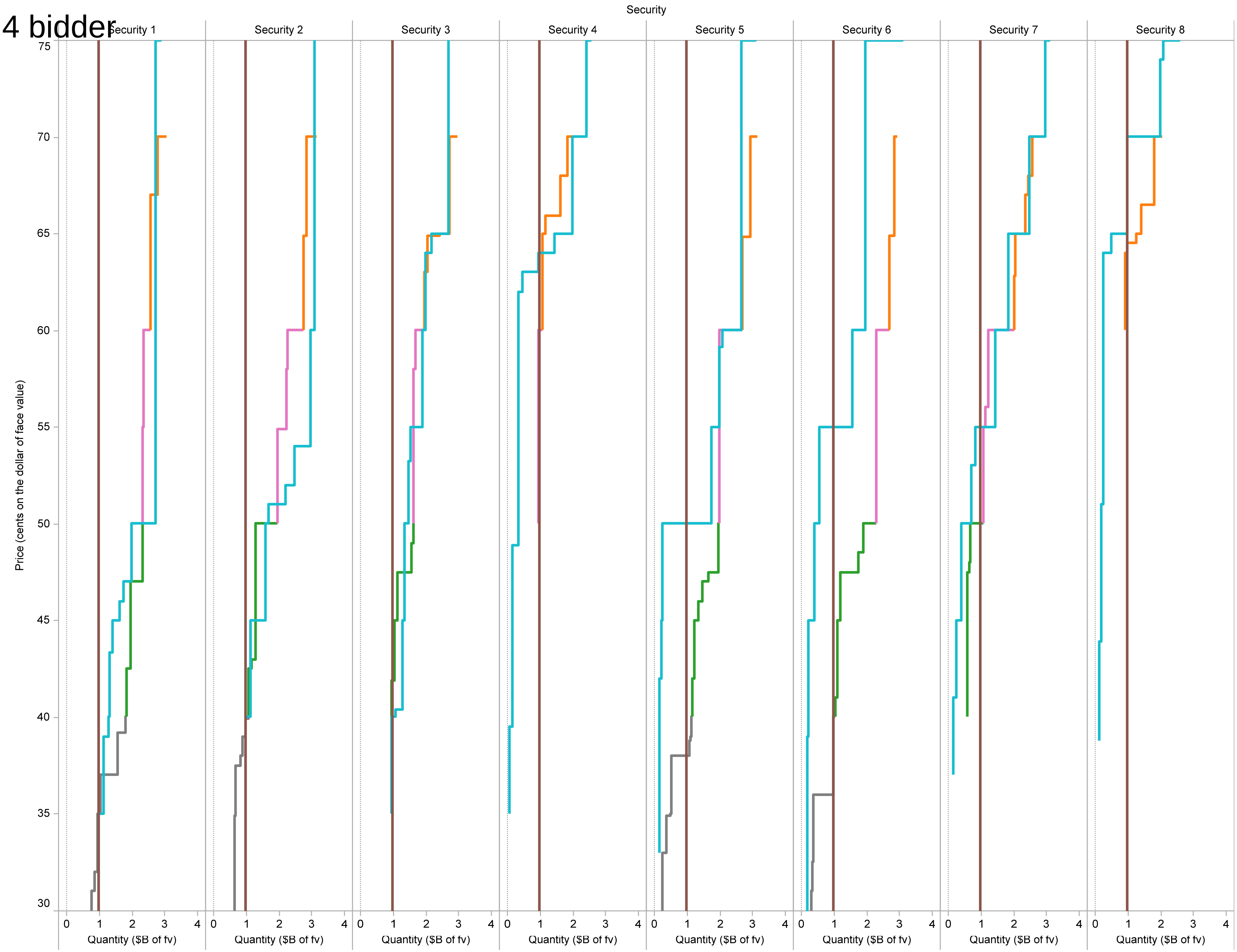
4 bidder



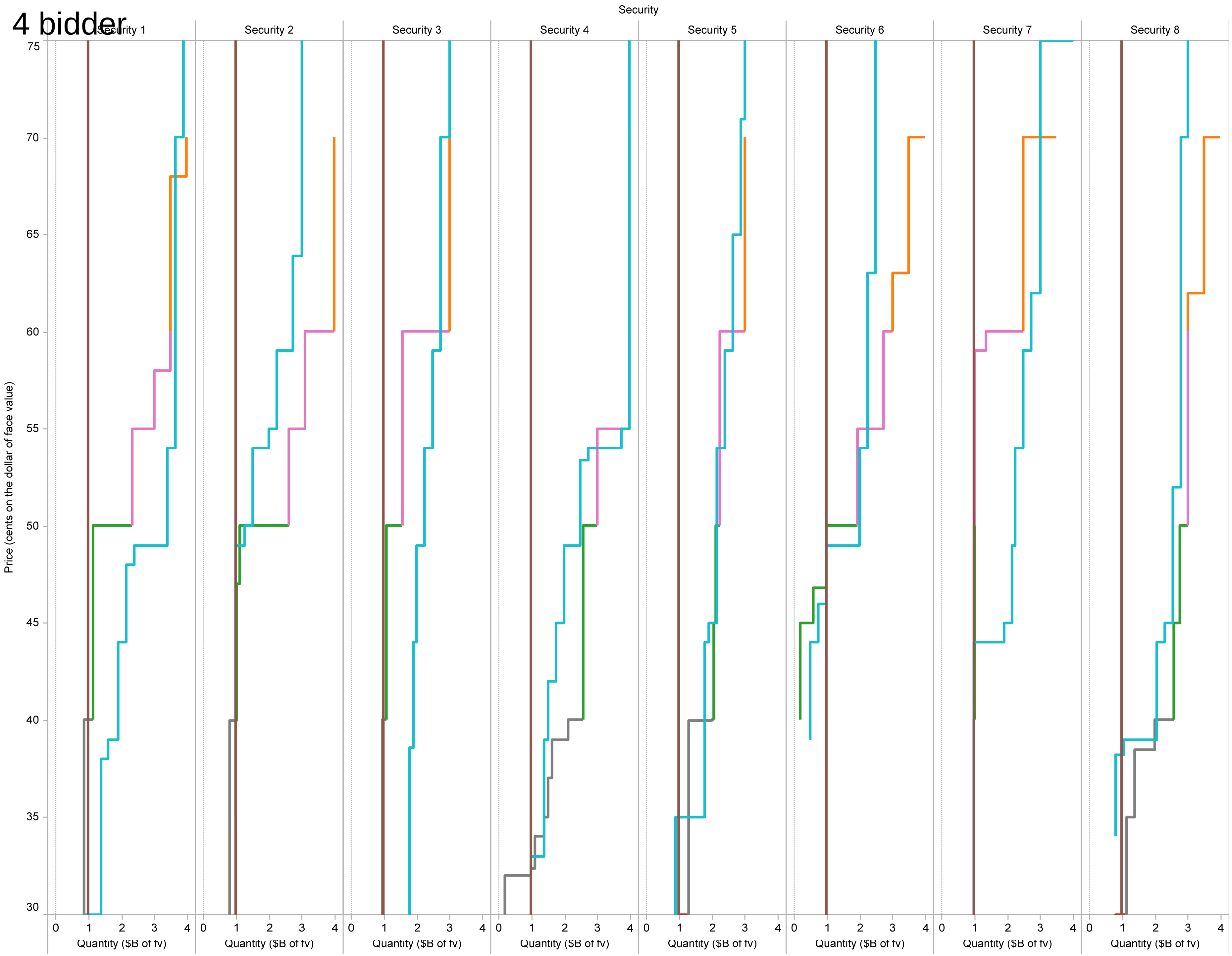
Security
Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
75
70
65
60
55
50
45
40
35
30
0
1
2
3
4
Quantity ($B of fv)


4 bidder
Security
Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
Quantity ($B of fv)

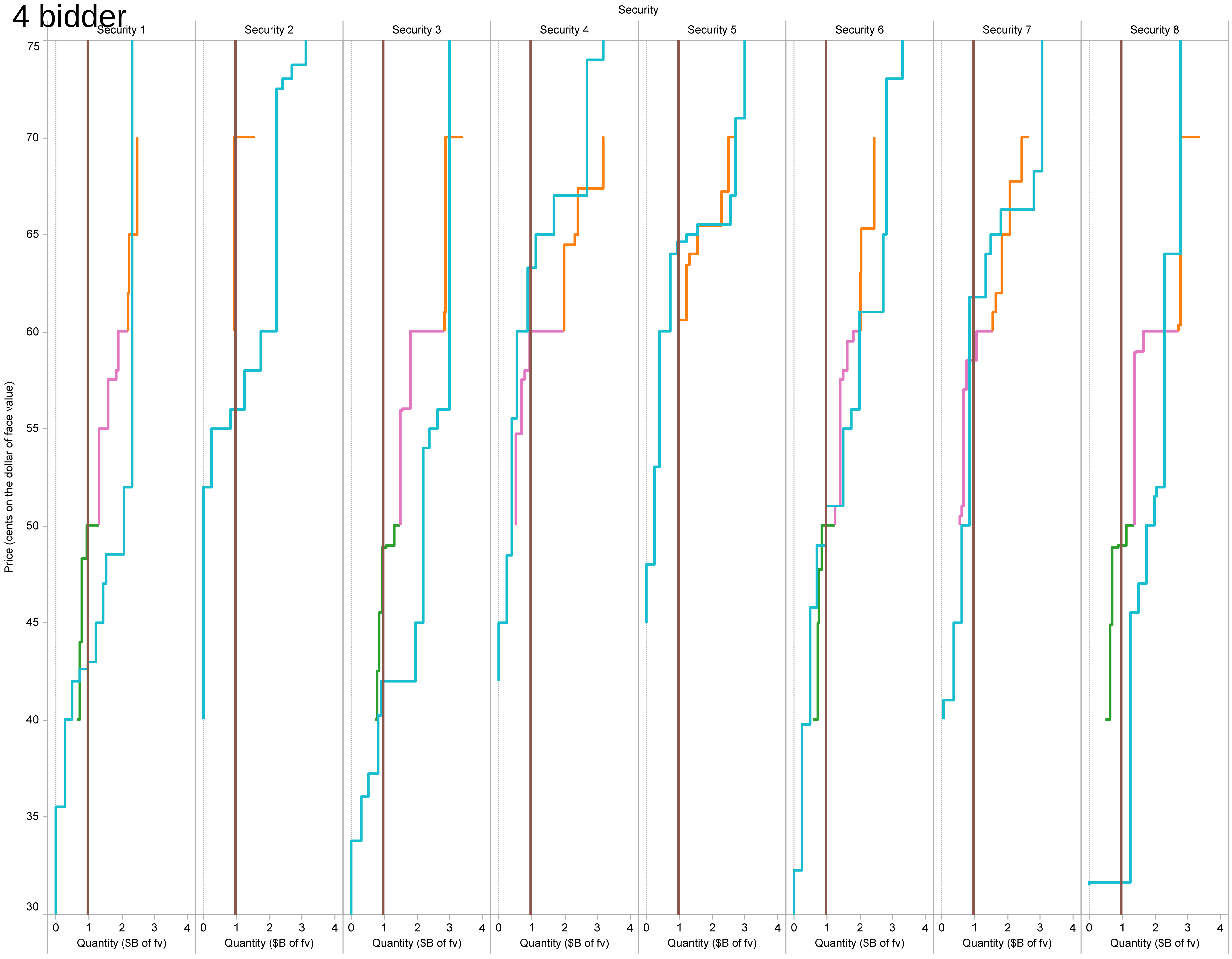
4 bidder

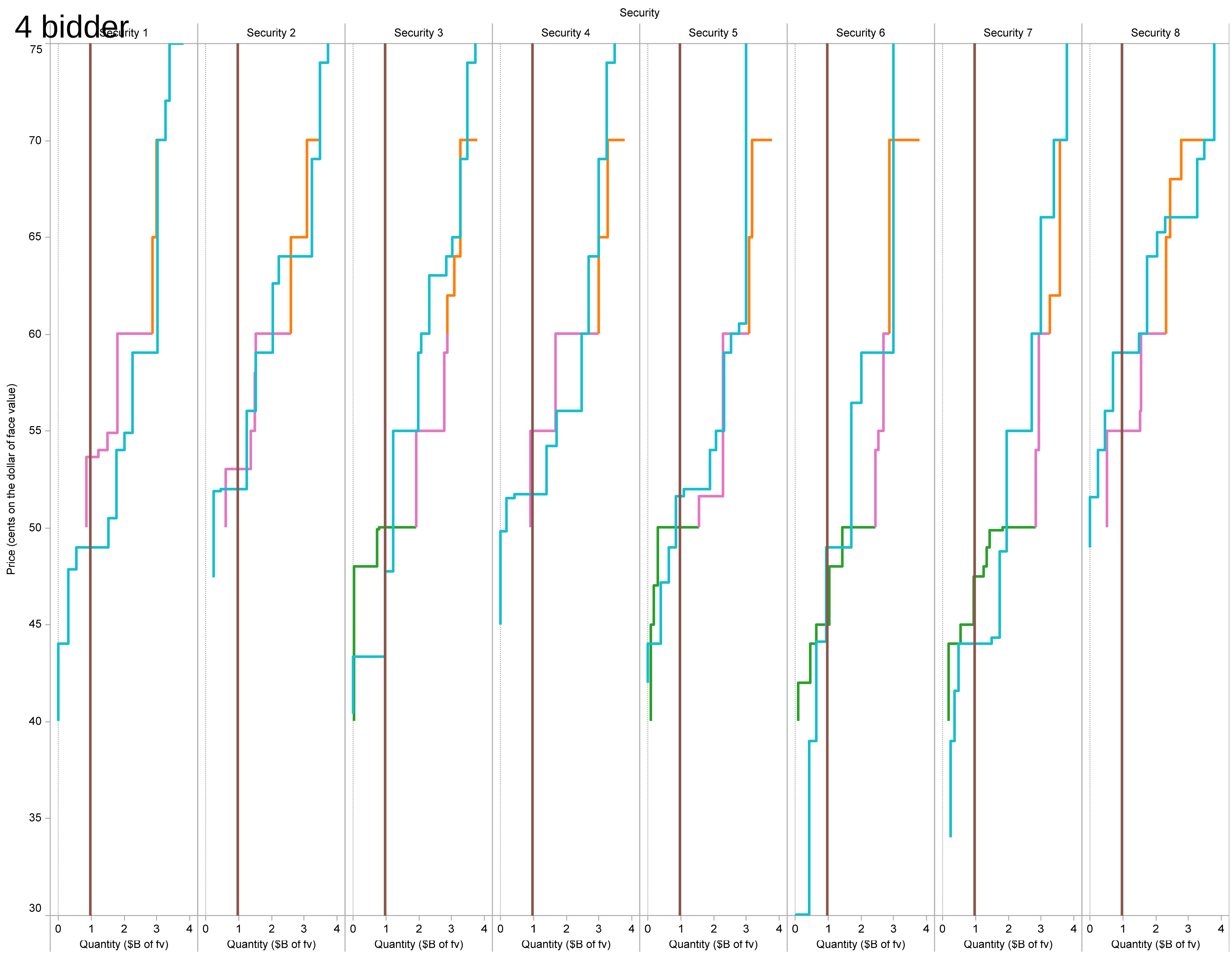

Security
Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
75
70
65
60
55
50
45
40
35
30
0 1 2 3 4
Quantity ($B of fv)

4 bidder

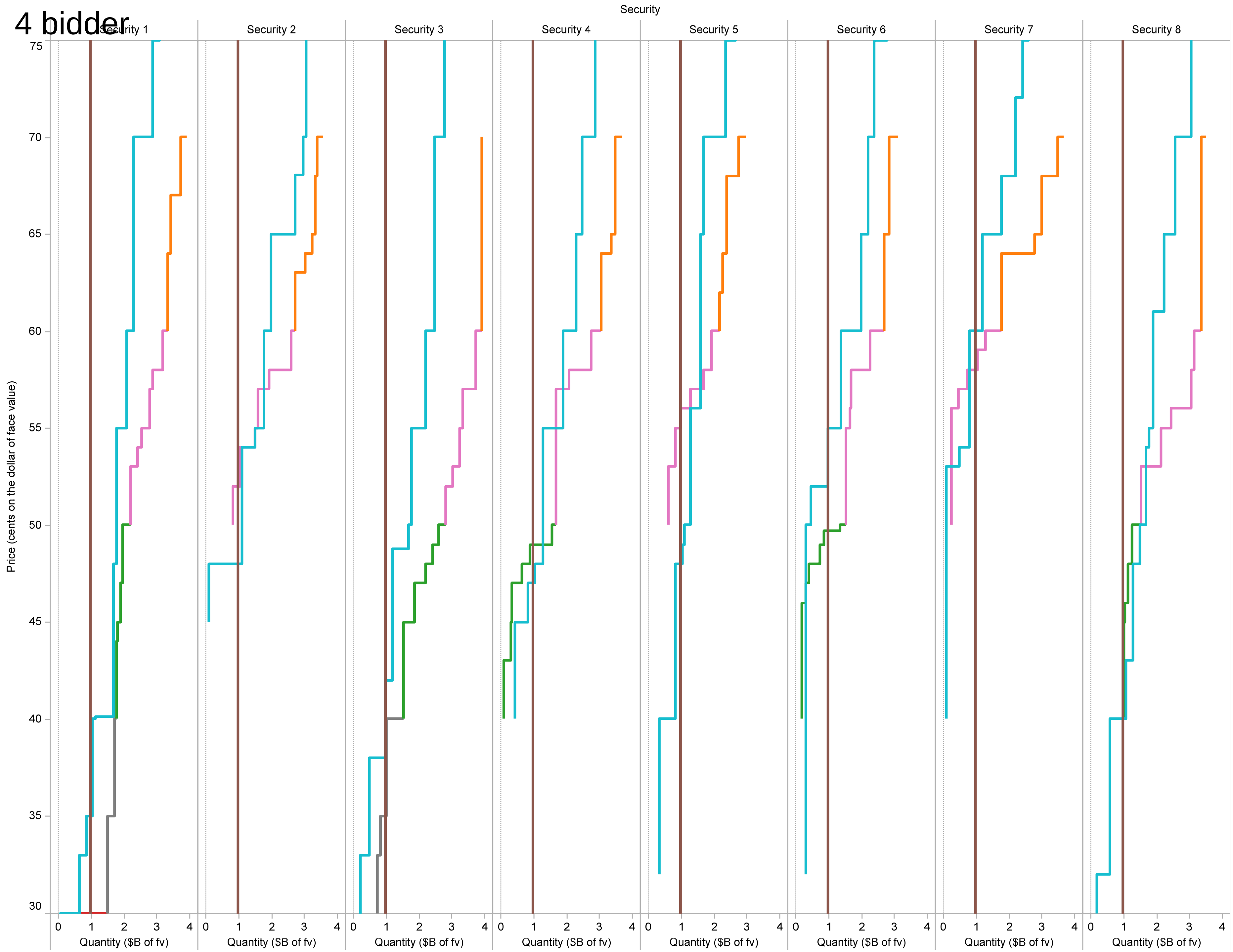

Security
Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
Quantity ($B of fv)

4 bidder

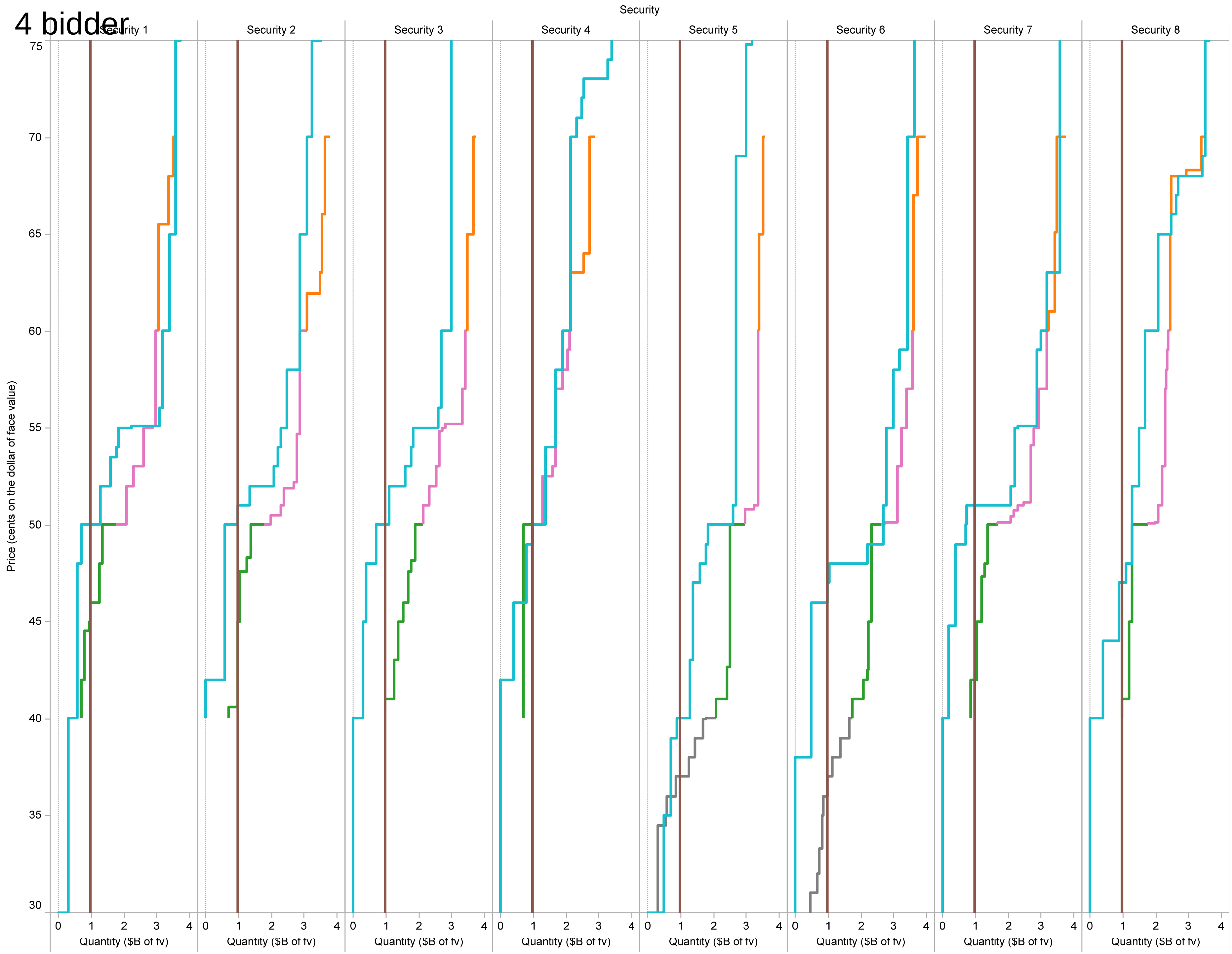

Security
Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
75
70
65
60
55
50
45
40
35
30
0 1 2 3 4
Quantity ($B of fv)


4 bidder
Security
Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
Quantity ($B of fv)

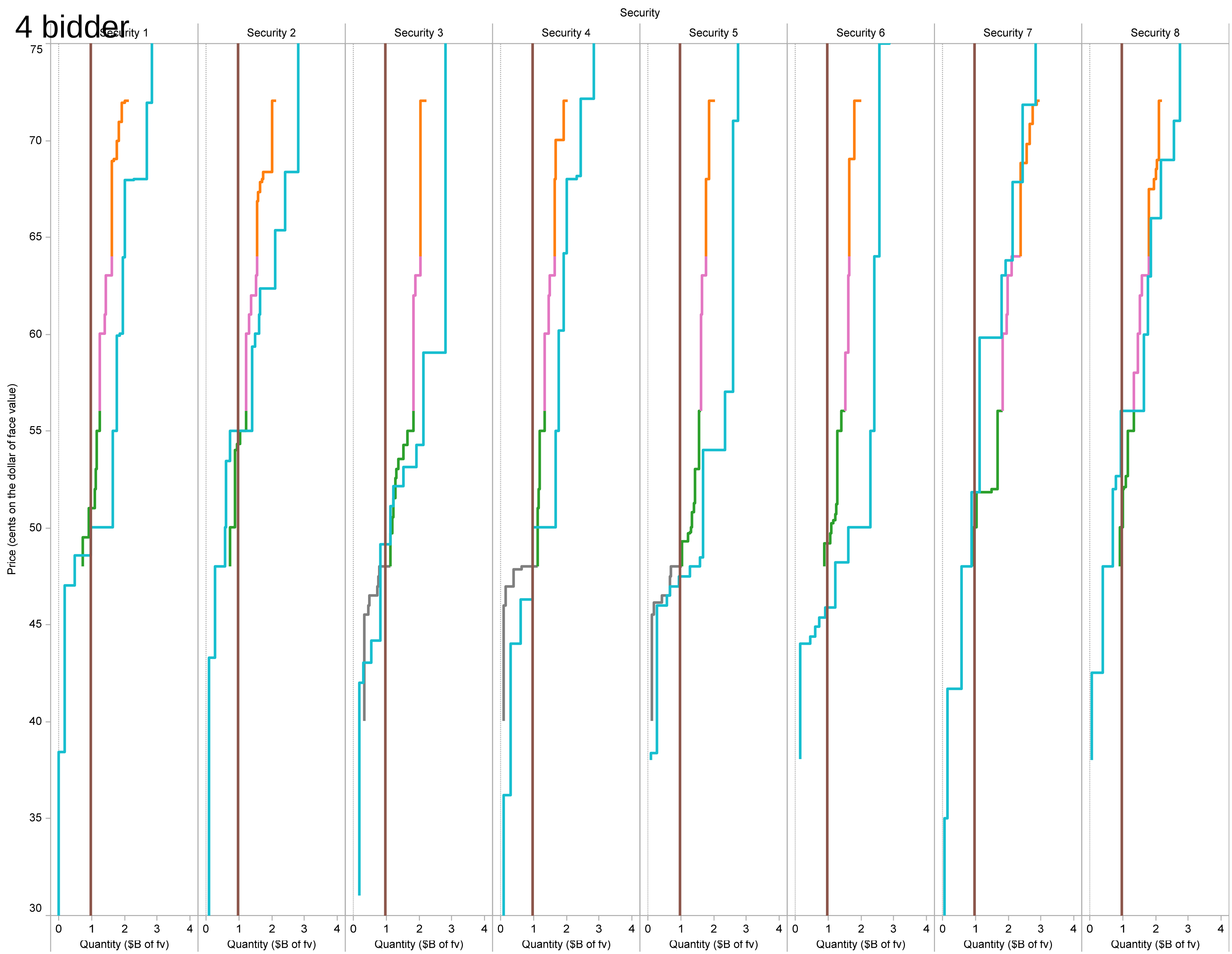
4 bidder

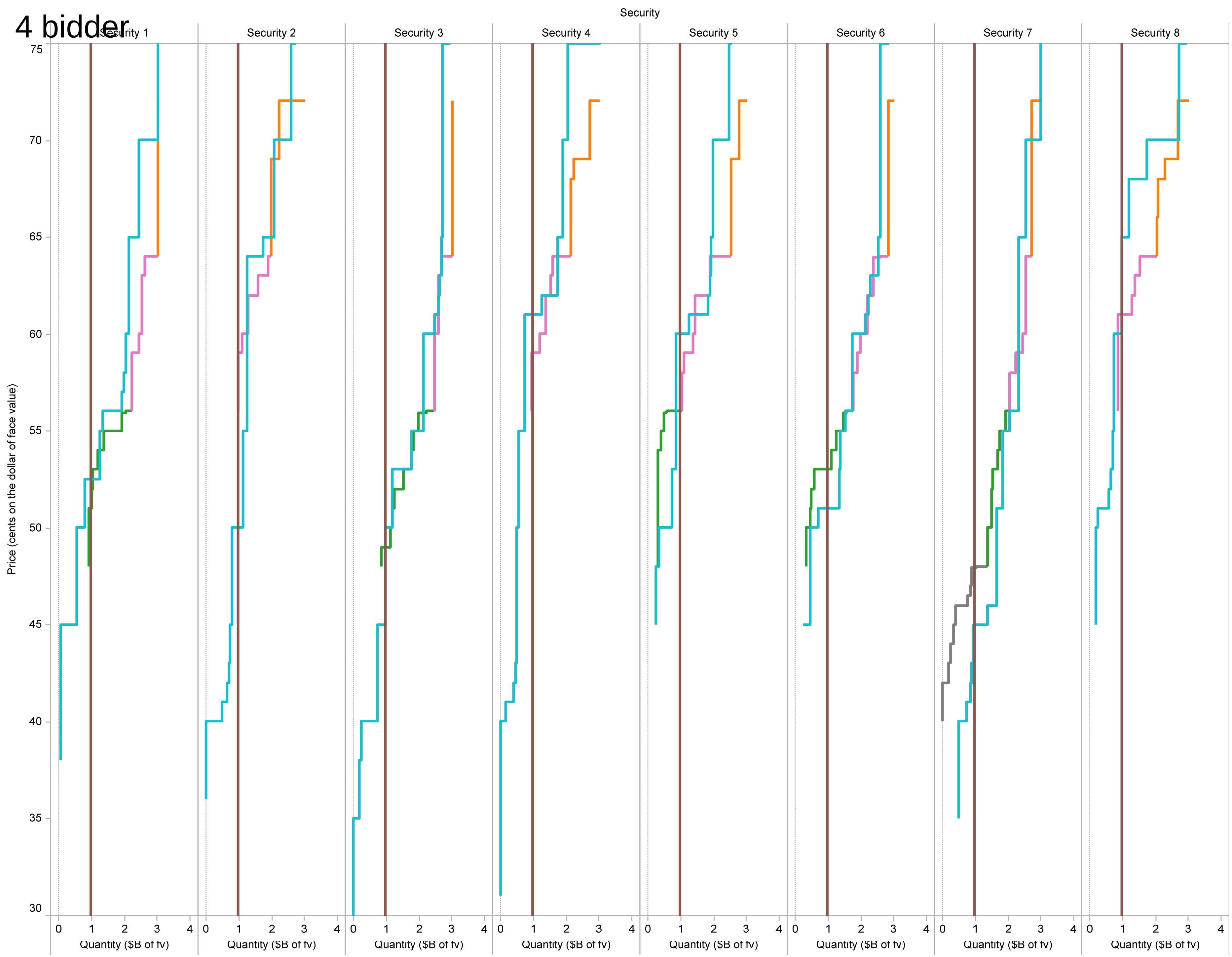


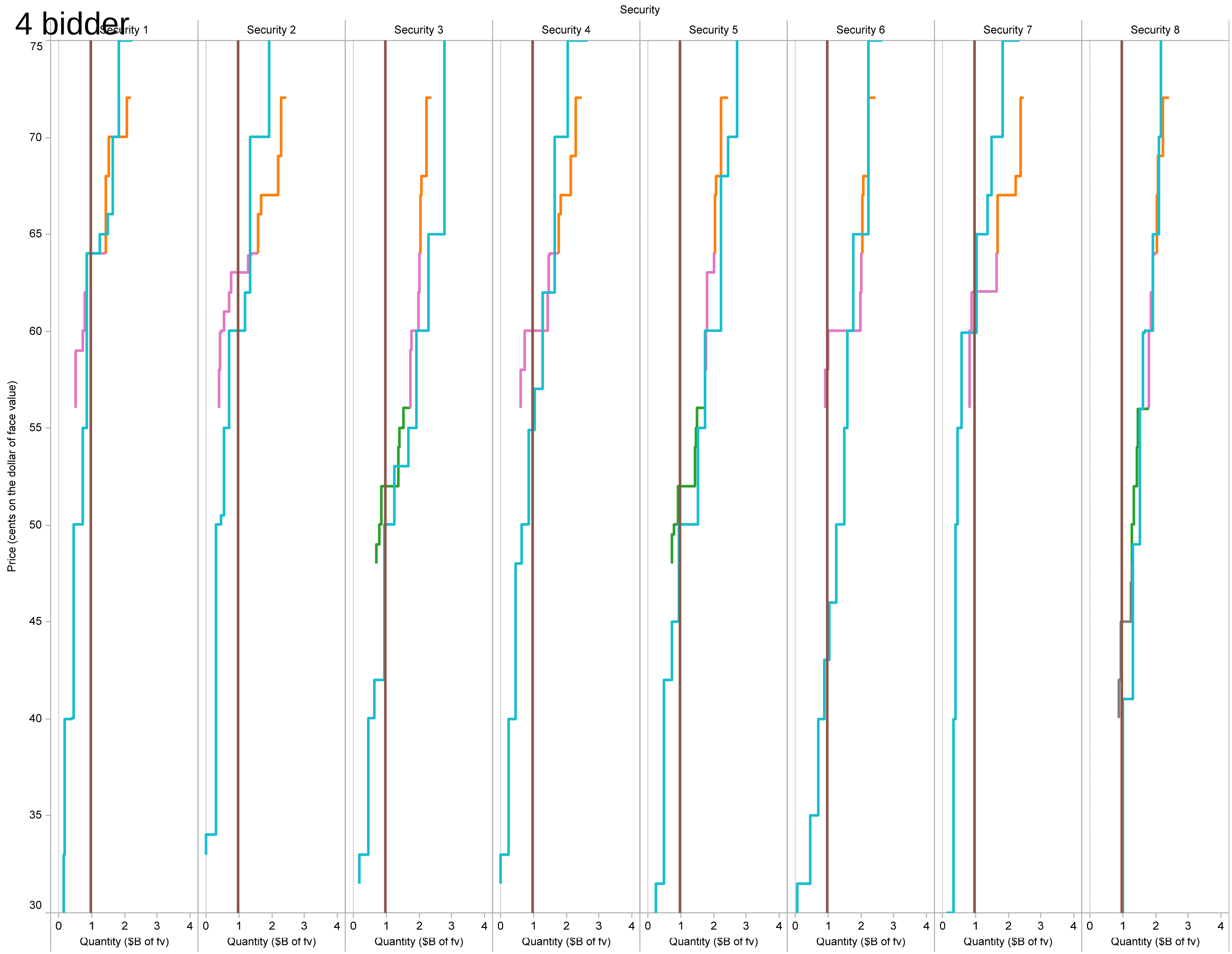
Security
Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
75
70
65
60
55
50
45
40
35
30
0
1
2
3
4
Quantity ($B of fv)



