

Notes on the Construction of Demand & Supply Schedules

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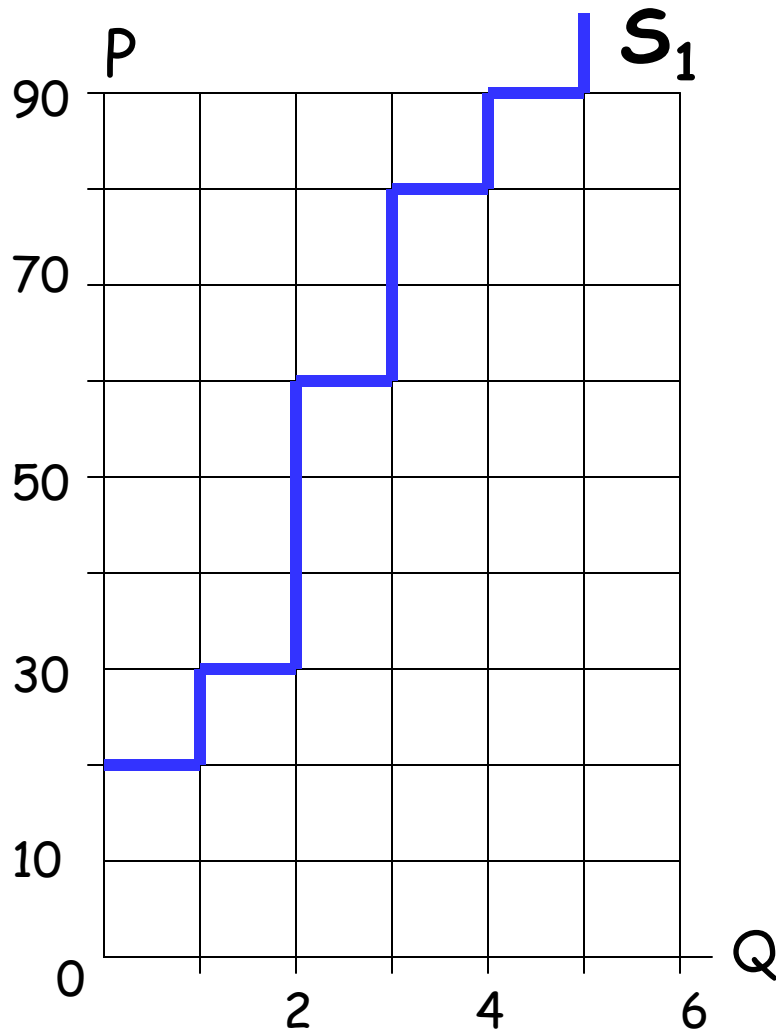
Clarification of Terminology

- 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)

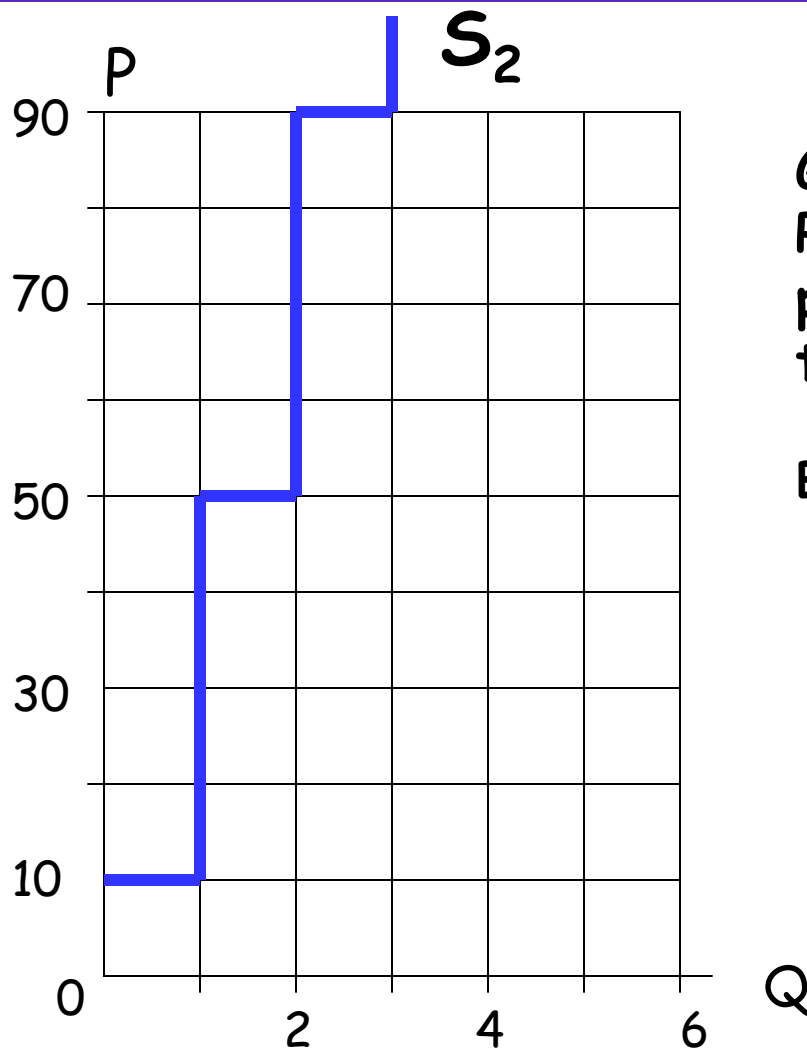
Given any Q , the function $P=S_1(Q)$ gives Seller 1's minimum per-unit sale price (\$/bushel) for the "last" unit supplied at this Q .

Bushel Unit Seller 1 Min Sale Price

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

Seller 2 Supply Schedule

Inverse Form $P = S_2(Q)$



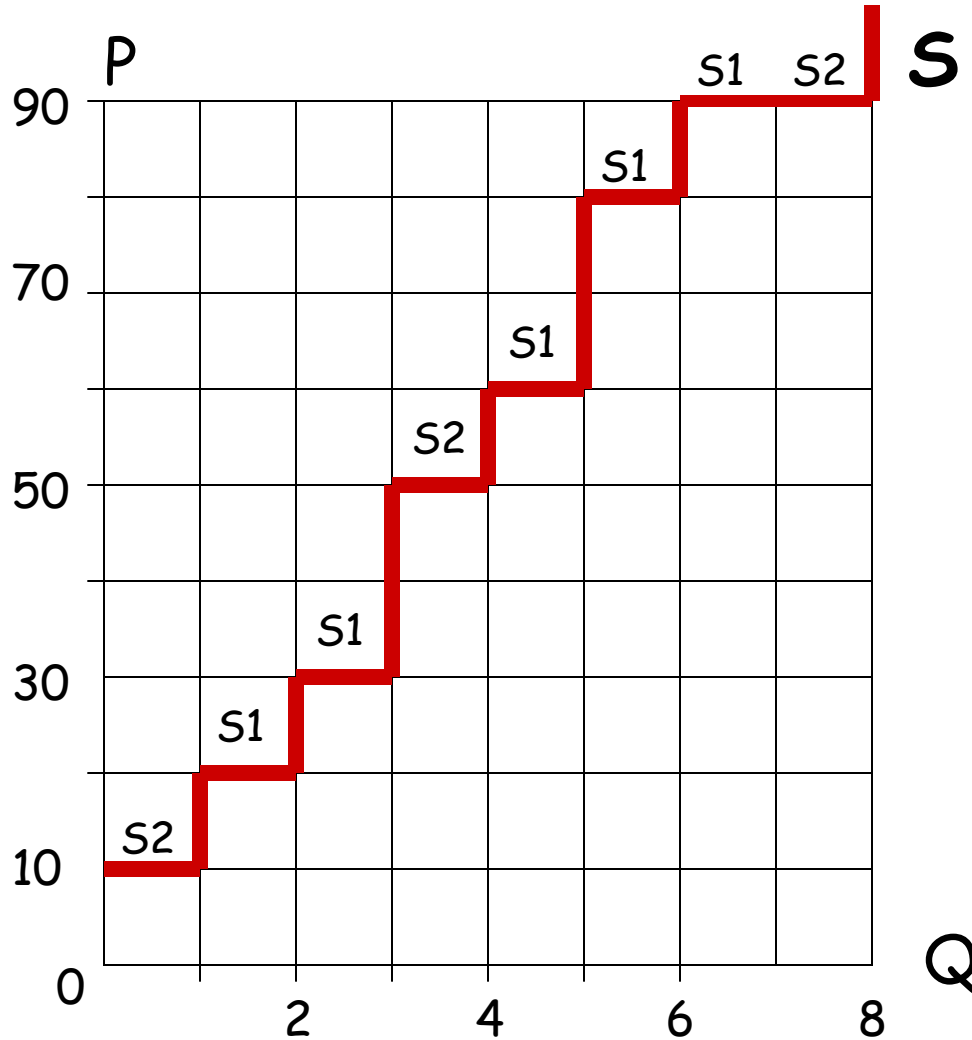
Given any Q , the function $P=S_2(Q)$ gives Seller 2's minimum per-unit sale price (\$/bushel) for the "last" unit supplied at this Q .

