

Notes on the Construction of Demand & Supply Schedules

Leigh Tesfatsion
Department of Economics
Iowa State University
Ames, IA 5001-1070

<https://www2.econ.iastate.edu/tesfatsi/>

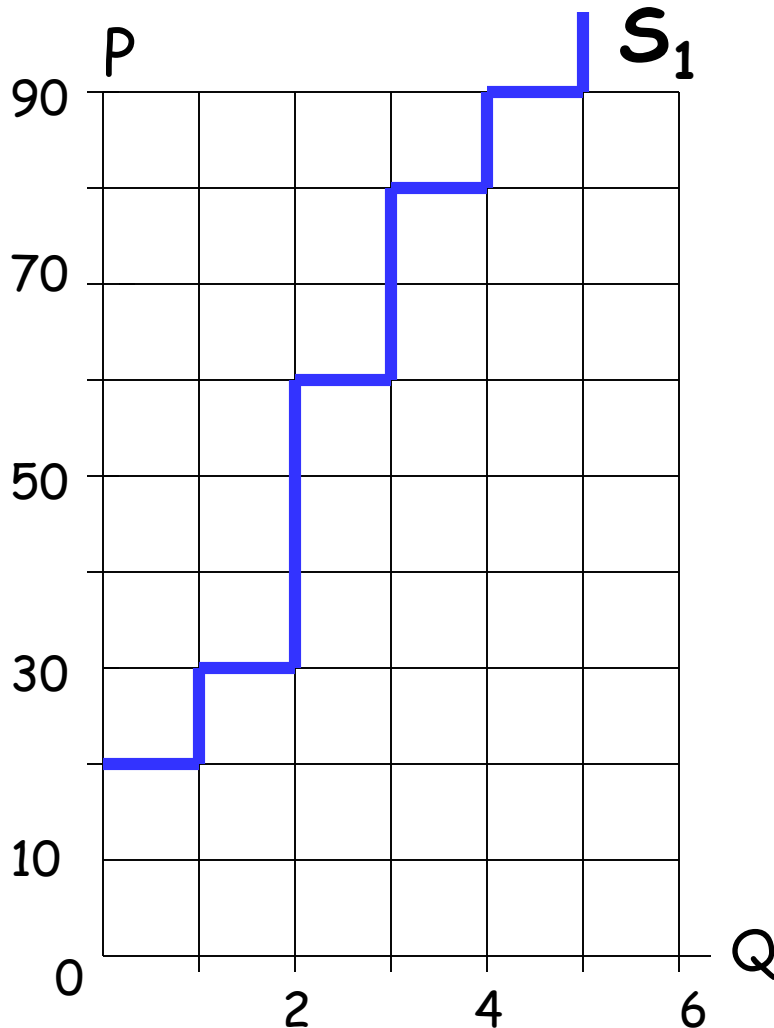
Clarification of Terminology

- In market analyses:
 - *Ordinary* supply and demand schedules give *quantity for each (per unit) price*: $Q = S^o(P)$; $Q = D^o(P)$
 - *Inverse* supply and demand schedules give *(per unit) price for each quantity*: $P = S(Q)$; $P = D(Q)$.
- In this class we will stress price-setting agents who determine price for each quantity bought/sold, so we focus on inverse supply/demand functions.
- The exact relationship between ordinary/inverse supply and demand is illustrated at the end of these notes.

EXAMPLE 1:

Seller 1 Supply Schedule

Inverse Form $P = S_1(Q)$



Let Q = Apple Amount (in bushels)

Let P = Per-unit price of apples
(i.e., dollars \$ per bushel)

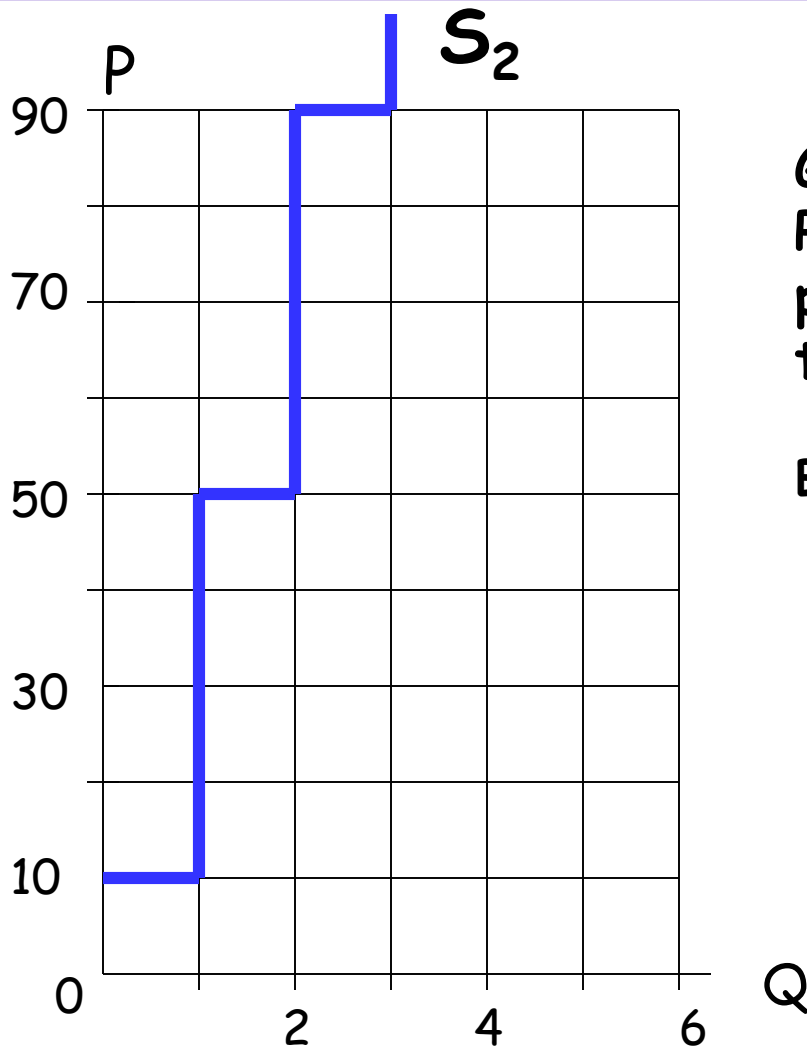
Given any Q , the function $P=S_1(Q)$ gives Seller 1's minimum per-unit sale price (\$/bushel) for the "last" unit supplied at this Q .

Bushel Unit Seller 1 Min Sale Price

1	\$20
2	\$30
3	\$60
4	\$80
5	\$90
6	∞

Seller 2 Supply Schedule

Inverse Form $P = S_2(Q)$



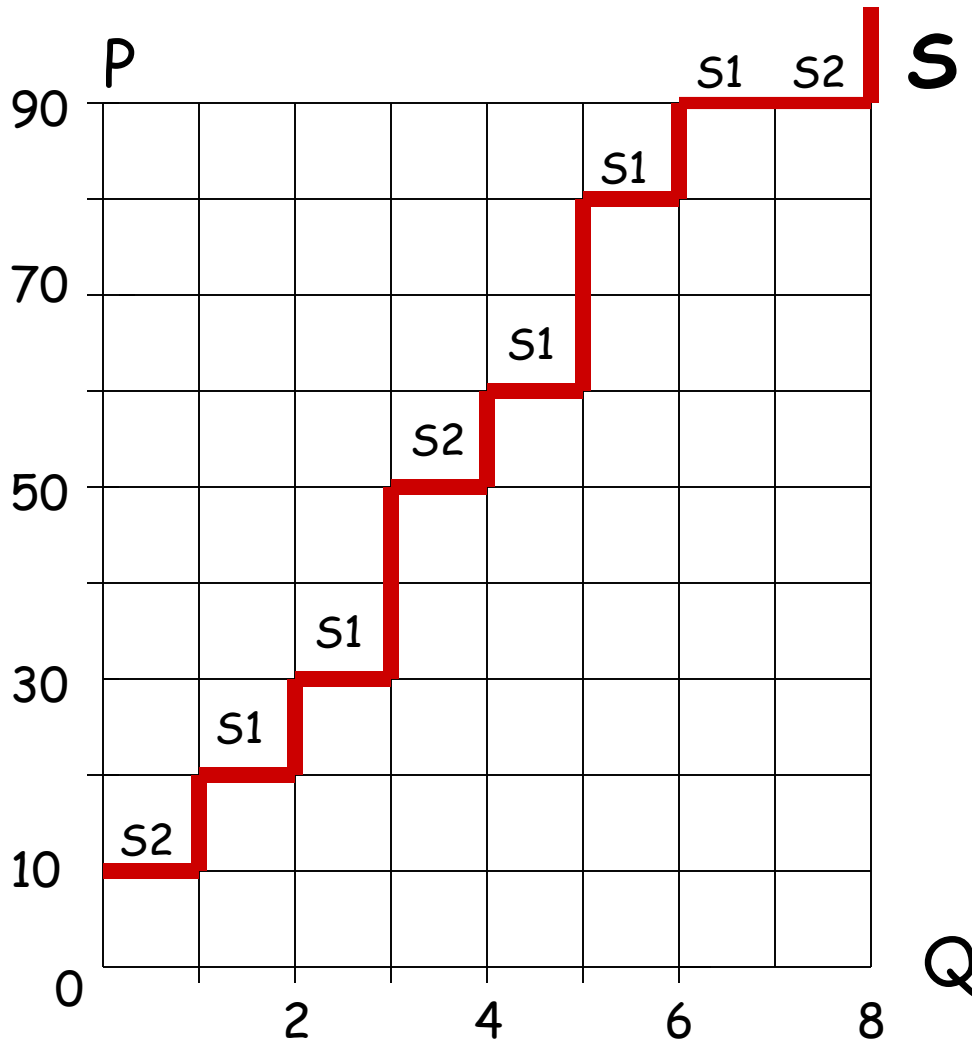
Given any Q , the function $P=S_2(Q)$ gives Seller 2's minimum per-unit sale price (\$/bushel) for the "last" unit supplied at this Q .

Bushel Unit Seller 2 Min Sale Price

1	\$10
2	\$50
3	\$90
4	∞

Total Supply Schedule (Sellers 1 & 2)