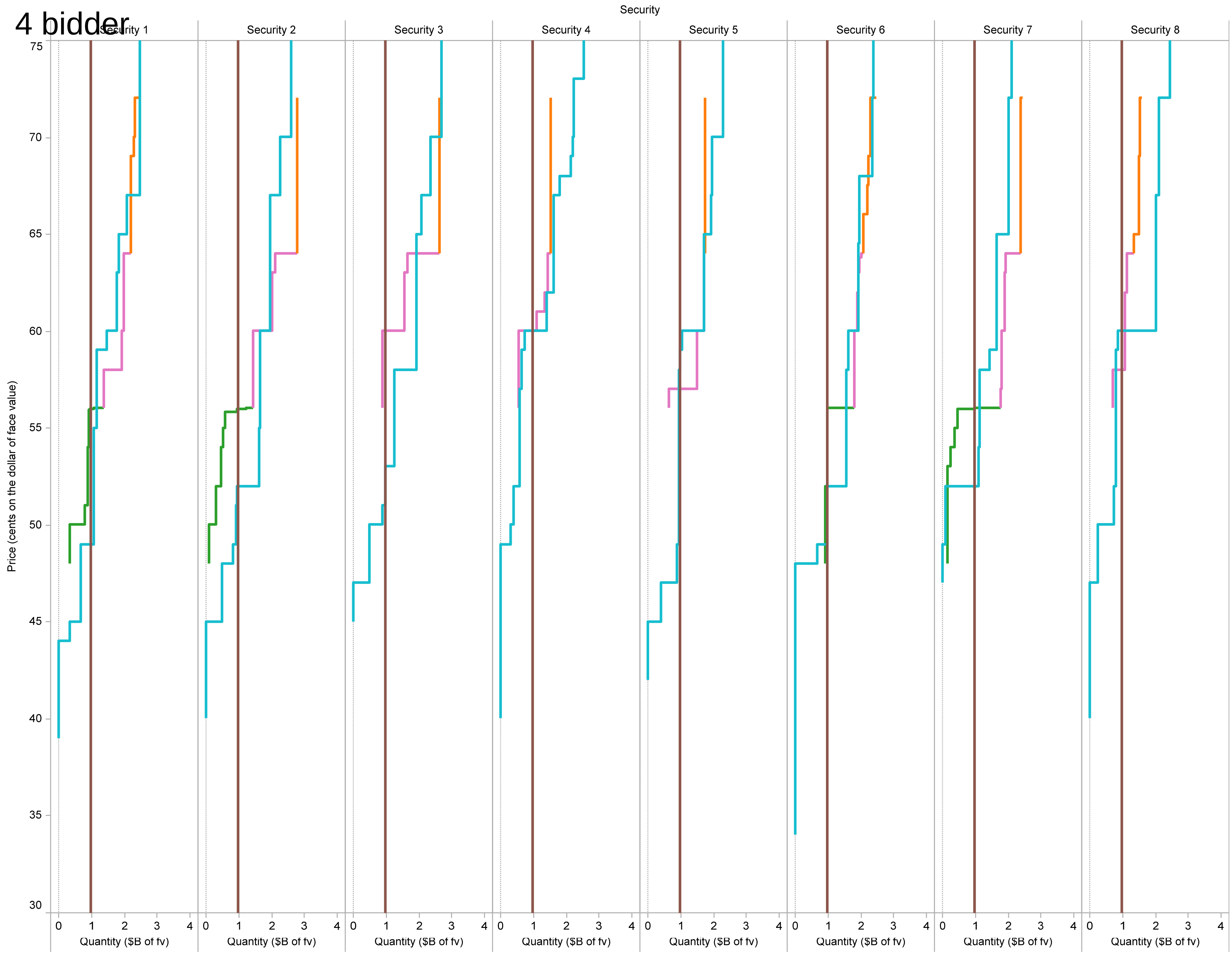
4 bidder
Security
Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
30
35
40
45
50
55
60
65
70
75
0 1 2 3 4
Quantity ($B of fv)


4 bidder
Security
Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
Quantity ($B of fv)

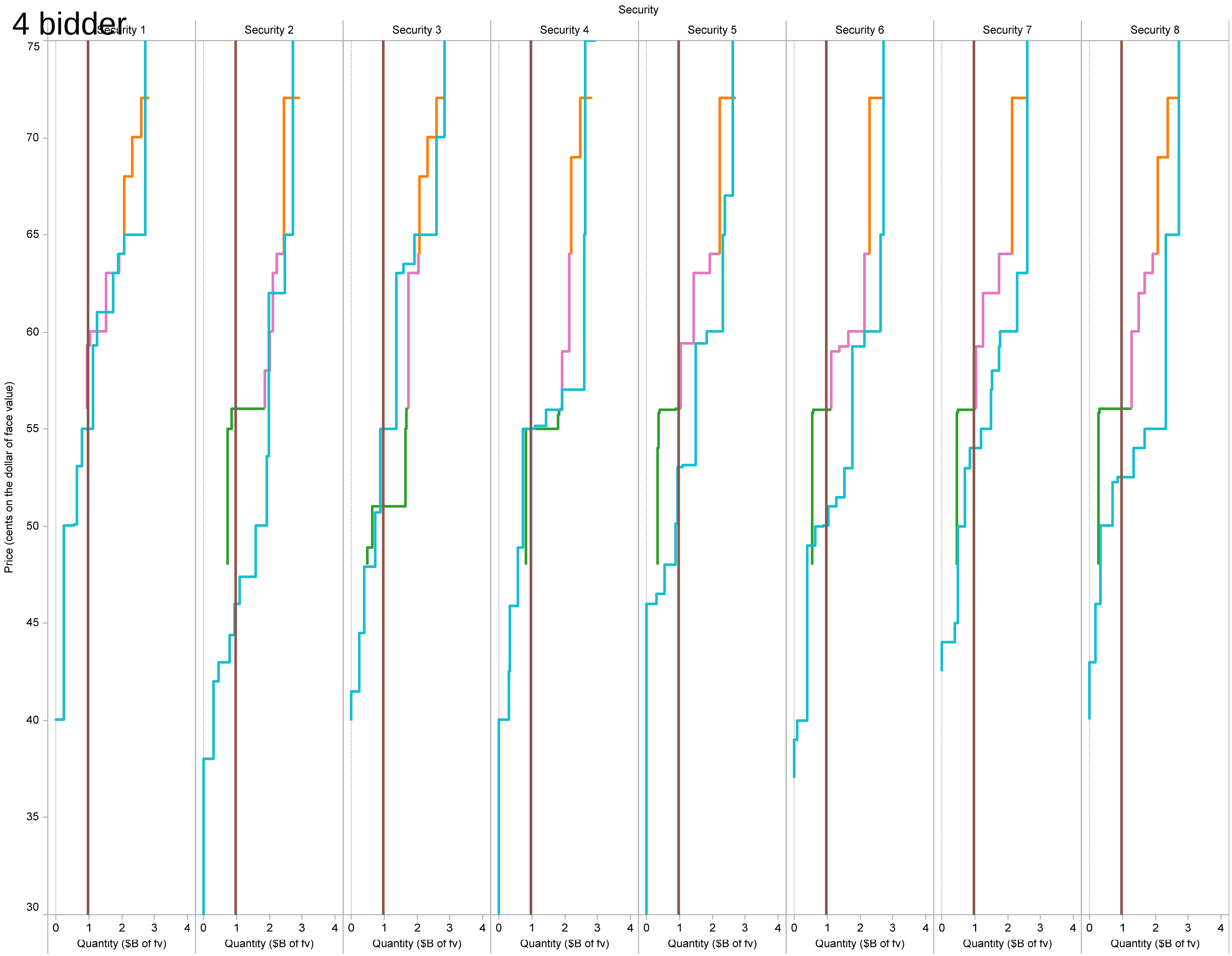

4 bidder
Security
Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
75
70
65
60
55
50
45
40
35
30
0 1 2 3 4
Quantity ($B of fv)



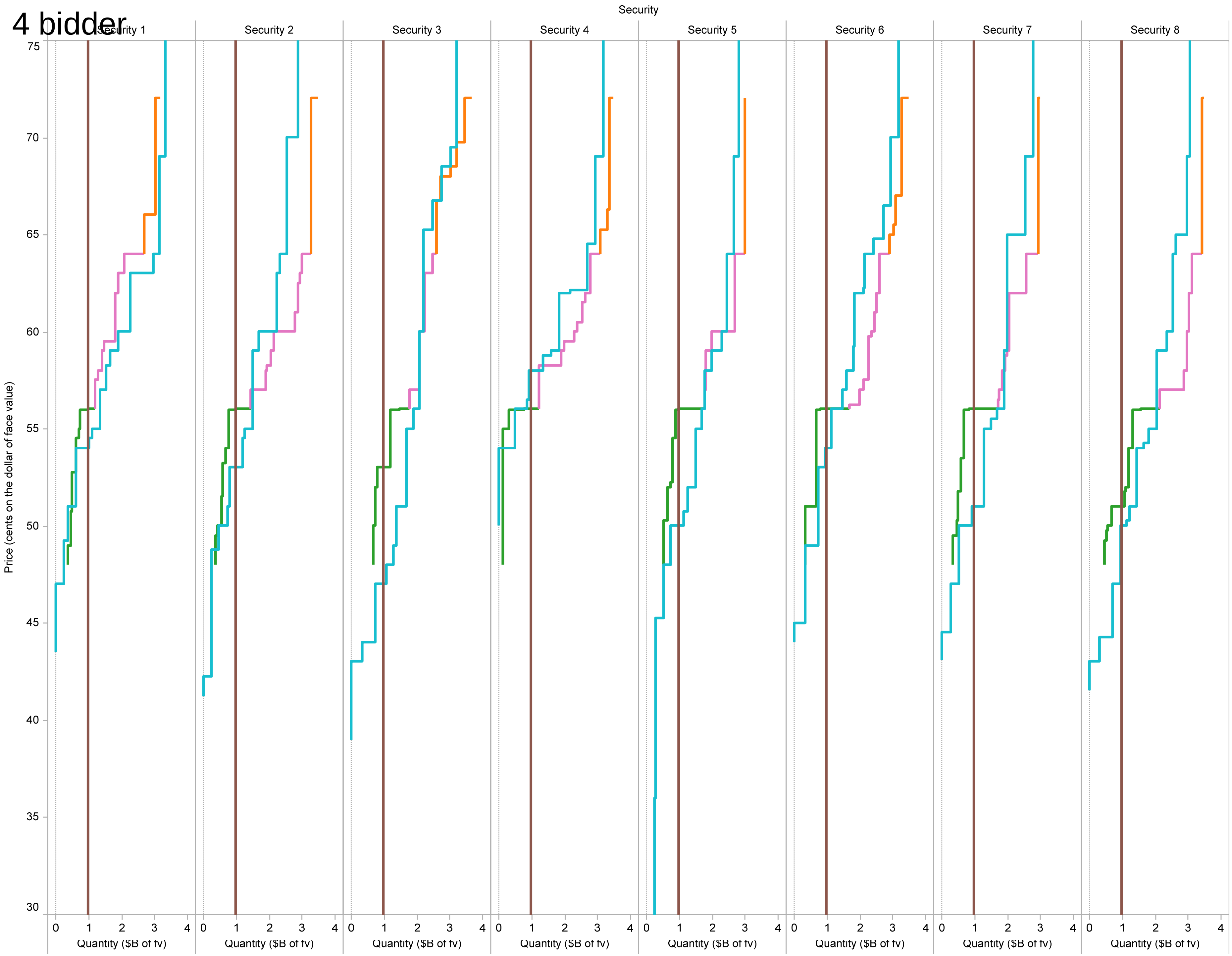
4 bidder
Security
Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
75
70
65
60
55
50
45
40
35
30
0
1
2
3
4
Quantity ($B of fv)


4 bidder
Security
Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
75
70
65
60
55
50
45
40
35
30
0
1
2
3
4
Quantity ($B of fv)

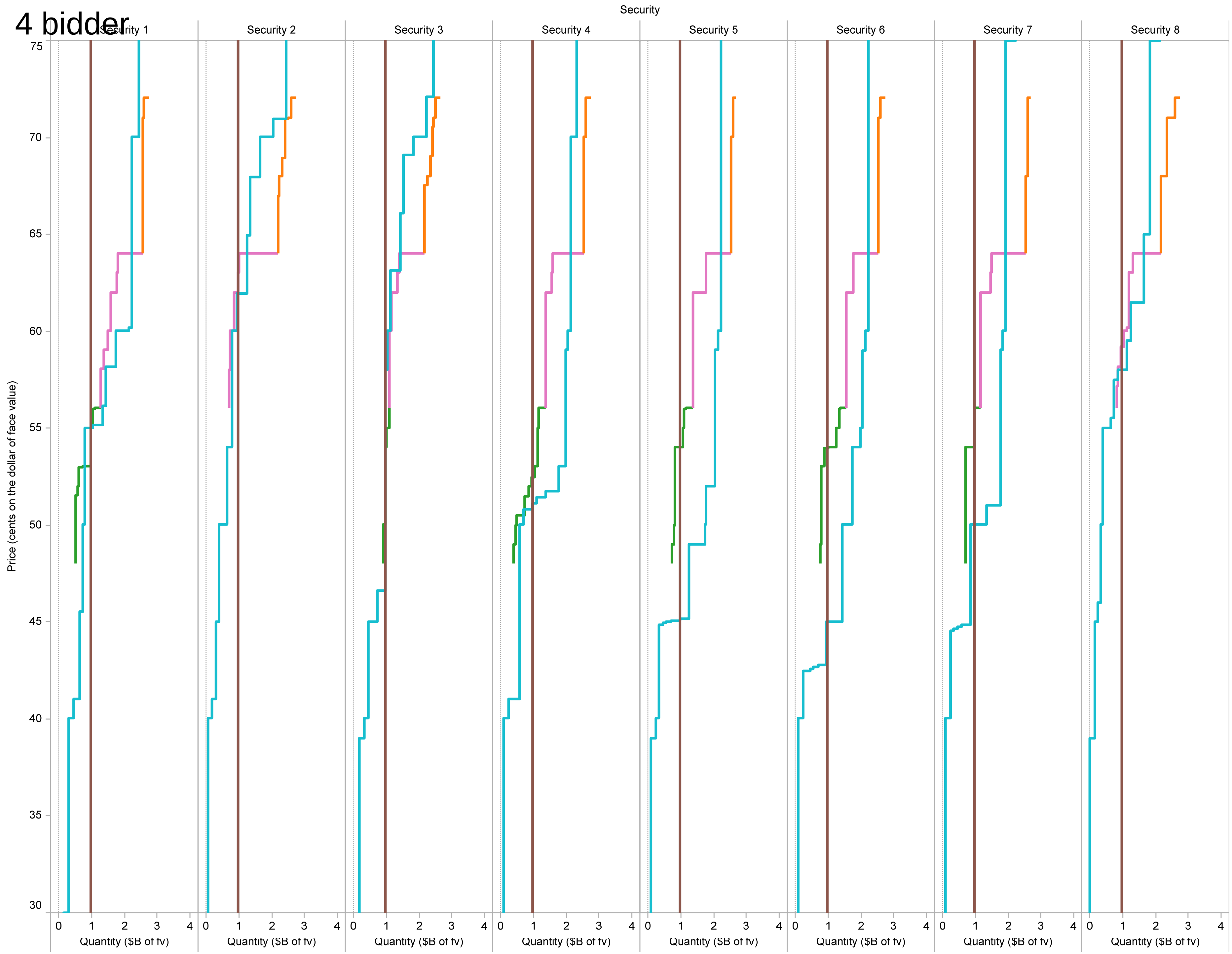
4 bidder


Security
Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
75
70
65
60
55
50
45
40
35
30
0 1 2 3 4
Quantity ($B of fv)

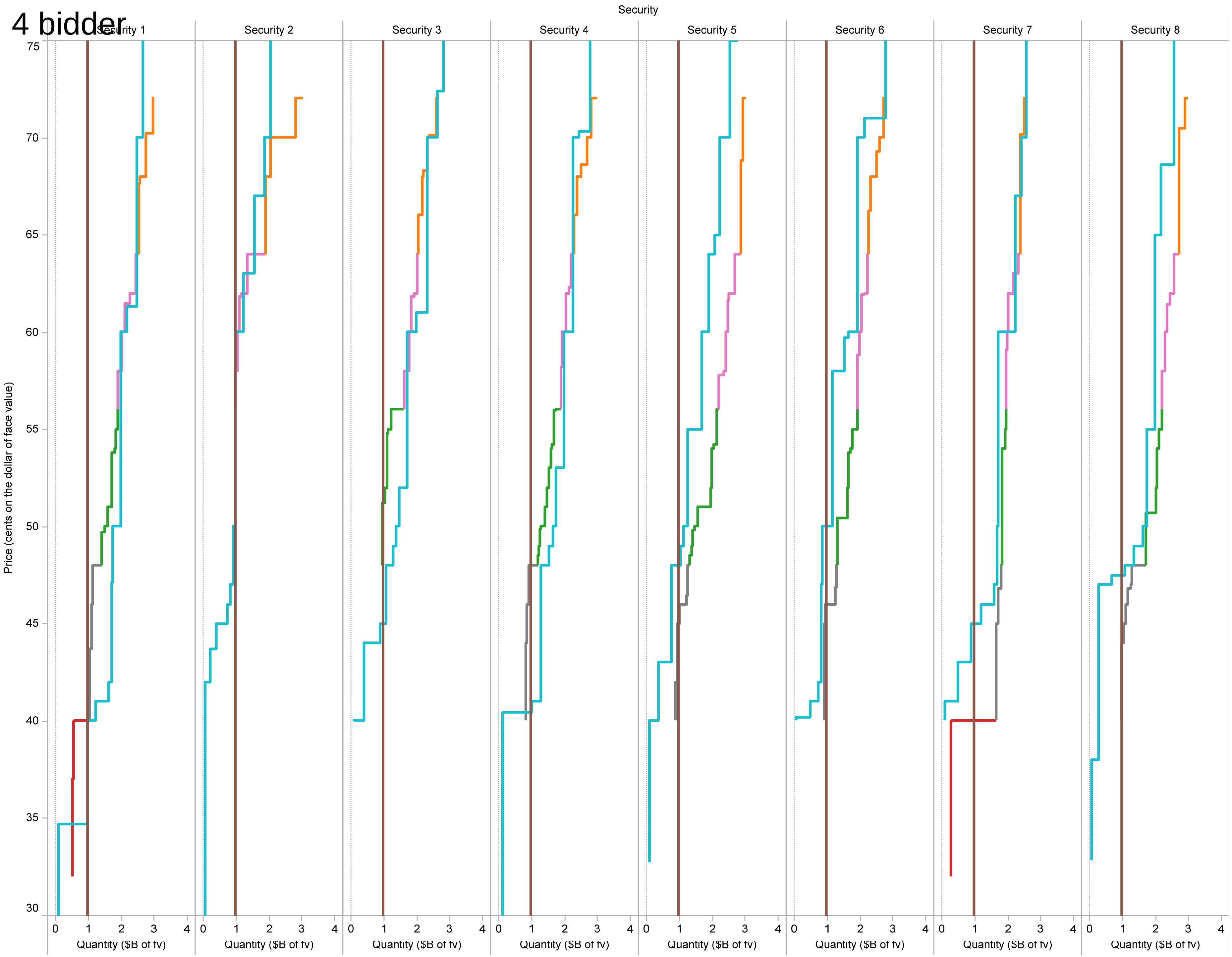
4 bidder



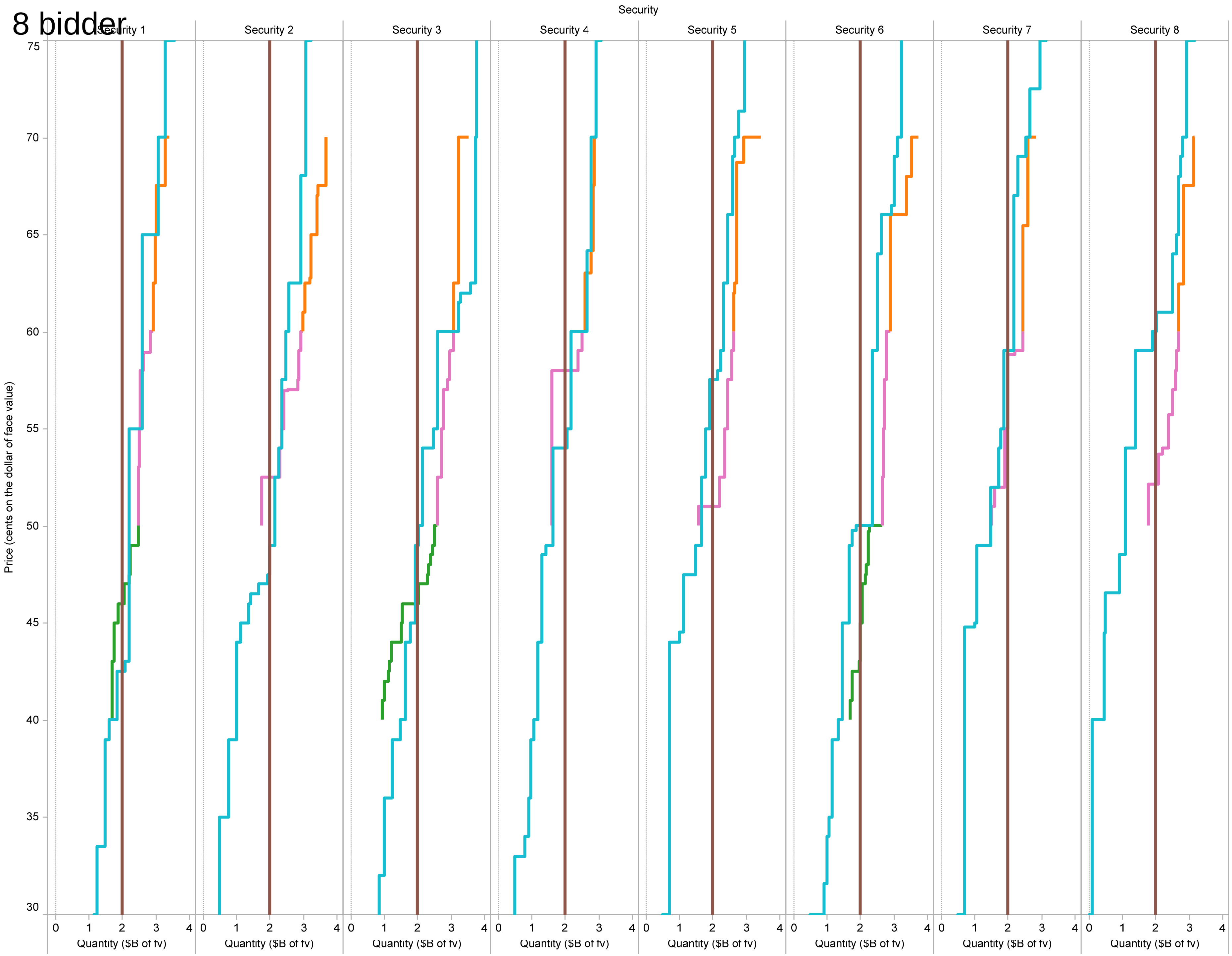
Security
Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
75
70
65
60
55
50
45
40
35
30
0 1 2 3 4
Quantity ($B of fv)


4 bidder
Security
Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
Quantity ($B of fv)

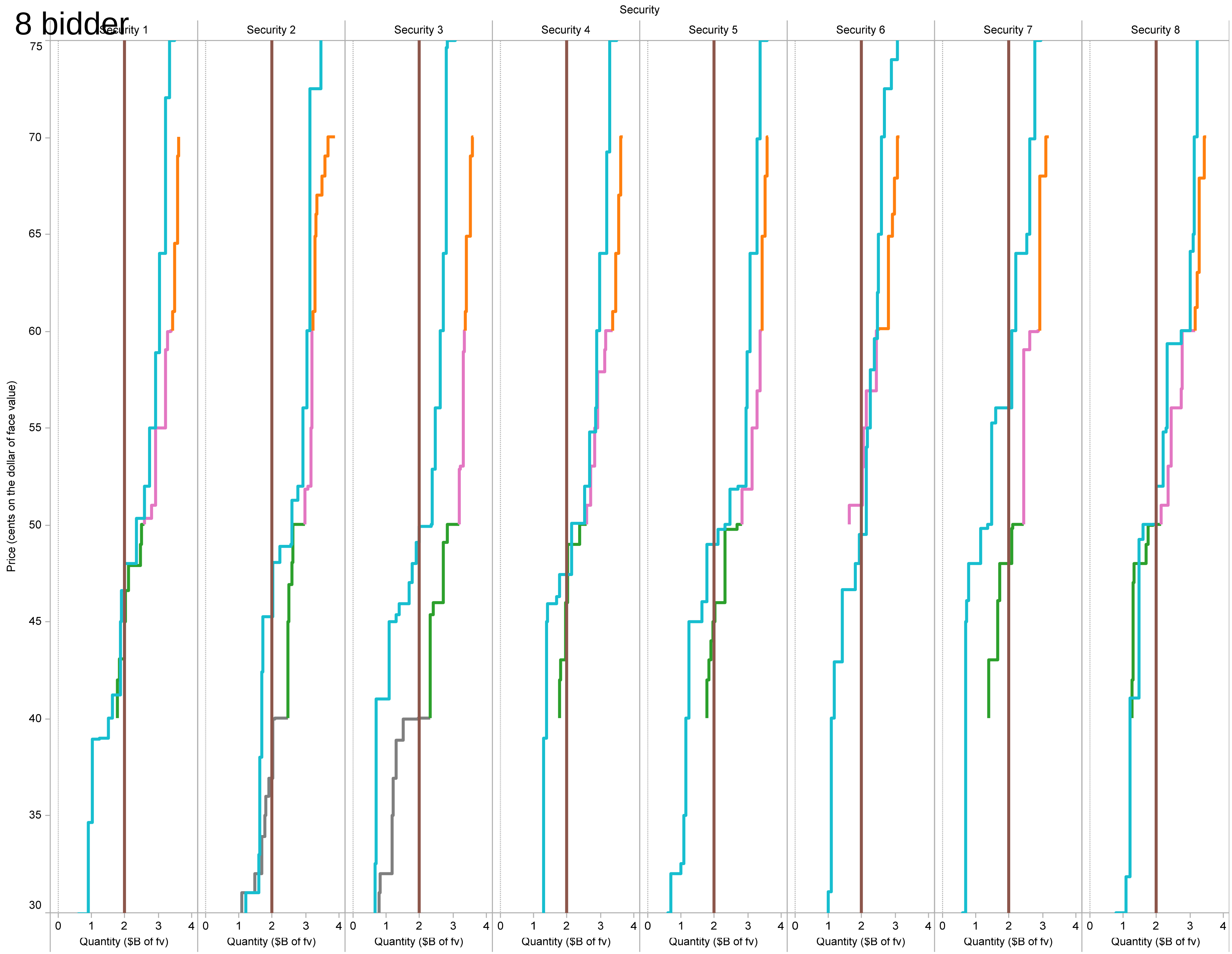
4 bidder


Security
Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
75
70
65
60
55
50
45
40
35
30
0 1 2 3 4
Quantity ($B of fv)