Bushel Unit Seller 2 Min Sale Price

1	\$10
2	\$50
3	\$90
4	∞

Total Supply Schedule (Sellers 1 & 2)

Inverse Form $P = S(Q)$

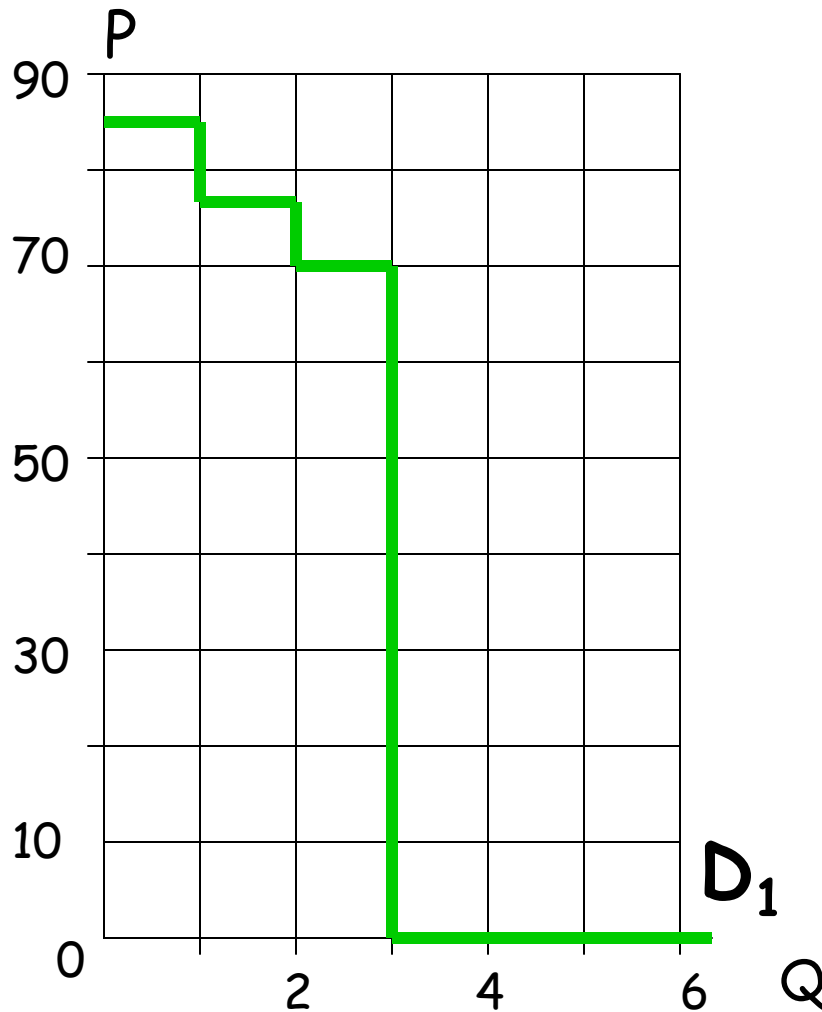


Bushel Unit Min Seller Price

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

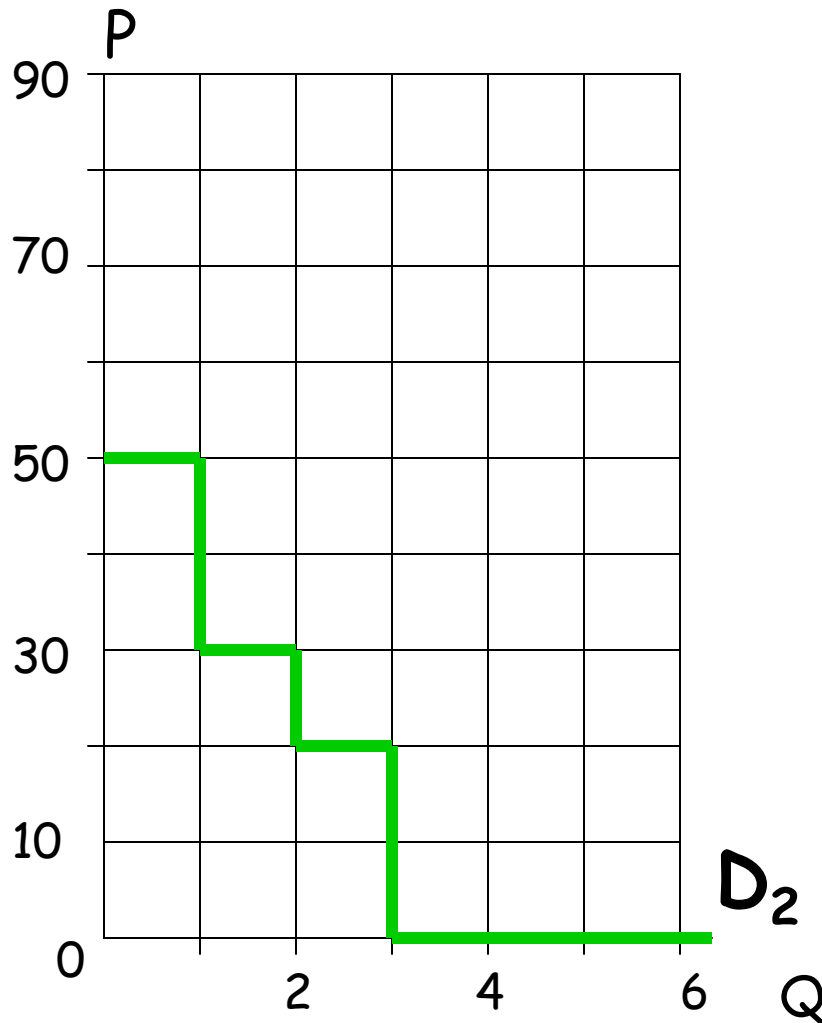
Inverse Form $P = D_1(Q)$



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
1	\$84
2	\$76
3	\$70
4	\$0

Buyer 2 Demand Schedule Inverse Form $P = D_2(Q)$

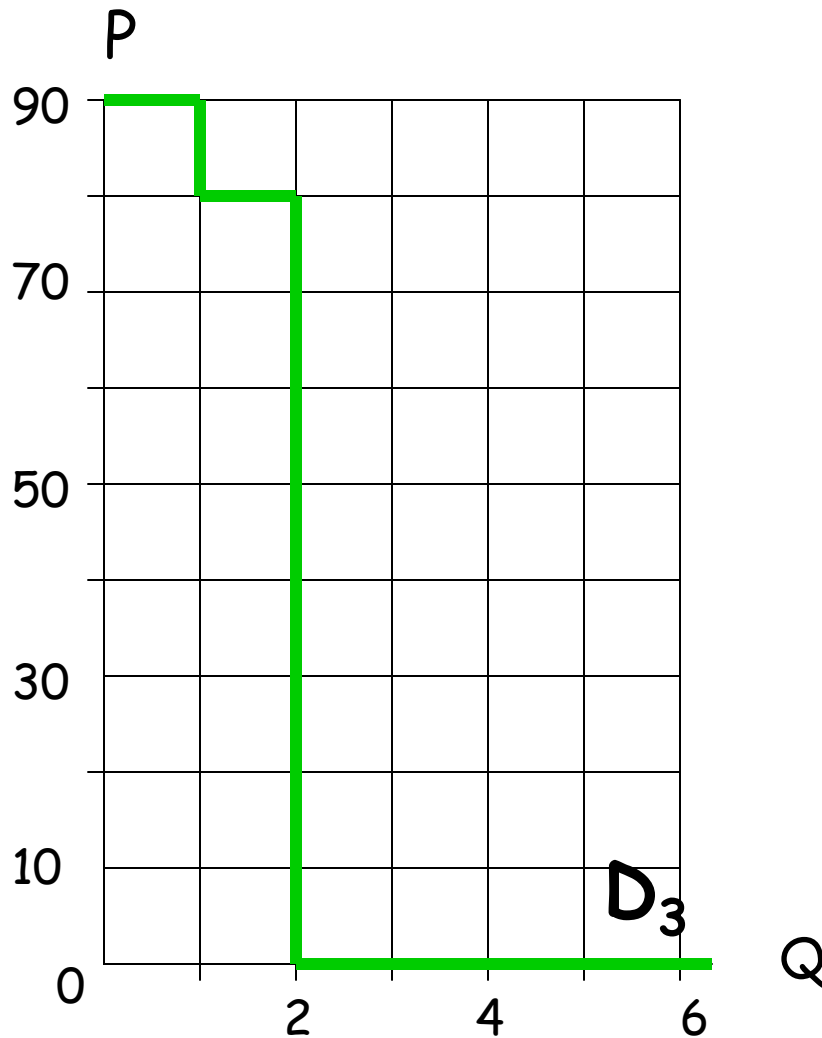


Given any Q , the function $P=D_2(Q)$ gives Buyer 2's maximum per-unit purchase price (\$/bushel) for the "last" unit purchased at this Q .