Inverse Form $P = S(Q)$

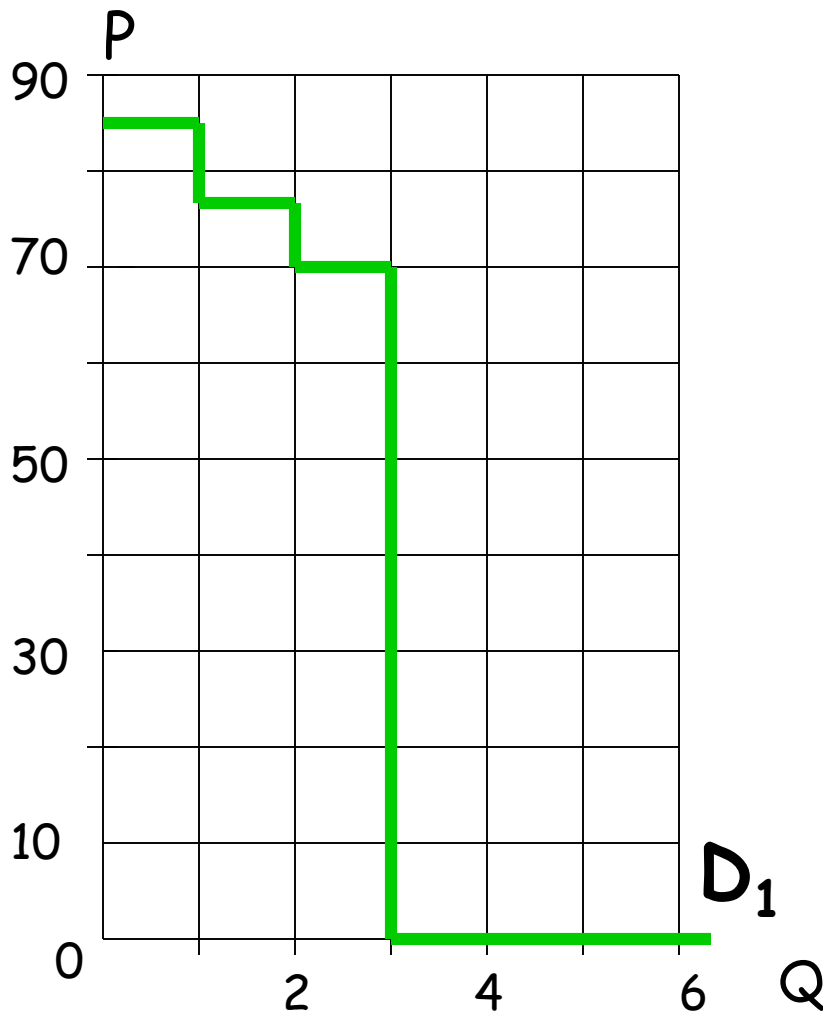


Bushel Unit Min Seller Price

1	\$10 (S2)
2	\$20 (S1)
3	\$30 (S1)
4	\$50 (S2)
5	\$60 (S1)
6	\$80 (S1)
7	\$90 (S1/S2)
8	\$90 (S2/S1)
9	∞

Buyer 1 Demand Schedule

Inverse Form $P = D_1(Q)$



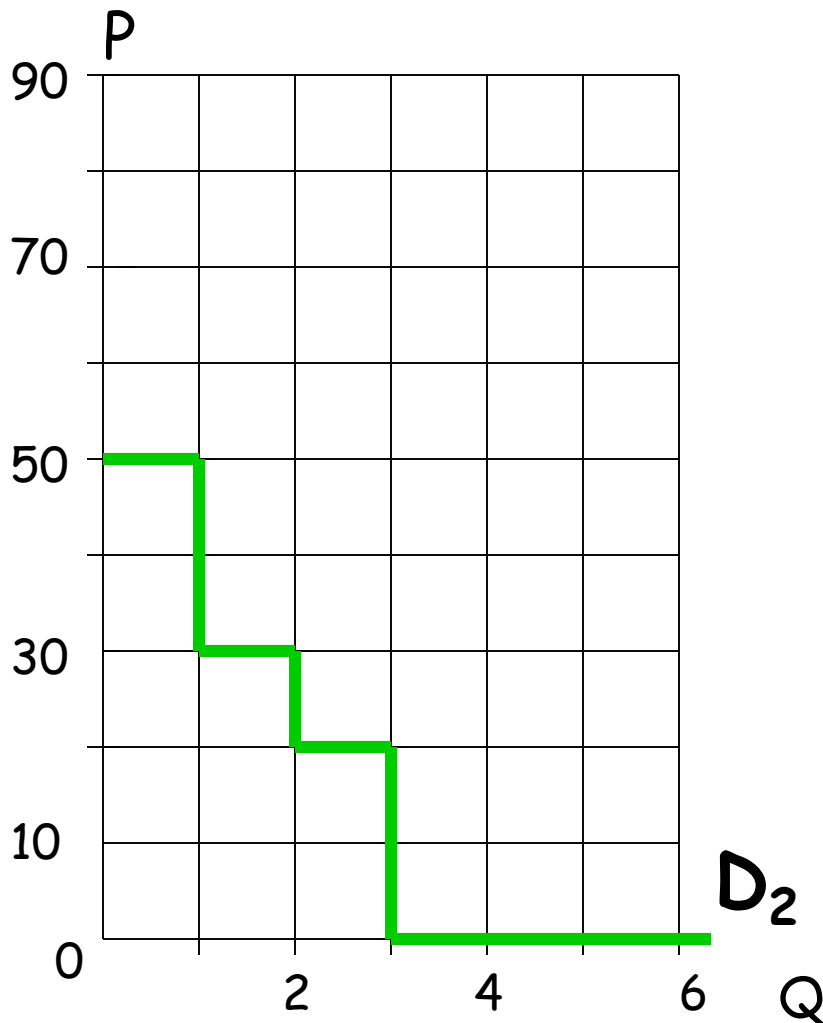
Given any Q , the function $P=D_1(Q)$ gives Buyer 1's maximum per-unit purchase price (\$/bushel) for the "last" unit purchased at this Q .

Bushel Unit	Buyer 1's Max Per-Unit Price
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1	\$84
2	\$76
3	\$70
4	\$ 0

Buyer 2 Demand Schedule

Inverse Form $P = D_2(Q)$



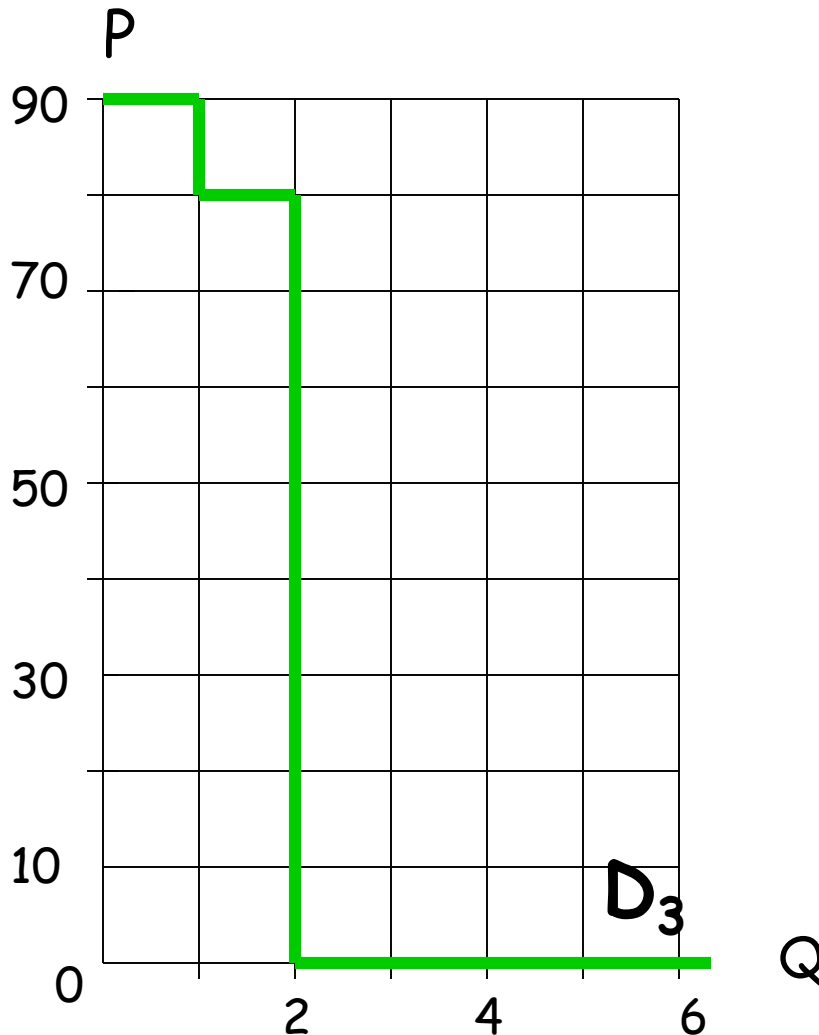
Given any Q , the function $P=D_2(Q)$ gives Buyer 2's maximum per-unit purchase price (\$/bushel) for the "last" unit purchased at this Q .

Bushel Unit	Buyer 2's Max Per-Unit Price
-------------	------------------------------

1	\$50
2	\$30
3	\$20
4	\$ 0

Buyer 3 Demand Schedule

Inverse Form $P = D_3(Q)$



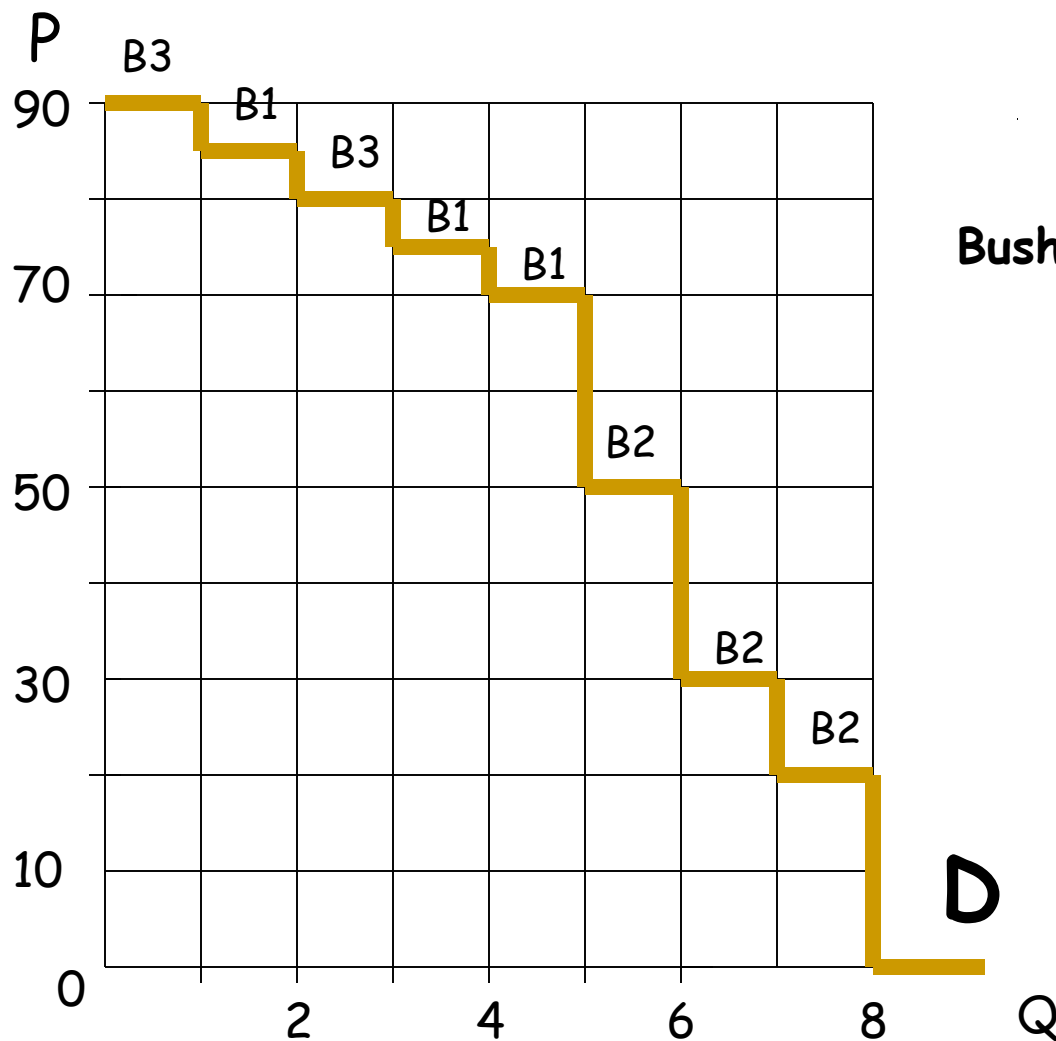
Given any Q , the function $P=D_3(Q)$ gives Buyer 3's maximum per-unit purchase price (\$/bushel) for the "last" unit purchased at this Q .

Bushel Unit	Buyer 3's Max Per-Unit Price
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1	\$90
2	\$80
3	\$ 0

Total Demand Schedule (Buyers 1,2,& 3)

Inverse Form $P = D(Q)$

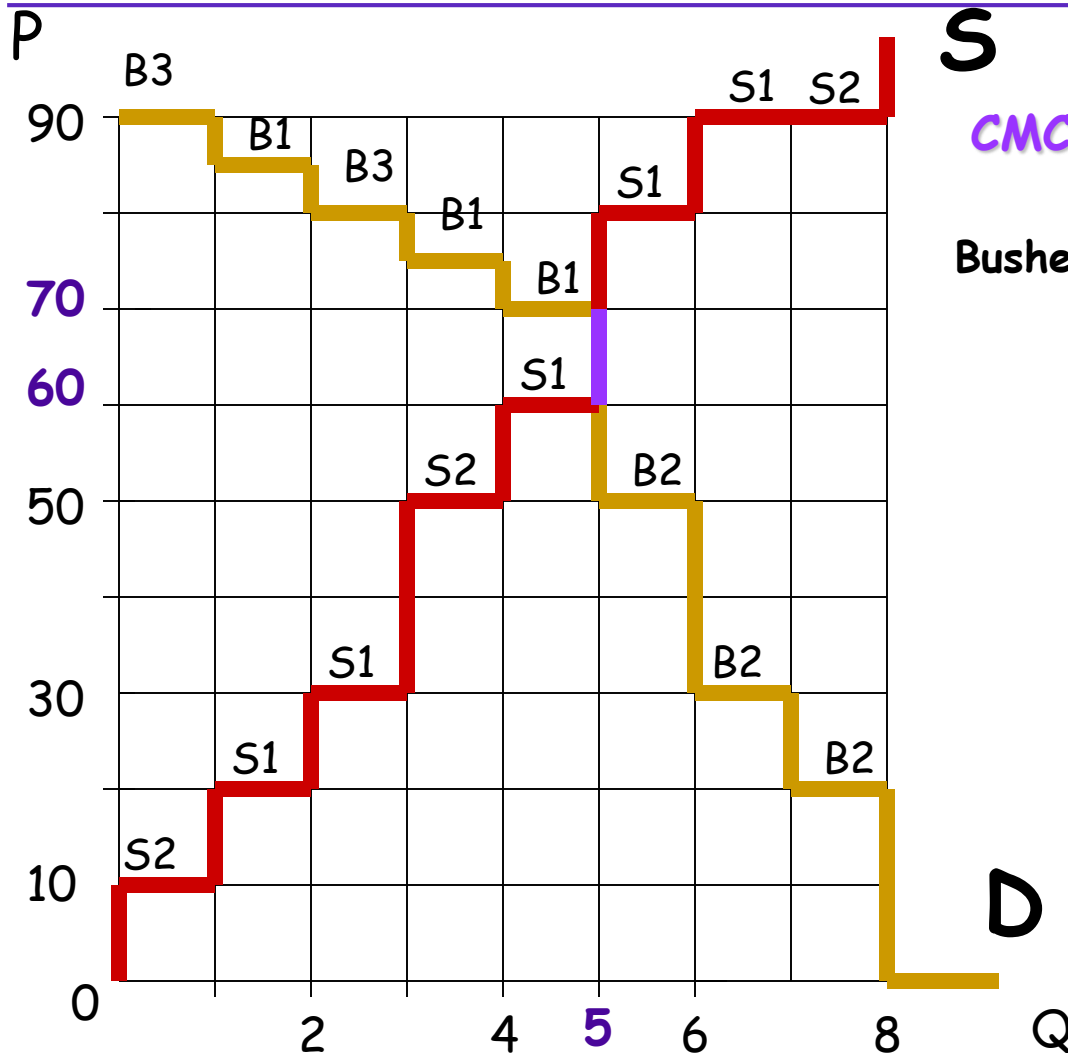


Bushel Unit

Max Buyer
Per-Unit Price

1	\$90 (B3)
2	\$84 (B1)
3	\$80 (B3)
4	\$76 (B1)
5	\$70 (B1)
6	\$50 (B2)
7	\$30 (B2)
8	\$20 (B2)
9	0

CMC Points (S=D)