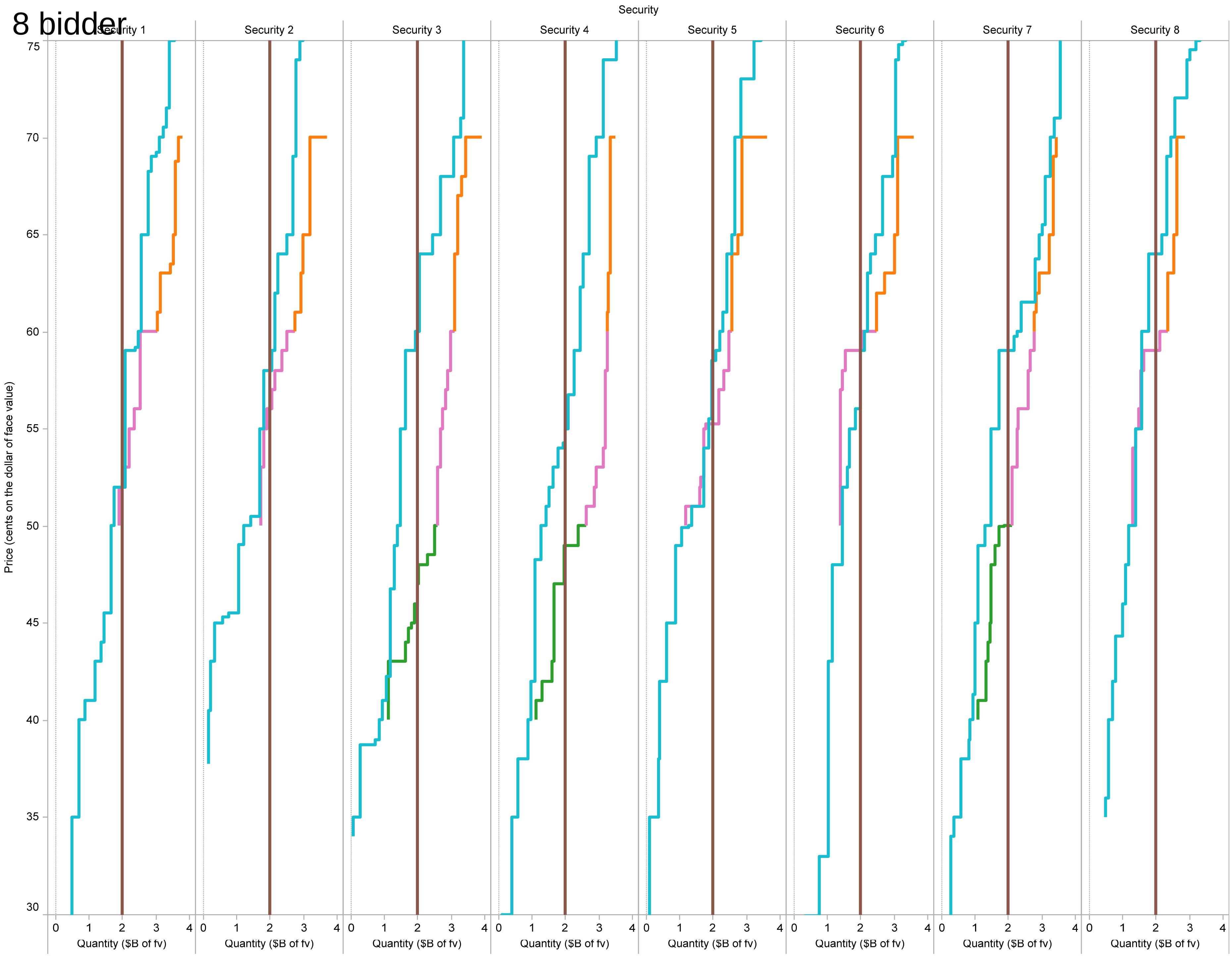
8 bidder



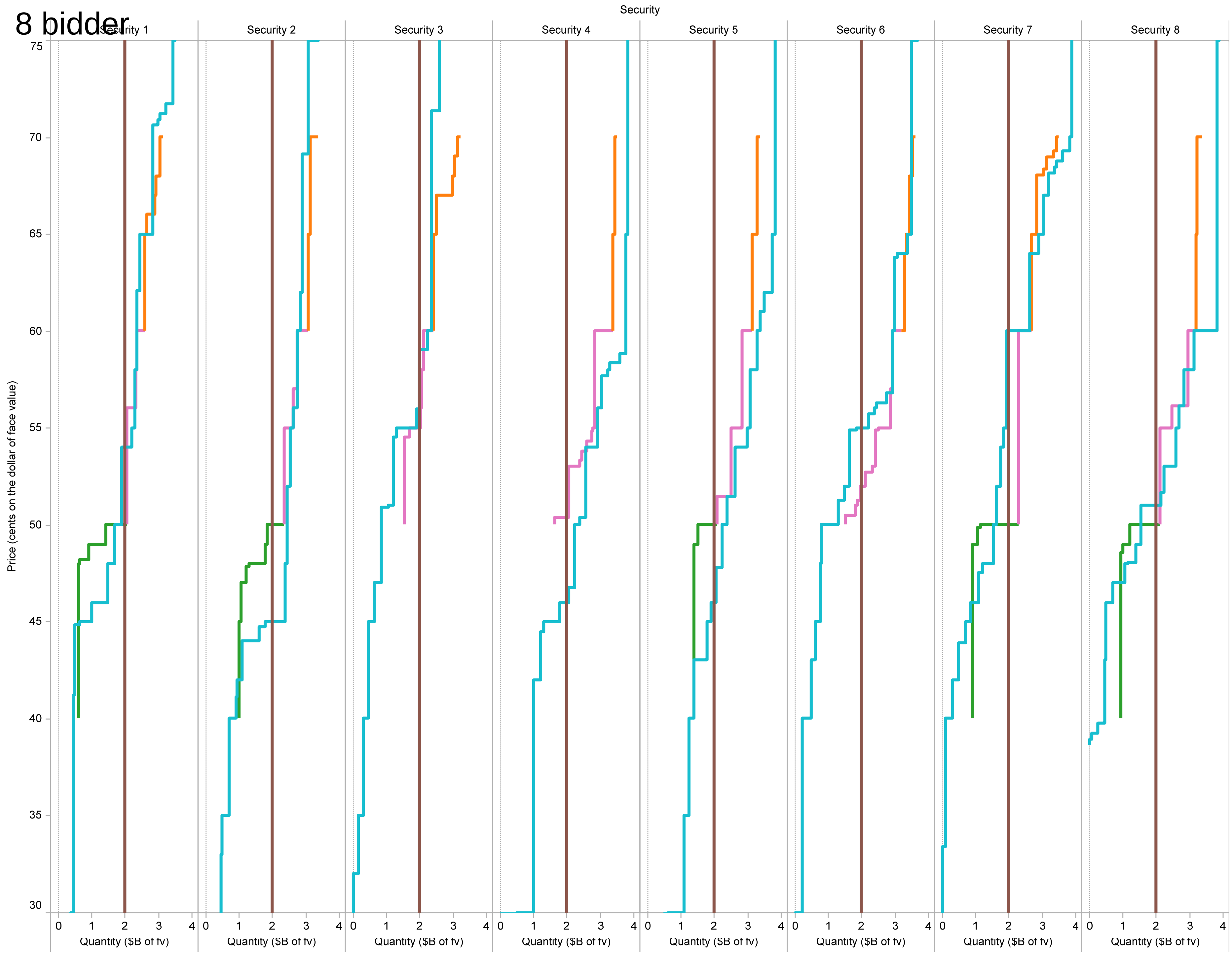
Security
Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
75
70
65
60
55
50
45
40
35
30
0 1 2 3 4
Quantity ($B of fv)


8 bidder
Security
Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
75
70
65
60
55
50
45
40
35
30
0 1 2 3 4
Quantity ($B of fv)

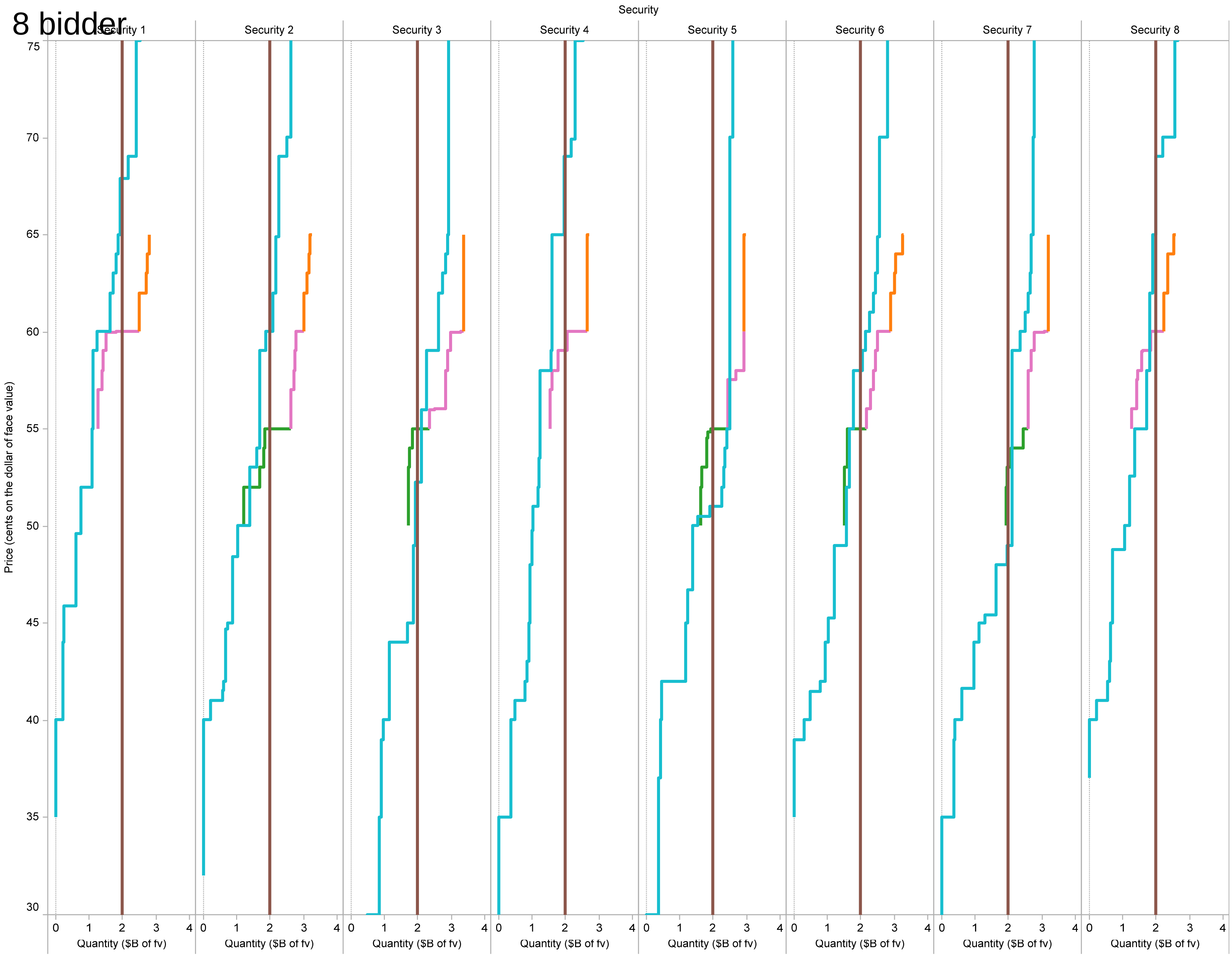
8 bidder



Security
Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
75
70
65
60
55
50
45
40
35
30
0 1 2 3 4
Quantity ($B of fv)

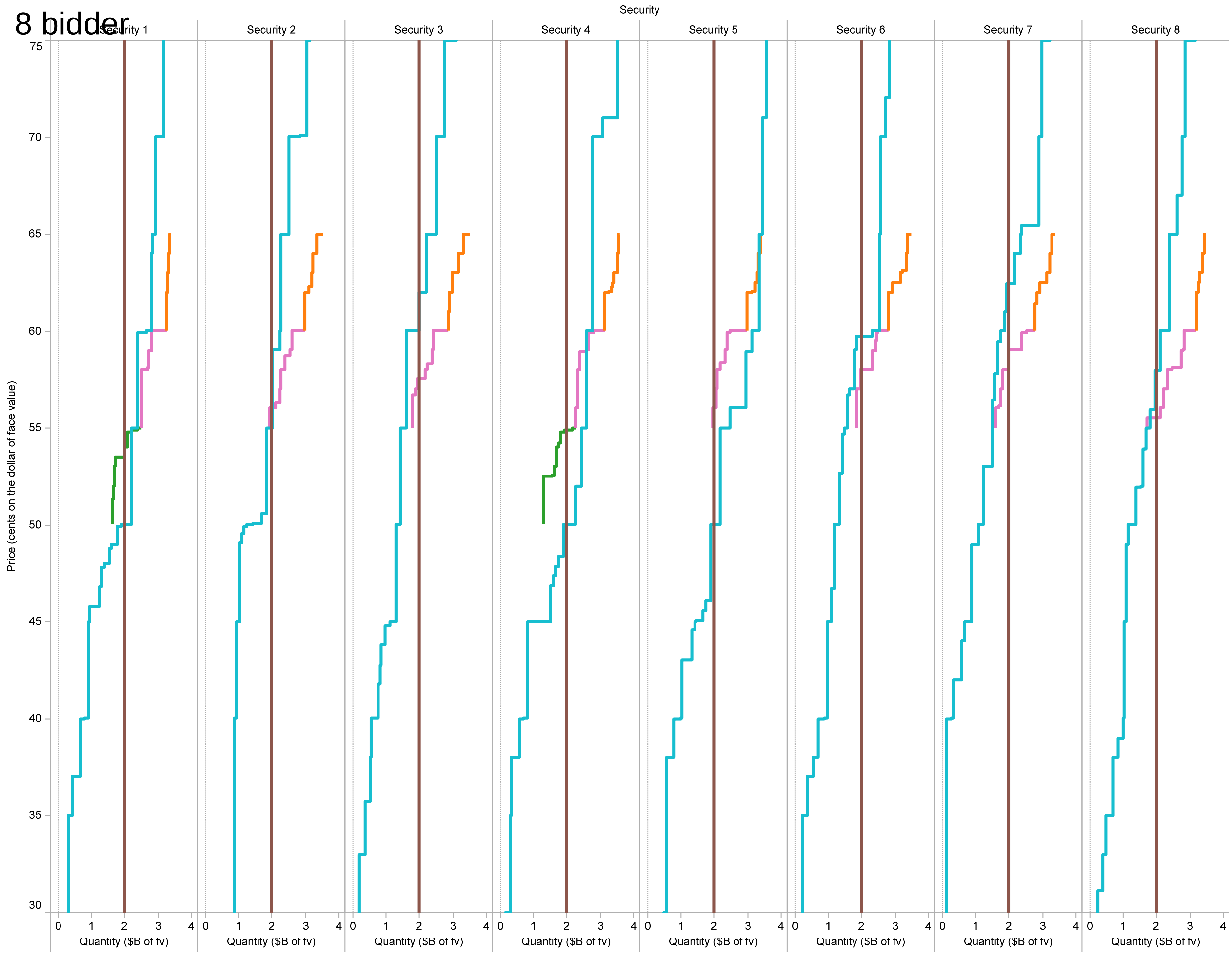


8 bidder
Security
Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
75
70
65
60
55
50
45
40
35
30
0 1 2 3 4
Quantity ($B of fv)

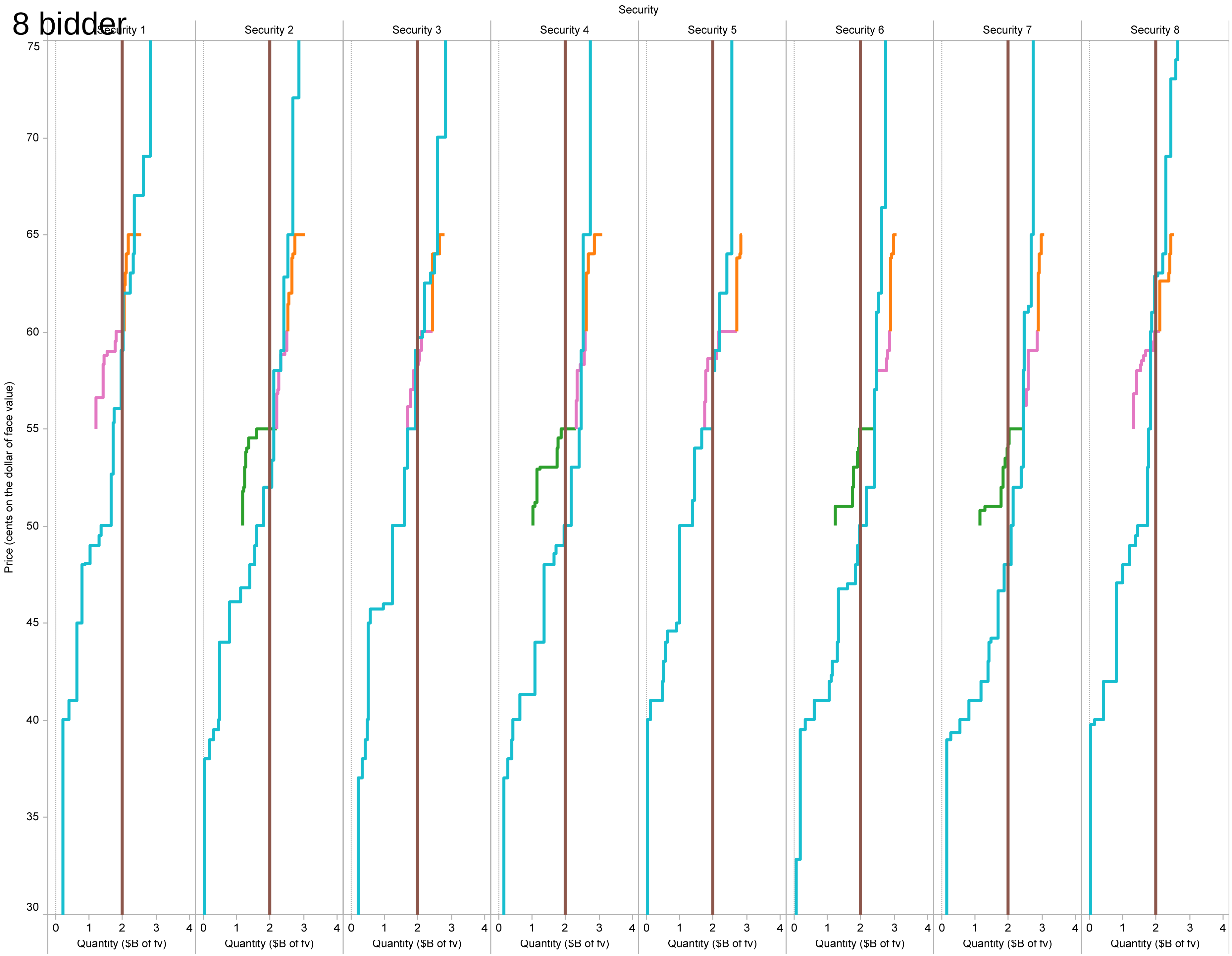


8 bidder
Security
Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
75
70
65
60
55
50
45
40
35
30
0 1 2 3 4
Quantity ($B of fv)

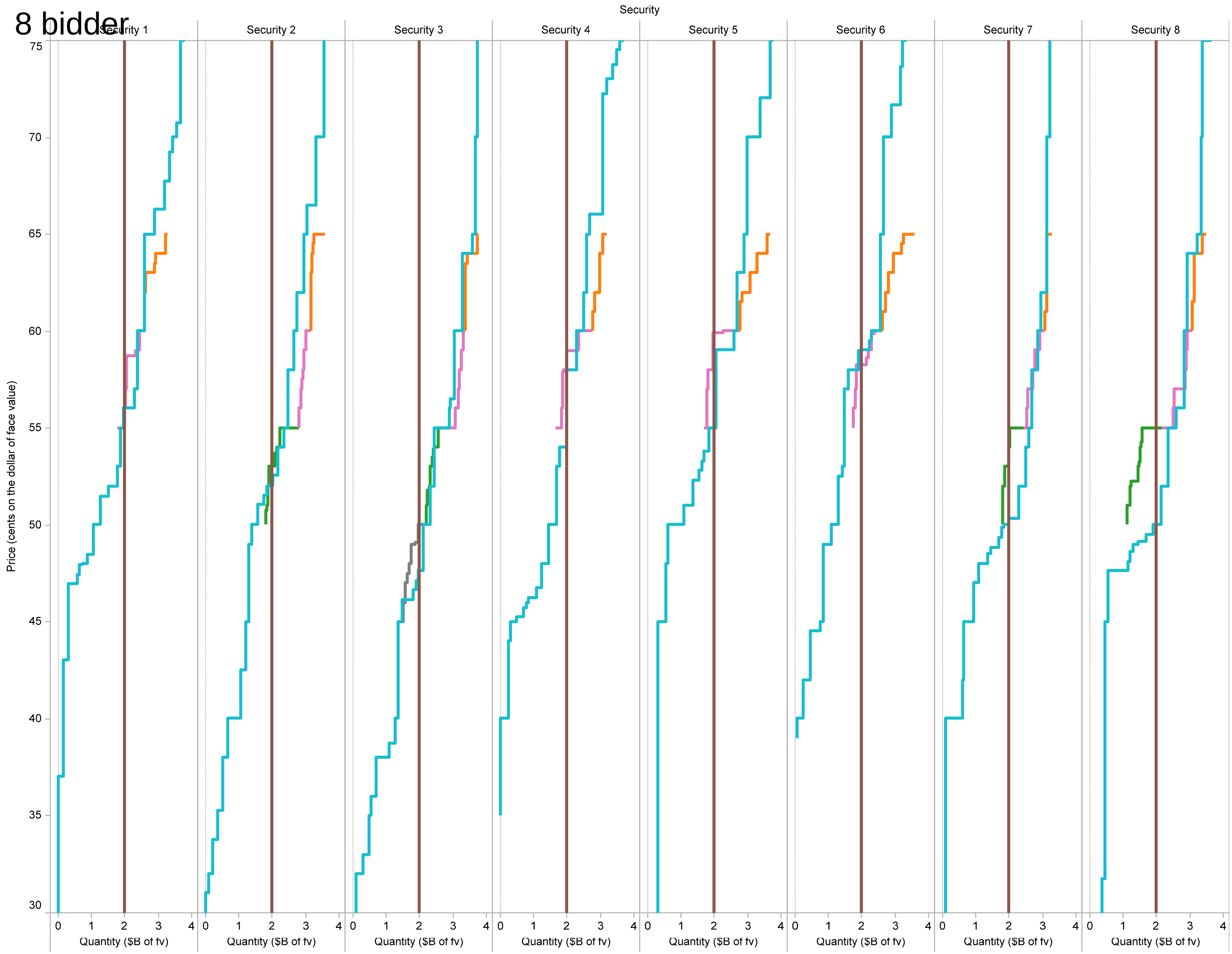
8 bidder


Security
Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
75
70
65
60
55
50
45
40
35
30
0 1 2 3 4
Quantity ($B of fv)

8 bidder



Security
Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
75
70
65
60
55
50
45
40
35
30
0 1 2 3 4
Quantity ($B of fv)



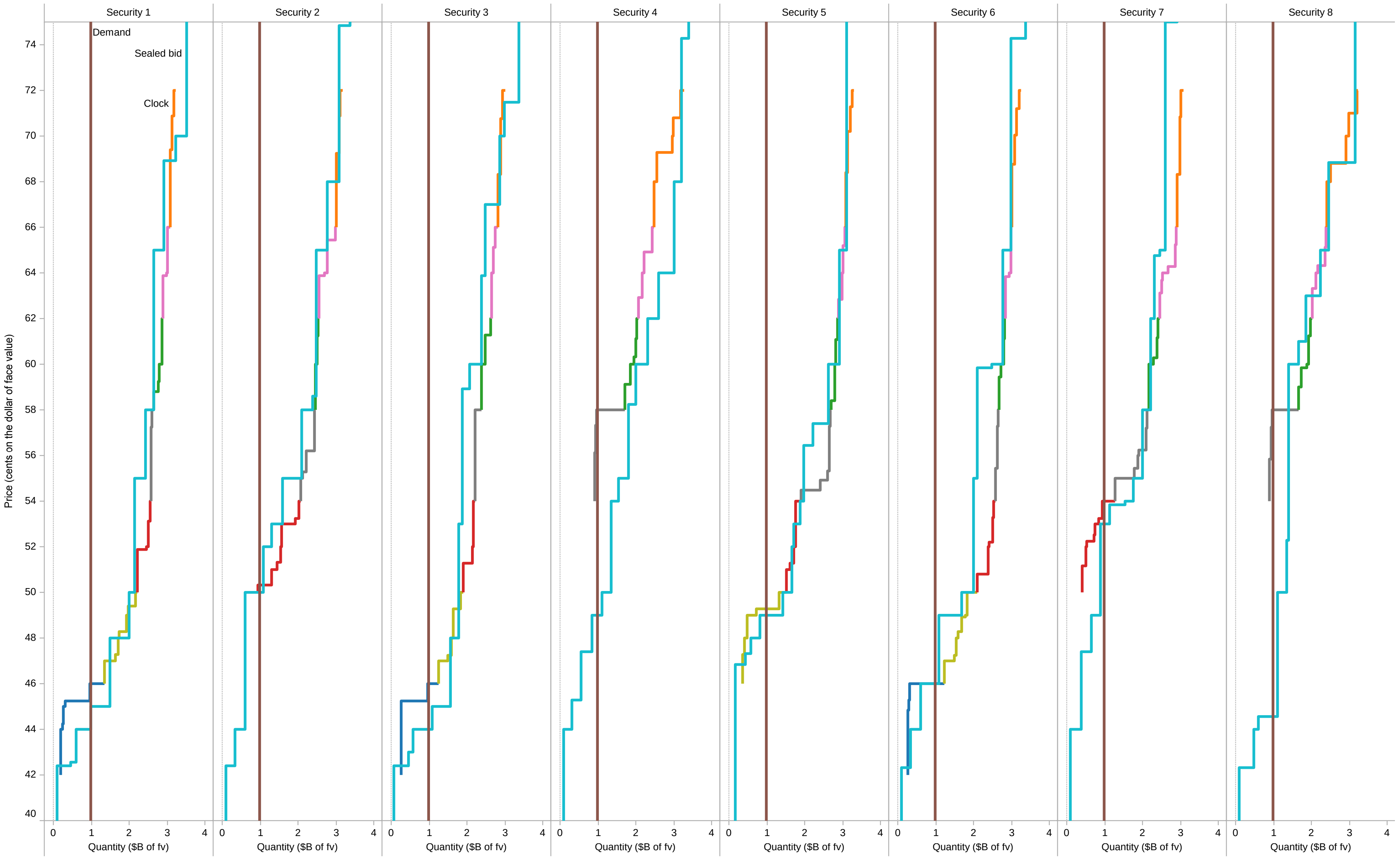
8 bidder
Security
Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
30
35
40
45
50
55
60
65
70
75
0
1
2
3
4
Quantity ($B of fv)

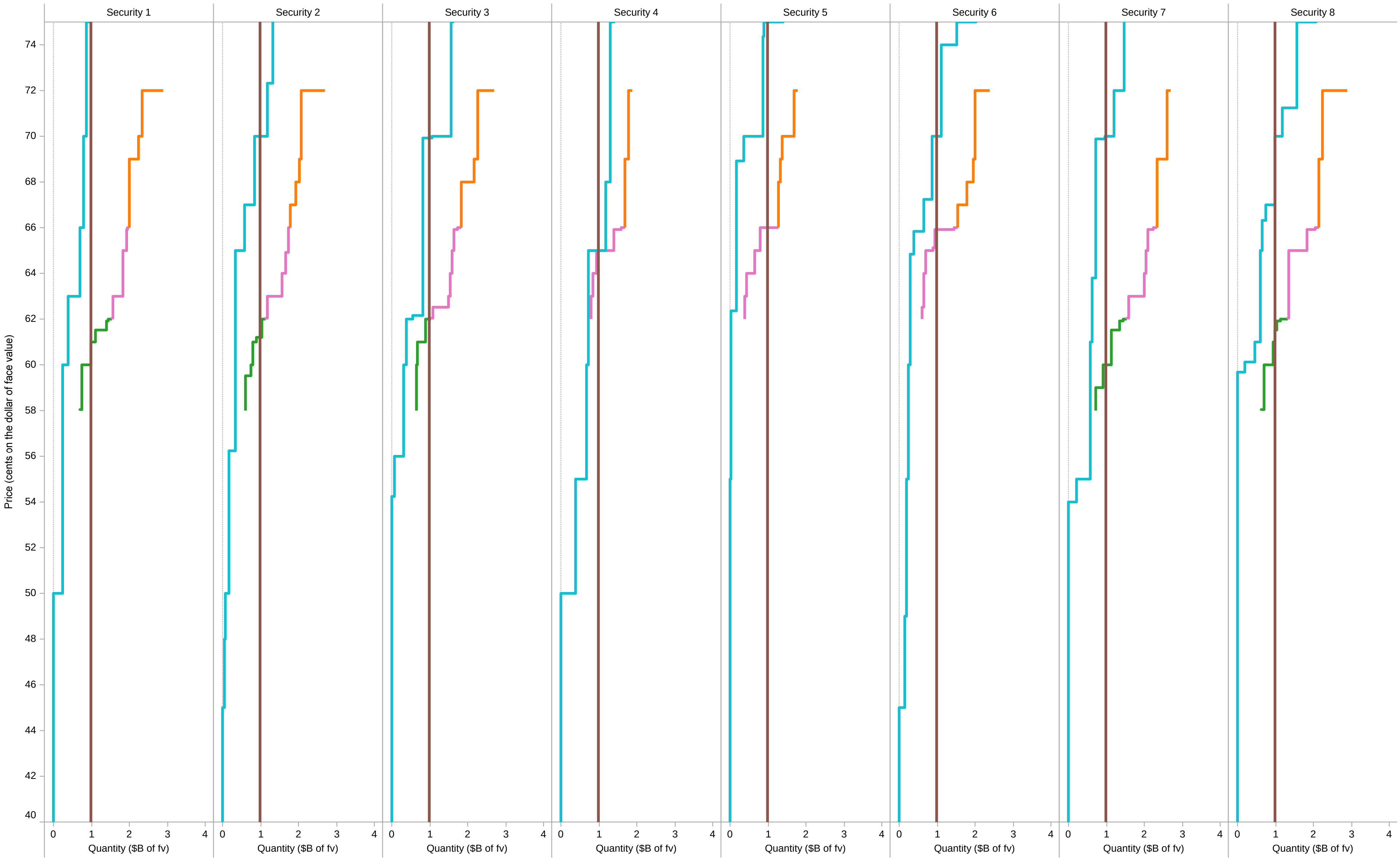
Experiment 3.1
Security by Security
No Liquidity Need