Bushel Unit	Buyer 2's Max Per-Unit Price
1	\$50
2	\$30
3	\$20
4	\$ 0

Buyer 3 Demand Schedule

Inverse Form $P = D_3(Q)$



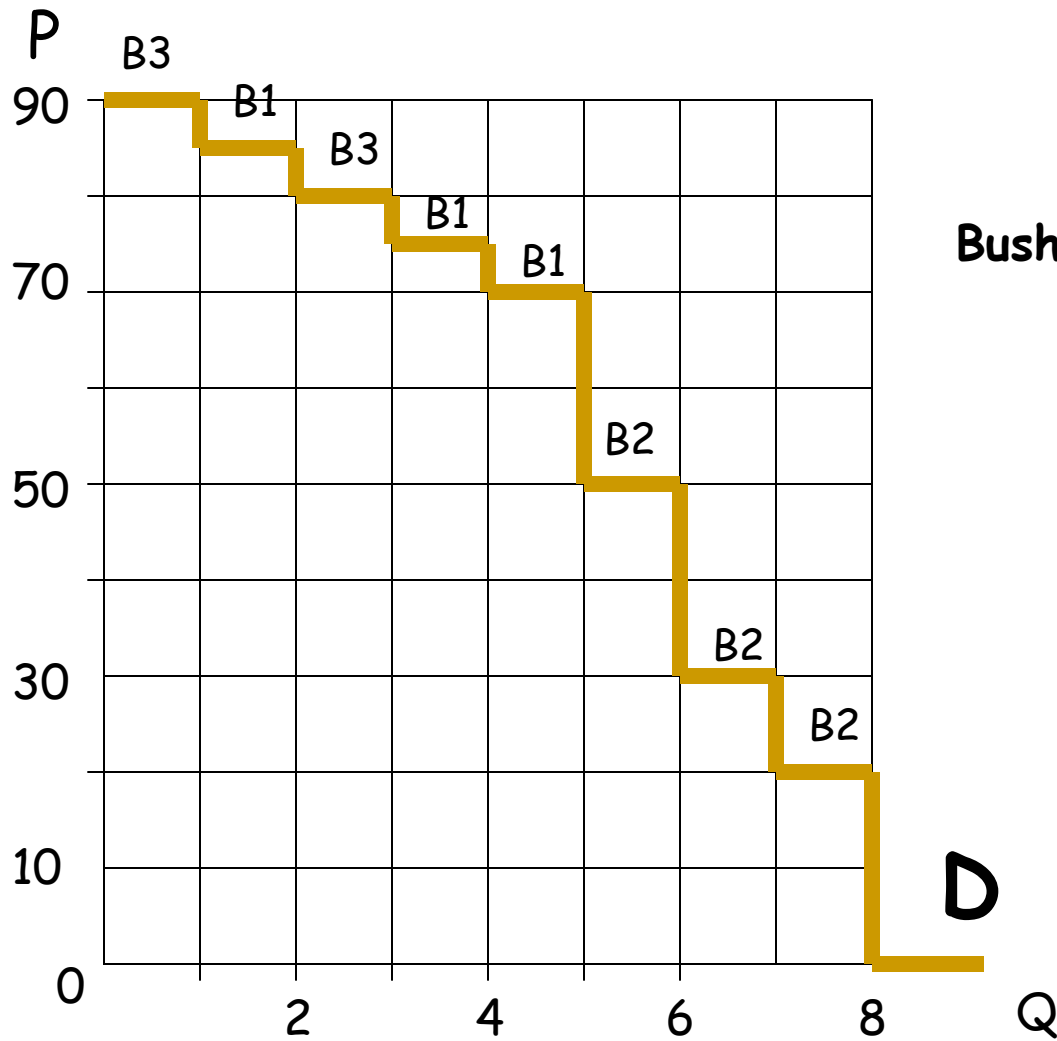
Given any Q , the function $P=D_3(Q)$ gives Buyer 3's maximum per-unit purchase price (\$/bushel) for the "last" unit purchased at this Q .

Bushel Unit **Buyer 3's Max Per-Unit Price**

1	\$90
2	\$80
3	\$0

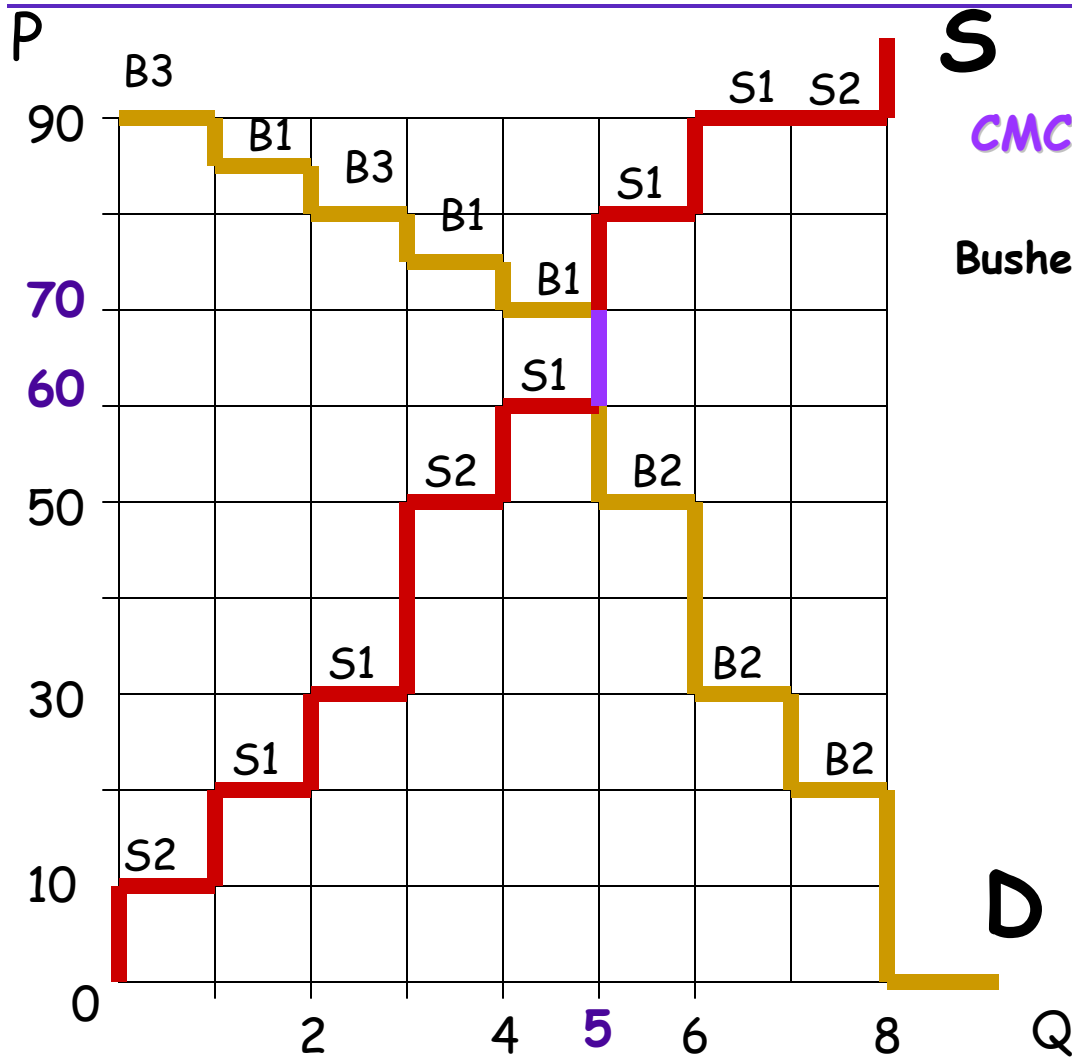
Total Demand Schedule (Buyers 1,2,& 3)

Inverse Form $P = D(Q)$



Bushel Unit	Max Buyer	Per-Unit Price
1	(B3)	\$90
2	(B1)	\$84
3	(B3)	\$80
4	(B1)	\$76
5	(B1)	\$70
6	(B2)	\$50
7	(B2)	\$30
8	(B2)	\$20
9		0

CMC Points (S=D)