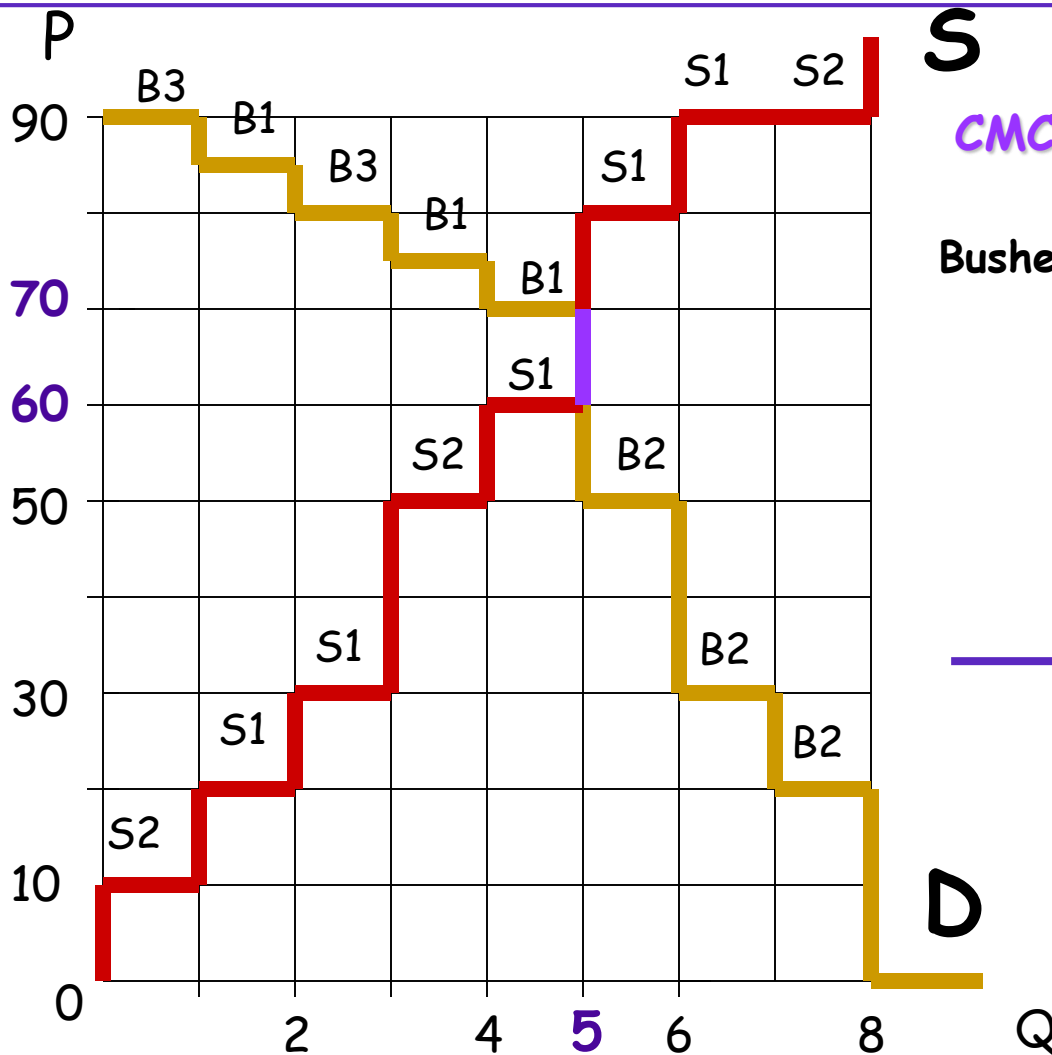
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CMC Pts: $Q^*=5$, $\$60 \leq P^* \leq \70

Bushel Unit	MaxBuyPrice	MinSellPrice
1	\$90	\$10
2	\$84	\$20
3	\$80	\$30
4	\$76	\$50
5	\$70	\$60
6	\$50	\$80
7	\$30	\$90
8	\$20	\$90
9	0	∞

D

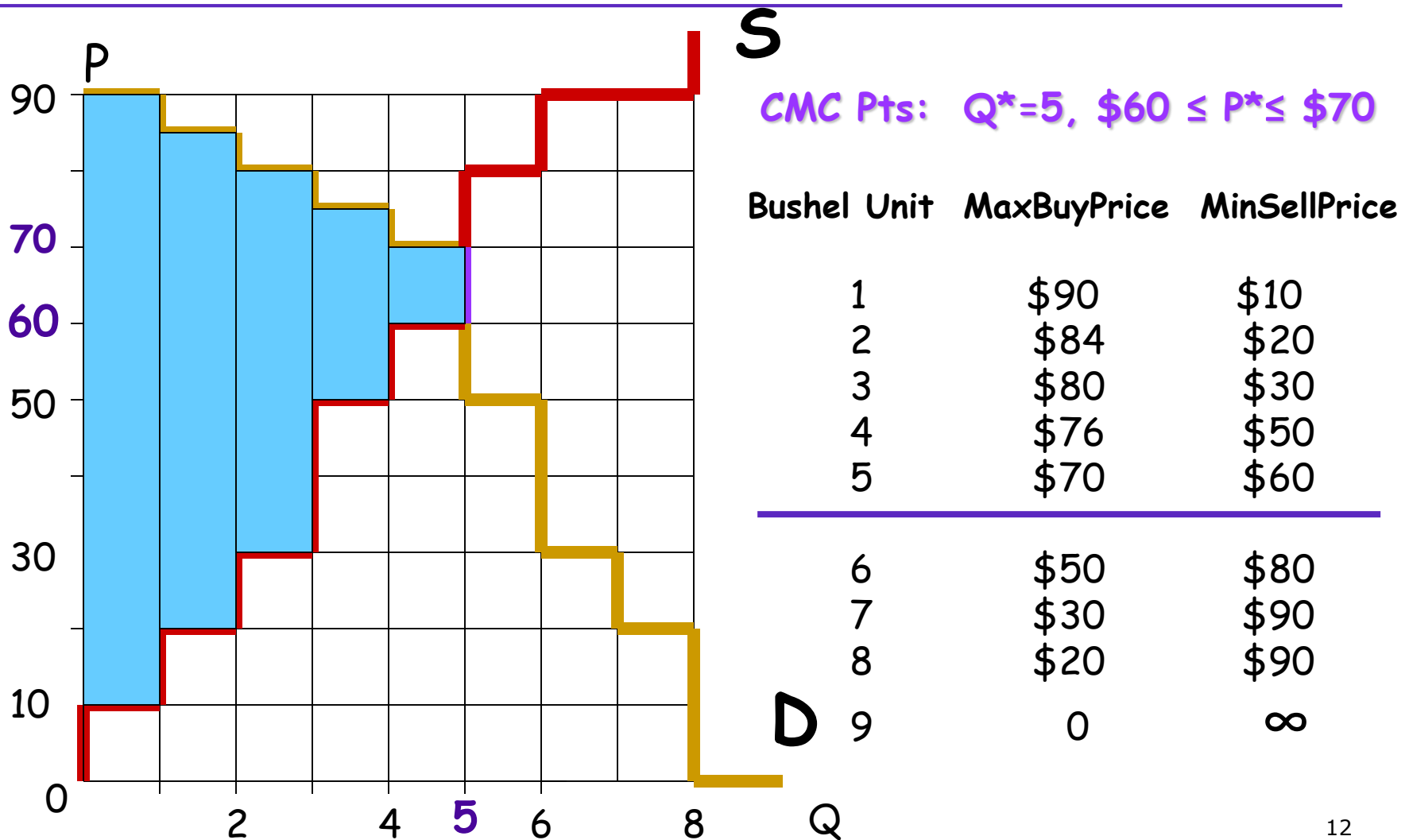
Remark: *Inframarginal* (traded) units versus *extramarginal* (non-traded) units at CMC Pts



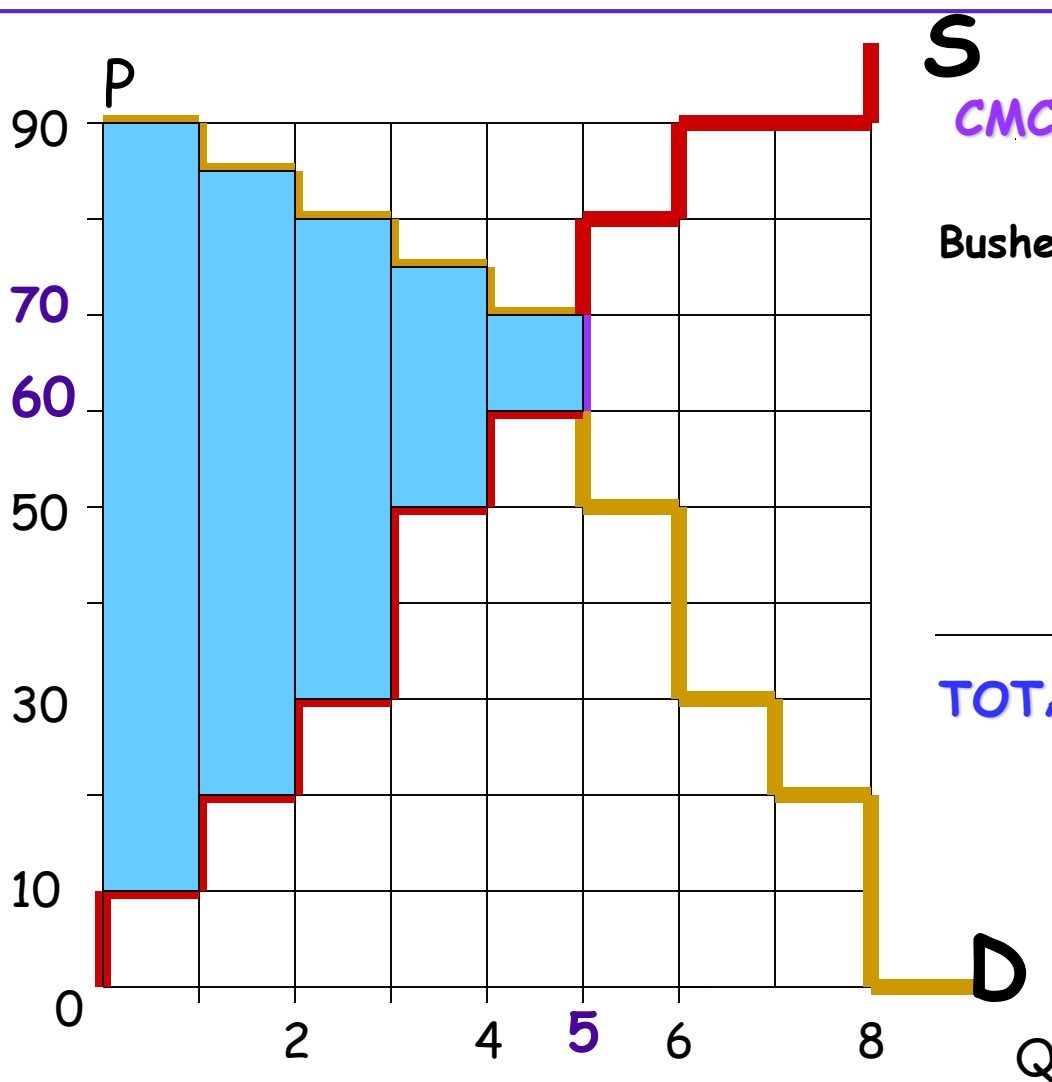
CMC Pts: $Q^*=5$, $\$60 \leq P^* \leq \70

Bushel Unit	MaxBuyPrice	MinSellPrice
1	\$90	\$10
2	\$84	\$20
3	\$80	\$30
4	\$76	\$50
5	\$70	\$60
6	\$50	\$80
7	\$30	\$90
8	\$20	\$90
9	0	∞

Total Net Surplus at CMC Points (invariant to particular choice of CMC Point)



Total Net Surplus at CMC Points...