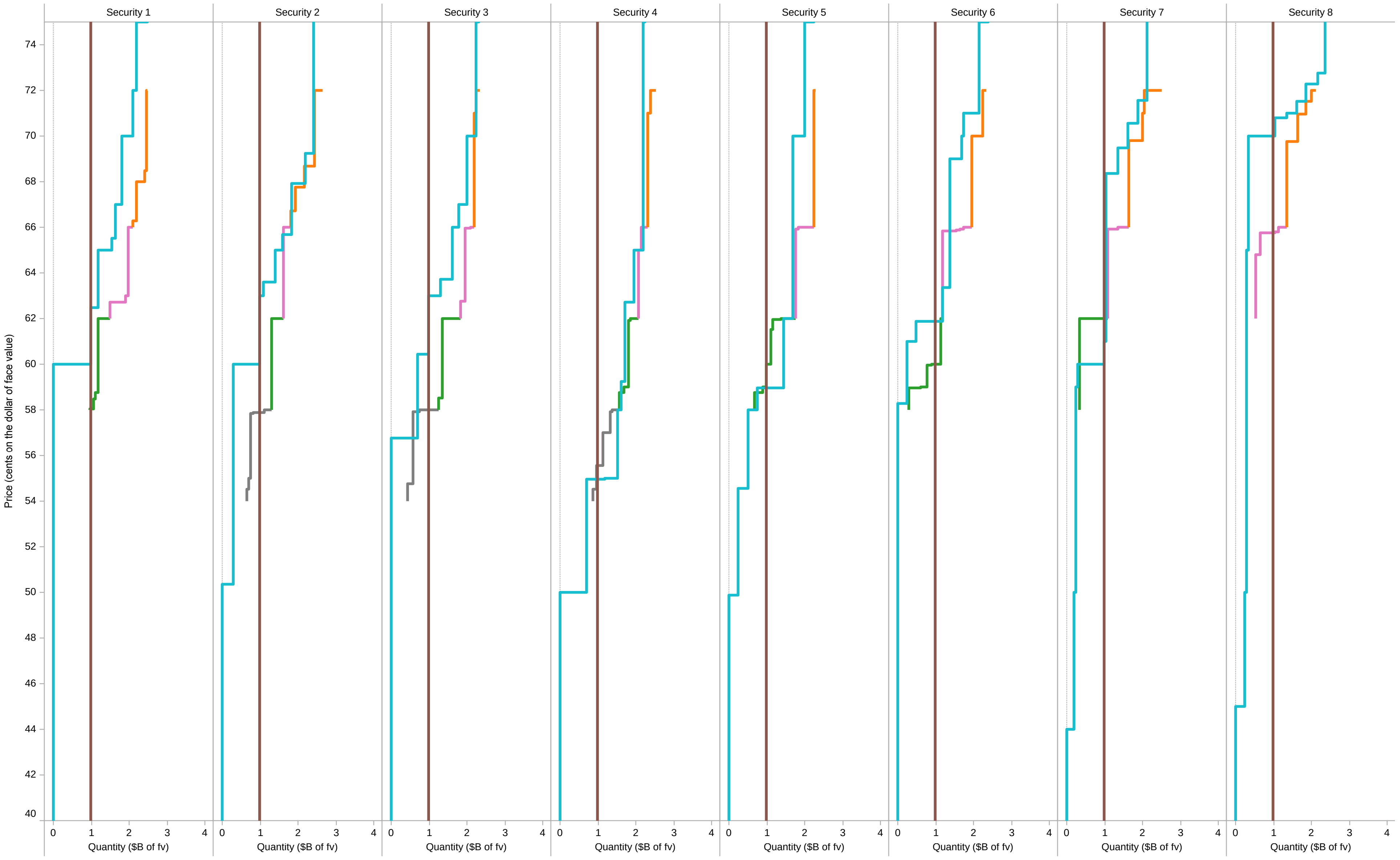
4-bidder auctions

4 auctions per session

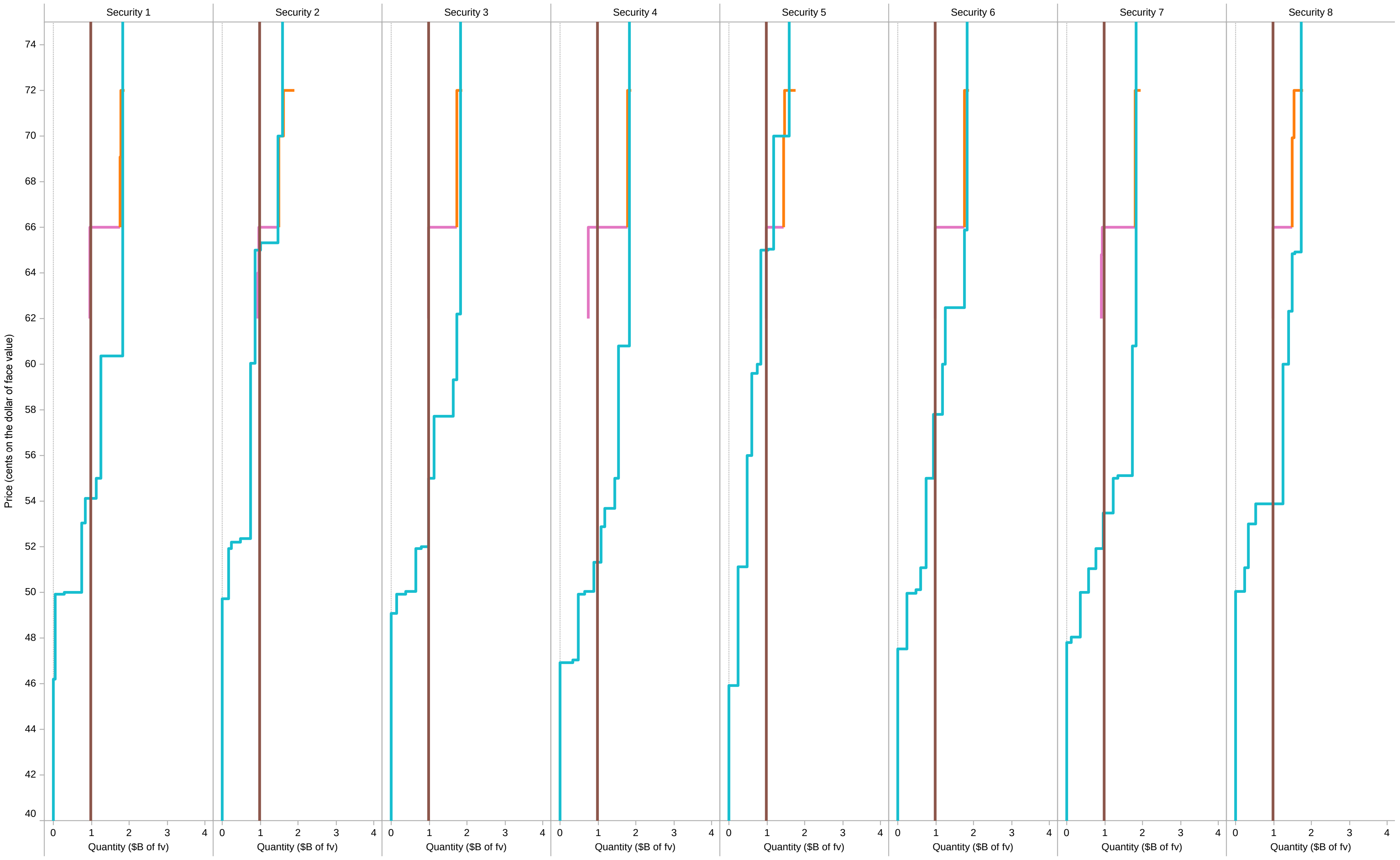
2 sessions


Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Demand
Sealed bid
Clock
Price (cents on the dollar of face value)
Quantity ($B of fv)

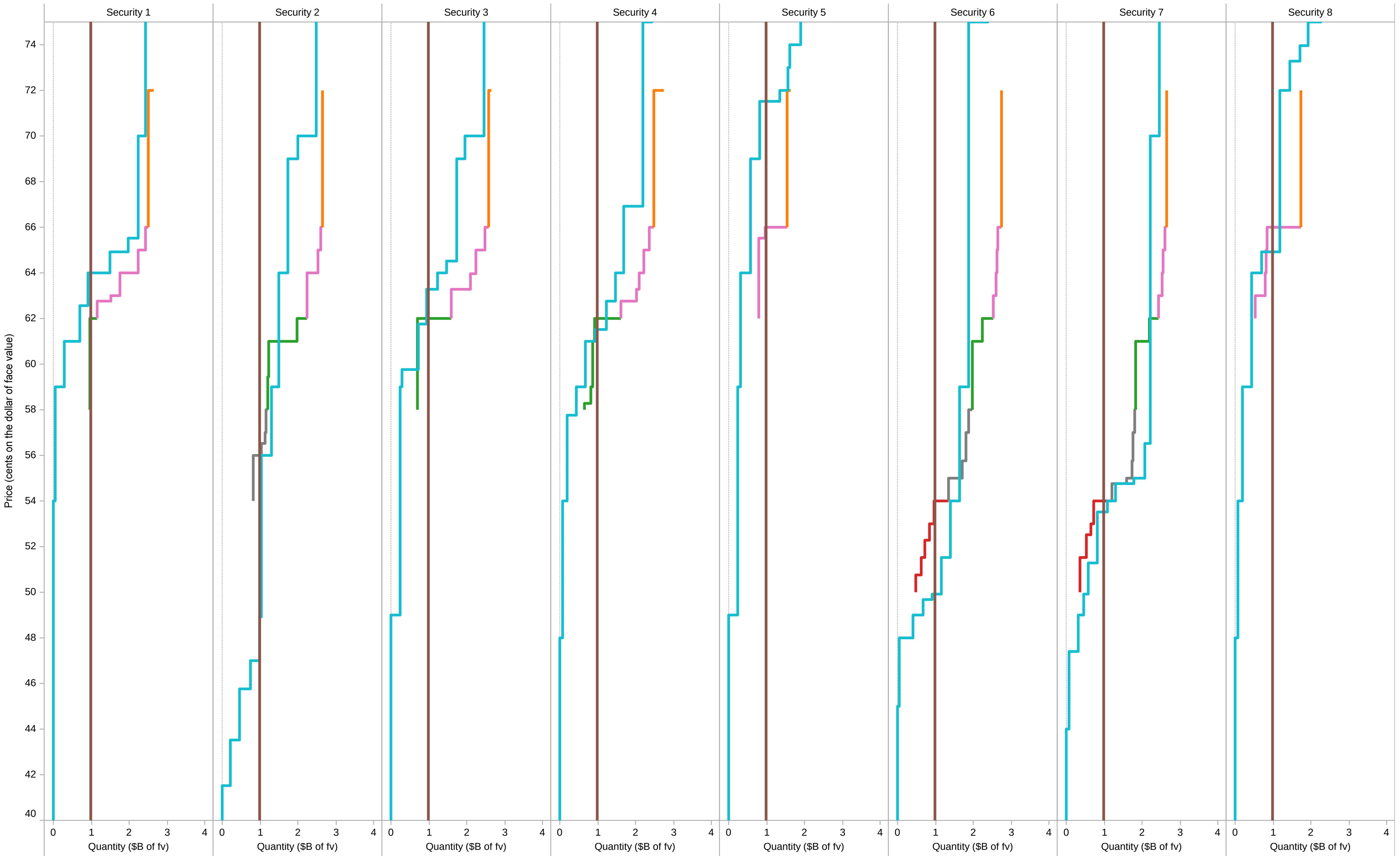

Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
Quantity ($B of fv)

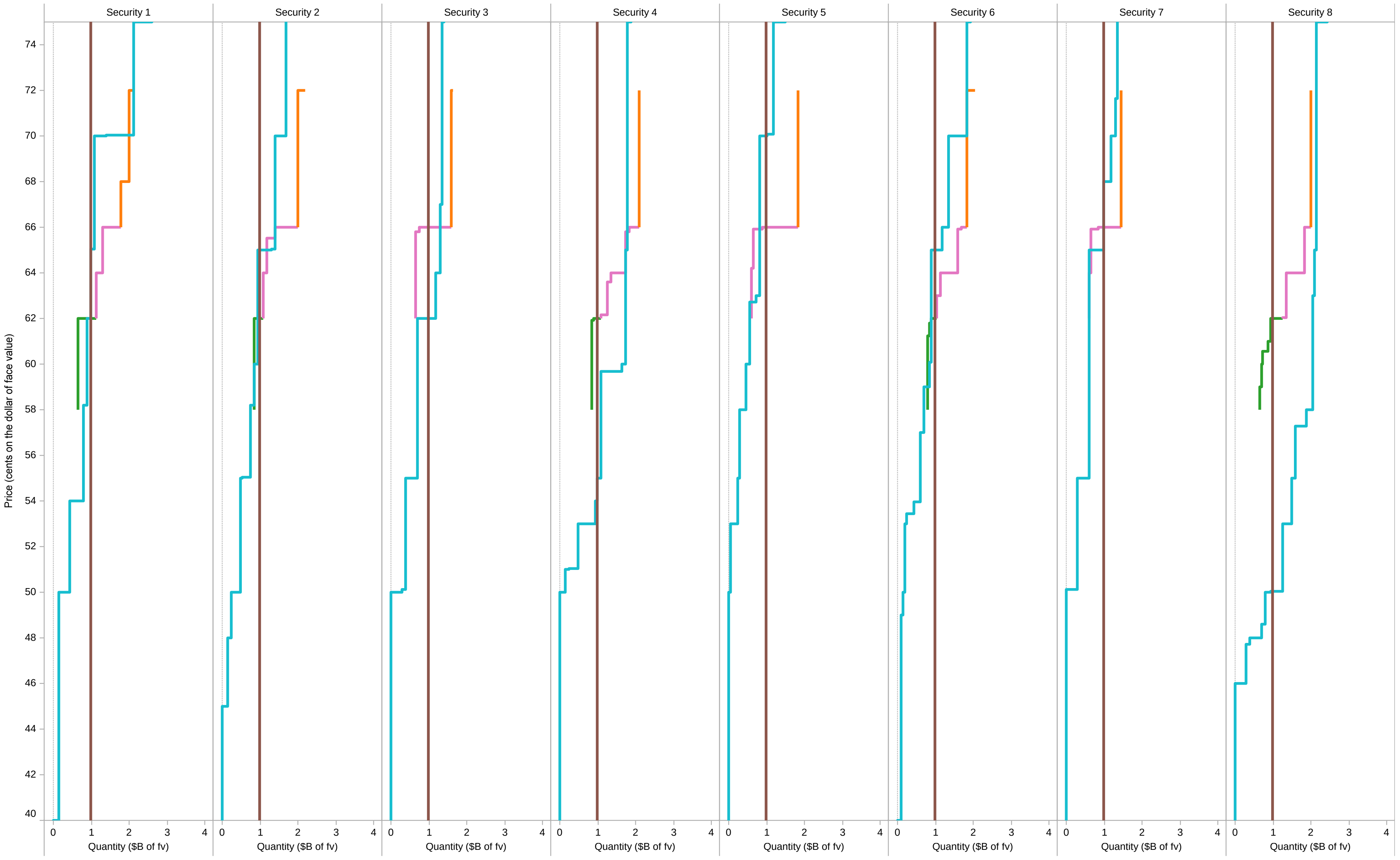


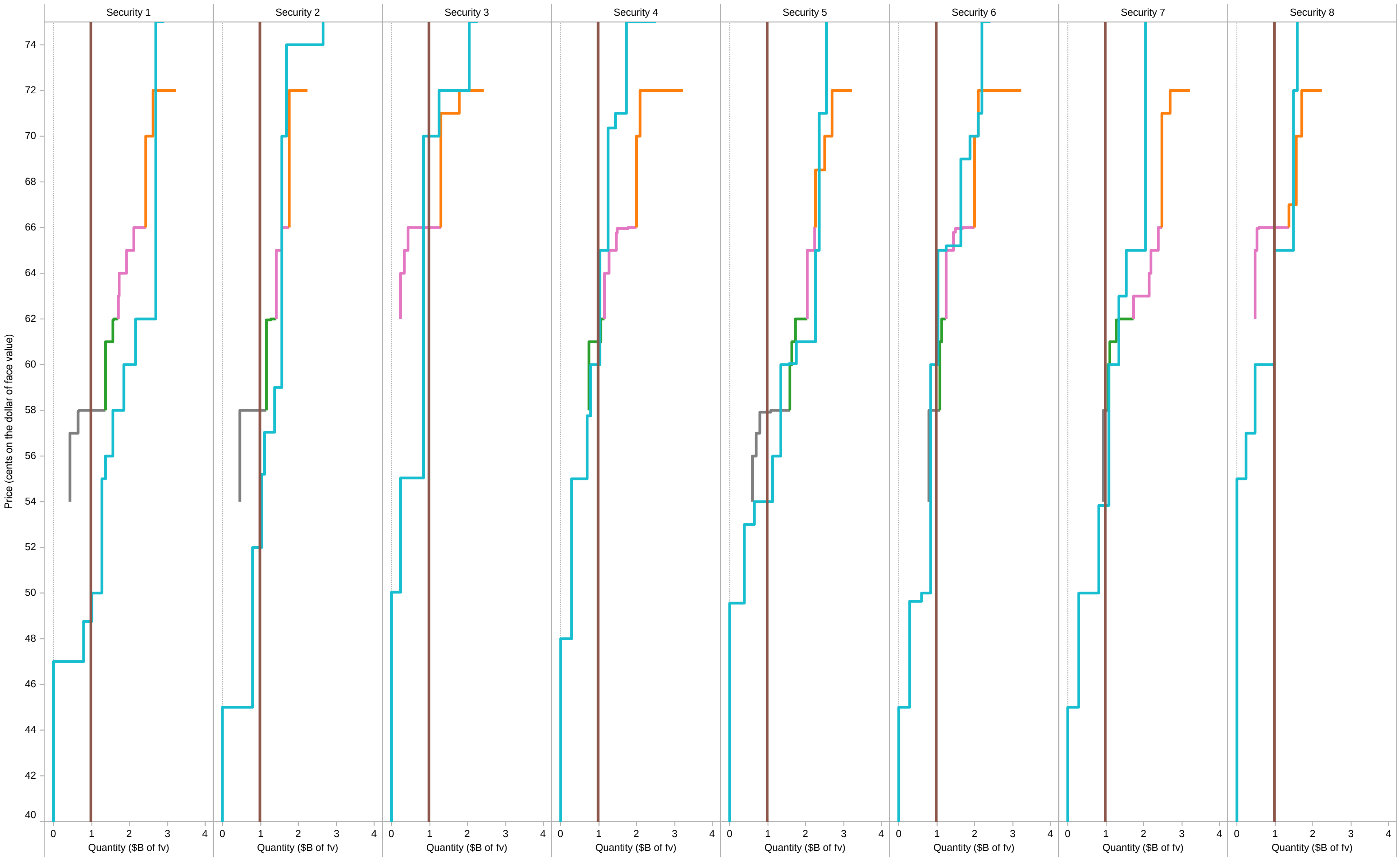
Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
74
72
70
68
66
64
62
60
58
56
54
52
50
48
46
44
42
40
0 1 2 3 4
Quantity ($B of fv)

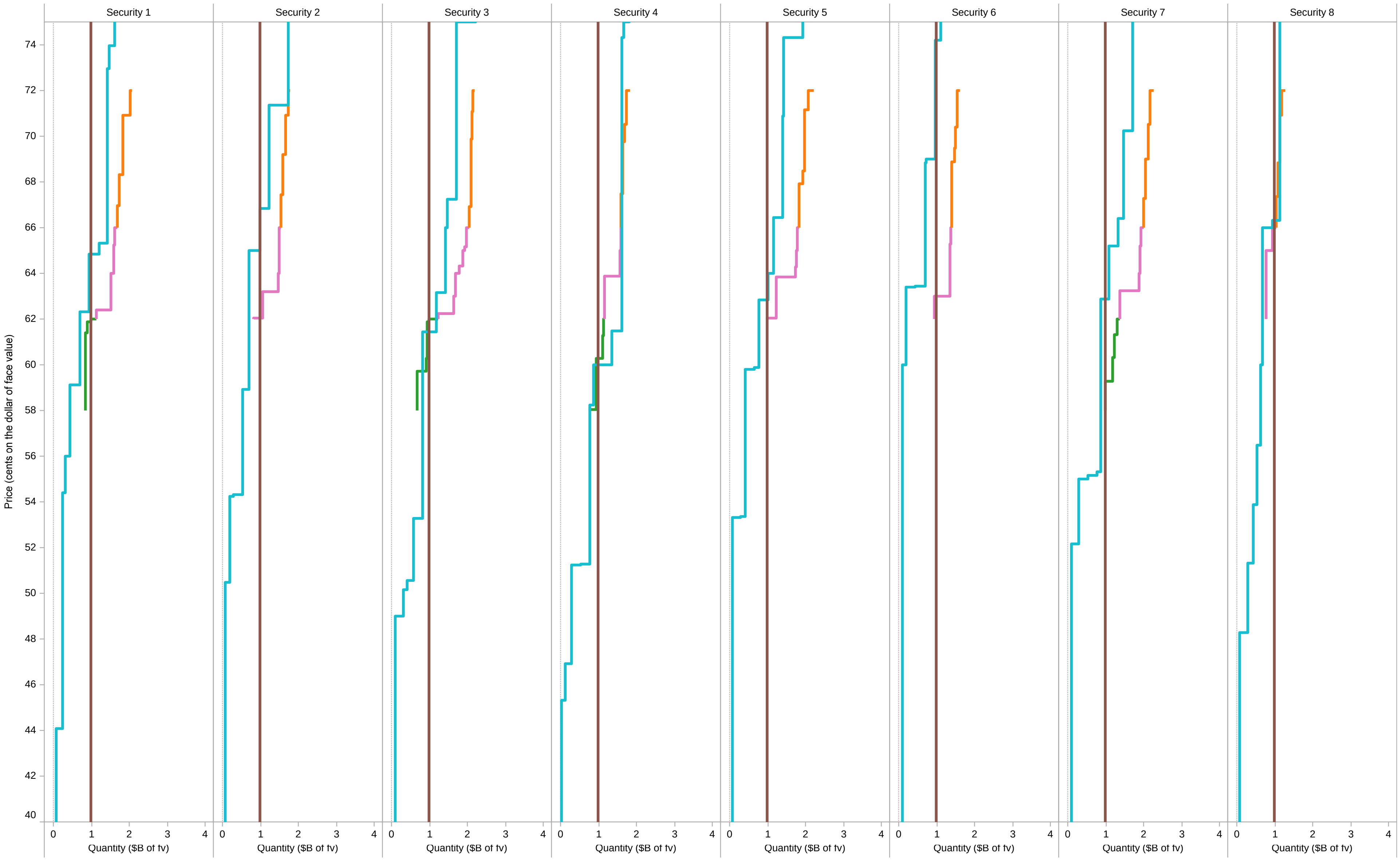


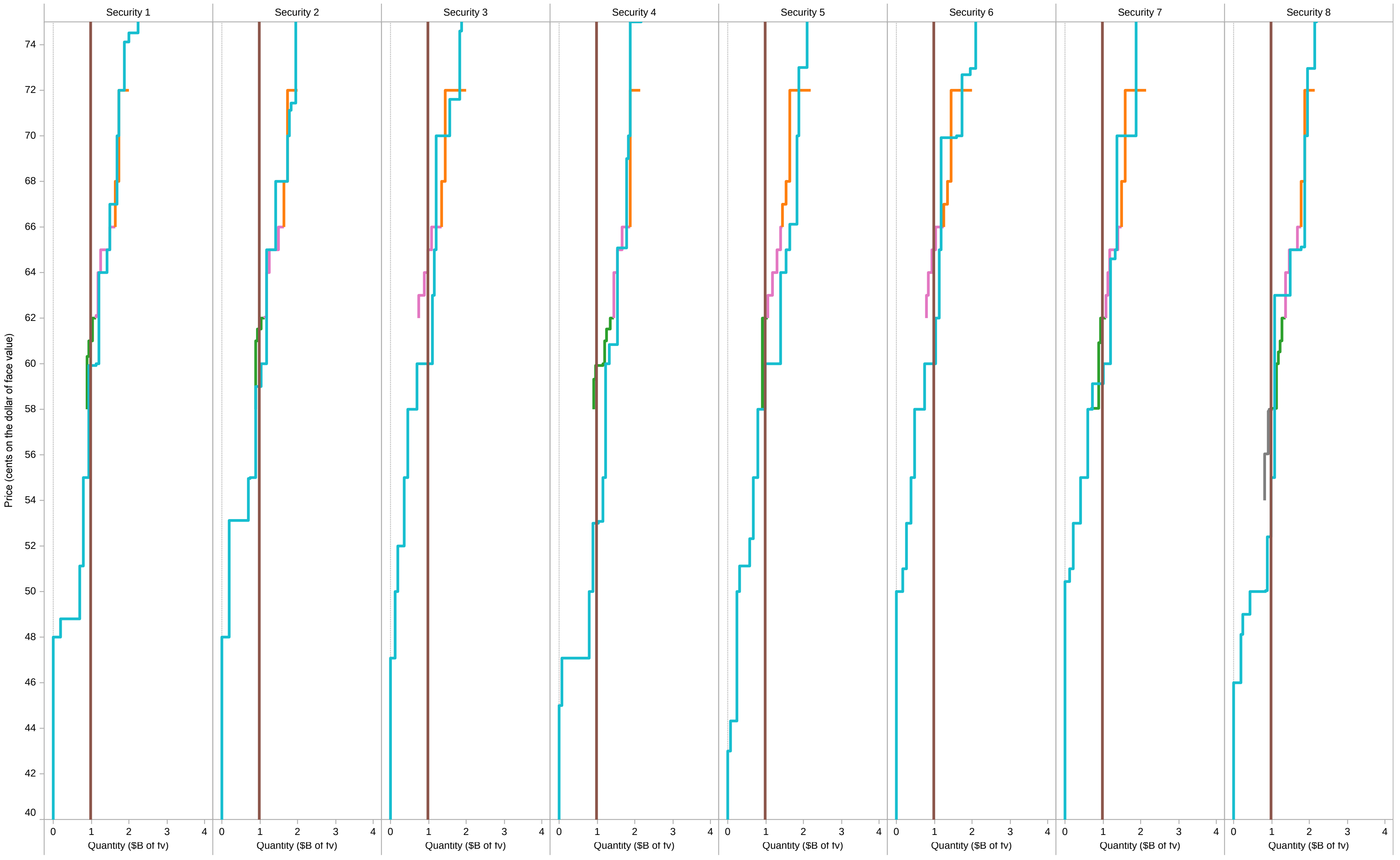
Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
74
72
70
68
66
64
62
60
58
56
54
52
50
48
46
44
42
40
0
1
2
3
4
Quantity ($B of fv)

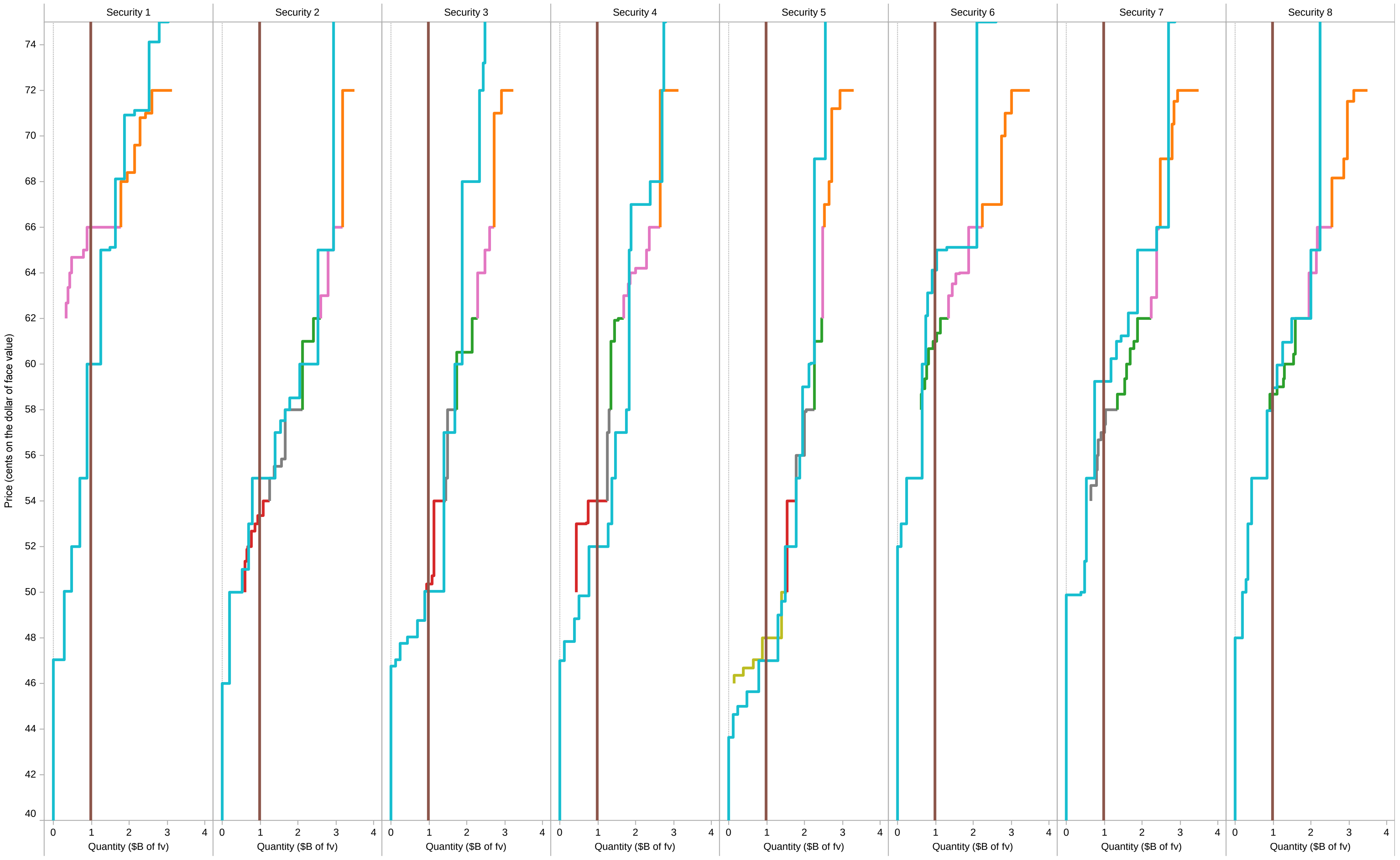

Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
Quantity ($B of fv)

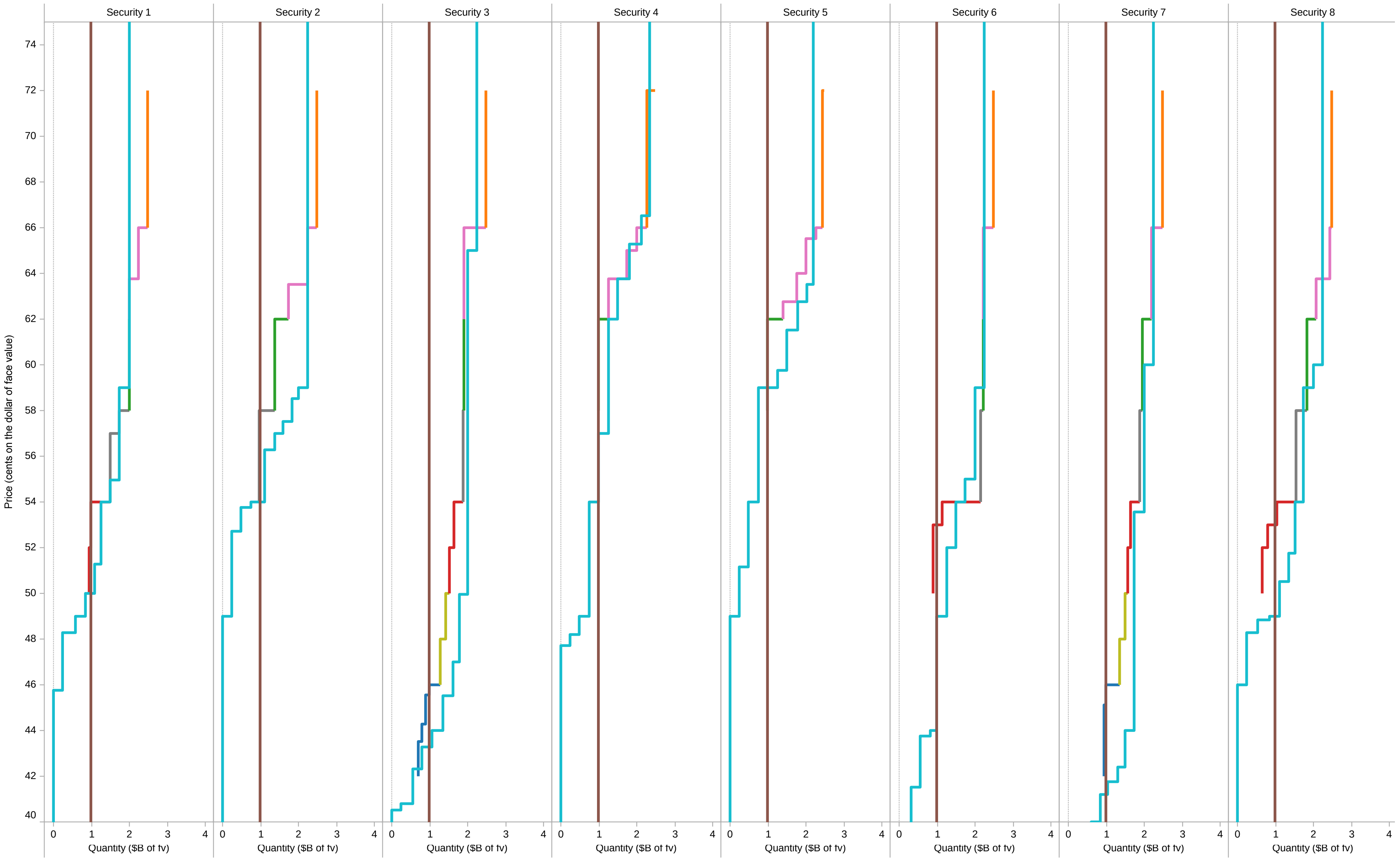

Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
Quantity ($B of fv)


Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
Quantity ($B of fv)

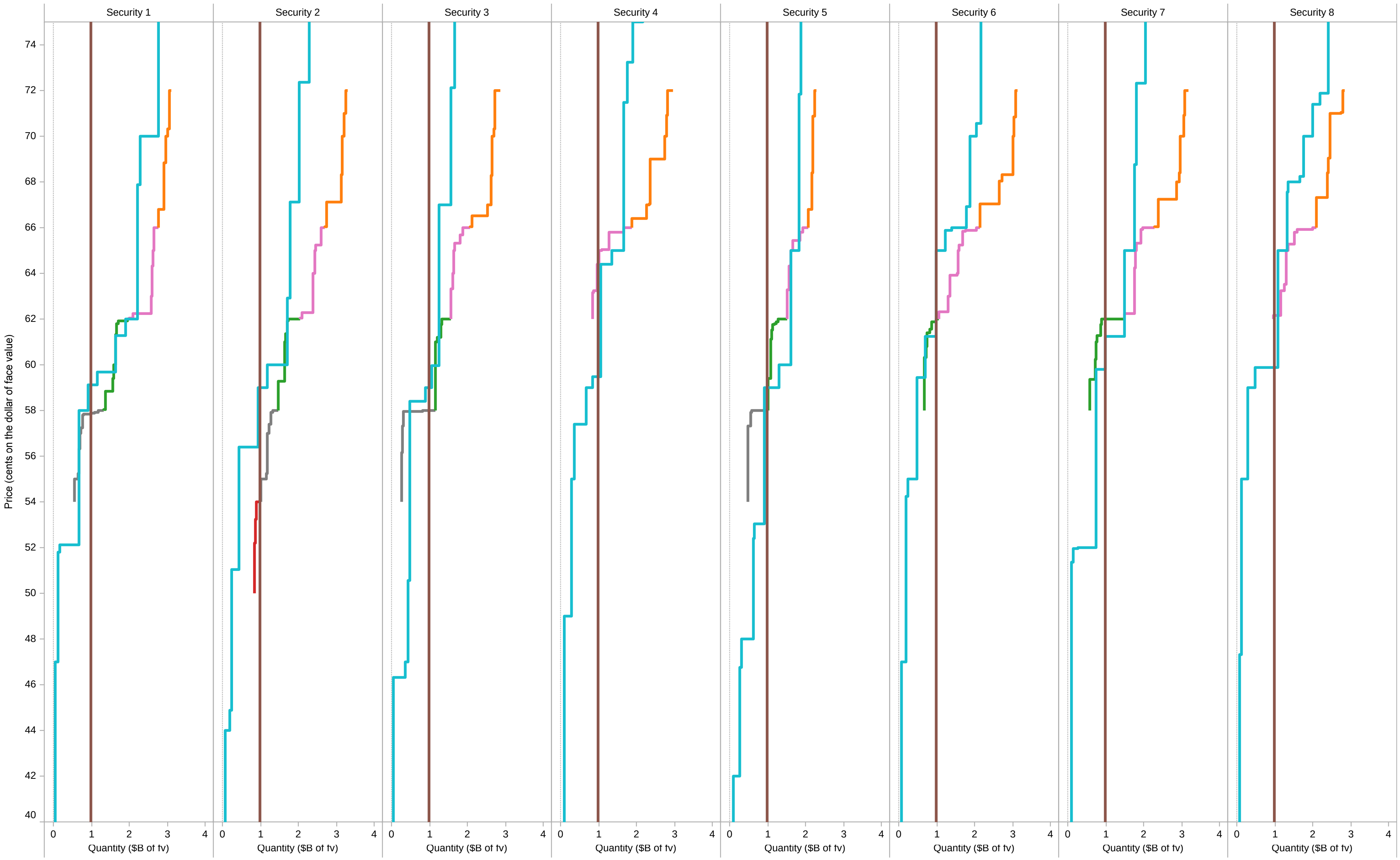

Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
74
72
70
68
66
64
62
60
58
56
54
52
50
48
46
44
42
40
0 1 2 3 4
Quantity ($B of fv)

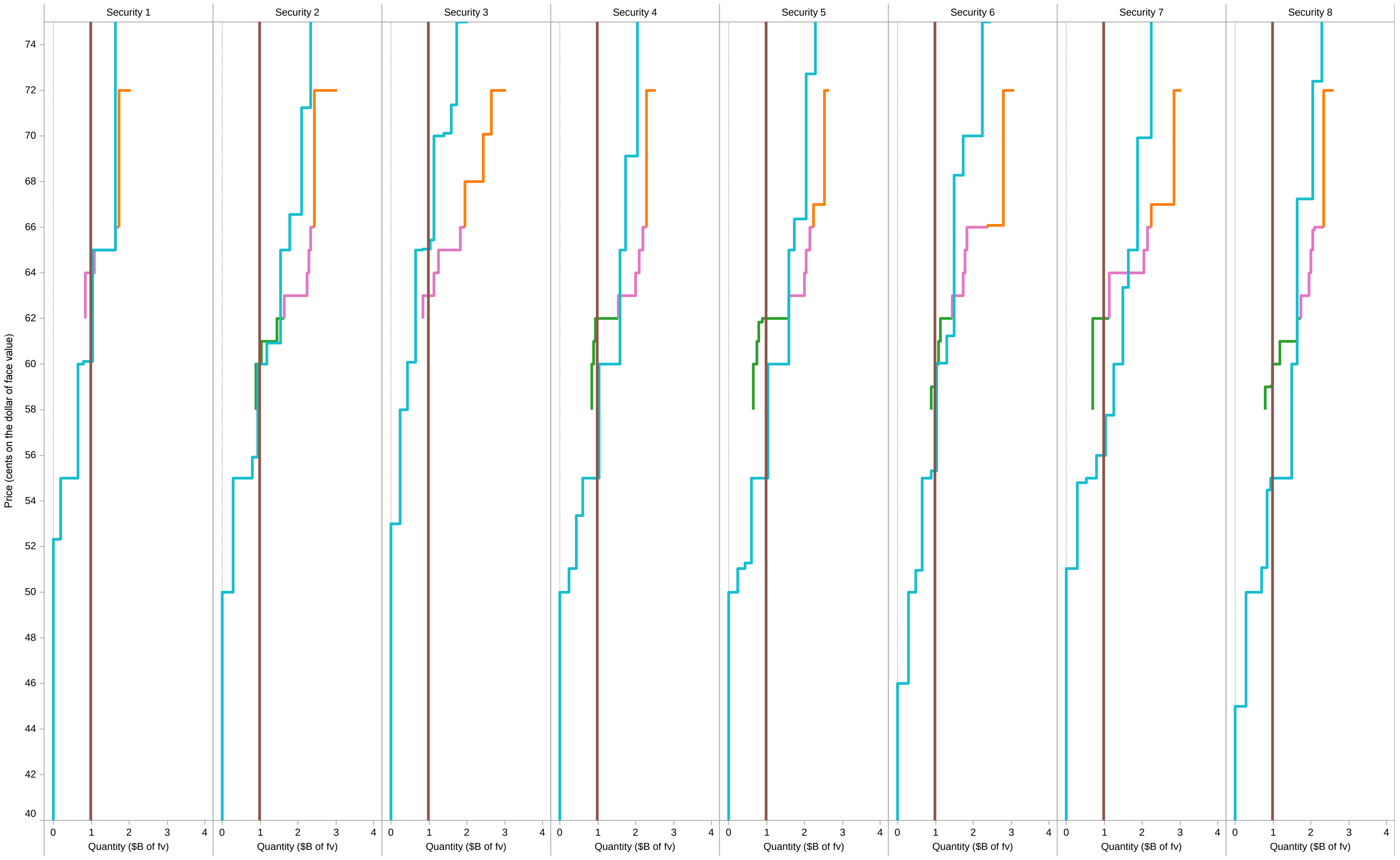

Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
Quantity ($B of fv)
40
42
44
46
48
50
52
54
56
58
60
62
64
66
68
70
72
74
0
1
2
3
4


Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
Quantity ($B of fv)

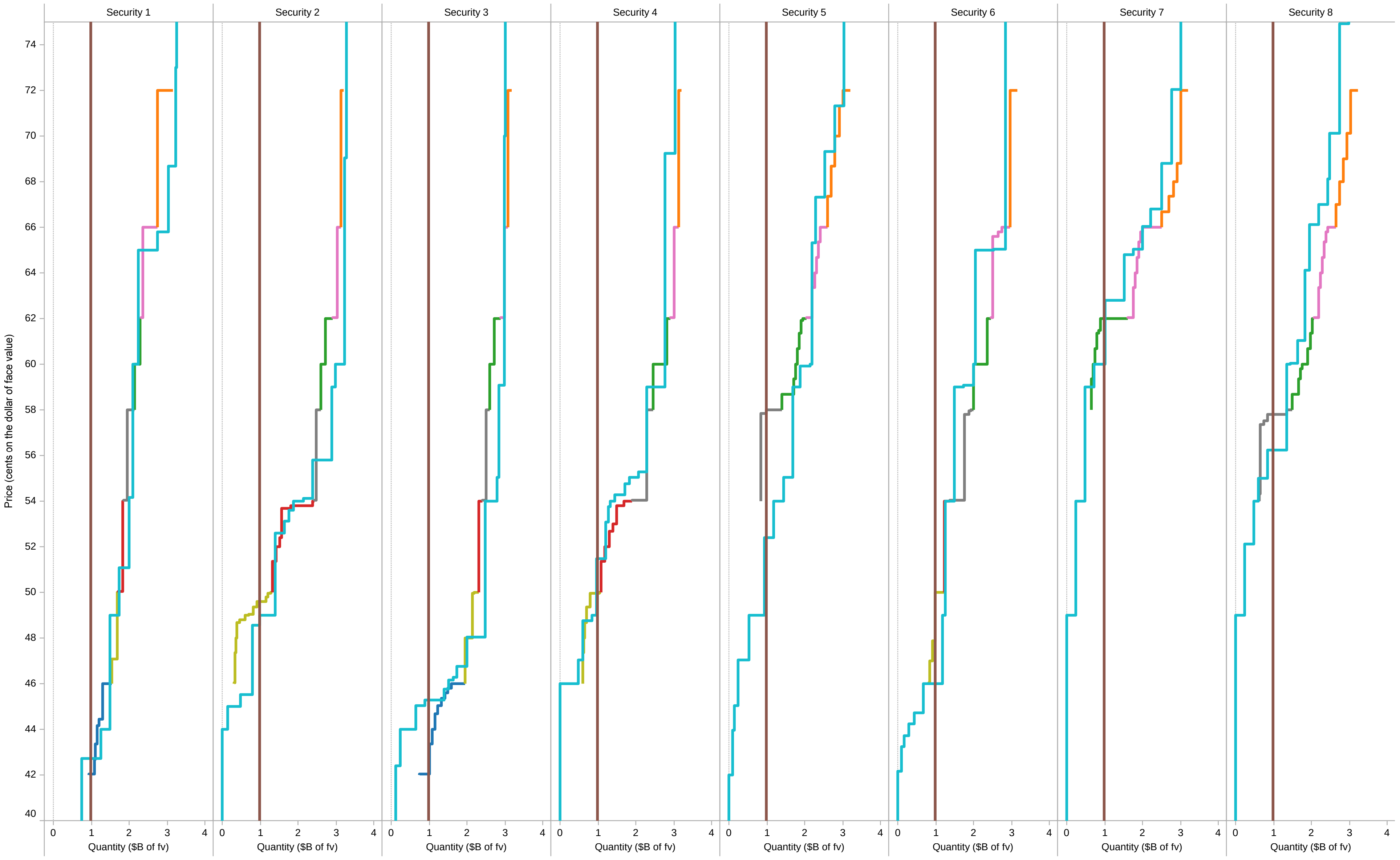


Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
74
72
70
68
66
64
62
60
58
56
54
52
50
48
46
44
42
40
0 1 2 3 4
Quantity ($B of fv)

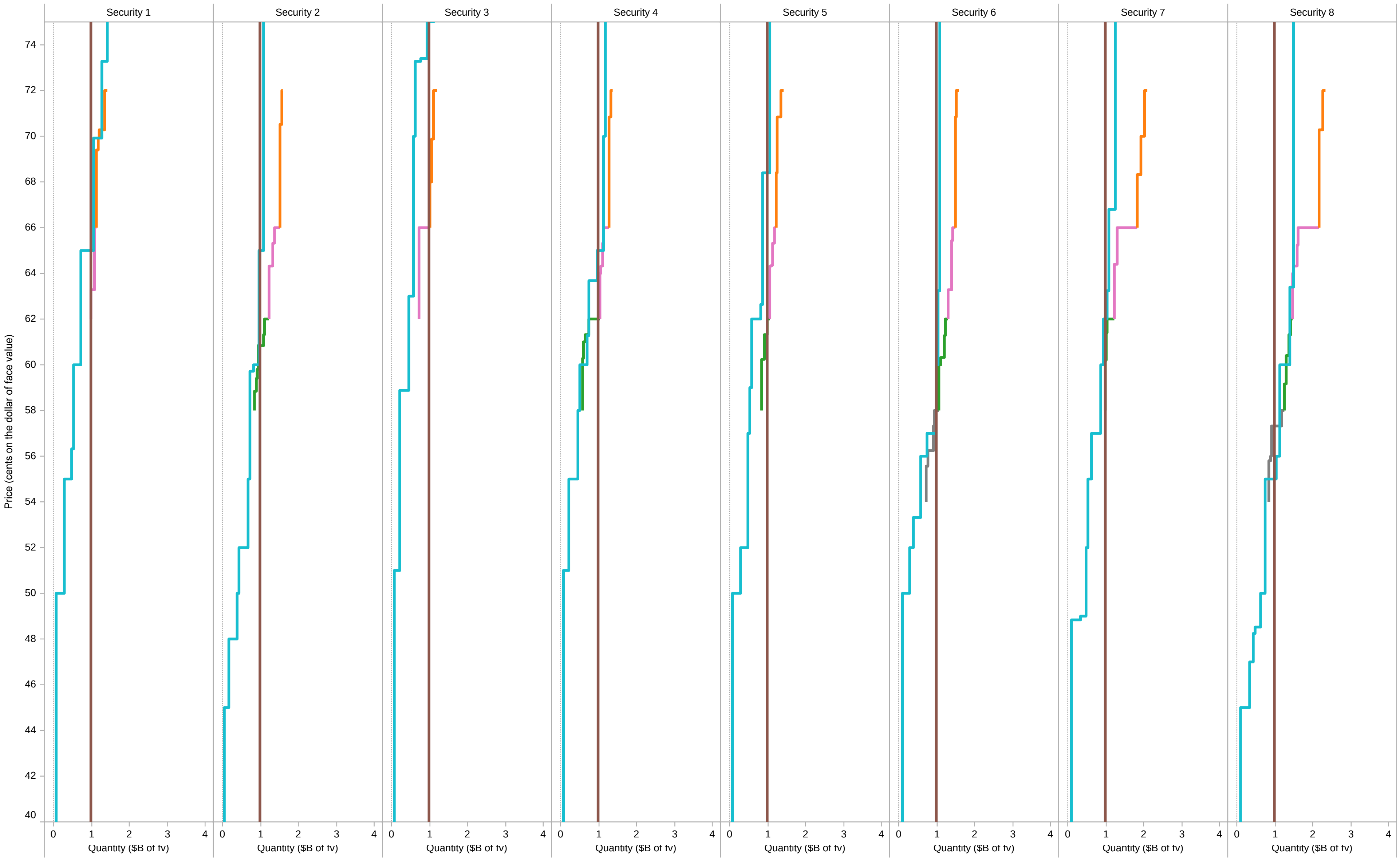

Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
40
42
44
46
48
50
52
54
56
58
60
62
64
66
68
70
72
74
0
1
2
3
4
Quantity ($B of fv)

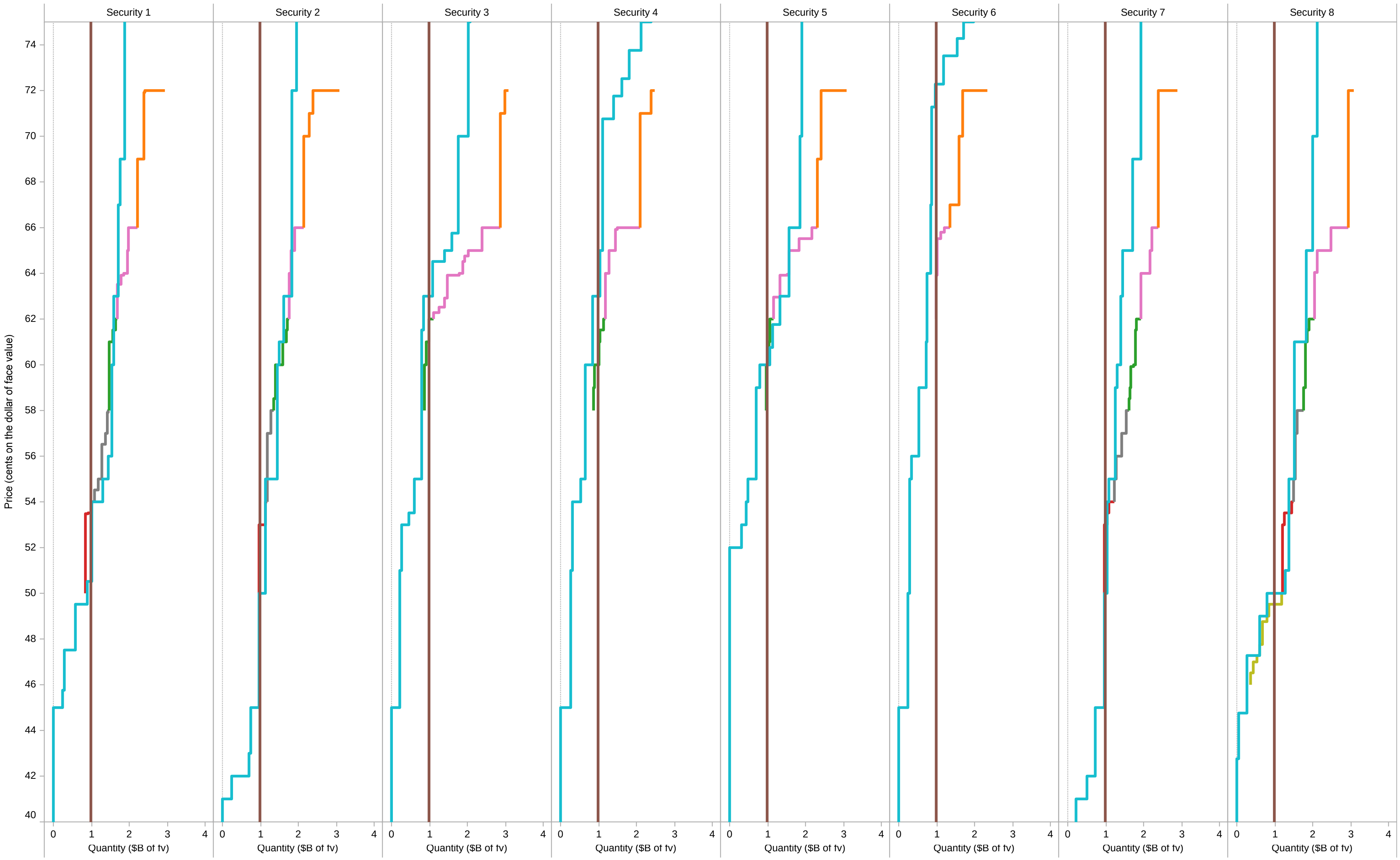


Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
Quantity ($B of fv)



Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
74
72
70
68
66
64
62
60
58
56
54
52
50
48
46
44
42
40
0 1 2 3 4
Quantity ($B of fv)


Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
74
72
70
68
66
64
62
60
58
56
54
52
50
48
46
44
42
40
0 1 2 3 4
Quantity ($B of fv)

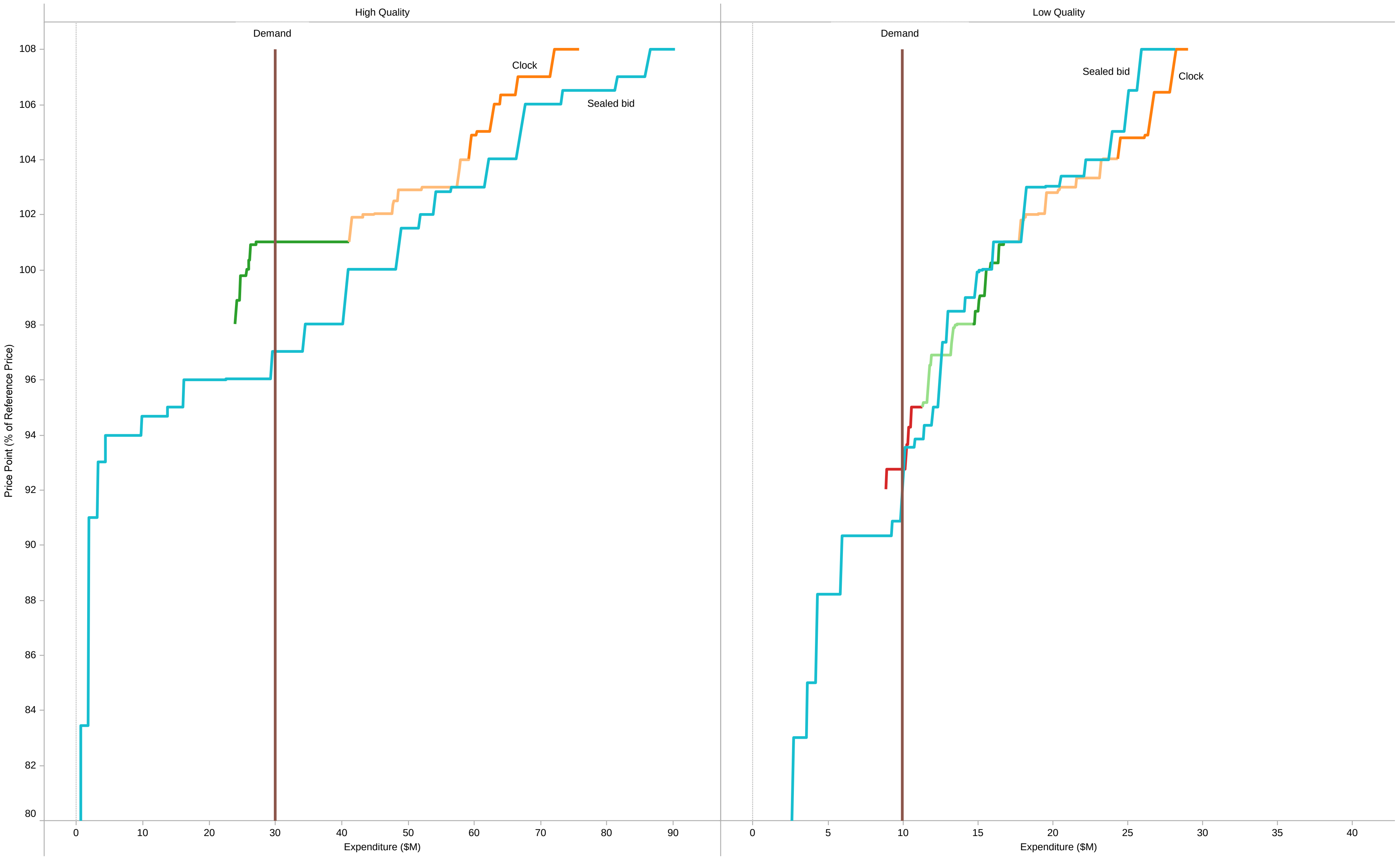

Security 1
Security 2
Security 3
Security 4
Security 5
Security 6
Security 7
Security 8
Price (cents on the dollar of face value)
74
72
70
68
66
64
62
60
58
56
54
52
50
48
46
44
42
40
0 1 2 3 4
Quantity ($B of fv)