S

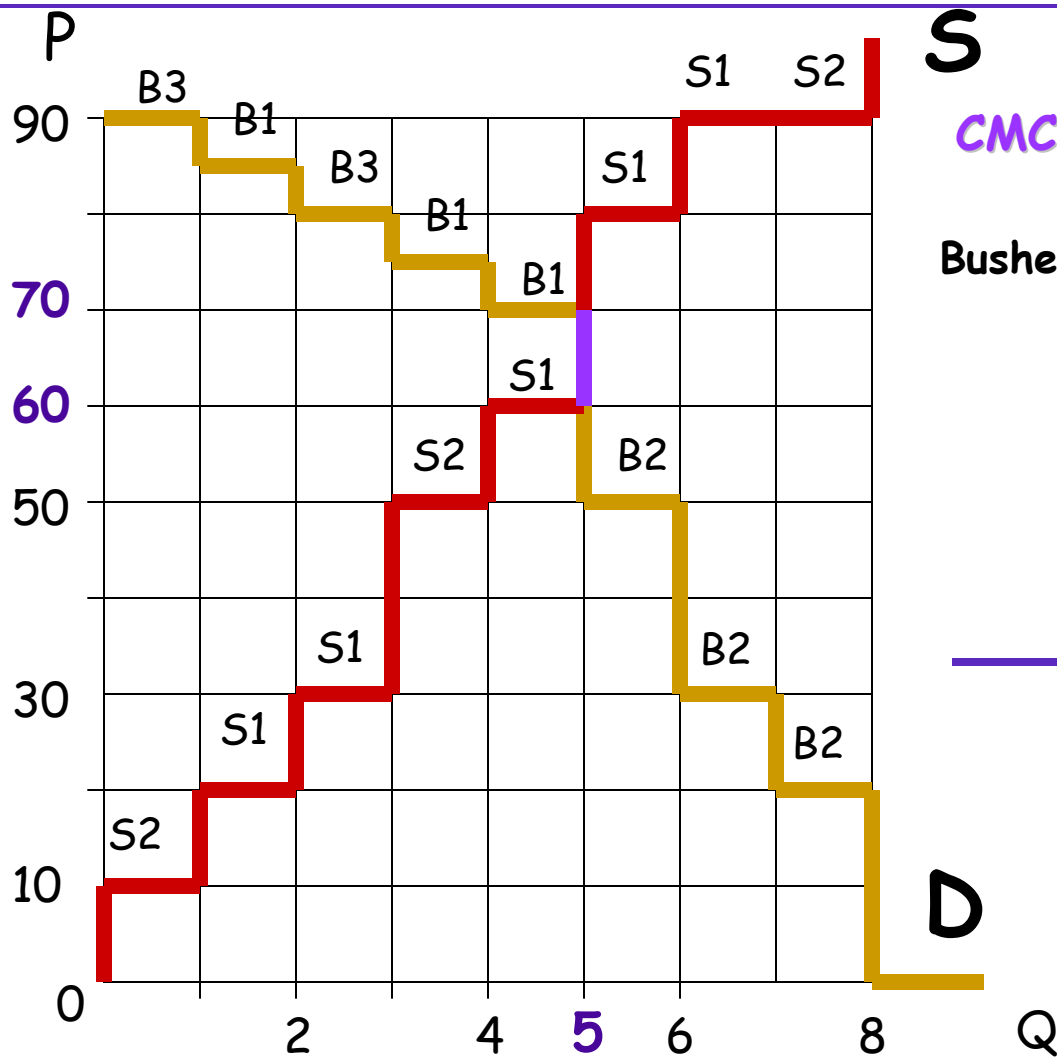
CMC Pts: $Q^*=5, \$60 \leq P^* \leq \70

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

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



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

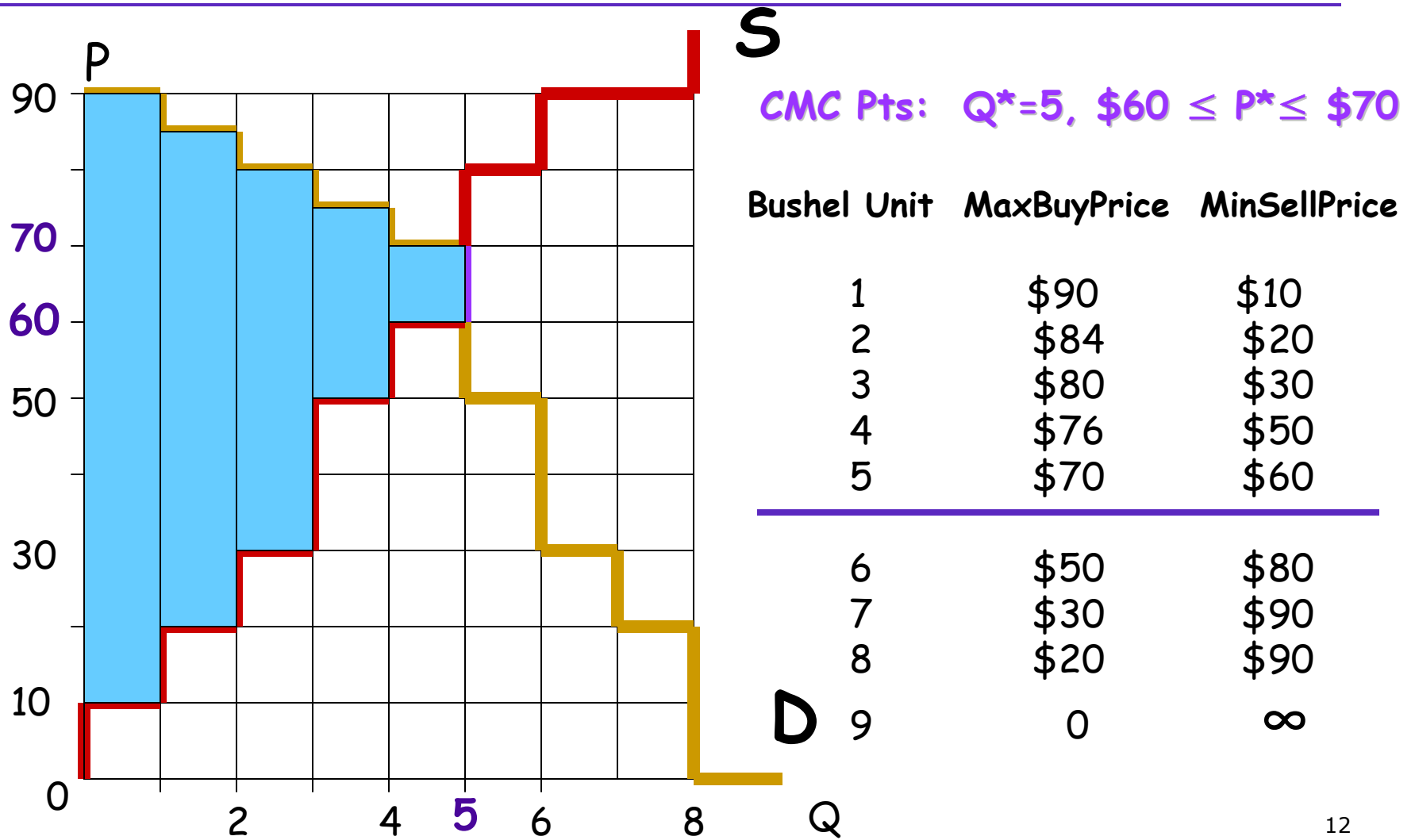
7 \$30 \$90

8 \$20 \$90

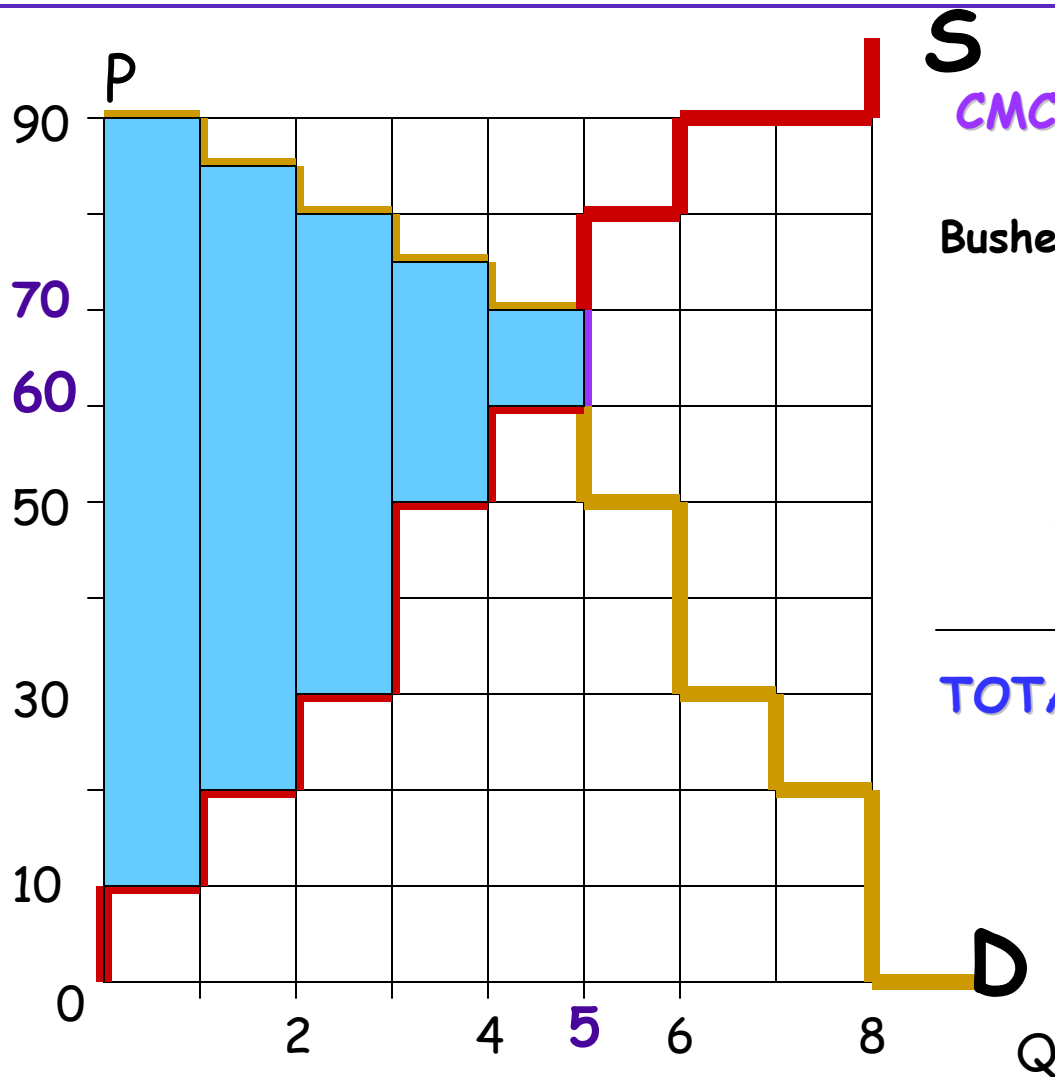
9 0 ∞

D

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



Total Net Surplus at CMC Points...