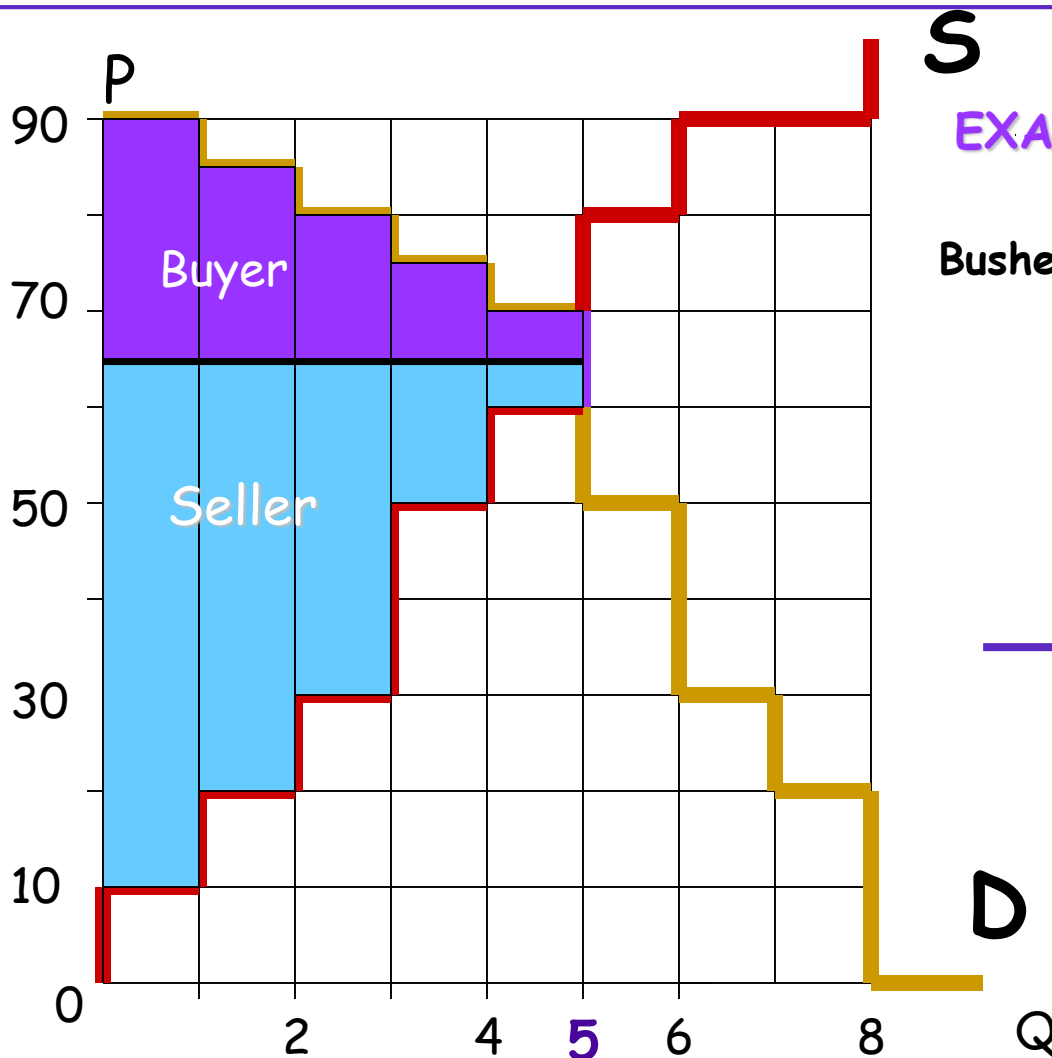
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CMC Pts: $Q^*=5$, $\$60 \leq P^* \leq \70

BushelUnit	MaxBuyP	MinSellP	Net Surplus
1	\$90	\$10	= \$80
2	\$84	\$20	= \$64
3	\$80	\$30	= \$50
4	\$76	\$50	= \$26
5	\$70	\$60	= \$10

TOTAL NET SURPLUS: \$230

Net Buyer/Seller Surplus at CMC Points (surplus division DOES depend on CMC point)



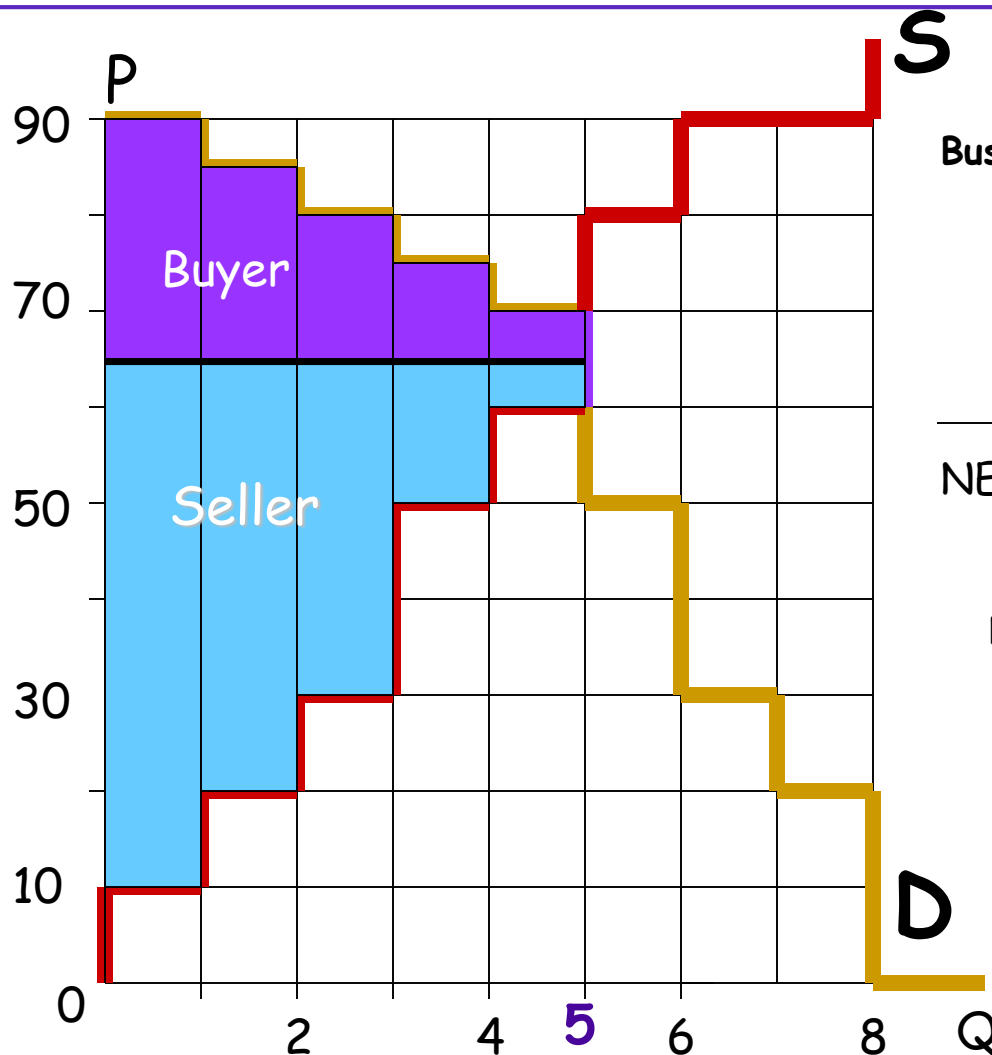
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EXAMPLE: $Q^* = 5$, $P^* = \$65$

Bushel Unit	MaxBuyPrice	MinSellPrice
1	\$90	\$10
2	\$84	\$20
3	\$80	\$30
4	\$76	\$50
5	\$70	\$60
6	\$50	\$80
7	\$30	\$90
8	\$20	\$90
9	0	∞

D

Net Buyer/Seller Surplus at CMC Points...



EXAMPLE: $Q^*=5$, $P^* = \$65$

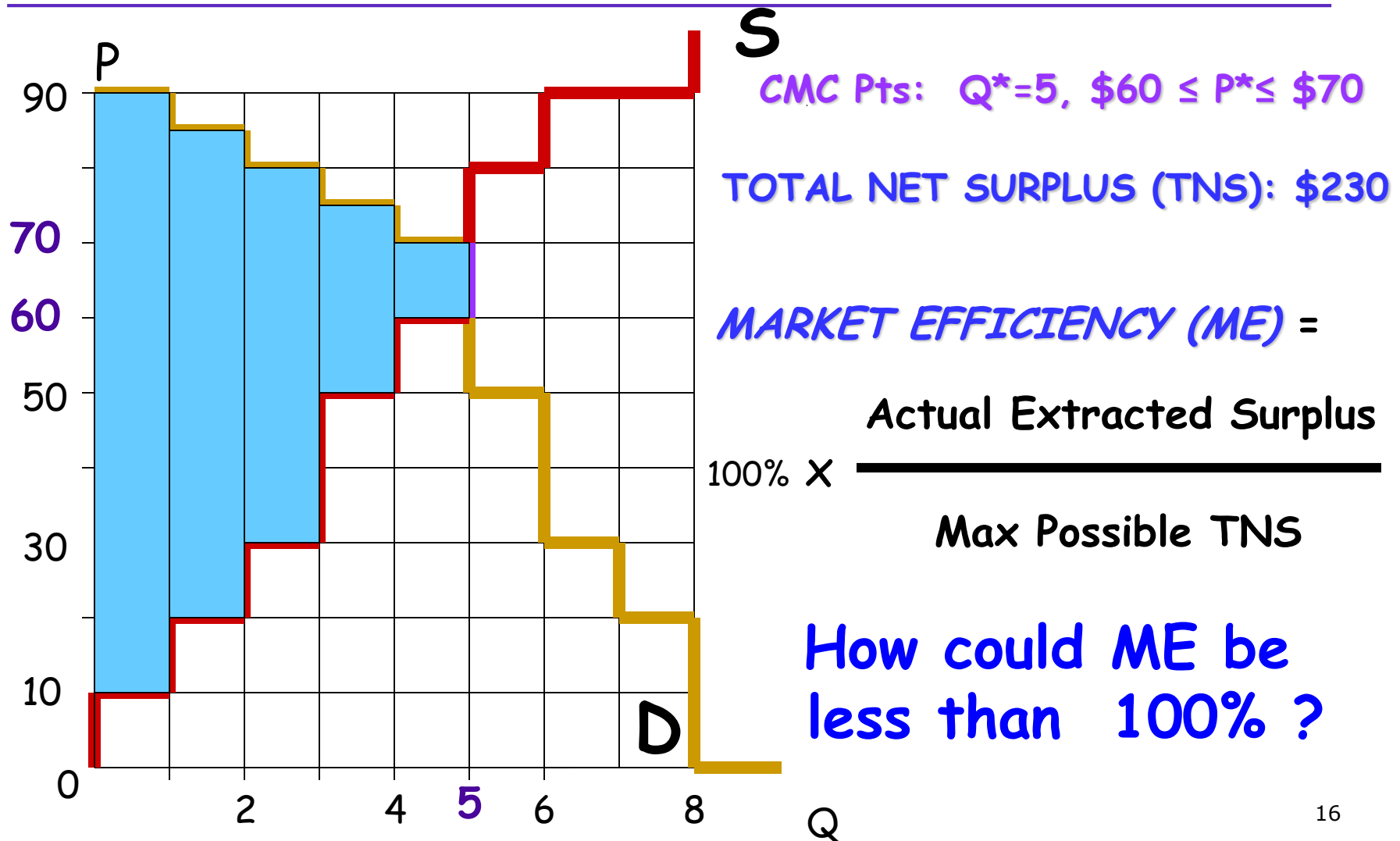
BushelUnit	MaxBPrice	$P^*=65$		BuySurplus
1	\$90	- \$65	=	\$25
2	\$84	- \$65	=	\$19
3	\$80	- \$65	=	\$15
4	\$76	- \$65	=	\$11
5	\$70	- \$65	=	\$5

NET BUYER SURPLUS: \$75

BushelUnit	$P^*=65$	MinSPrice		SellSurplus
1	\$65	- \$10	=	\$55
2	\$65	- \$20	=	\$45
3	\$65	- \$30	=	\$35
4	\$65	- \$50	=	\$15
5	\$65	- \$60	=	\$5

NET SELLER SURPLUS: \$155

Market Efficiency (ME)