Experiment 3.2
Reference Price
No Liquidity Need

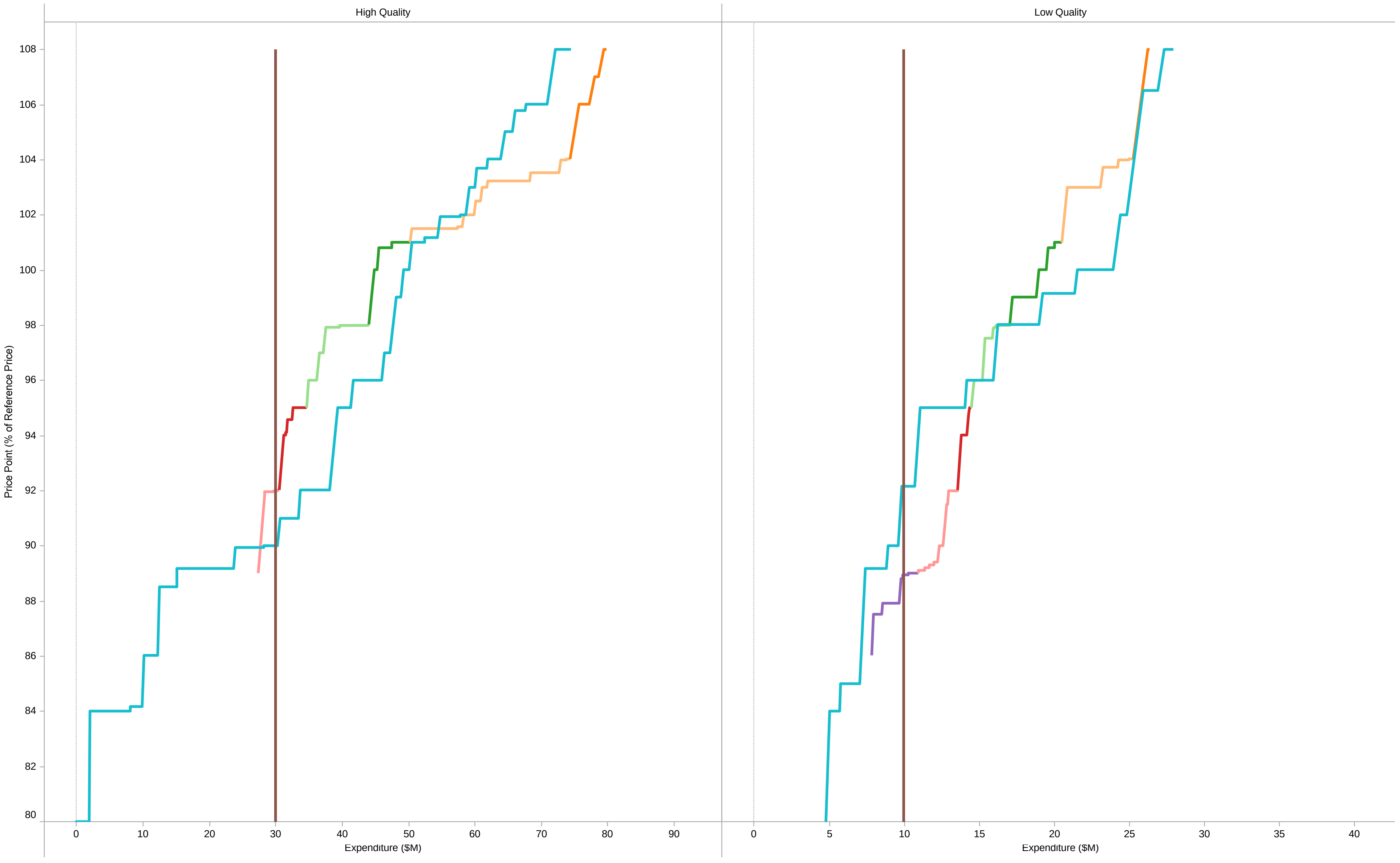
8-bidder auctions

4 auctions per session

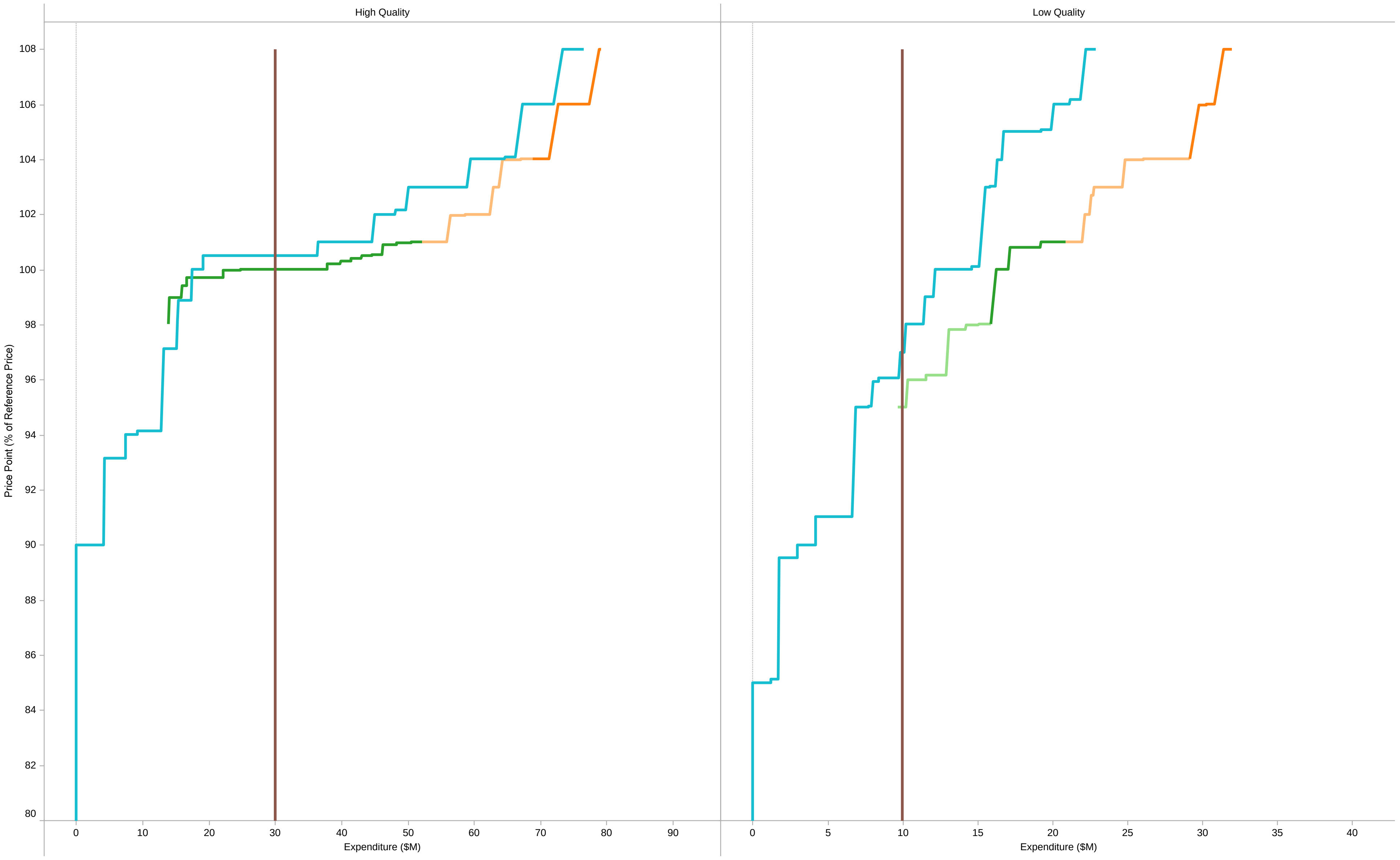
2 sessions

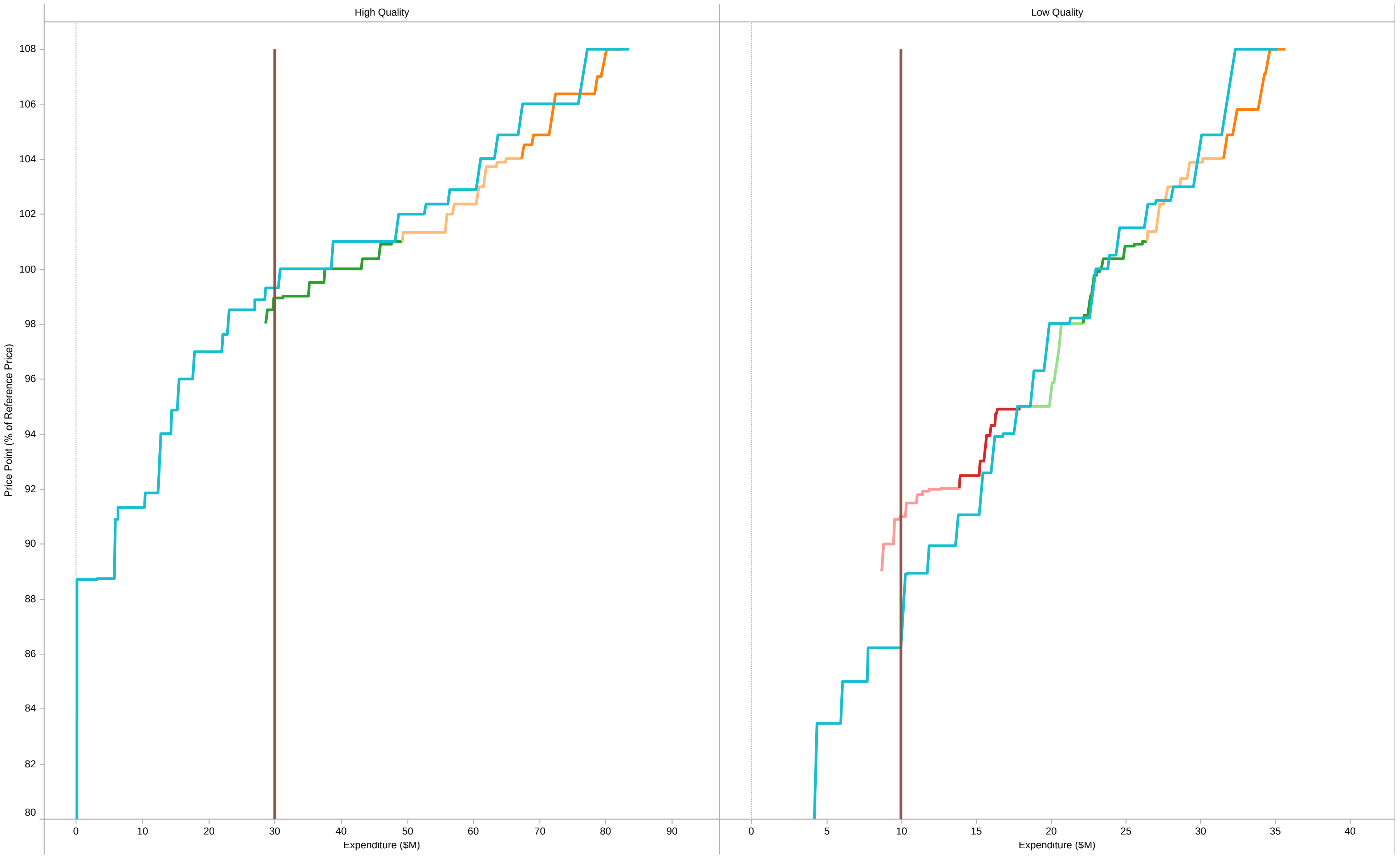


High Quality
Low Quality
Demand
Clock
Sealed bid
Price Point (% of Reference Price)
Expenditure ($M)
108
106
104
102
100
98
96
94
92
90
88
86
84
82
80
0
10
20
30
40
50
60
70
80
90
5
15
25
35

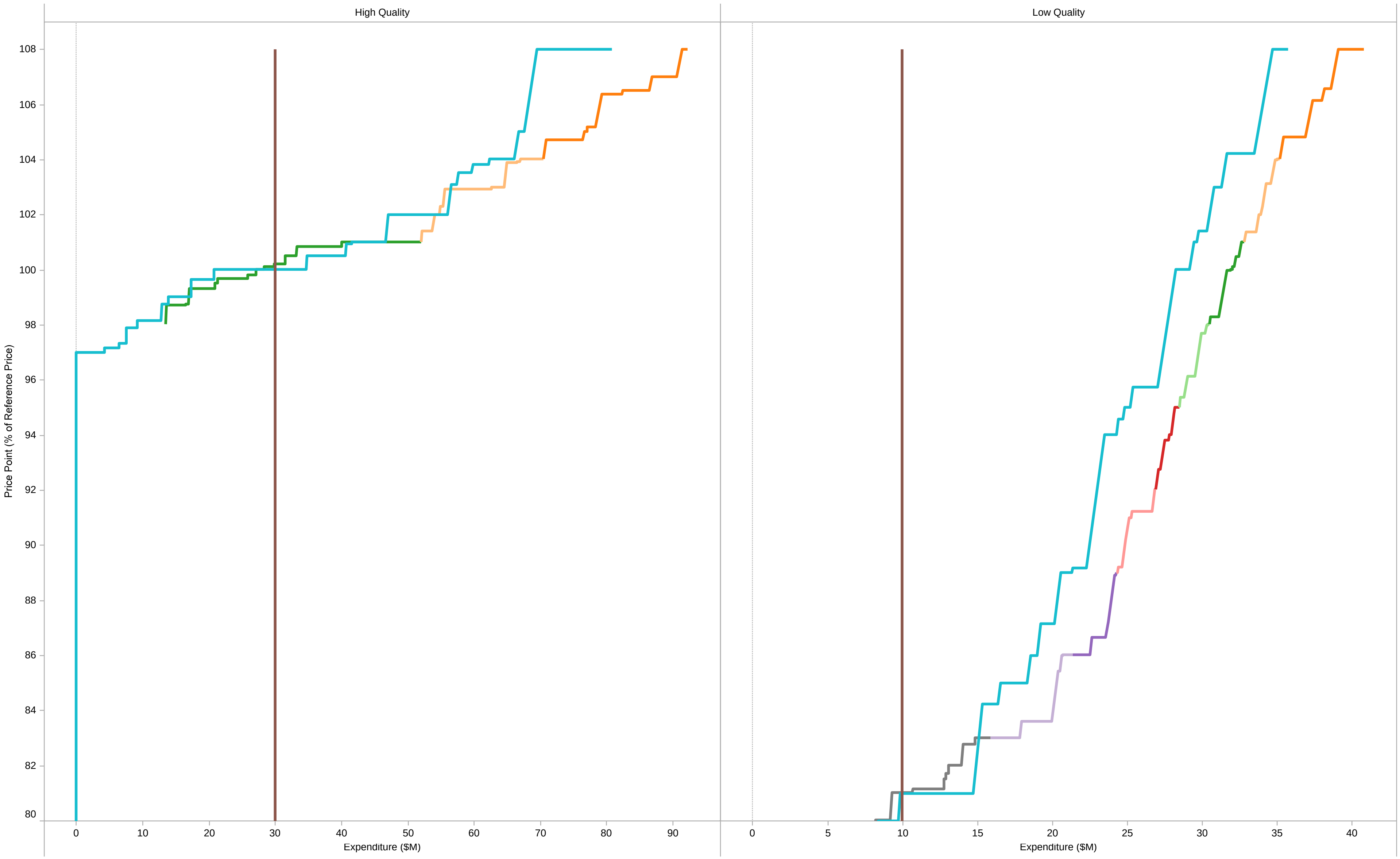


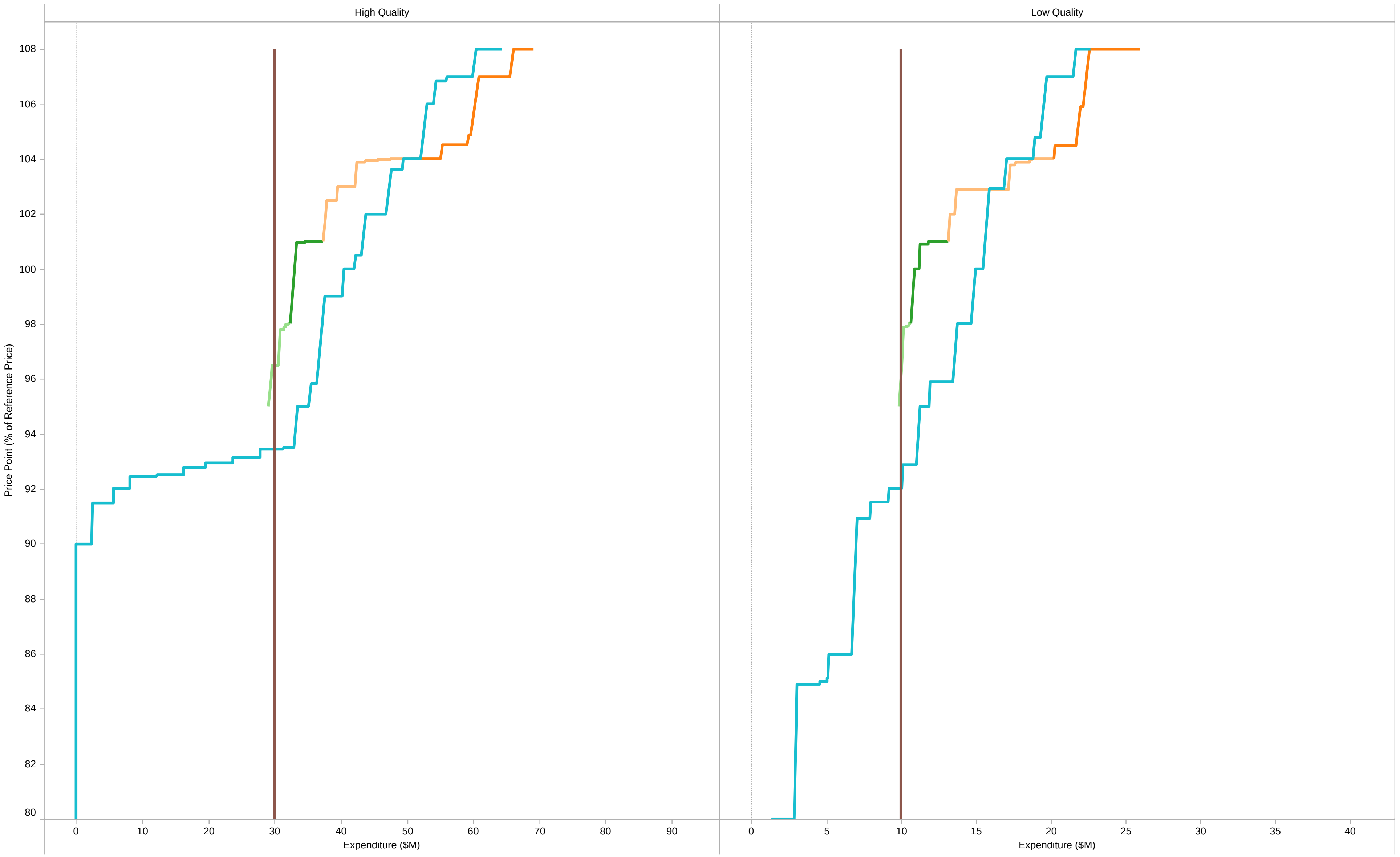
High Quality
Low Quality
Price Point (% of Reference Price)
108
106
104
102
100
98
96
94
92
90
88
86
84
82
80
0
10
20
30
40
50
60
70
80
90
Expenditure ($M)
0
5
10
15
20
25
30
35
40
Expenditure ($M)


High Quality
Low Quality
Price Point (% of Reference Price)
108
106
104
102
100
98
96
94
92
90
88
86
84
82
80
0
10
20
30
40
50
60
70
80
90
Expenditure ($M)
0
5
10
15
20
25
30
35
40
Expenditure ($M)

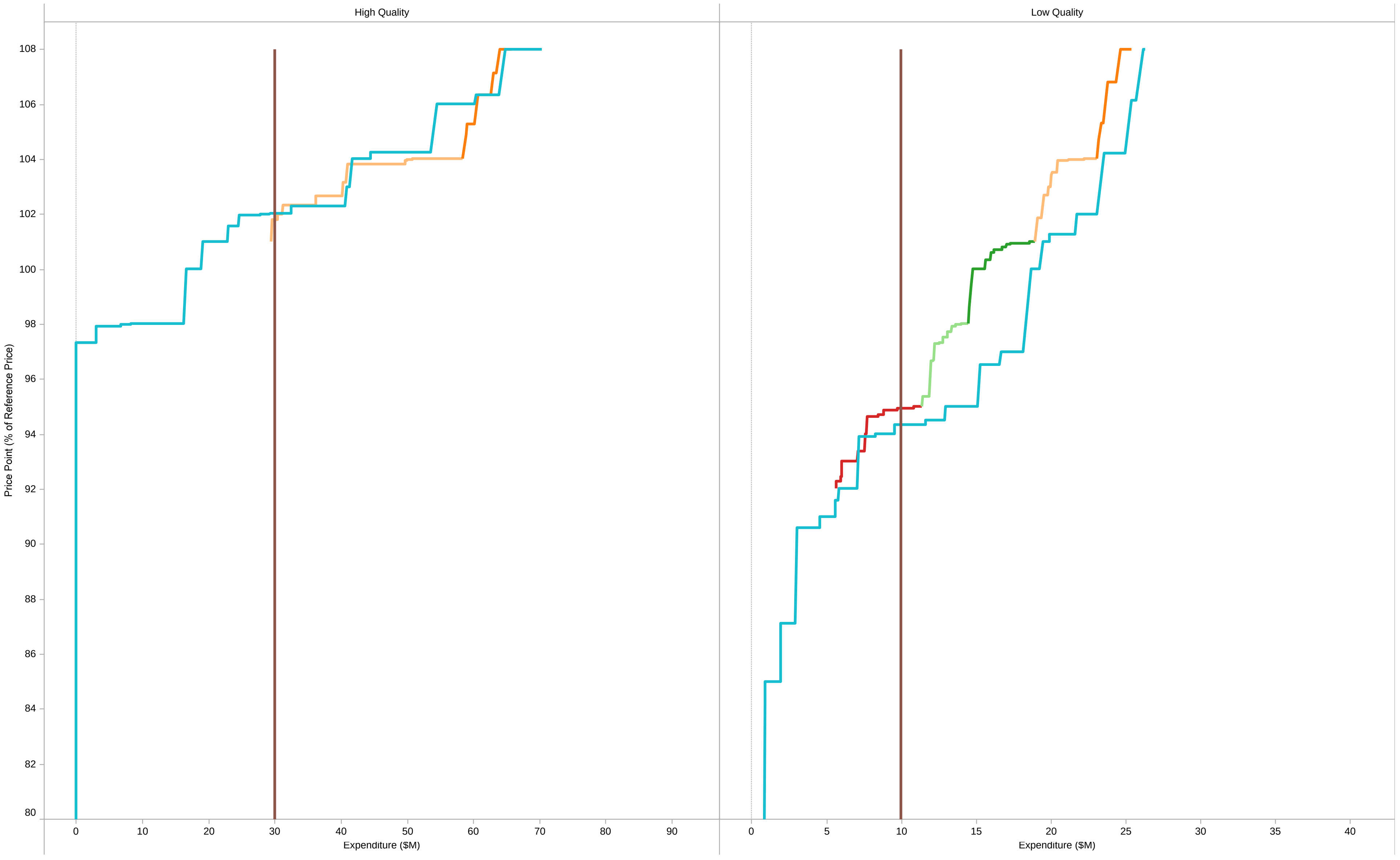


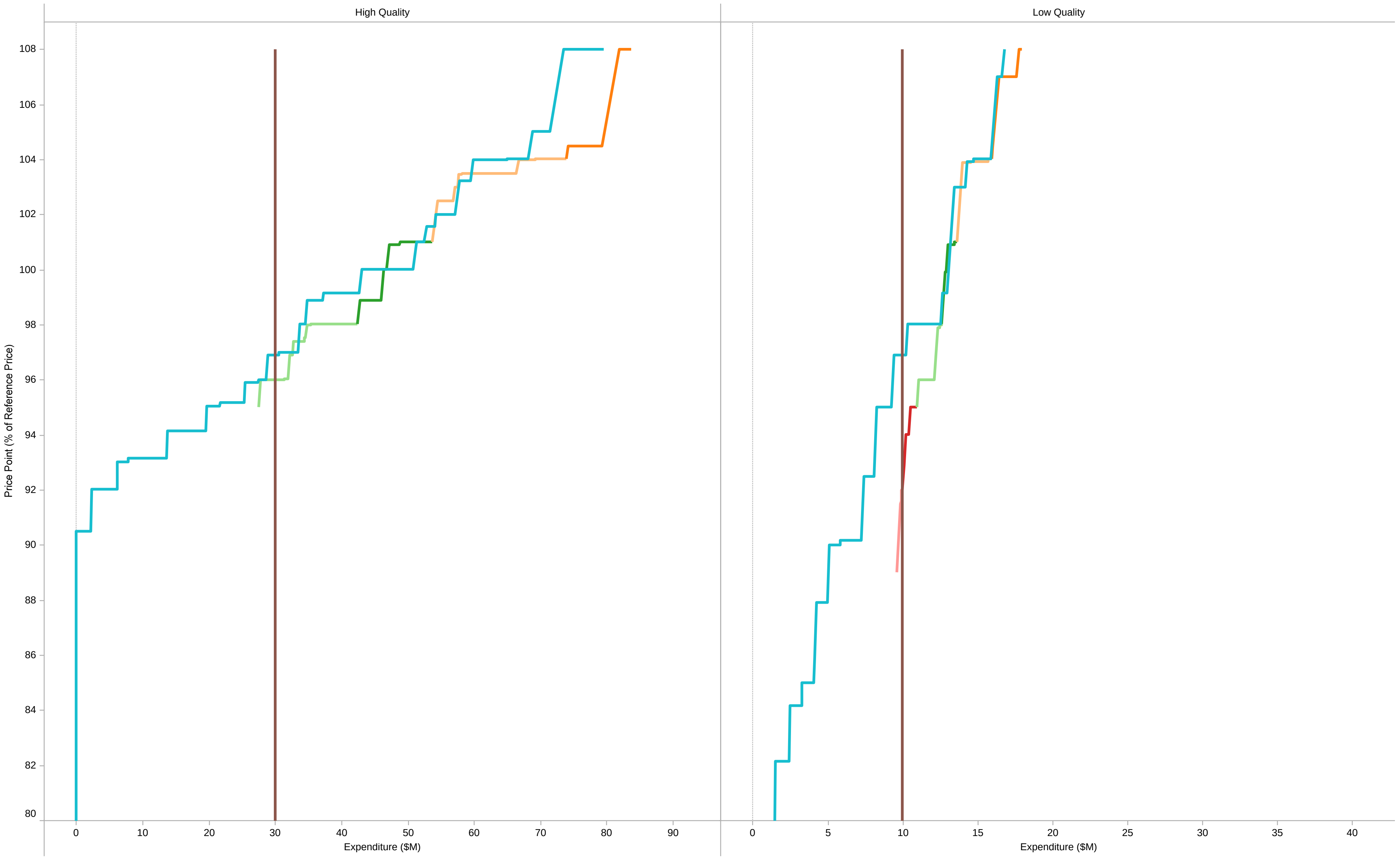
High Quality
Low Quality
Price Point (% of Reference Price)
108
106
104
102
100
98
96
94
92
90
88
86
84
82
80
0
10
20
30
40
50
60
70
80
90
Expenditure ($M)
0
5
10
15
20
25
30
35
40
Expenditure ($M)


High Quality
Low Quality
Price Point (% of Reference Price)
108
106
104
102
100
98
96
94
92
90
88
86
84
82
80
0
10
20
30
40
50
60
70
80
90
Expenditure ($M)
0
5
10
15
20
25
30
35
40
Expenditure ($M)

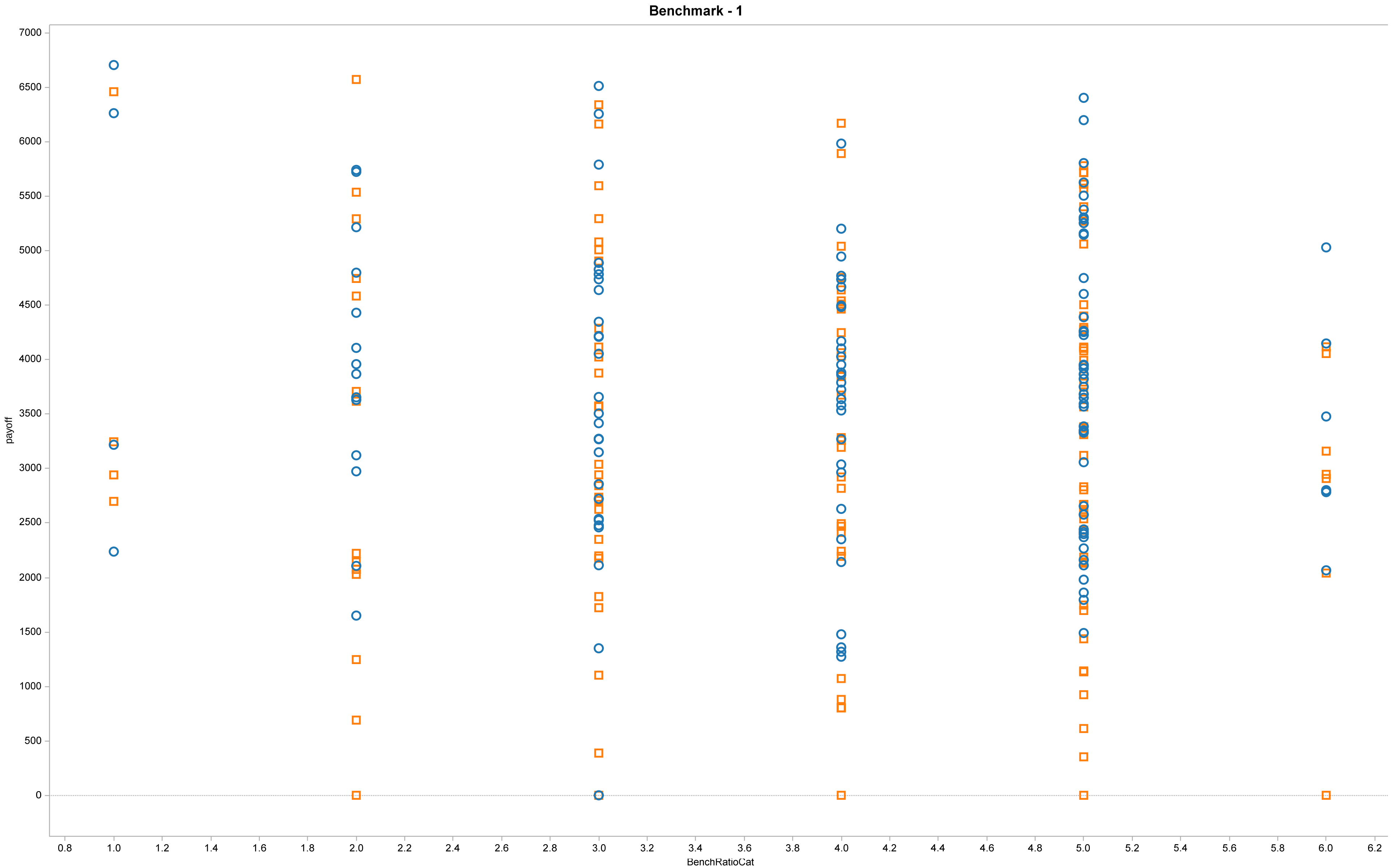


High Quality
Low Quality
Price Point (% of Reference Price)
108
106
104
102
100
98
96
94
92
90
88
86
84
82
80
0
10
20
30
40
50
60
70
80
90
Expenditure ($M)
0
5
10
15
20
25
30
35
40
Expenditure ($M)


High Quality
Low Quality
Price Point (% of Reference Price)
108
106
104
102
100
98
96
94
92
90
88
86
84
82
80
0
10
20
30
40
50
60
70
80
90
Expenditure ($M)
0
5
10
15
20
25
30
35
40
Expenditure ($M)


High Quality
Low Quality
Price Point (% of Reference Price)
108
106
104
102
100
98
96
94
92
90
88
86
84
82
80
0
10
20
30
40
50
60
70
80
90
Expenditure ($M)
0
5
10
15
20
25
30
35
40
Expenditure ($M)

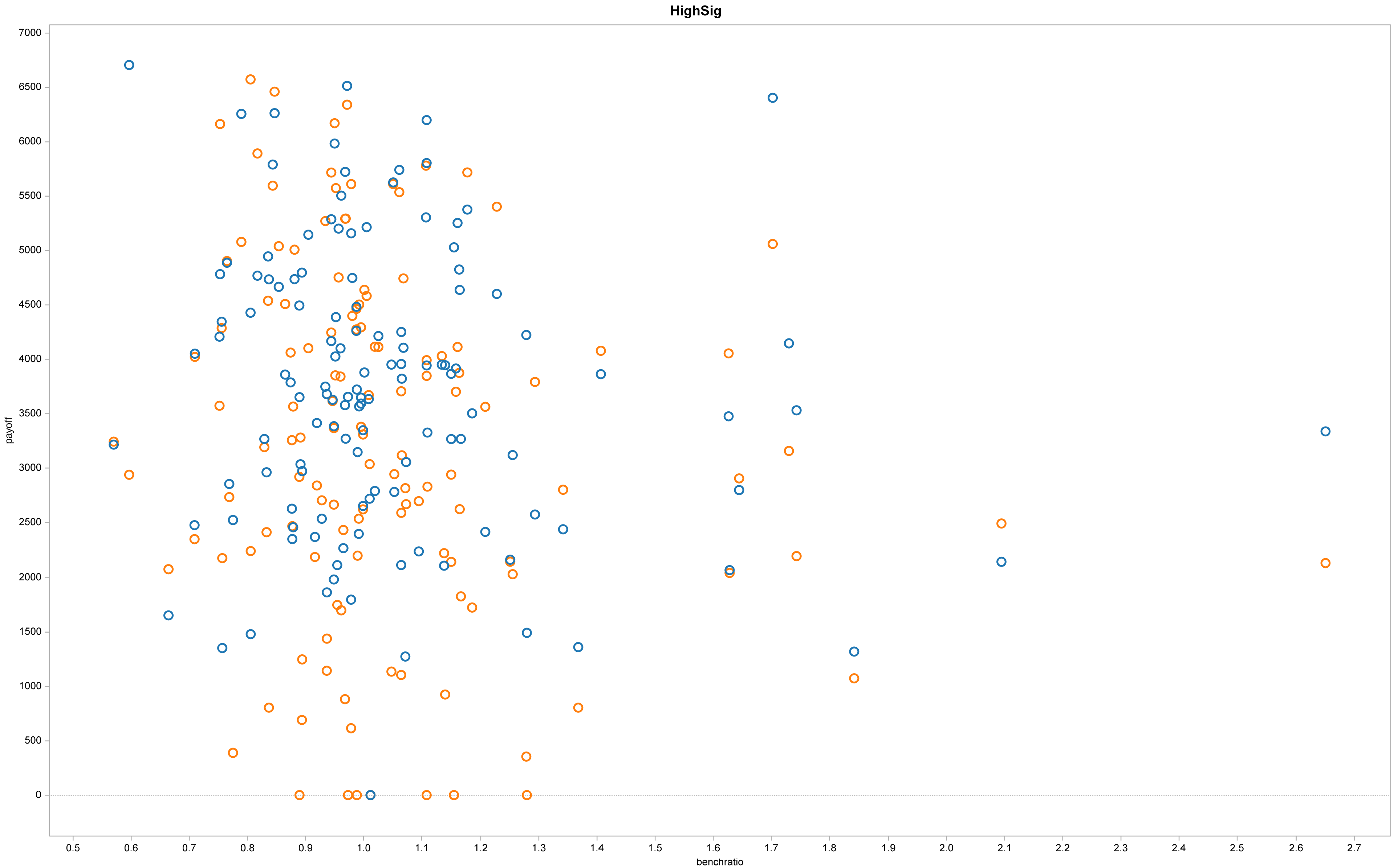
Benchmark - 1



BenchRatioCat vs. payoff for 1. Color shows details about Clock. Shape shows details about Clock. The data is filtered on Day, which ranges from 1 to 4. The view is filtered on bratio1rank, which keeps 1, 2, 3 and 4.