S

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

BushelUnit	MaxBuyP	MinSellP	Net Surplus
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1	\$90	- \$10	= \$80
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2	\$84	- \$20	= \$64
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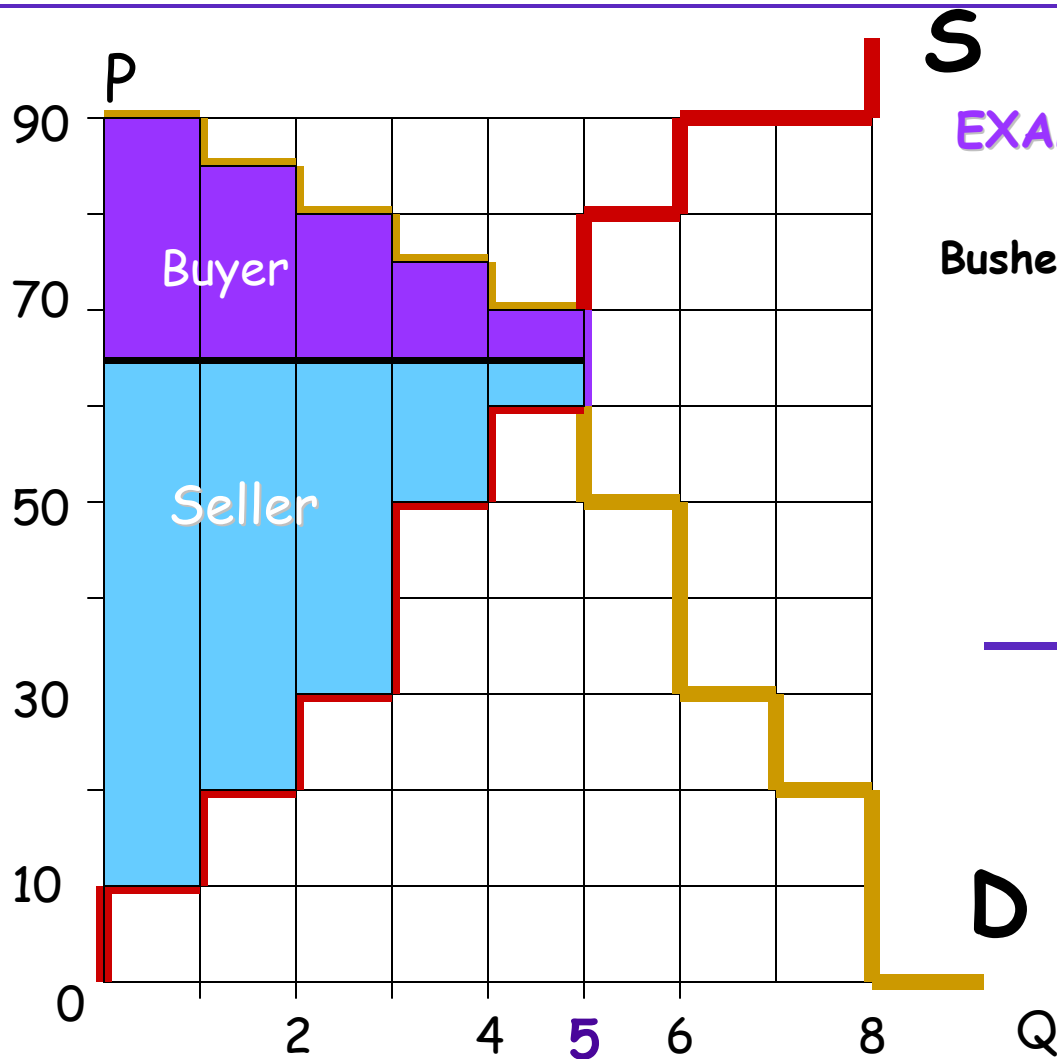
3	\$80	- \$30	= \$50
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4	\$76	- \$50	= \$26
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5	\$70	- \$60	= \$10
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TOTAL NET SURPLUS: \$230

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



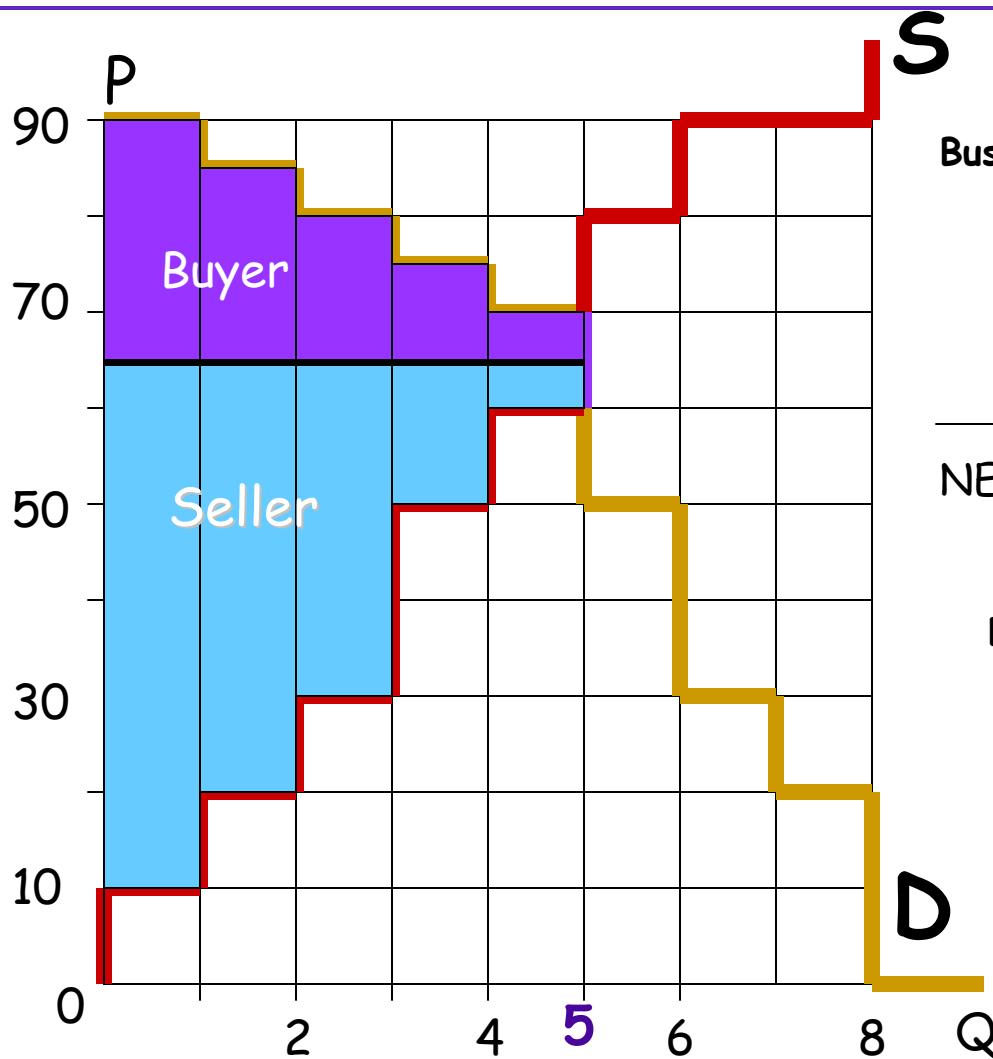
S

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

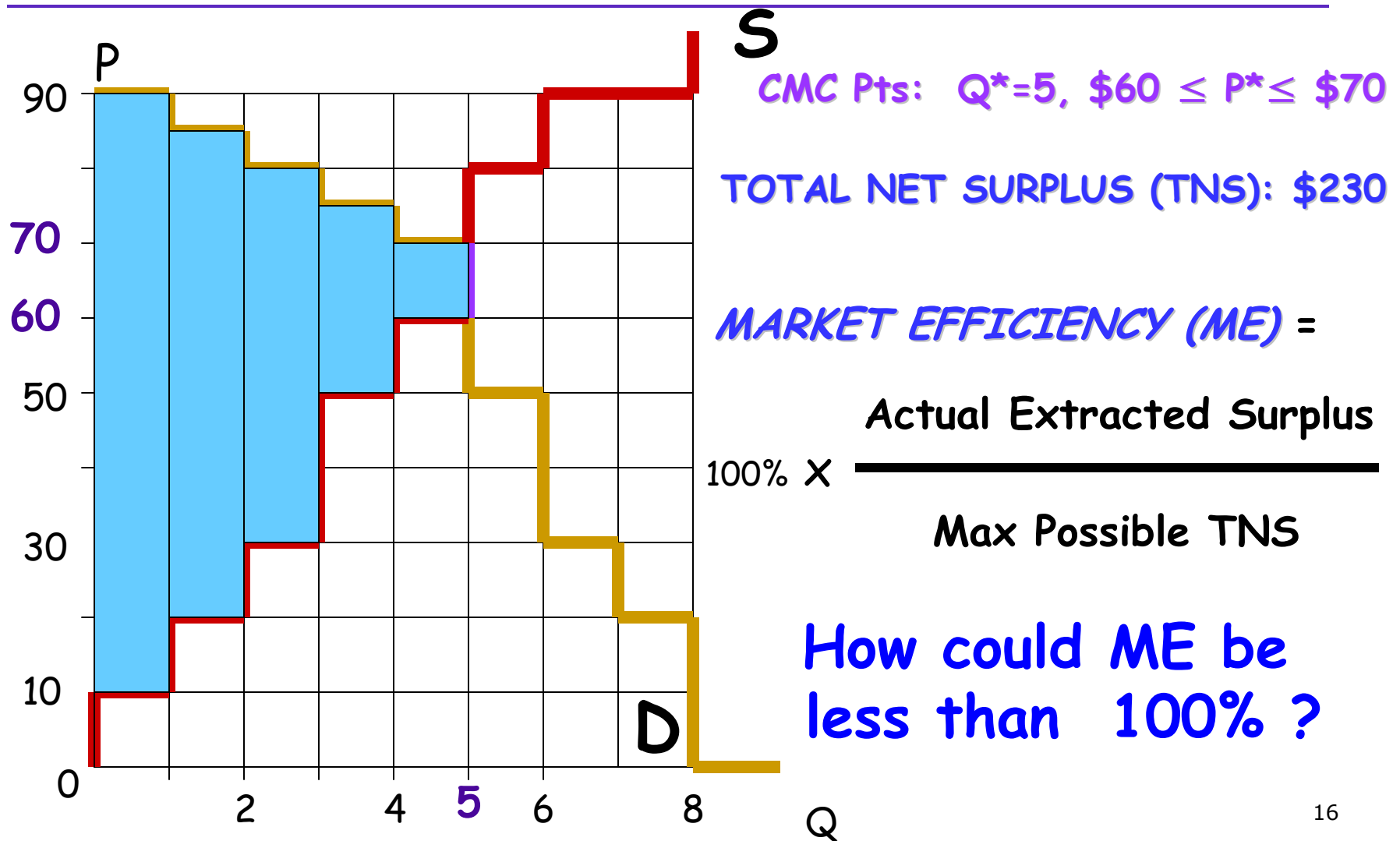
BushelUnit	MaxBPrice	$P^*=65$	BuySurplus
1	\$90	- \$65	= \$25
2	\$84	- \$65	= \$19
3	\$80	- \$65	= \$15
4	\$76	- \$65	= \$11
5	\$70	- \$65	= \$5