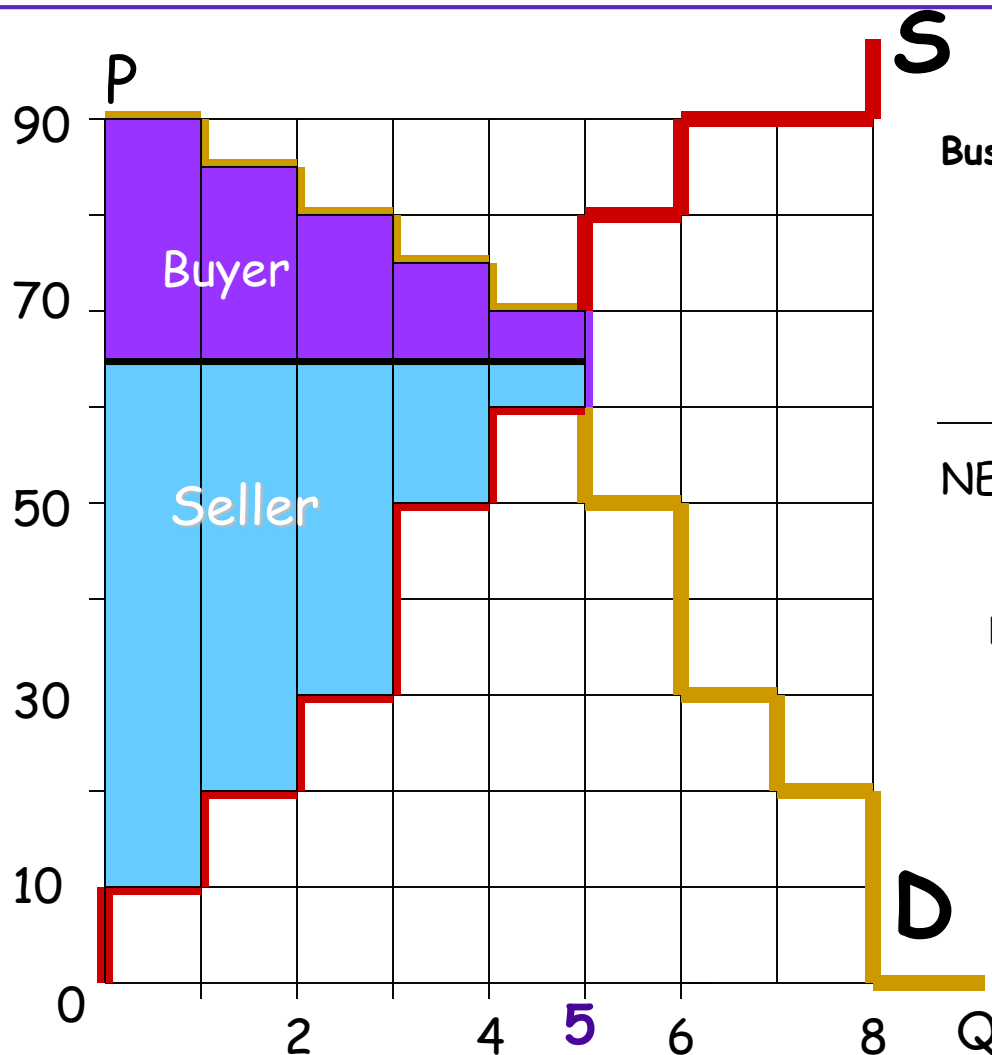


ME < 100% under What Conditions?

- ❑ Some "inframarginal" quantity unit FAILS to trade
- ❑ Or some "extramarginal" quantity unit SUCCEEDS in being traded

NOTE: If the price received by the seller of some quantity unit is LESS than the price paid by the buyer of this quantity unit (so some net surplus is extracted by a "third party"), then Buyer Net Surplus + Seller Net Surplus < 100%
→ ISO's in wholesale power markets !

Market Power: Ability to Extract More Actual Surplus Than at CMC Point



EXAMPLE: $Q^*=5$, $P^* = \$65$

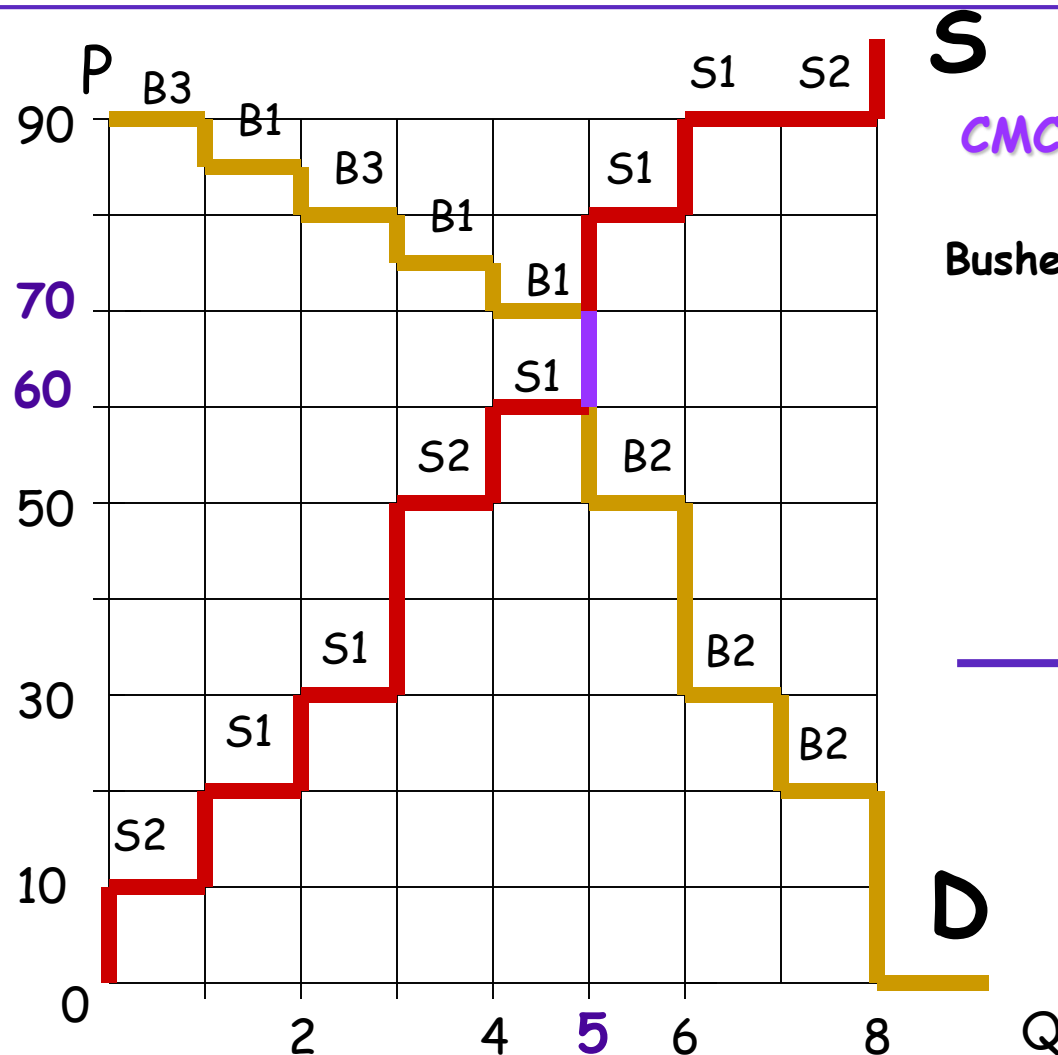
BushelUnit	MaxBPrice	$P^*=65$		BuySurplus
1	\$90	- \$65	=	\$25
2	\$84	- \$65	=	\$19
3	\$80	- \$65	=	\$15
4	\$76	- \$65	=	\$11
5	\$70	- \$65	=	\$5

NET BUYER SURPLUS: \$75

BushelUnit	$P^*=65$	MinSPrice		SellSurplus
1	\$65	- \$10	=	\$55
2	\$65	- \$20	=	\$45
3	\$65	- \$30	=	\$35
4	\$65	- \$50	=	\$15
5	\$65	- \$60	=	\$5

NET SELLER SURPLUS: \$155

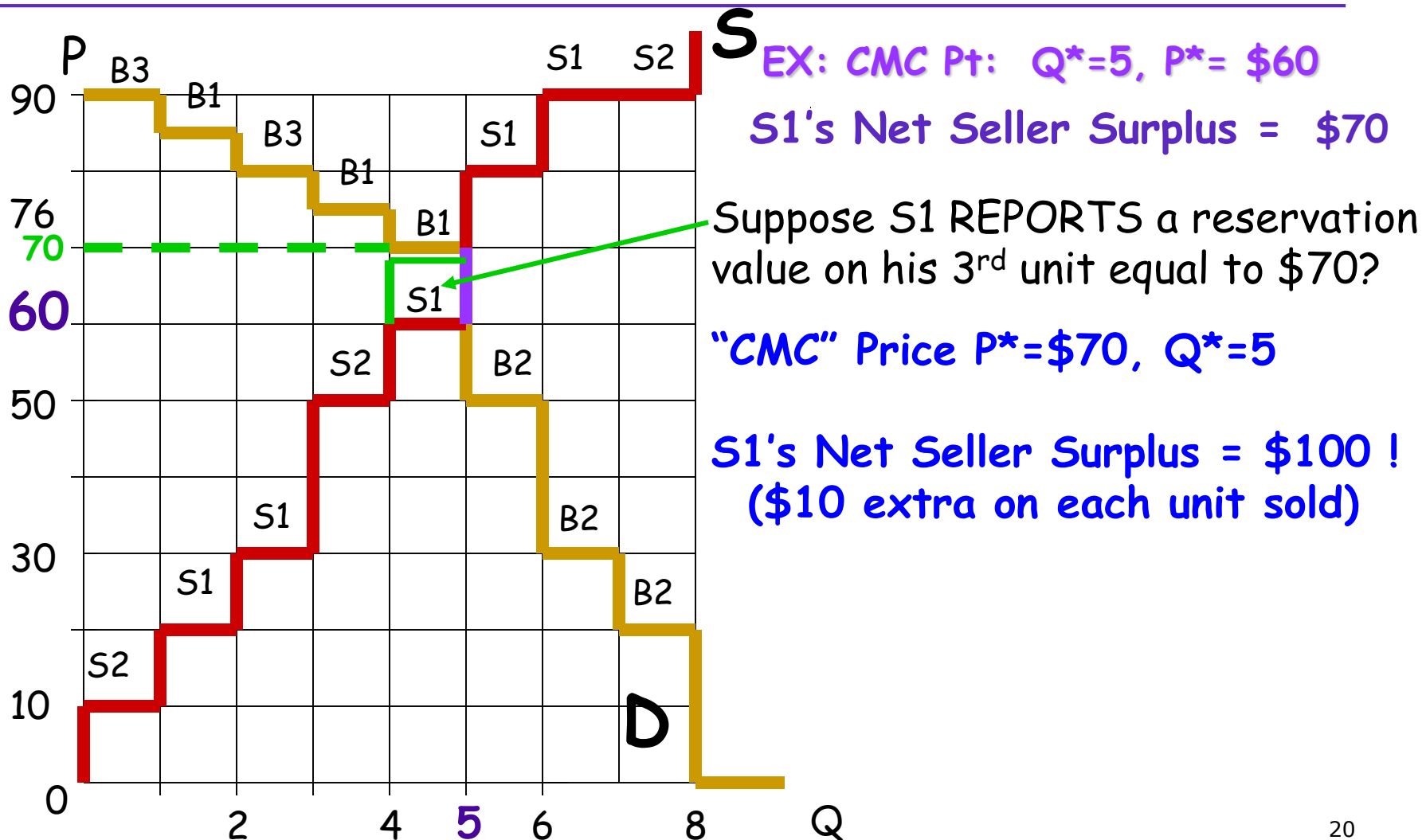
Does any trader below have an incentive to offer or bid *strategically*?