Clock

- clock
- sbid

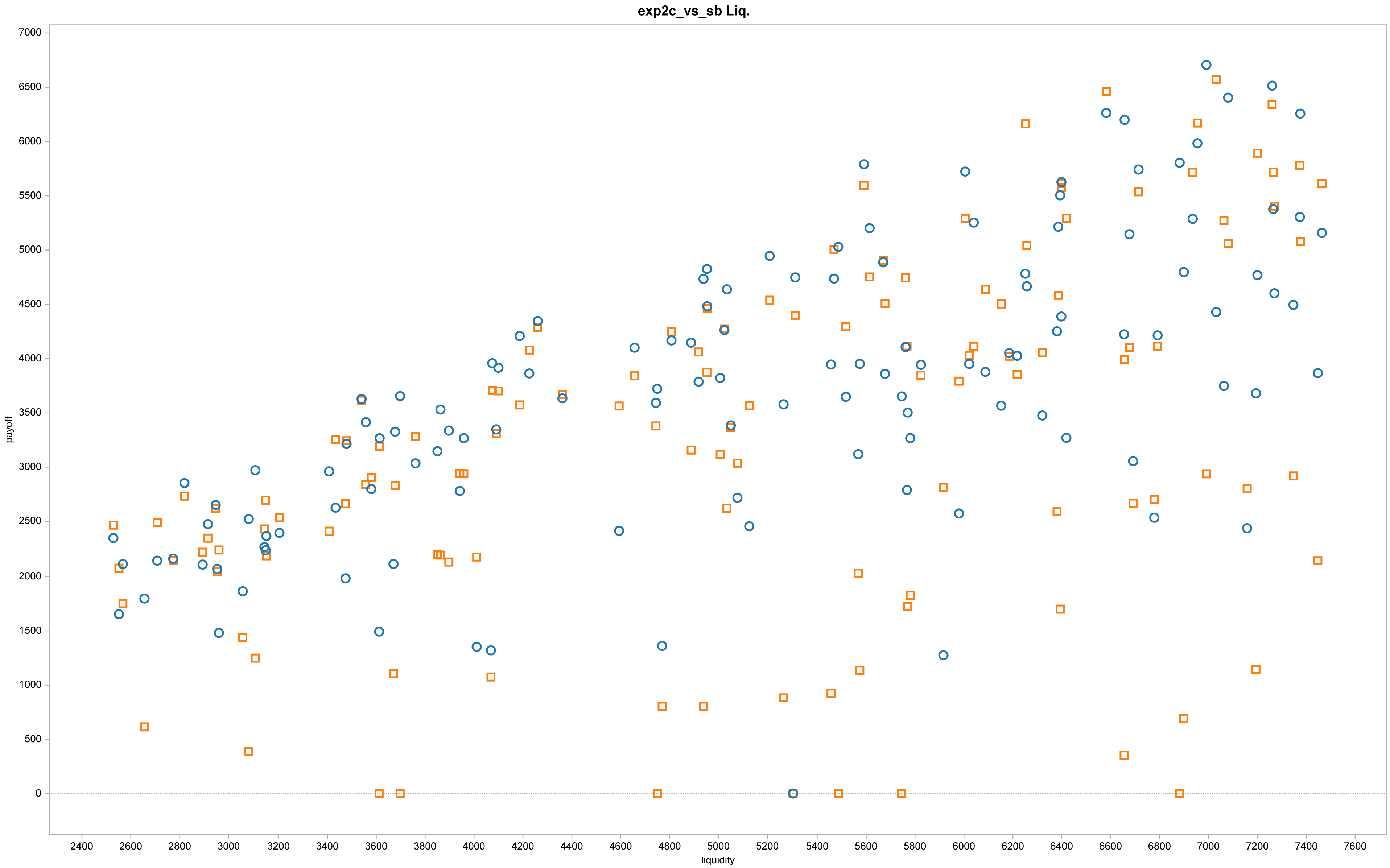


Benchratio vs. payoff. Color shows details about Clock. The data is filtered on Day and numsignals. The Day filter ranges from 1 to 4. The numsignals filter ranges from 4 to 4.

Clock

clock

sbid

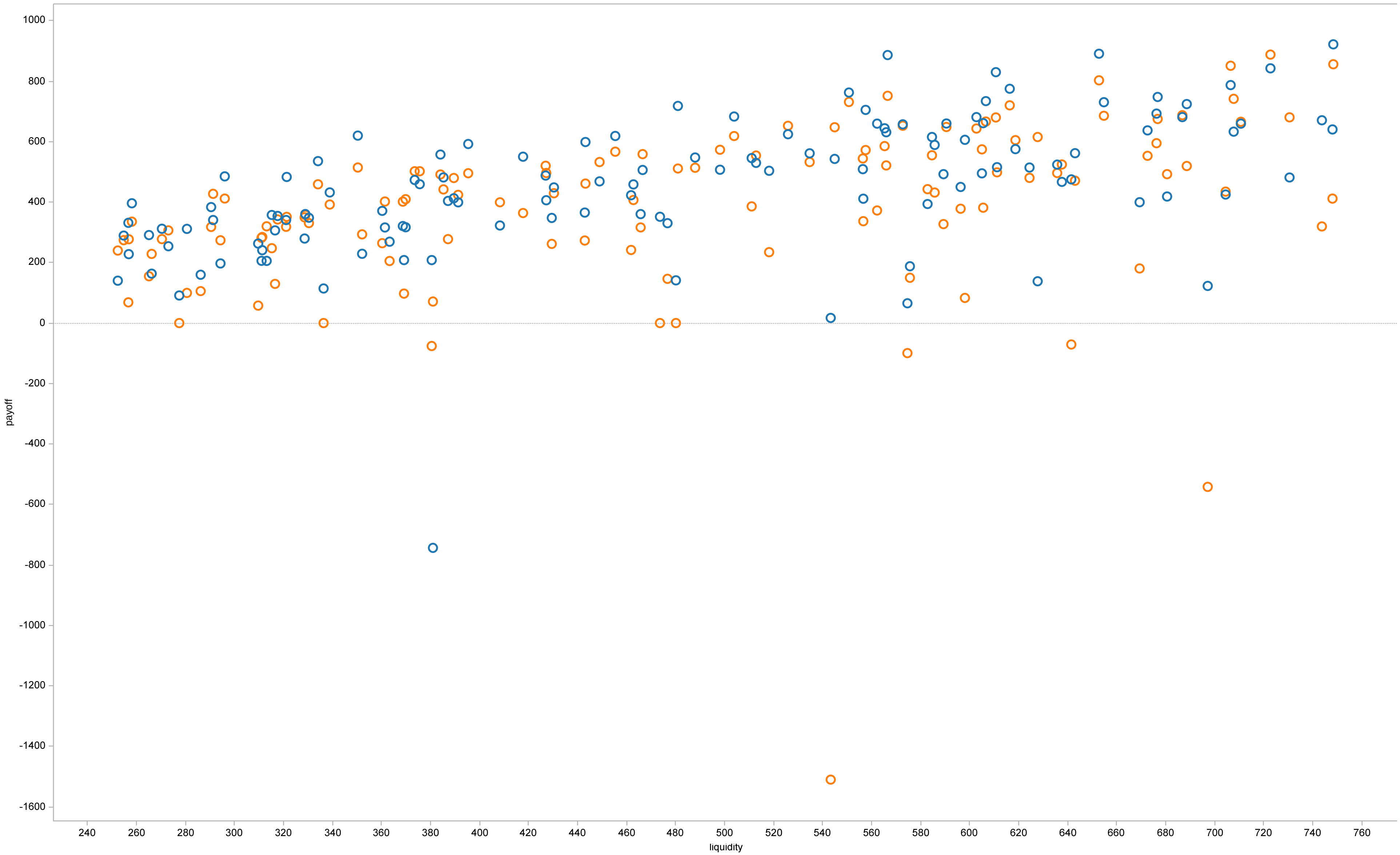


Liquidity vs. payoff. Color shows details about Clock. Shape shows details about Clock. The data is filtered on Day, which ranges from 1 to 4.

Clock

- clock
- sbid

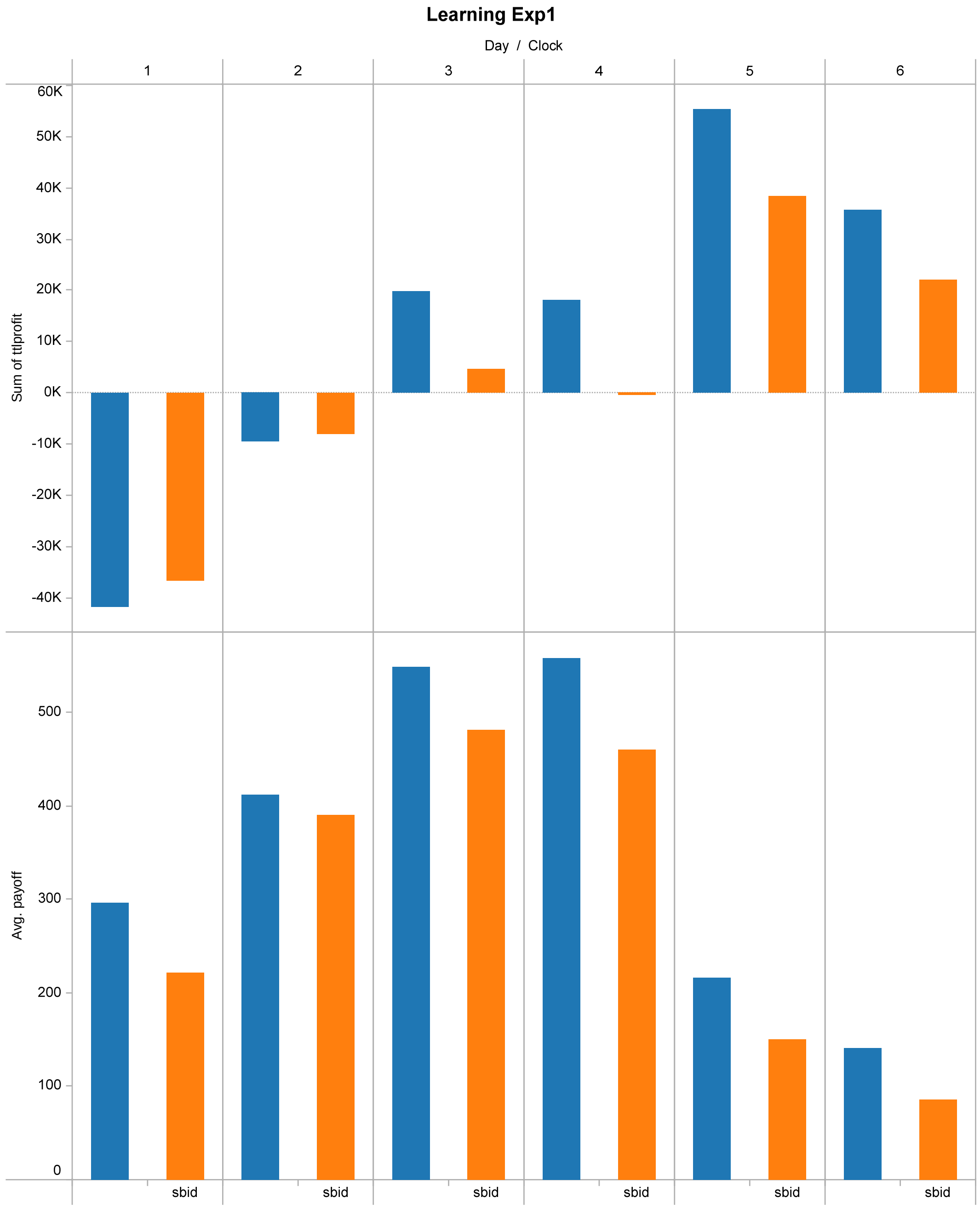
exp1c vs sb liq



Liquidity vs. payoff. Color shows details about Clock. The data is filtered on Day, which has multiple members selected.

Clock

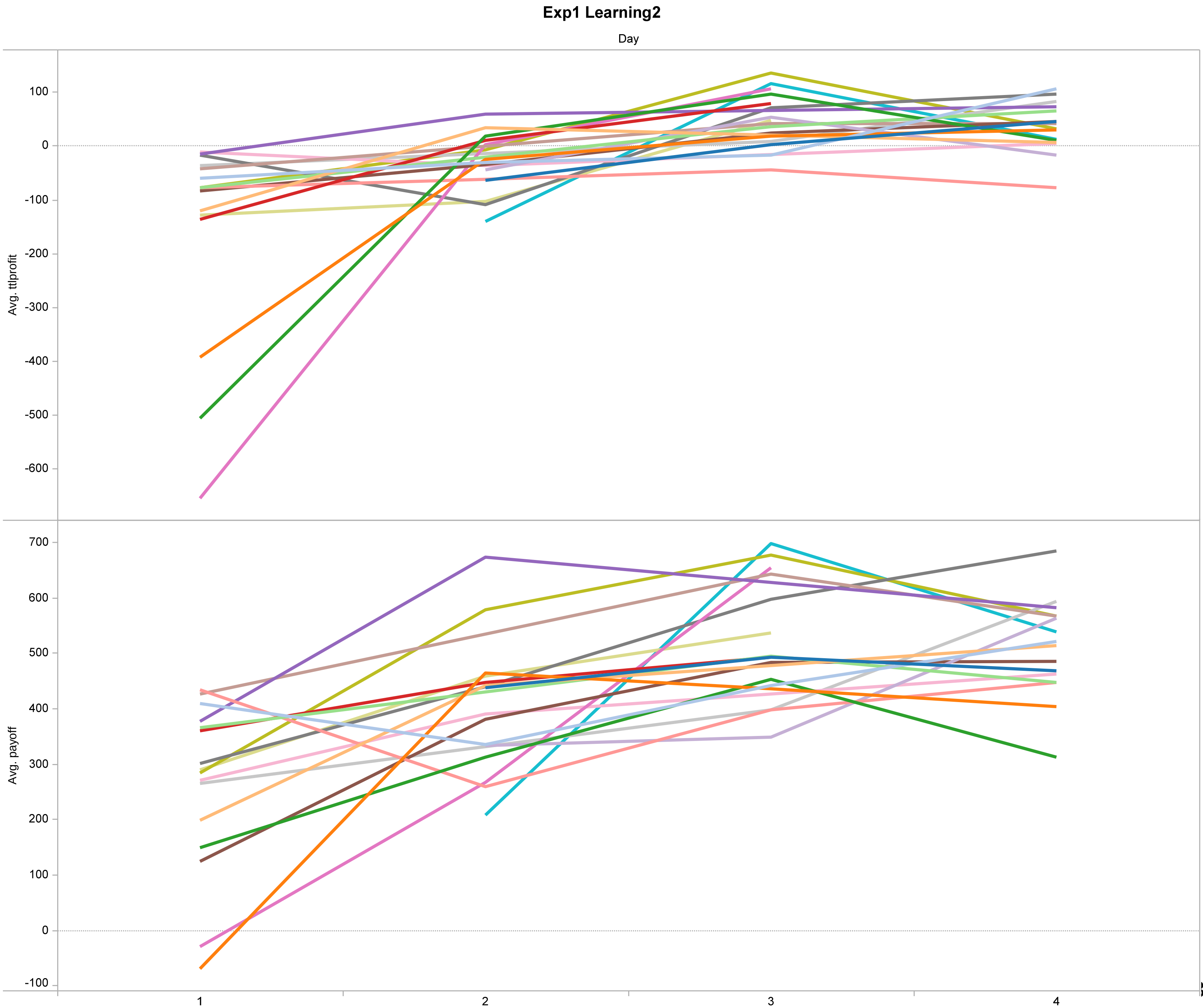
- clock
- sbid



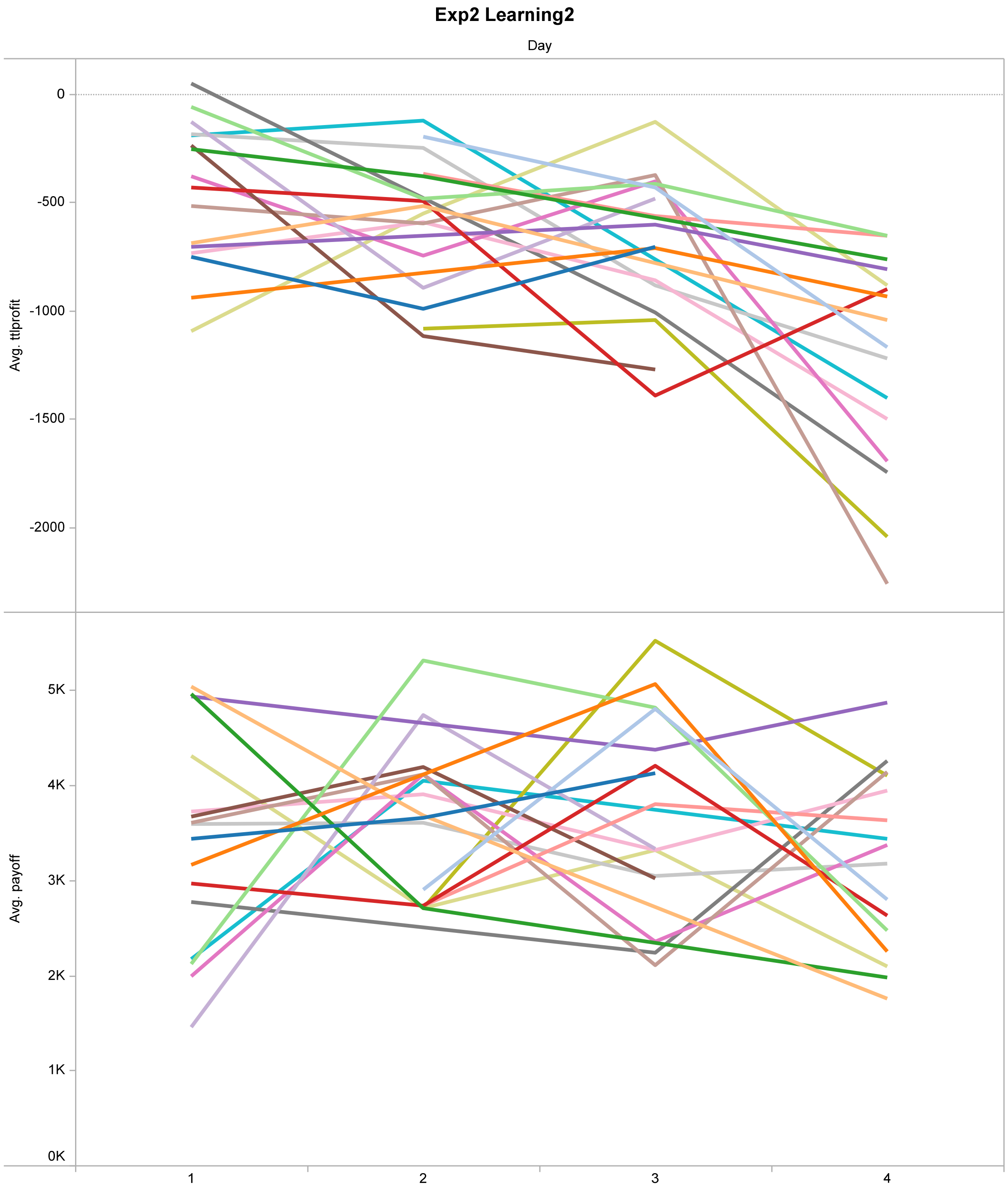
Sum of ttlprofit and average of payoff for each Clock broken down by Day. Color shows details about Clock.

Clock

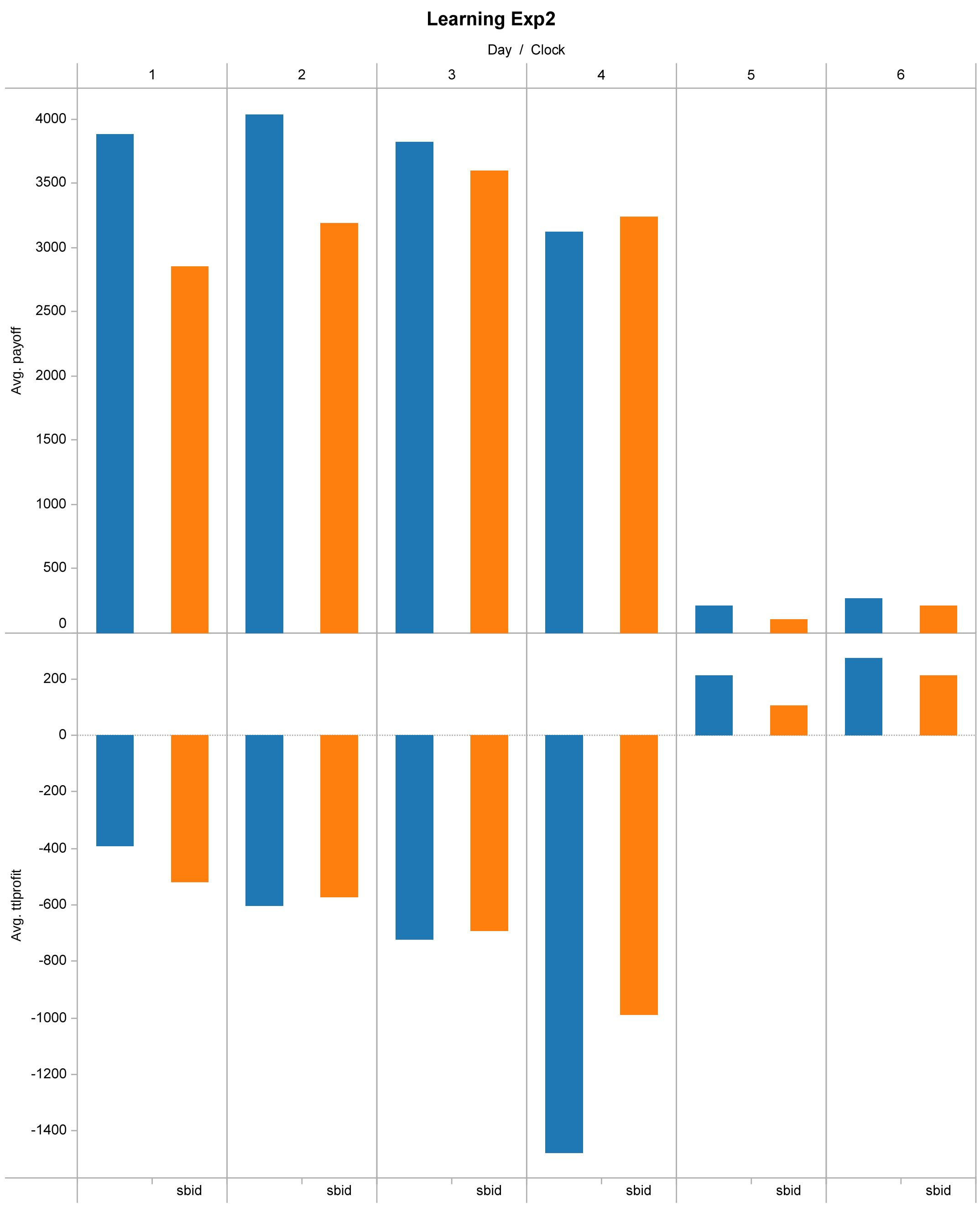
sbid



Comparing the trends of average of ttlprofit and average of payoff with Day. Color shows details about subject. The view is filtered on Day, which has multiple members selected.



Comparing the trends of average of ttlprofit and average of payoff with Day. Color shows details about Subject. The view is filtered on Day, which has multiple members selected.



Average of payoff and average of ttlprofit for each Clock broken down by Day. Color shows details about Clock.

Clock

sbid

Table 1. Experiment 1 (and 3)

	Liquidity >0		Liquidity=0
	(1)	(2)	(3)
dep var:	payoff	profit	profit=payoff
Liquidity	0.740***	-0.159	
	[0.0912]	[0.0879]	
Day 2	183.4***	123.9***	
	[37.01]	[35.68]	
Day 3	283.9***	211.7***	
	[36.88]	[35.56]	
Day 4	250.0***	184.3***	
	[36.83]	[35.51]	
Day 5			58.82**
			[19.59]
Day 6			omitted
Clock	65.39*	26.51	60.13**
	[25.22]	[24.31]	[18.96]
_ISubject_2	45.02	42.74	-22.30
	[77.48]	[74.70]	[53.64]
_ISubject_3	-99.67	-43.34	-45.37
	[77.40]	[74.62]	[53.64]
_ISubject_4	38.14	42.71	
	[83.35]	[80.36]	
_ISubject_5	-67.36	-53.21	-239.2***
	[77.53]	[74.74]	[66.42]
_ISubject_6	2.353	60.12	-127.6*
	[83.30]	[80.31]	[53.64]
_ISubject_7	50.32	50.68	-60.40
	[83.26]	[80.28]	[53.64]
_ISubject_8	-16.25	-18.32	-64.31
	[77.41]	[74.63]	[53.64]
_ISubject_9	115.0	126.7	-113.5*
	[83.51]	[80.51]	[53.64]
_ISubject_10	-16.25	-4.615	-86.78
	[82.46]	[79.50]	[53.64]
_ISubject_11	-20.59	32.51	-53.47
	[77.45]	[74.67]	[66.42]
_ISubject_12	93.86	70.37	-59.59
	[83.38]	[80.39]	[53.64]
_ISubject_13	-91.53	-114.2	-101.0
	[83.27]	[80.28]	[53.64]
_ISubject_14	2.848	61.25	5.287
	[83.27]	[80.28]	[53.64]
_ISubject_15	56.64	68.17	-62.47
	[77.55]	[74.77]	[53.64]
_ISubject_16	19.63	64.14	-66.53
	[83.29]	[80.30]	[53.64]
_ISubject_17	71.97	79.94	-116.6*
	[77.60]	[74.81]	[53.64]
_ISubject_18	-3.744	16.03	
	[83.50]	[80.50]	
_ISubject_19	4.689	3.245	-73.27
	[82.36]	[79.41]	[53.64]
_cons	-24.62	-64.70	280.2***
	[87.89]	[84.73]	[48.41]
	256	256	128
N	0.374	0.142	0.196
adj. R-sq	0.374	0.018	0.341

Standard errors in brackets; * p<0.05 ** p<0.01 *** p<0.001

Table 2. dependent variable=payoff; clustered standard errors

	Liquidity >0				Liquidity=0		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	payoff	payoff	payoff	payoff	payoff	payoff	payoff
Liquidity	0.740***	0.810***	0.810***	0.875***			
	[0.0855]	[0.0594]	[0.0595]	[0.0609]			
Day 1	omitted	omitted	omitted	omitted			
Day 2	183.4***	186.2***	186.2***	188.8***			
	[44.03]	[43.97]	[44.06]	[43.30]			
Day 3	283.9***	285.4***	285.4***	290.9***			
	[47.04]	[47.14]	[47.23]	[48.74]			
Day 4	250.0***	249.7***	249.7***	252.4***			
	[33.52]	[34.87]	[34.94]	[34.70]			
Day 5	0	0	0	0	58.82	58.82	65.85*
	[0]	[0]	[0]	[0]	[30.03]	[30.03]	[29.60]
Day 6	0	0	0	0	*omitted*	*omitted*	*omitted*
	[0]	[0]	[0]	[0]			
Clock	65.39***	65.39***	119.6**	65.34***	60.13**	60.13**	59.09**
	[16.36]	[16.39]	[31.78]	[16.34]	[16.08]	[16.08]	[16.08]
8_Bidders		185.6***	239.7***	190.8***			
		[28.33]	[37.68]	[29.24]			
Clock*8_Bidders			-108.3**				
			[35.52]				
e_payoff				-0.0914			0.156
				[0.0648]			[0.116]
_cons	-147.2*	-274.2***	-301.3***	-265.9***	208.9***	208.9***	193.9***
	[54.83]	[43.63]	[47.67]	[42.81]	[29.10]	[29.10]	[30.30]
Subject FE	*Yes*	*Yes*	*Yes*		*Yes*	*Yes*	*Yes*
N	256	256	256		128	128	128
adj. R-sq	0.419	0.552	0.551		0.299	0.299	0.315

Standard errors in brackets clustered on subjects; * p<0.05 ** p<0.01 *** p<0.001

Table 3a. dependent variable=payoff for only days 1-4; clustered standard errors

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	payoff	payoff	payoff	payoff	payoff	payoff	payoff	payoff	payoff
liquidity	0.740***	0.810***	0.817***	0.761***	0.761***	0.787***	0.791***	0.891***	0.899***
	[0.0855]	[0.0594]	[0.0595]	[0.0679]	[0.0679]	[0.0731]	[0.127]	[0.0930]	[0.101]
Day 1	*omitted*	*omitted*	*omitted*						
Day 2	183.4***	186.2***	185.7***	385.5*	385.5*	381.0*			
	[44.03]	[43.97]	[43.83]	[151.2]	[151.2]	[147.2]			
Day 3	283.9***	285.4***	281.0***	522.0**	522.0**	521.7**			
	[47.04]	[47.14]	[46.48]	[145.6]	[145.6]	[144.8]			
Day 4	250.0***	249.7***	247.5***	440.7**	440.7**	443.4**			
	[33.52]	[34.87]	[34.97]	[142.5]	[142.5]	[138.8]			
Clock	65.39***	65.39***	65.37***	65.39**	65.39**	65.34**	65.39**	65.39**	65.37**
	[16.36]	[16.39]	[16.53]	[17.01]	[17.01]	[17.35]	[17.93]	[17.97]	[18.12]
8_Bidders		185.6***	182.1***		935.7	1142.0		187.9***	184.6***
		[28.33]	[28.42]		[914.7]	[1016.2]		[32.52]	[34.12]
e_profit			0.118			0.293			0.115
			[0.145]			[0.161]			[0.232]
_cons	-16.42	-143.4**	-149.0**	-414.4**	287.4	427.2	-89.42	-241.4***	-181.0**
	[55.76]	[41.43]	[41.36]	[124.8]	[712.6]	[770.0]	[67.35]	[54.28]	[49.23]
Subject FE	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Competitor FE				*Yes*	*Yes*	*Yes*			
Subject*Day FE							*Yes*	*Yes*	*Yes*
N	256	256	256	256	256	256	256	256	256
adj. R-sq	0.419	0.552	0.551	0.638	0.638	0.642	0.407	0.569	0.568

Standard errors in brackets clustered on subjects; * $p<0.05$ ** $p<0.01$ *** $p<0.001$

Table 3b. dependent variable=payoff for only days 5-6; clustered standard errors

	(1)	(2)	(3)	(4)	(5)	(6)
	payoff	payoff	payoff	payoff	payoff	payoff
Day 5	58.82	65.85*	26.71	35.74		
	[30.03]	[29.60]	[18.06]	[20.68]		
Day 6	*omitted*	*omitted*	*omitted*	*omitted*		
Clock	60.13**	59.09**	60.13**	59.34**	60.13**	58.65**
	[16.08]	[16.08]	[16.92]	[16.92]	[17.07]	[17.30]
e_profit		0.156		0.119		0.223
		[0.116]		[0.0799]		[0.178]
_cons	208.9***	193.9***	196.9***	194.1***	214.6***	193.0***
	[29.10]	[30.30]	[42.07]	[44.30]	[25.60]	[33.31]
Subject FE	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Competitor FE			*Yes*	*Yes*		
Subject*Day FE					*Yes*	*Yes*
N	128	128	128	128	128	128
adj. R-sq	0.299	0.315	0.649	0.657	0.447	0.471