NET BUYER SURPLUS: \$75

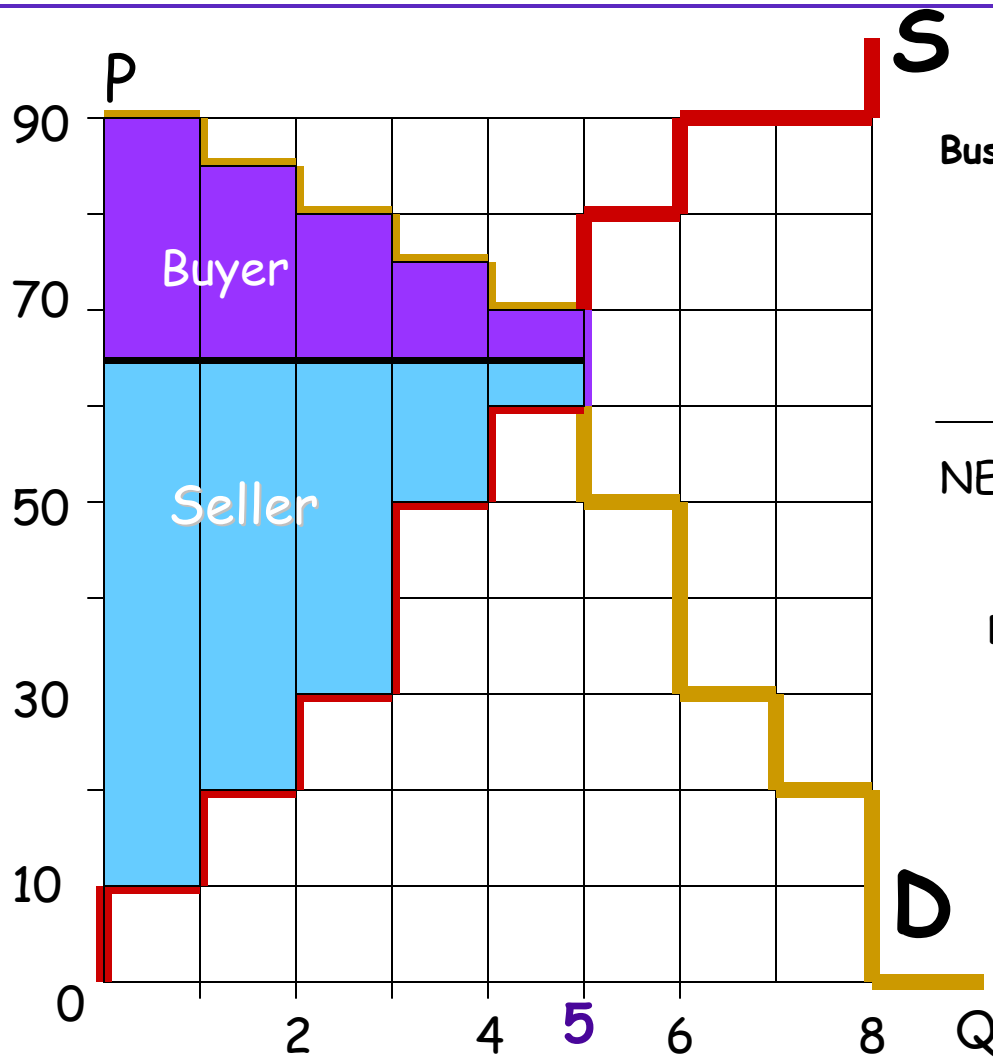
BushelUnit	$P^*=65$	MinSPrice	SellSurplus
1	\$65	- \$10	= \$55
2	\$65	- \$20	= \$45
3	\$65	- \$30	= \$35
4	\$65	- \$50	= \$15
5	\$65	- \$60	= \$5

NET SELLER SURPLUS: \$155

Market Efficiency (ME)



ME < 100% if "Wrong" Trades Made



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

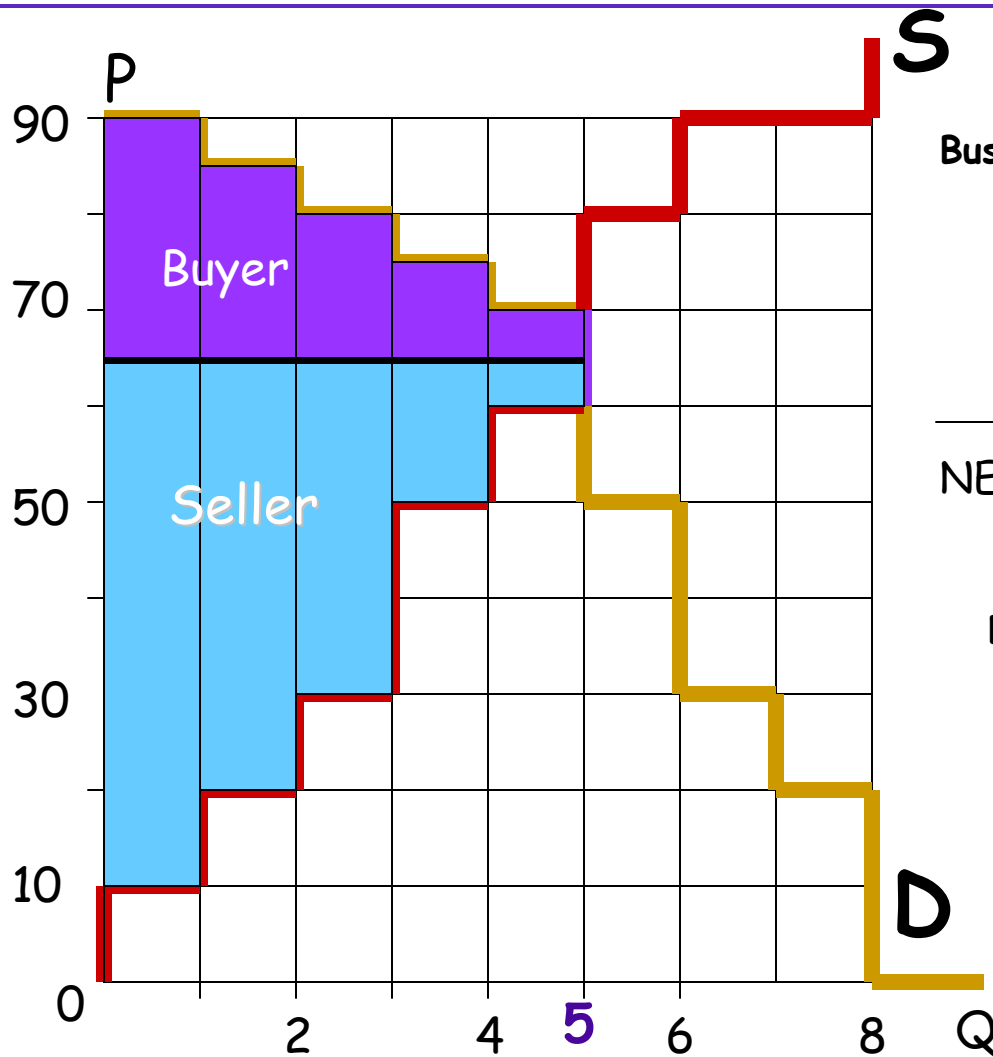
BushelUnit	$P^*=65$	MinSPrice	SellSurplus
1	\$65	- \$10	= \$55
2	\$65	- \$20	= \$45
3	\$65	- \$30	= \$35
4	\$65	- \$50	= \$15
5	\$65	- \$60	= \$5

NET SELLER SURPLUS: \$155

A "Wrong" Trade Means ?