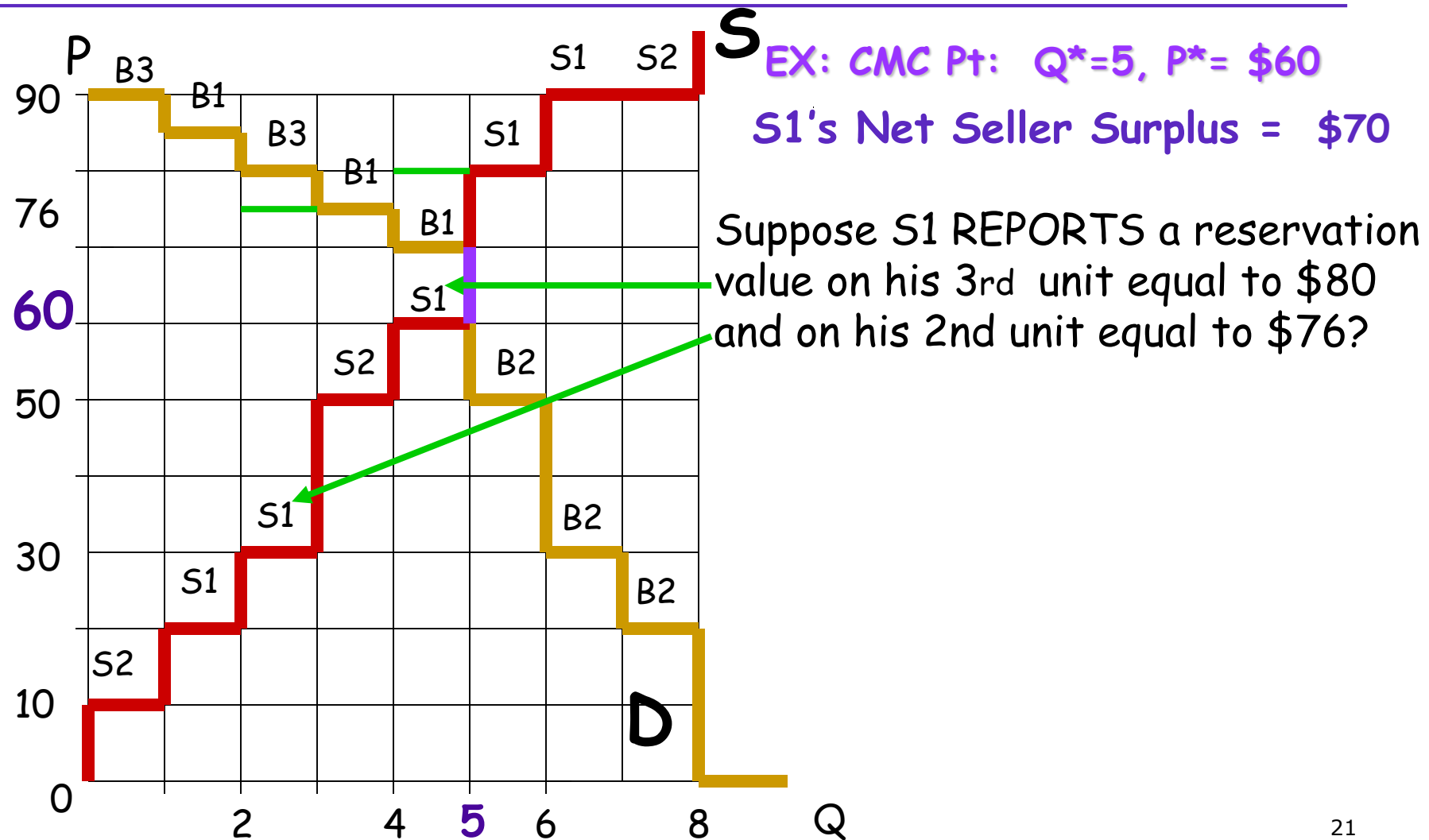
CMC Pts: $Q^*=5$, $\$60 \leq P^* \leq \70

Bushel Unit	MaxBuyPrice	MinSellPrice
1	\$90	\$10
2	\$84	\$20
3	\$80	\$30
4	\$76	\$50
5	\$70	\$60
6	\$50	\$80
7	\$30	\$90
8	\$20	\$90
9	0	∞

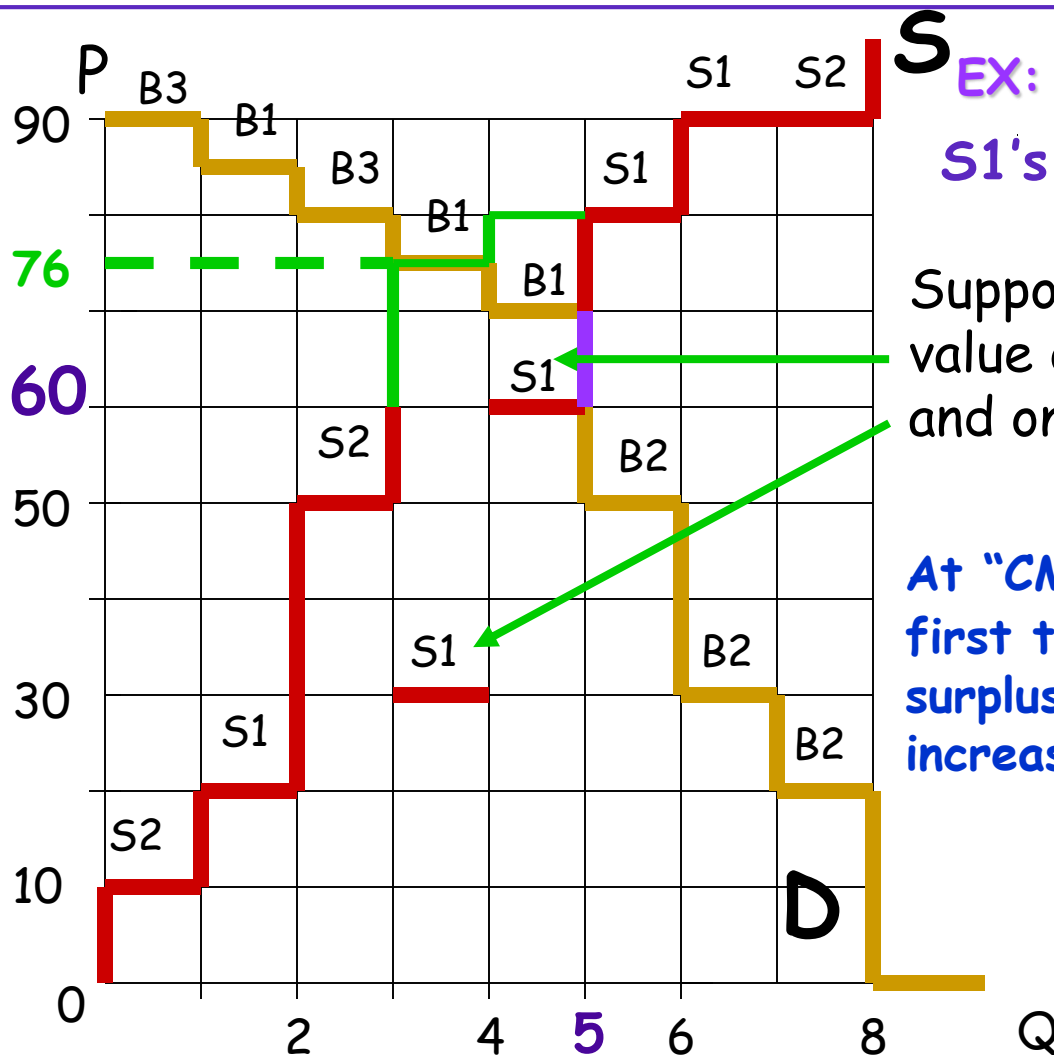
Does any trader below have an incentive to offer or bid *strategically* ?



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Does any trader below have an incentive to offer or bid *strategically* ?



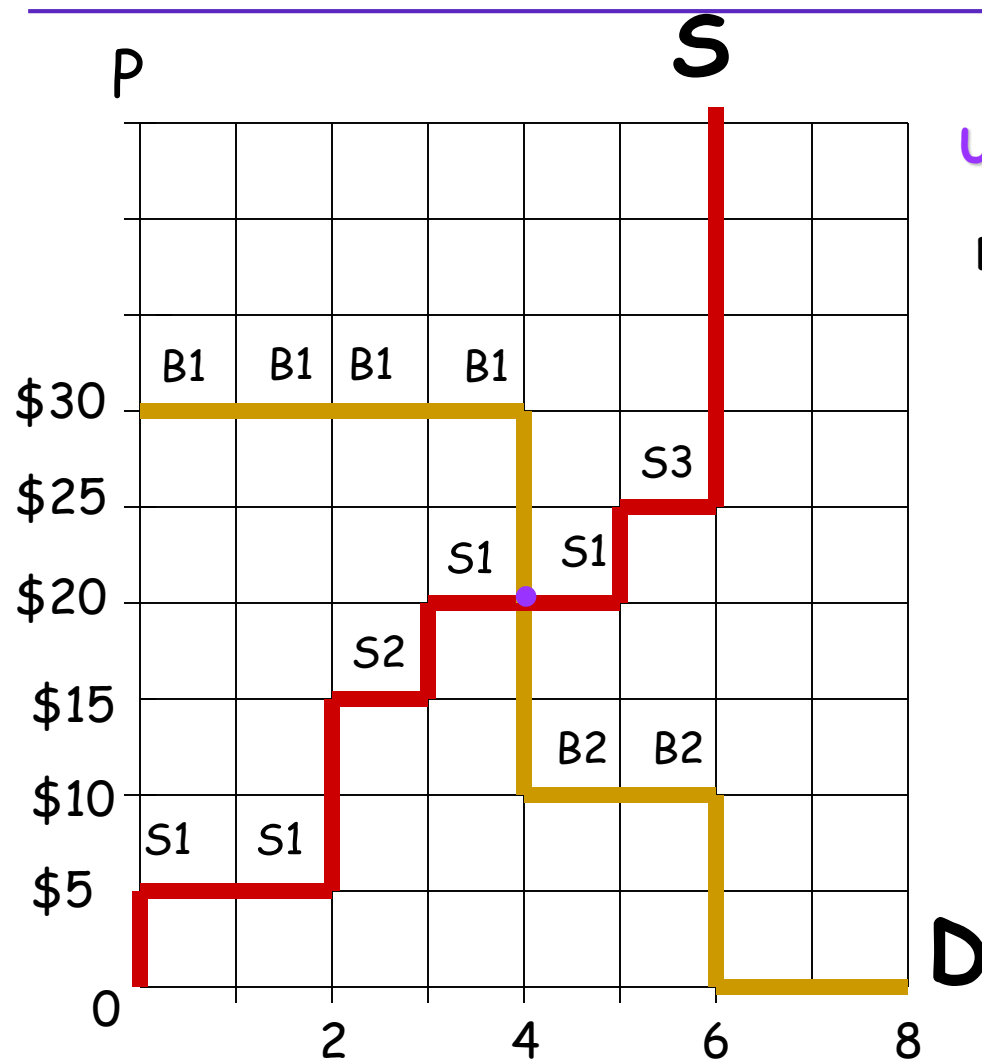
S EX: CMC Pt: $Q^*=5$, $P^* = \$60$

S1's Net Seller Surplus = \$70

Suppose S1 REPORTS a reservation value on his 3rd unit equal to \$80 and on his 2nd unit equal to \$76?

At "CMC" price \$76, S1 only sells his first two units, but his net seller surplus on these two units alone increases to \$102 = [\$56+\$46] !

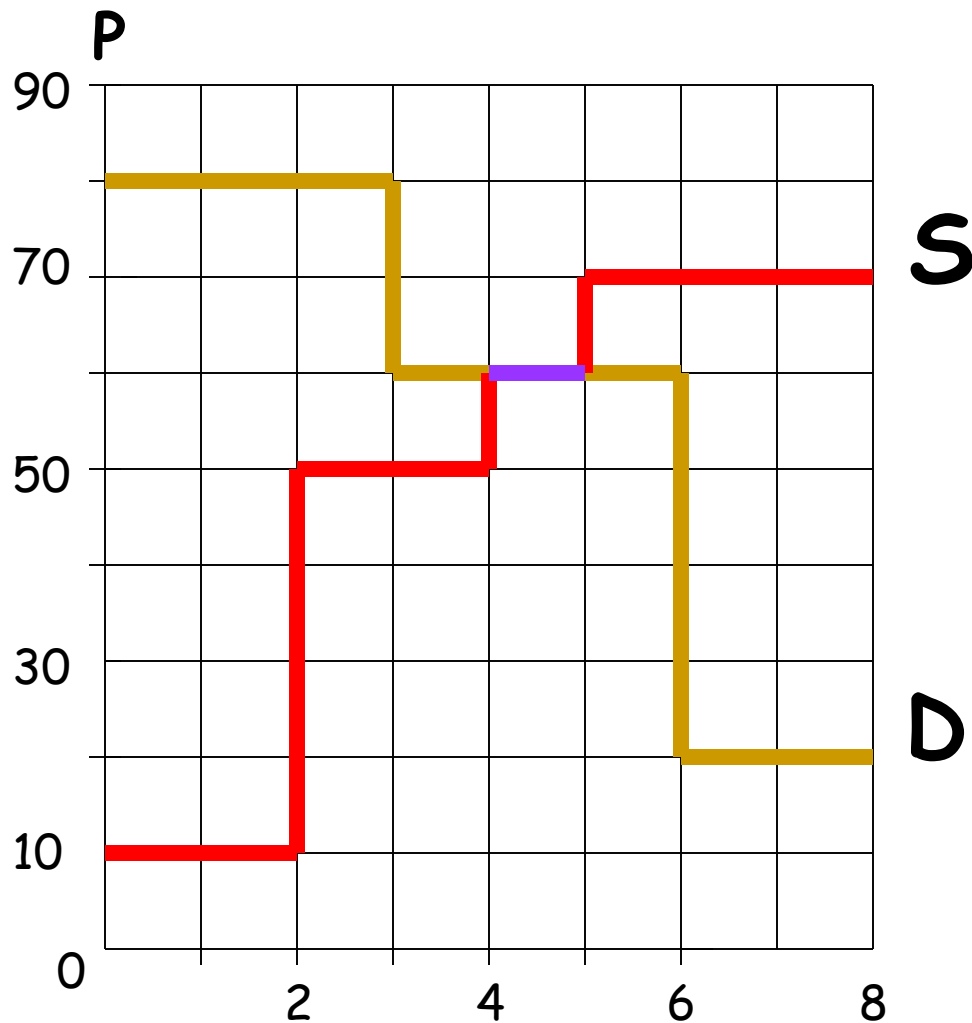
More on CMC Points: Illustrative Example 2