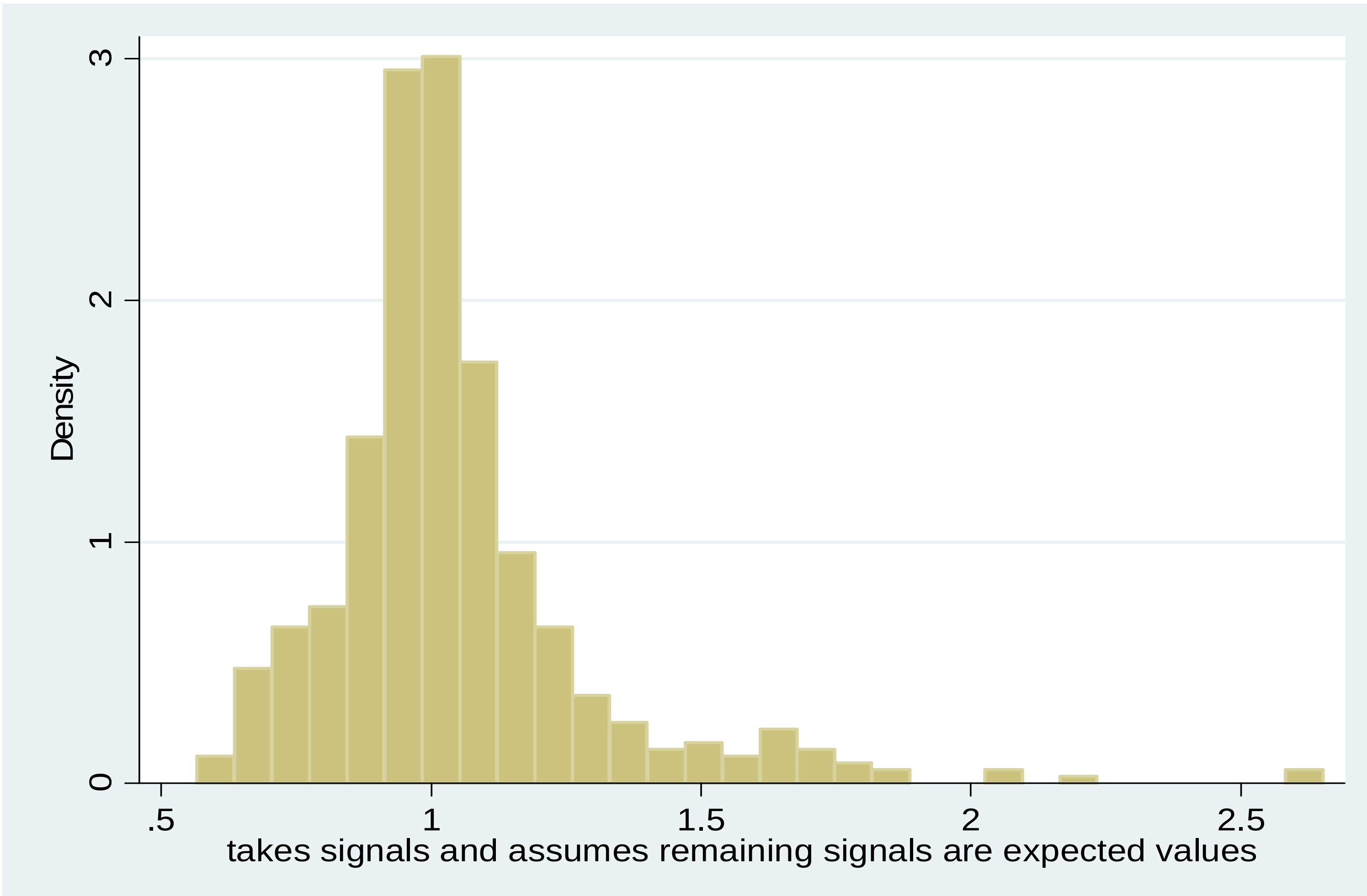
Standard errors in brackets clustered on subjects; * p<0.05 ** p<0.01 *** p<0.001

Table 1. Experiment 2 (and 3)

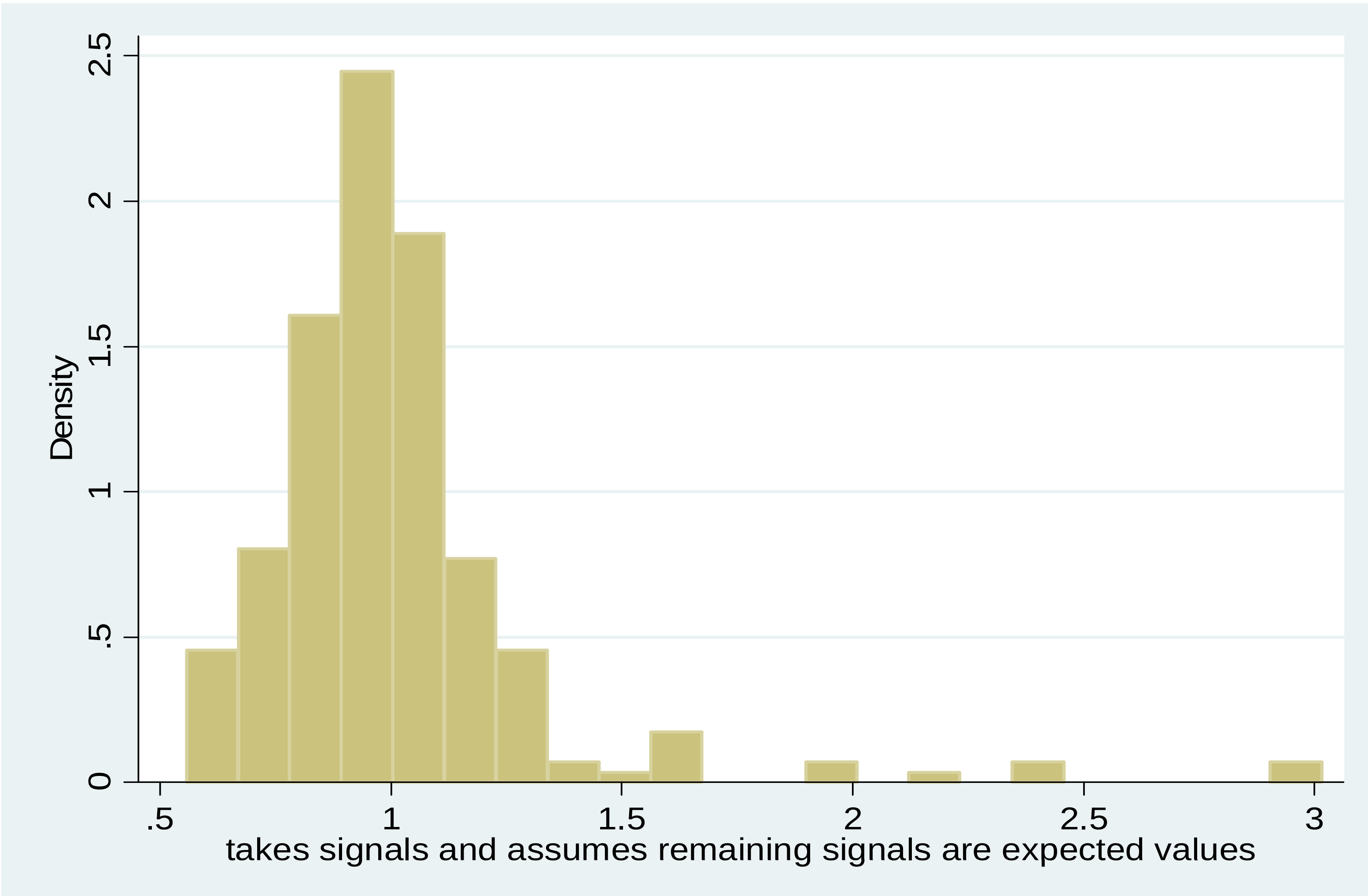
	(1)	(2)	(3)
dep var:	payoff	profit	payoff=profit
Liquidity	0.606***	-0.119***	
	[0.0545]	[0.0217]	
Day 2	189.9	-120.8	
	[220.0]	[87.43]	
Day 3	326.4	-225.6*	
	[219.8]	[87.37]	
Day 4	-315.4	-791.3***	
	[219.9]	[87.42]	
Day 5			-84.66
			[46.74]
Day 6			*omitted*
Clock	496.7**	105.5	-84.49
	[150.5]	[59.82]	[46.74]
LessPrecise	-44.68	-43.82	
	[150.6]	[59.87]	
_ISubject_2	-80.46	472.0*	493.1***
	[497.0]	[197.5]	[132.2]
_ISubject_3	-119.6	186.1	134.8
	[497.0]	[197.5]	[132.2]
_ISubject_4	56.07	238.7	353.3**
	[497.1]	[197.6]	[132.2]
_ISubject_5	-984.8	672.3***	
	[500.2]	[198.8]	
_ISubject_6	294.7	536.8**	117.3
	[462.5]	[183.8]	[132.2]
_ISubject_7	-831.8	248.8	275.0*
	[462.9]	[184.0]	[132.2]
_ISubject_8	-727.8	647.5**	26.68
	[498.6]	[198.2]	[132.2]
_ISubject_9	682.2	429.1*	
	[498.8]	[198.3]	
_ISubject_10	-654.2	332.8	-40.32
	[491.6]	[195.4]	[132.2]
_ISubject_11	-580.0	33.59	392.1**
	[493.3]	[196.1]	[132.2]
_ISubject_12	-303.4	82.20	104.6
	[462.2]	[183.7]	[132.2]
_ISubject_13	-876.7	222.0	200.8
	[462.3]	[183.8]	[132.2]
_ISubject_14	-254.0	136.3	476.3***
	[463.0]	[184.0]	[132.2]
_ISubject_15	-884.8	219.6	547.5***
	[498.3]	[198.1]	[132.2]
_ISubject_16	-75.94	315.1	302.5*
	[462.3]	[183.8]	[132.2]
_ISubject_17	-62.64	-202.3	153.2
	[499.0]	[198.4]	[132.2]
_ISubject_18	-530.6	325.2	215.1
	[462.0]	[183.6]	[132.2]
_ISubject_19	-212.3	414.8*	
	[497.1]	[197.6]	
_cons	1372.5**	-265.9	136.9
	[509.7]	[202.6]	[119.2]
N	256	256	128
adj. R-sq	0.364	0.388	0.265

Standard errors in brackets; * p<0.05 ** p<0.01 *** p<0.001

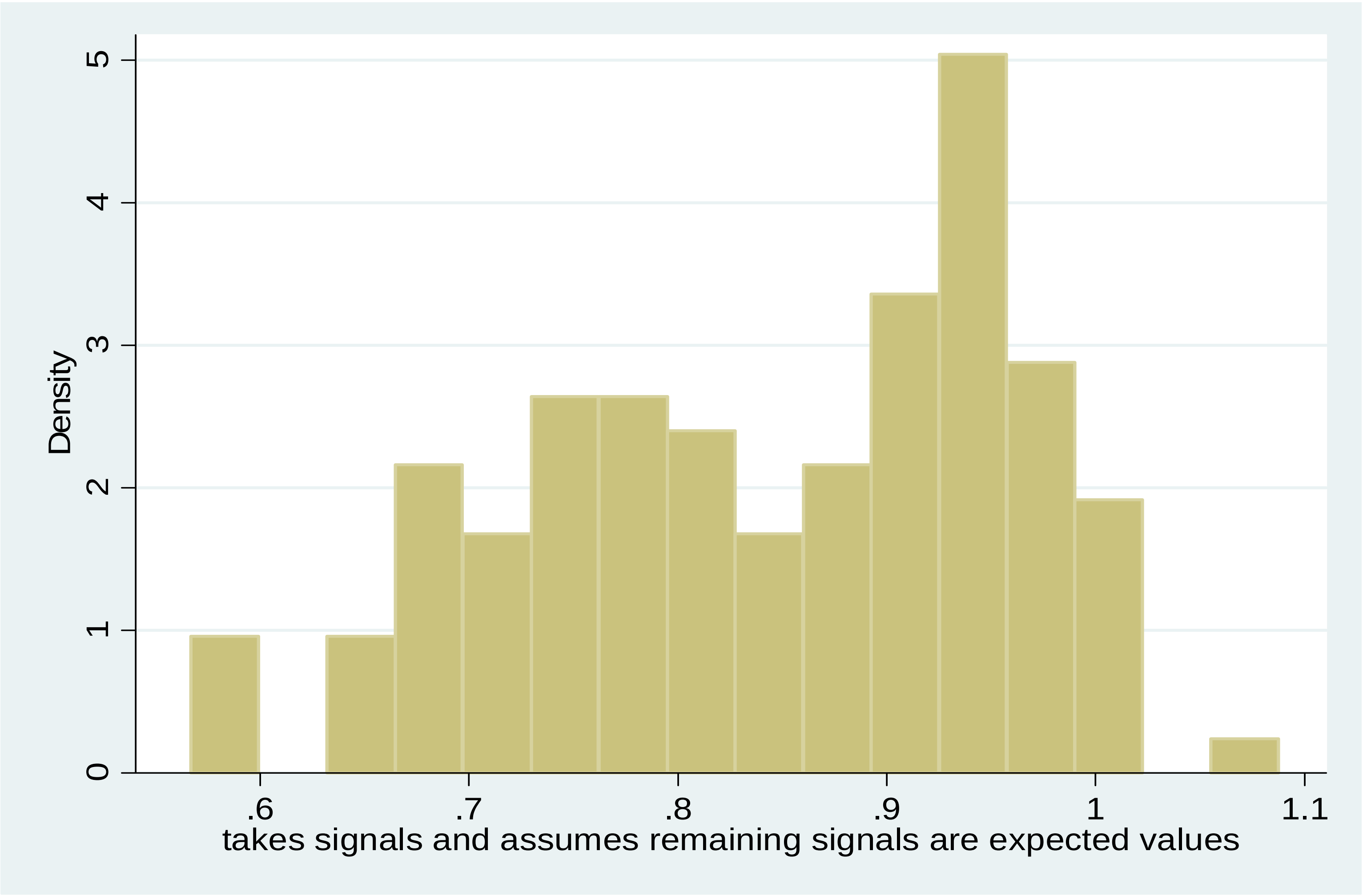
Benchmark ratios (signals*private + E[v]*8-signals)/8*ref) when Liquidity>0



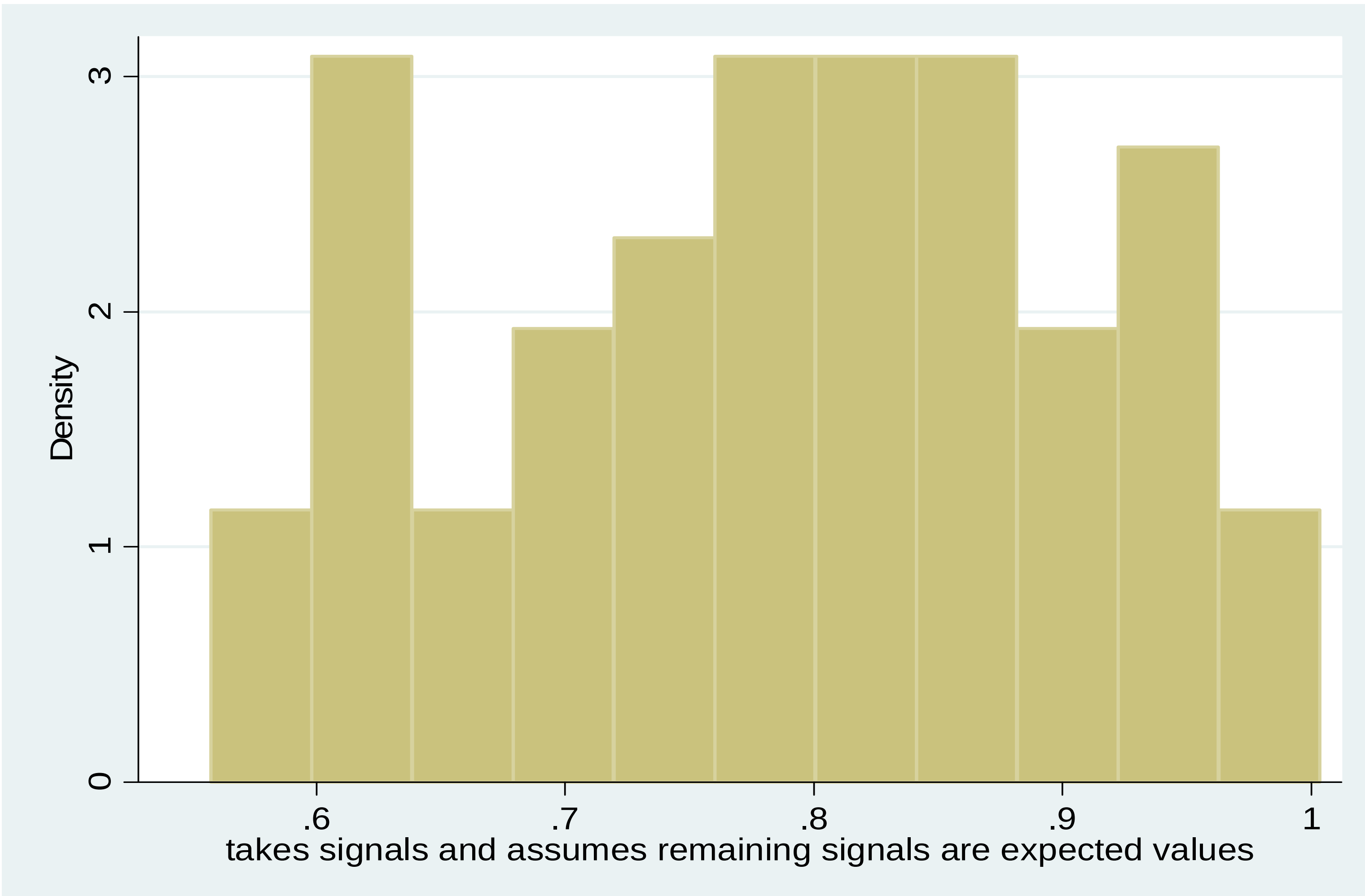
Benchmark ratios (signals*private + E[v]*8-signals)/8*ref) when Liquidity=0



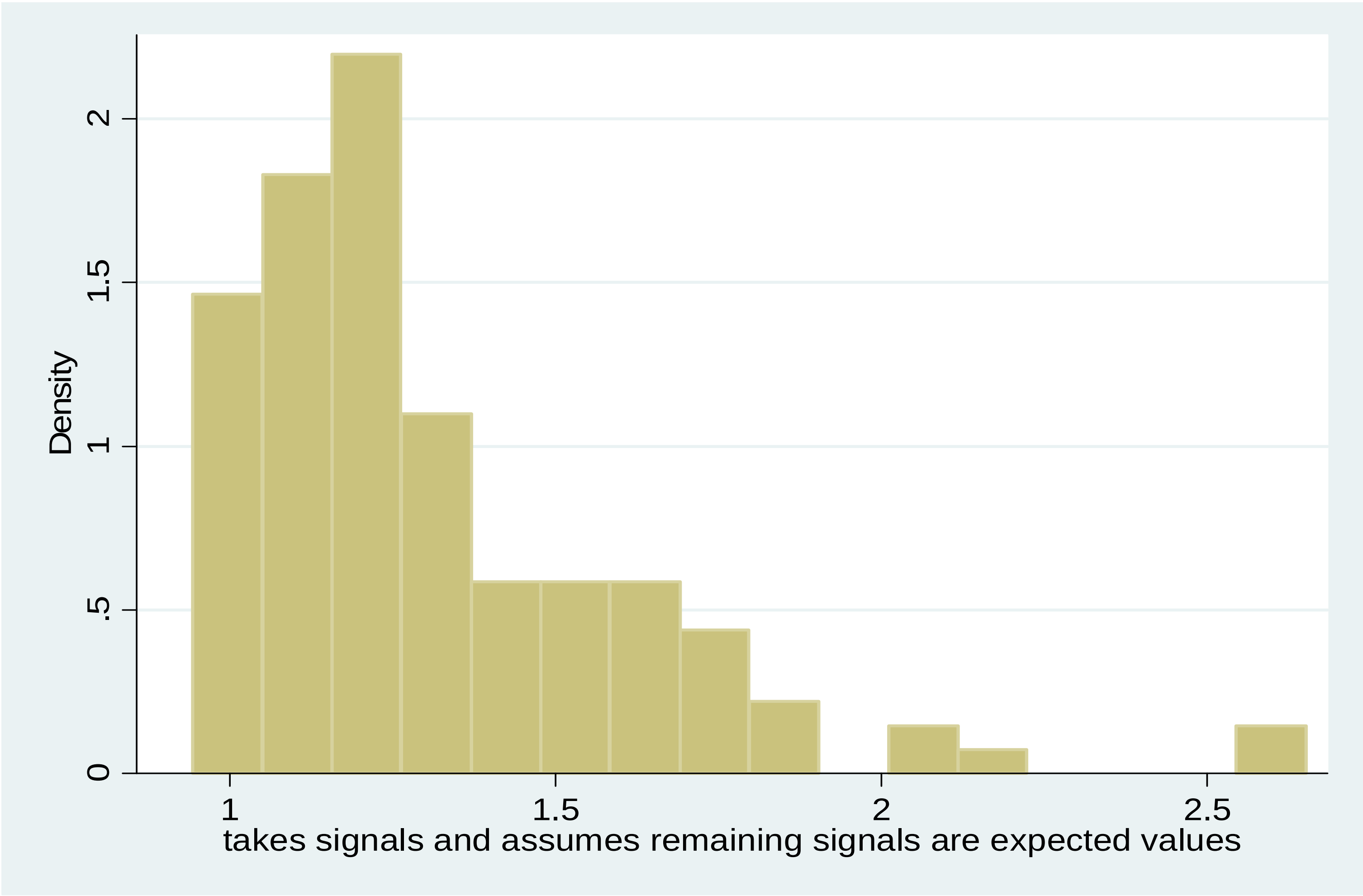
Distribution of lowest benchmark ratio



Distribution of lowest benchmark ratio



Distribution of highest benchmark ratio



Distribution of highest benchmark ratio

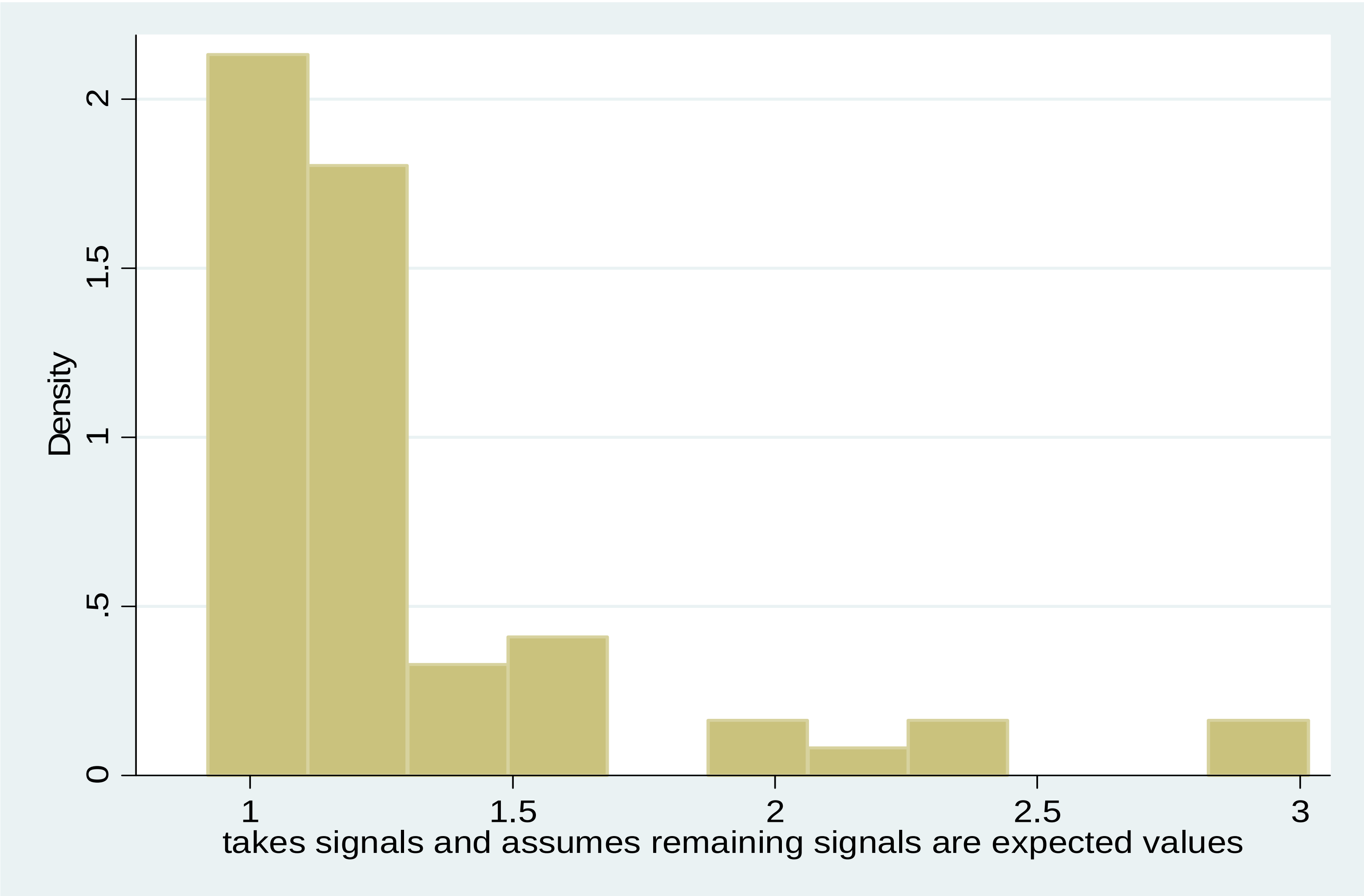


Table. When the lowest calculated benchmark ratio falls in the following ranges*

	(1)	(2)	(3)	(4)	(5)	(6)
	BR<0.6	0.6 ≤ BR < 0.7	0.7 ≤ BR < 0.8	0.8 ≤ BR < 0.9	0.9 ≤ BR < 1	1 ≤ BR
dep var:	payoff	payoff	payoff	payoff	payoff	payoff
Liquidity	1.134***	-0.798***	0.706***	1.500***	0.519***	0
	[9.57e-17]	[2.91e-16]	[0.139]	[0.344]	[0.0645]	[0]
Day 2	0	1860.1***	-1502.9*	2128.8**	-713.0	0
	[0]	[9.59e-13]	[566.1]	[628.0]	[516.3]	[0]
Day 3	0	0	19.45	1133.9	-406.1	0
	[0]	[0]	[517.9]	[790.2]	[357.5]	[0]
Day 4	0	2546.6***	1629.5	-381.9	-1218.3*	0
	[0]	[1.39e-12]	[1191.5]	[182.2]	[464.9]	[0]
Clock	769.1	751.8	405.6	303.2	564.2*	553.2
	[1376.0]	[461.7]	[260.8]	[252.2]	[265.5]	[823.1]
LessPrecise	0	0	-200.4	1061.9*	-483.1	0
	[0]	[0]	[626.1]	[394.4]	[444.3]	[0]
_cons	-1890.3	5934.7***	-322.0	-5288.1*	1369.1*	2747.1***
	[688.0]	[230.8]	[879.8]	[1912.8]	[580.5]	[411.6]
Subject FE	Yes	Yes	Yes	Yes	Yes	Yes
N	8	28	56	58	92	14
adj. R-sq	0.665	0.721	0.741	0.631	0.563	0.251

Standard errors in brackets clustered on subjects; * p<0.05 ** p<0.01 *** p<0.001
* benchmark ratio calculated based on your signals and expected values for unknown signals / ref price

Table. When the lowest calculated benchmark ratio falls in the following ranges*

	(1)	(2)	(3)	(4)	(5)	(6)
	BR<0.6	0.6 ≤ BR < 0.7	0.7 ≤ BR < 0.8	0.8 ≤ BR < 0.9	0.9 ≤ BR < 1	1 ≤ BR
dep var:	profit	profit	profit	profit	profit	profit
Liquidity	-0.0258	-0.0637***	0.00173	0.0497	0.0292	0
	[0]	[1.62e-17]	[0.0396]	[0.0339]	[0.0193]	[0]
Day 2	0	248.6***	11.27	-35.91	-15.65	0
	[0]	[3.32e-14]	[135.4]	[70.62]	[84.42]	[0]
Day 3	0	0	-212.6	-14.54	-155.2	0
	[0]	[0]	[113.2]	[50.76]	[154.5]	[0]
Day 4	0	114.5***	-157.5	-131.9**	-68.35	0
	[0]	[6.66e-14]	[134.3]	[43.74]	[129.4]	[0]
Clock	-80.04	-55.96	-27.48	-17.11	-116.0*	-158.2*
	[34.94]	[27.81]	[30.77]	[29.81]	[46.36]	[60.67]
LessPrecise	0	0	130.0	-12.14	131.1	0
	[0]	[0]	[140.4]	[41.64]	[127.4]	[0]
_cons	260.2**	282.3***	6.339	-294.5	-413.9*	-379.9***
	[17.47]	[13.91]	[223.6]	[182.6]	[173.1]	[30.34]
Subject FE	Yes	Yes	Yes	Yes	Yes	Yes
N	8	28	56	58	92	14
adj. R-sq	0.842	0.717	0.466	0.595	0.397	0.951

Standard errors in brackets clustered on subjects; * p<0.05 ** p<0.01 *** p<0.001
* benchmark ratio calculated based on your signals and expected values for unknown signals / ref price

Table. Relative importance of 4-Signal Security with Liquidity

	(1)	(2)	(3)	(4)
dep var:	payoff	payoff	profit	profit
Liquidity	0.601***	0.594***	-0.0555*	-0.0579*
	[0.0801]	[0.0731]	[0.0209]	[0.0213]
BenchRatio	-560.8	-386.5	-43.91	20.19
	[305.6]	[272.1]	[75.23]	[67.38]
4 Signals = HighSec	-213.7	2620.5*	-396.8***	645.2
	[178.1]	[974.6]	[63.97]	[445.8]
4SigHighSec*BenchRatio		-2797.6**		-1028.5*
		[925.4]		[461.0]
Day 2	218.3	161.1	-142.1	-163.1
	[406.0]	[390.2]	[77.46]	[84.65]
Day 3	357.1	323.1	-186.5*	-199.0*
	[275.0]	[264.6]	[76.33]	[72.62]
Day 4	-257.4	-262.0	-418.2**	-419.9**
	[295.6]	[308.3]	[118.3]	[114.4]
Clock	496.7*	496.7*	-96.34*	-96.34*
	[198.2]	[198.6]	[42.76]	[42.84]
LessPrecise	-12.08	22.94	-38.49	-25.62
	[147.2]	[143.3]	[40.71]	[43.71]
_cons	769.4	628.7	419.4	367.7
	[660.5]	[658.1]	[209.9]	[202.3]
N	256	256	256	256
adj. R-sq	0.417	0.432	0.427	0.451

Standard errors in brackets clustered on subjects; * p<0.05 ** p<0.01 *** p<0.001
* benchmark ratio calculated based on your signals and expected values for unknown signals / ref price

Table. Relative importance of 4-Signal Security without Liquidity

	(1)	(2)
dep var:	payoff	profit
liquidity	0	0
	[0]	[0]
BenchRatio	-221.8	-120.9
	[182.6]	[134.7]
4 Signals = HighSec	42.52	972.9*
	[44.48]	[360.0]
4SigHighSec*benchratio		-989.1*
		[359.3]
Day 5	-95.88	-6.300
	[56.53]	[56.57]
Day 6	omitted	omitted
Clock	84.49***	35.93
	[16.97]	[17.31]
_cons	407.8*	190.7
	[154.7]	[127.2]
N	128	128
adj. R-sq	0.389	0.321

Standard errors in brackets clustered on subjects; * p<0.05 ** p<0.01 *** p<0.001

* benchmark ratio calculated based on your signals and expected values for unknown signals / ref price