- Some "inframarginal" quantity unit FAILS to trade
- Or some "extramarginal" quantity unit SUCCEEDS in being traded
- ★ Or 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 surplus is extracted by a "third party")
 - ISO's in wholesale power markets !

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



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

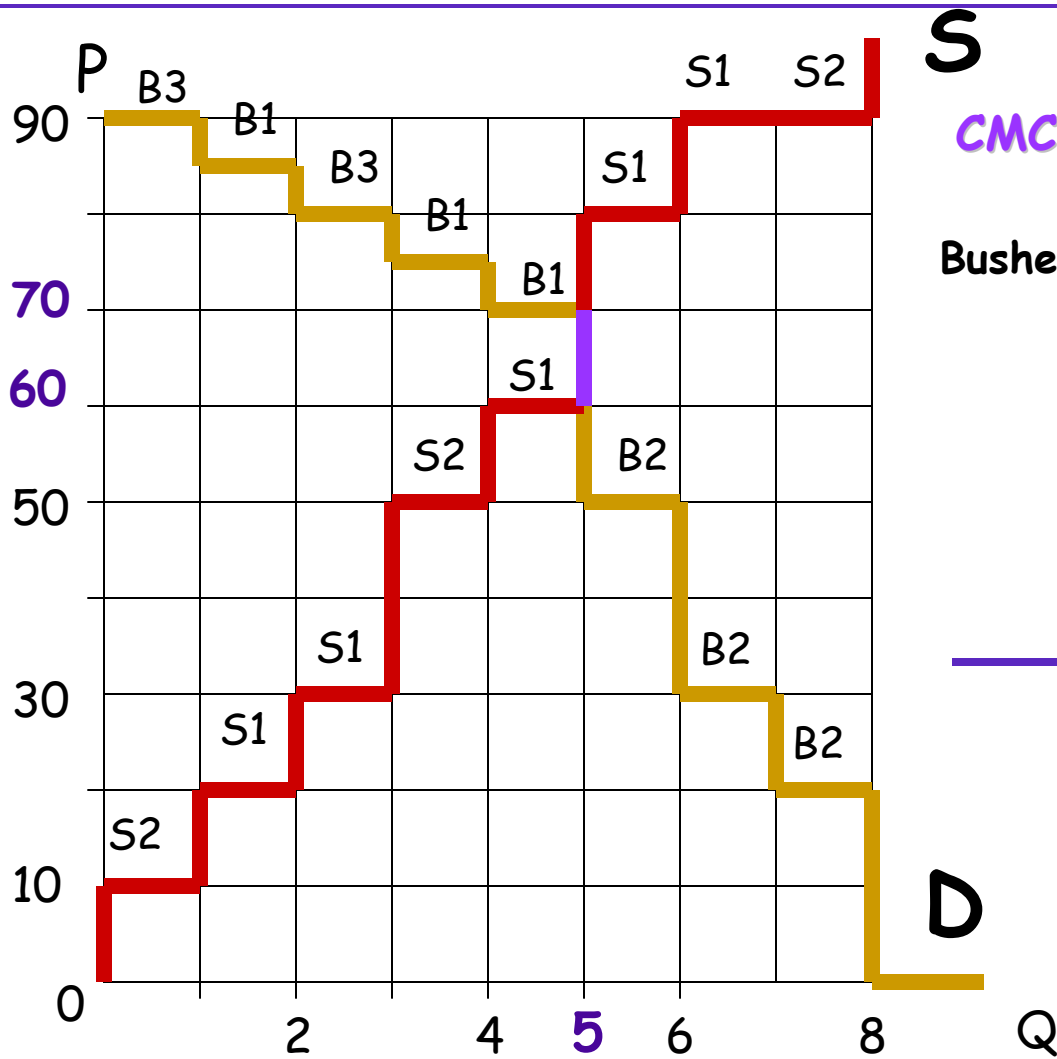
BushelUnit	MaxBPrice	$P^*=65$	BuySurplus
1	\$90	- \$65	= \$25
2	\$84	- \$65	= \$19
3	\$80	- \$65	= \$15
4	\$76	- \$65	= \$11
5	\$70	- \$65	= \$5

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* ?