Unique CMC Pt: $Q^*=4$, $P^*=\$20$

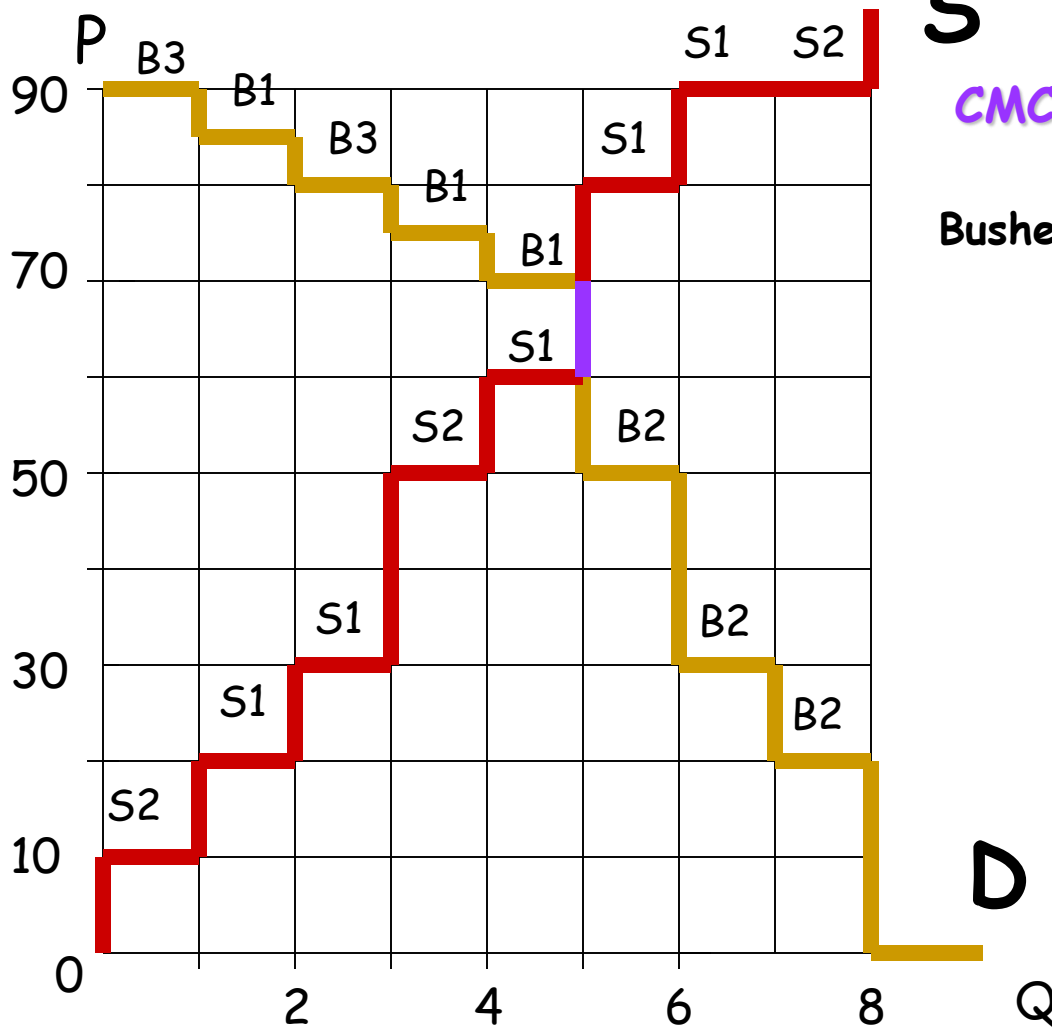
Bushel Unit	MaxBuyPrice	MinSellPrice
1	\$30	\$5
2	\$30	\$5
3	\$30	\$15
4	\$30	\$20
5	\$10	\$20
6	\$10	\$25
7	0	∞
8	0	∞

More on CMC Points: Illustrative Example 3



CMC Points:
 $P^* = \$60, 4 \leq Q^* \leq 5$

More on CMC Points: Illustrative Example 4



S

CMC Pts: $Q^*=5$, $\$60 \leq P^* \leq \70

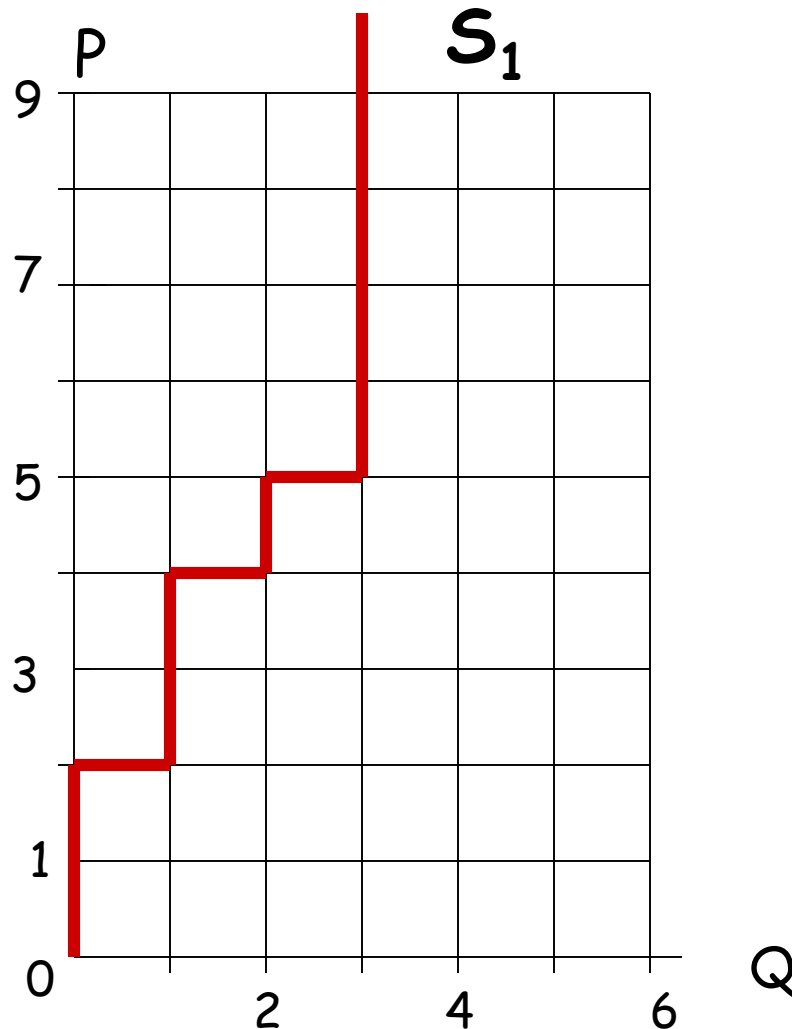
Bushel Unit	MaxBuyPrice	MinSellPrice
1	\$90	\$10
2	\$84	\$20
3	\$80	\$30
4	\$76	\$50
5	\$70	\$60
6	\$50	\$80
7	\$30	\$90
8	\$20	\$90
9	0	∞

D

Relationship of "Inverse" to "Ordinary" Supply and Demand Schedules

- ◆ In all of the previous "inverse" supply and demand examples, the minimum per-unit sale prices (i.e., the "sale reservation prices") and the maximum per-unit purchase prices (i.e., the "purchase reservation prices") were given for each successive quantity unit 1, 2, 3,...
- ◆ Conversely, for "ordinary" supply and demand, the maximum sale and purchase quantities are given for each successive per-unit price \$1, \$2, \$3,...

Illustrative Comparison of Inverse and Ordinary Supply: Supply Schedule for Seller 1 Inverse Form $P = S_1(Q)$

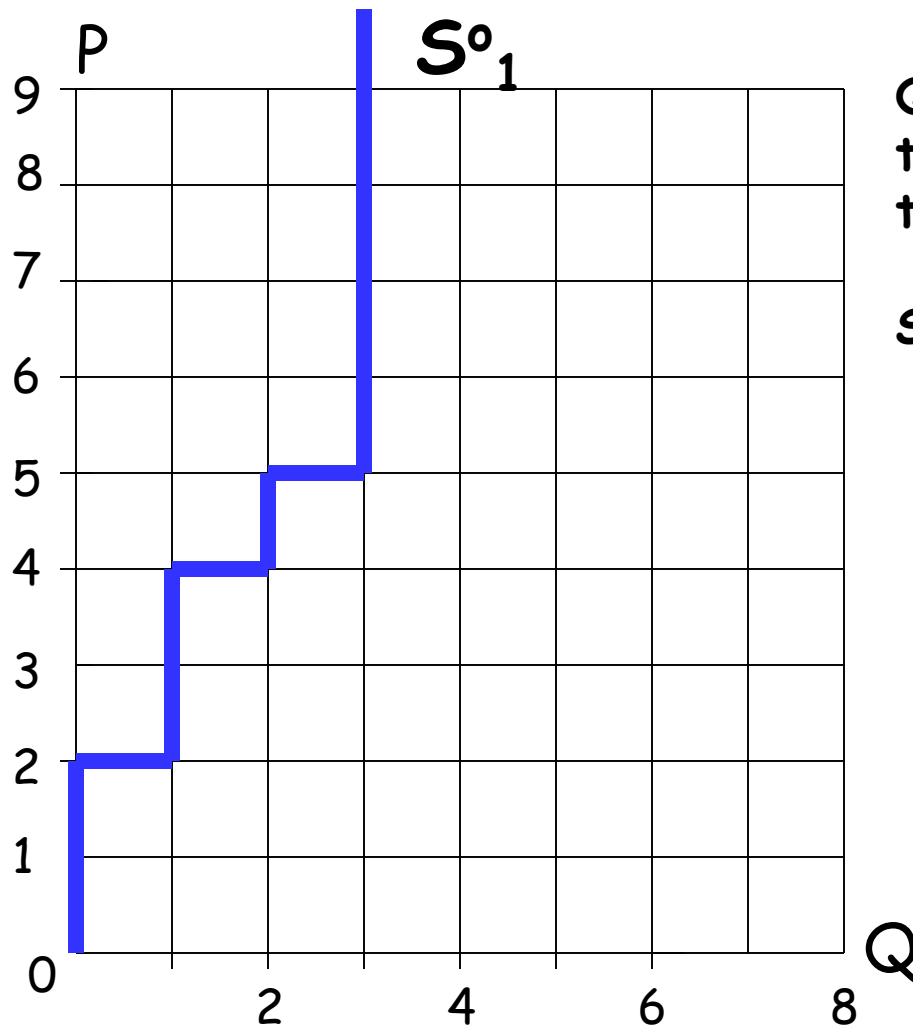


Supply Unit

Seller 1 Min
per-Unit Sale Price

0	\$0
1	\$2
2	\$4
3	\$5
4	∞
5	∞
6	∞

Supply Schedule for Seller 1 Re-Expressed in Ordinary Form $Q_1 = S^o(P)$

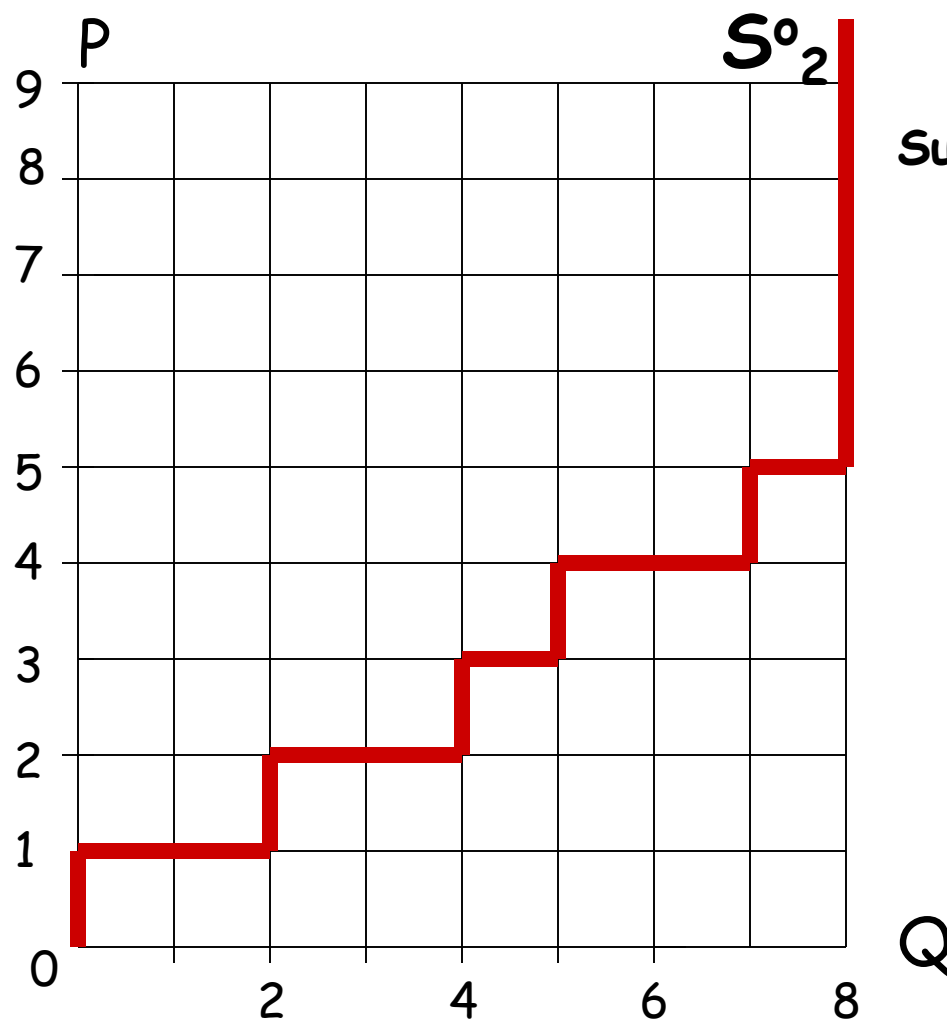


$Q = S^o_1(P)$ = Maximum amount of Q that Seller 1 is willing to supply at the per-unit sale price P

Seller 1 Max Supply	Per-Unit Sale Price
0	\$0
0	\$1
1	\$2
1	\$3
2	\$4
3	\$5
3	\$6
3	\$7
3	\$8
3	\$9

Supply Schedule for Seller 2

Inverse Form $P = S_2(Q)$

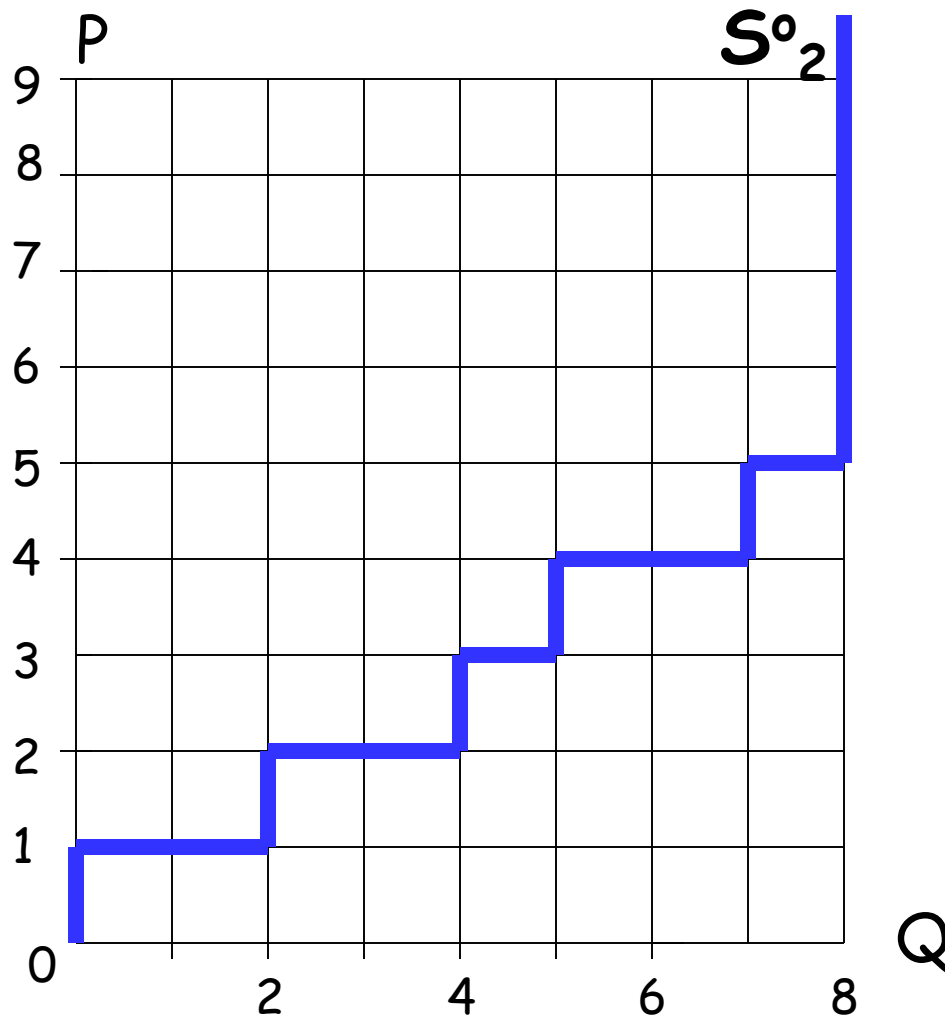


Supply Unit

Seller 2 Min
Per-Unit Sale Price

0	\$0
1	\$1
2	\$1
3	\$2
4	\$2
5	\$3
6	\$4
7	\$4
8	\$5
9	∞

Supply Schedule for Seller 2 Re-Expressed in Ordinary Form $Q = S^o_2(P)$



$Q = S^o_2(P)$ = Maximum amount of Q that Seller 2 is willing to supply at per-unit sale price P

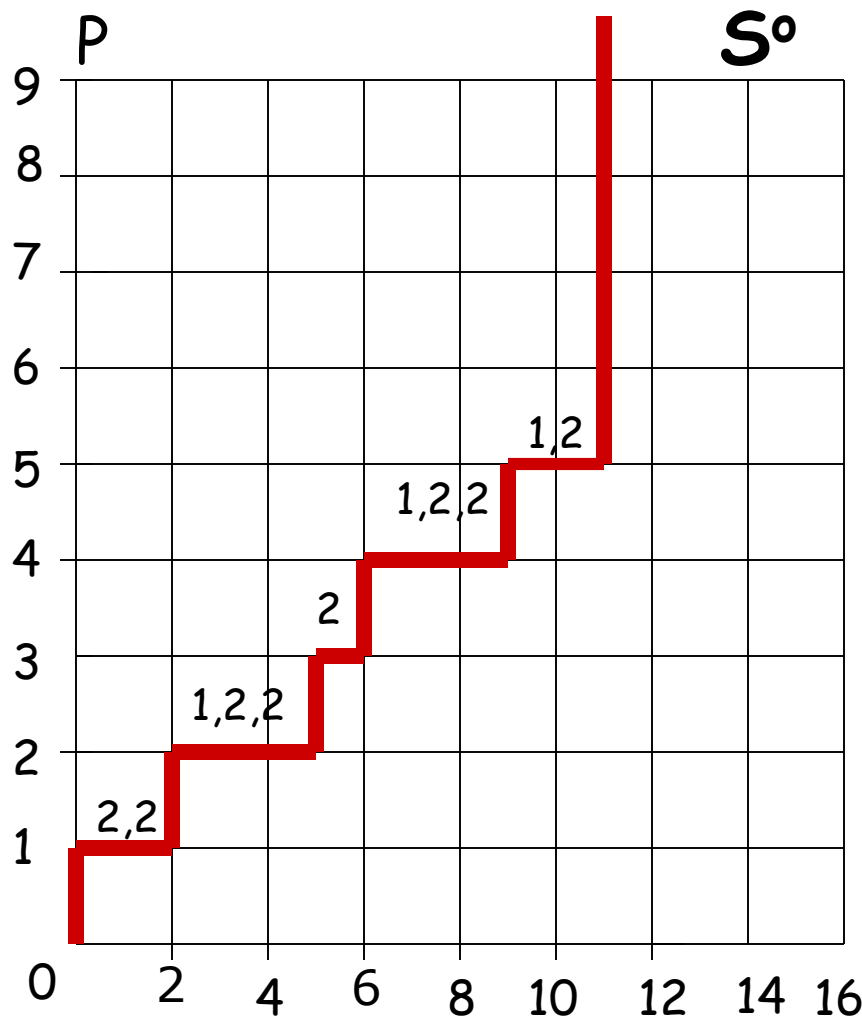
Seller 2 Max Supply

Per-Unit Sale Price

0	\$0
2	\$1
4	\$2
5	\$3
7	\$4
8	\$5
8	\$6
8	\$7
8	\$8
8	\$9

Total Supply Schedule (Sellers 1 & 2)

Inverse Form $P = S(Q)$

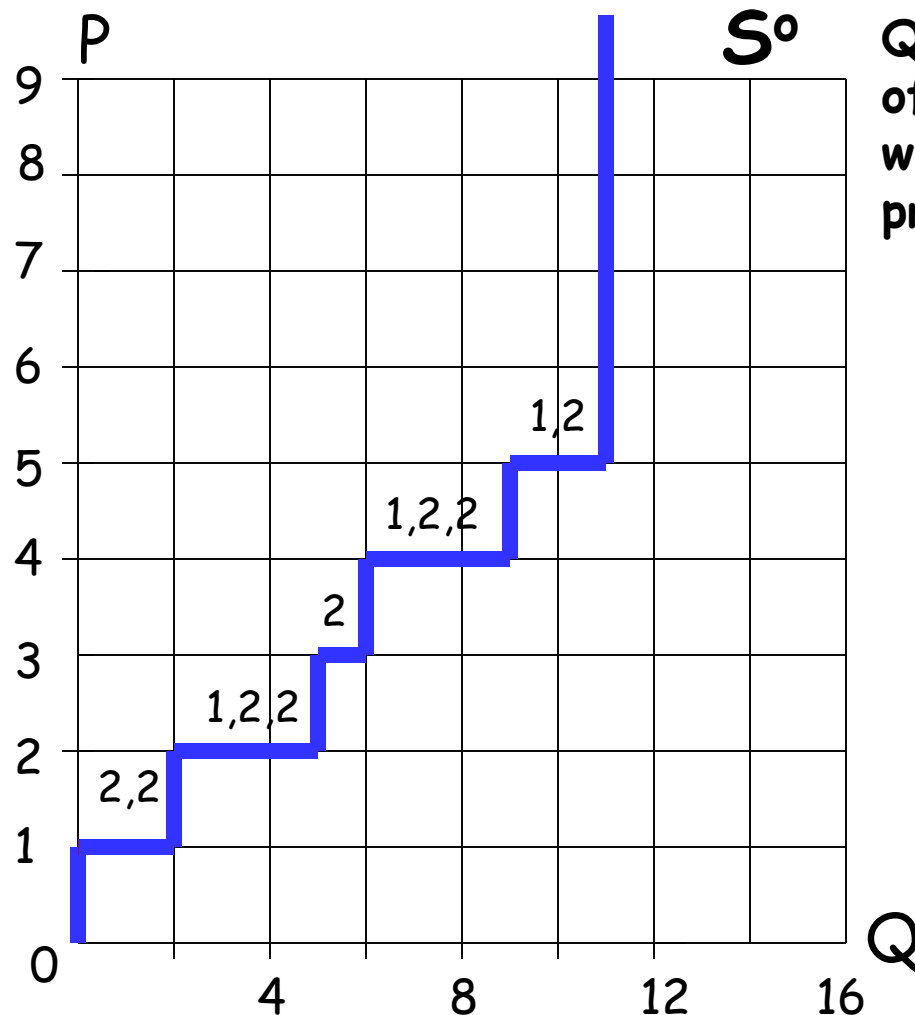


$P = S(Q)$ = Minimum per-unit sale price a seller (either Seller 1 or Seller 2) is willing to accept for the "last" unit supplied at Q

Supply Unit Min Per-Unit Sale Price

1	\$1 (S_2)
2	\$1 (S_2)
3	\$2 ($S_1/S_2/S_2$)
4	\$2 ($S_1/S_2/S_2$)
5	\$2 ($S_1/S_2/S_2$)
6	\$3 (S_2)
7	\$4 ($S_1/S_2/S_2$)
8	\$4 ($S_1/S_2/S_2$)
9	\$4 ($S_1/S_2/S_2$)
10	\$5 (S_1/S_2)
11	\$5 (S_1/S_2)
12	∞

Total Supply Schedule (Sellers 1 & 2) Re-Expressed in Ordinary Form $Q = S^o(P) = [S^o_1(P) + S^o_2(P)]$



$Q = S^o(P)$ = Maximum total amount of Q that Sellers 1 and 2 are willing to supply at the per-unit sale price P

Max Supply
 $Q = Q_1 + Q_2$

Unit Sale Price P

0=0+0	\$0
2=0+2	\$1
5=1+4	\$2
6=1+5	\$3
9=2+7	\$4
11=3+8	\$5
11=3+8	\$6
11=3+8	\$7
11=3+8	\$8
11=3+8	\$9