S

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

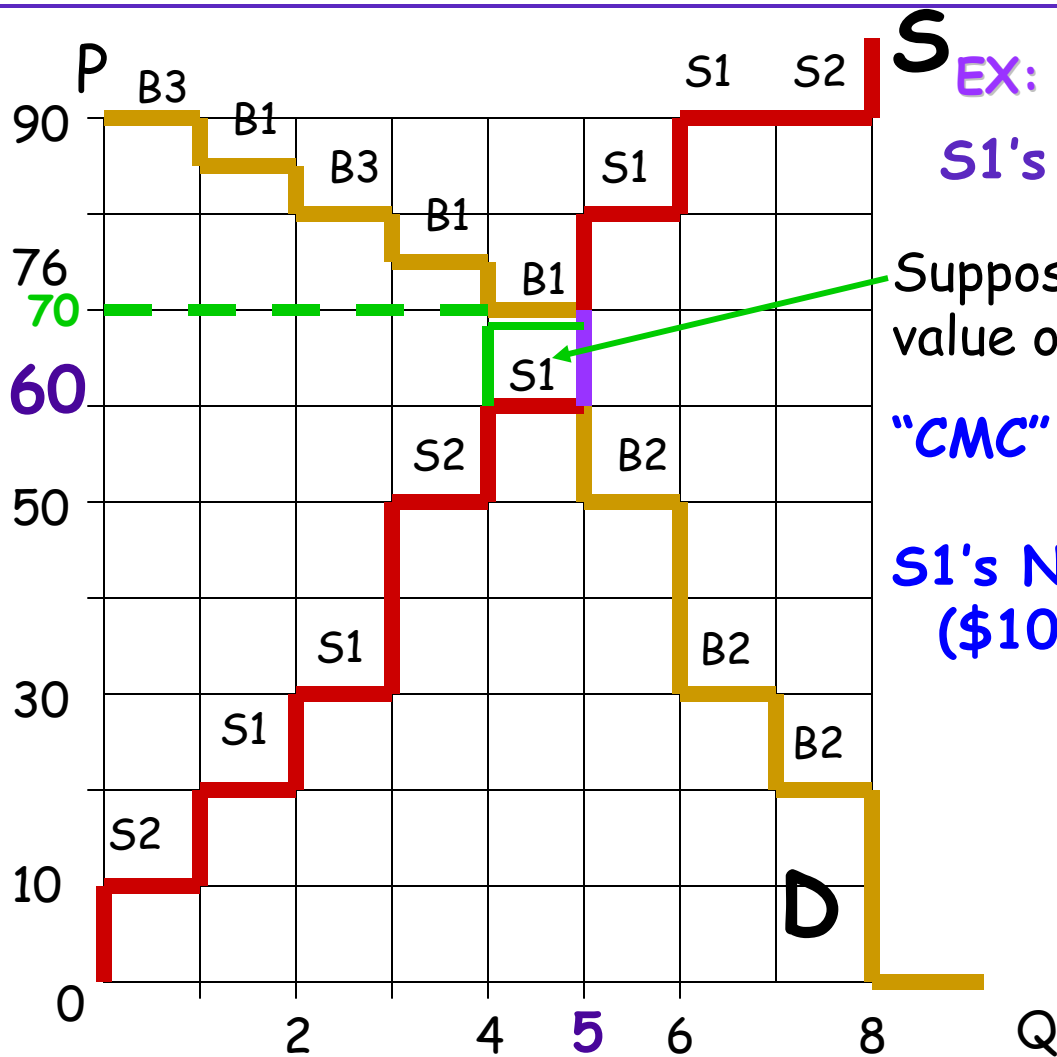
Bushel Unit MaxBuyPrice MinSellPrice

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

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



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

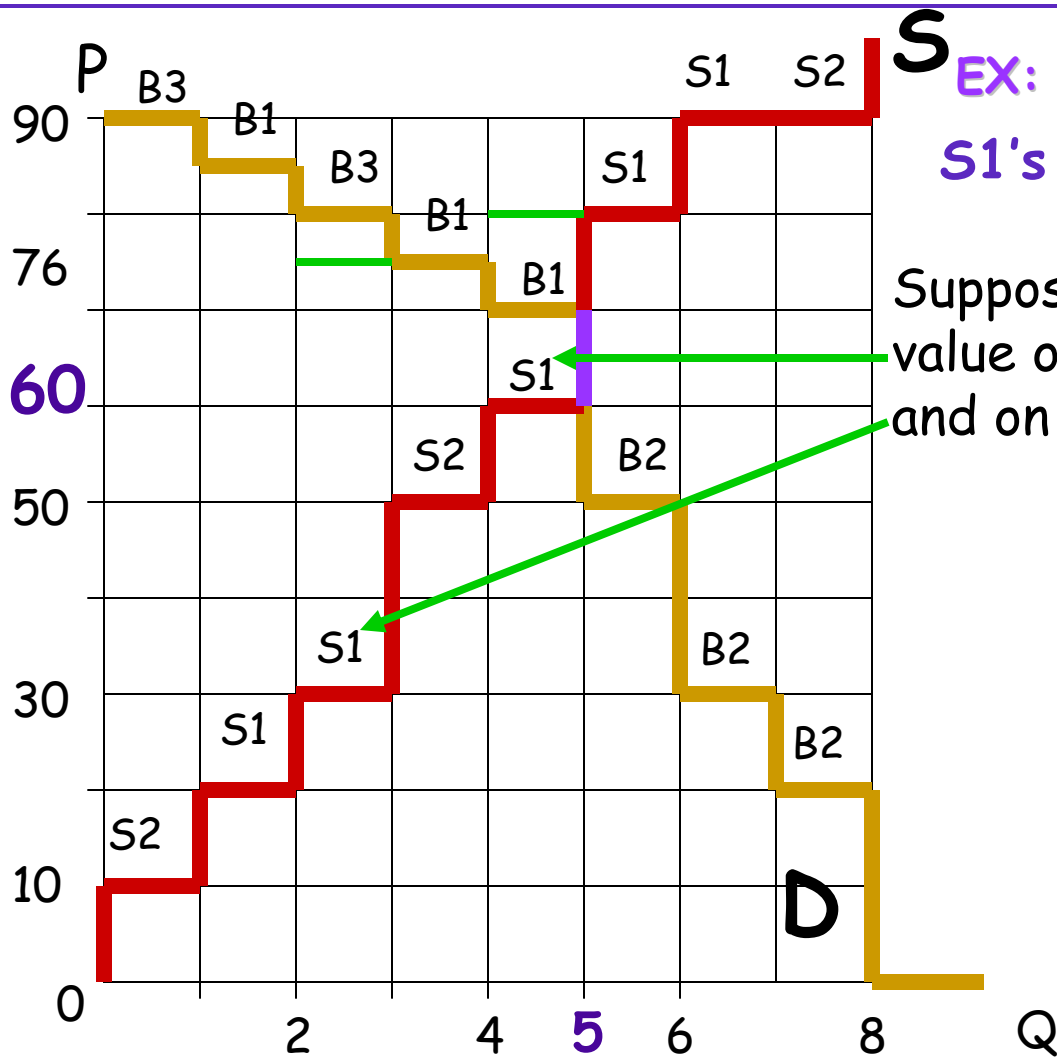
S1's Net Seller Surplus = \$70

Suppose S1 REPORTS a reservation value on his 3rd unit equal to \$70?

"CMC" Price $P^*=\$70, Q^*=5$

S1's Net Seller Surplus = \$100 !
(\$10 extra on each unit sold)

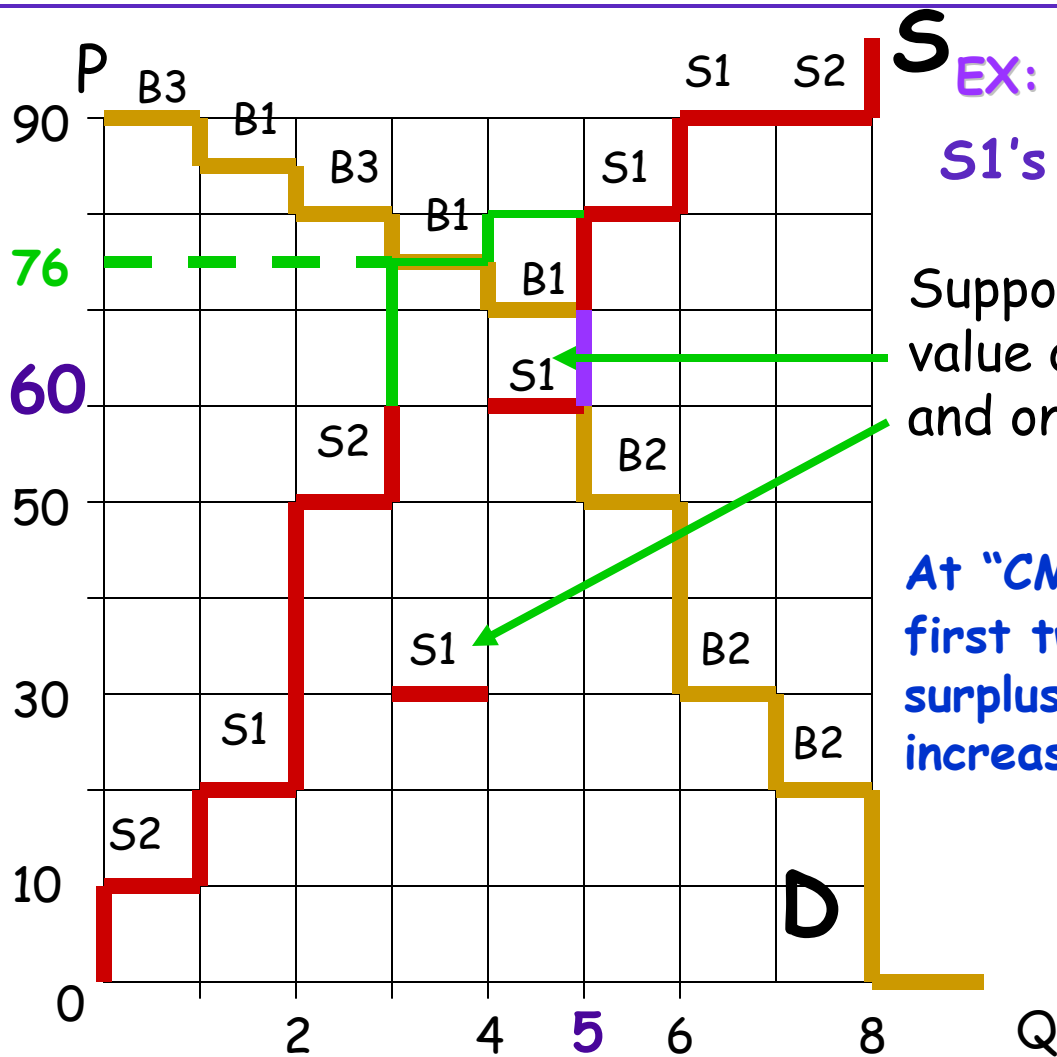
Does any trader below have an incentive to offer or bid *strategically* ?



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?

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

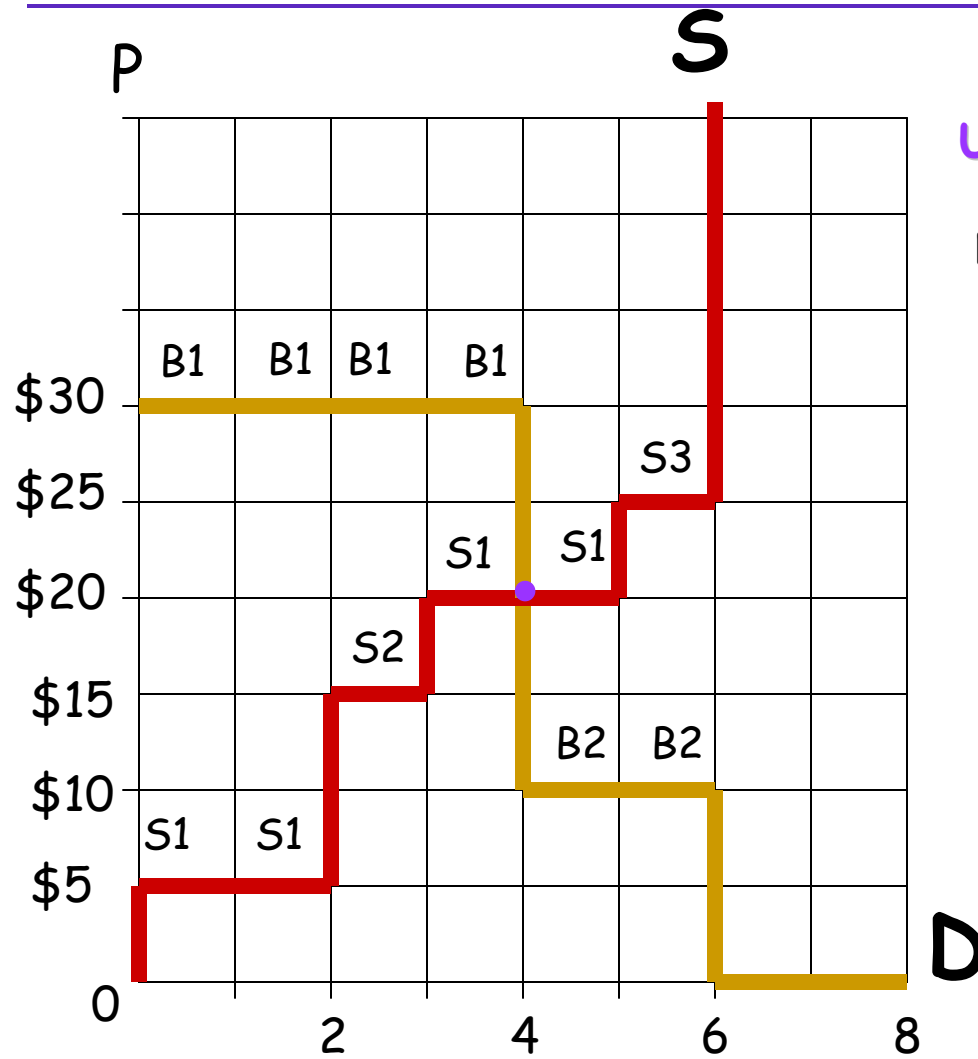


S EX: CMC Pt: $Q^*=5, P^*=\$60$
 S1's Net Seller Surplus = \$70

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

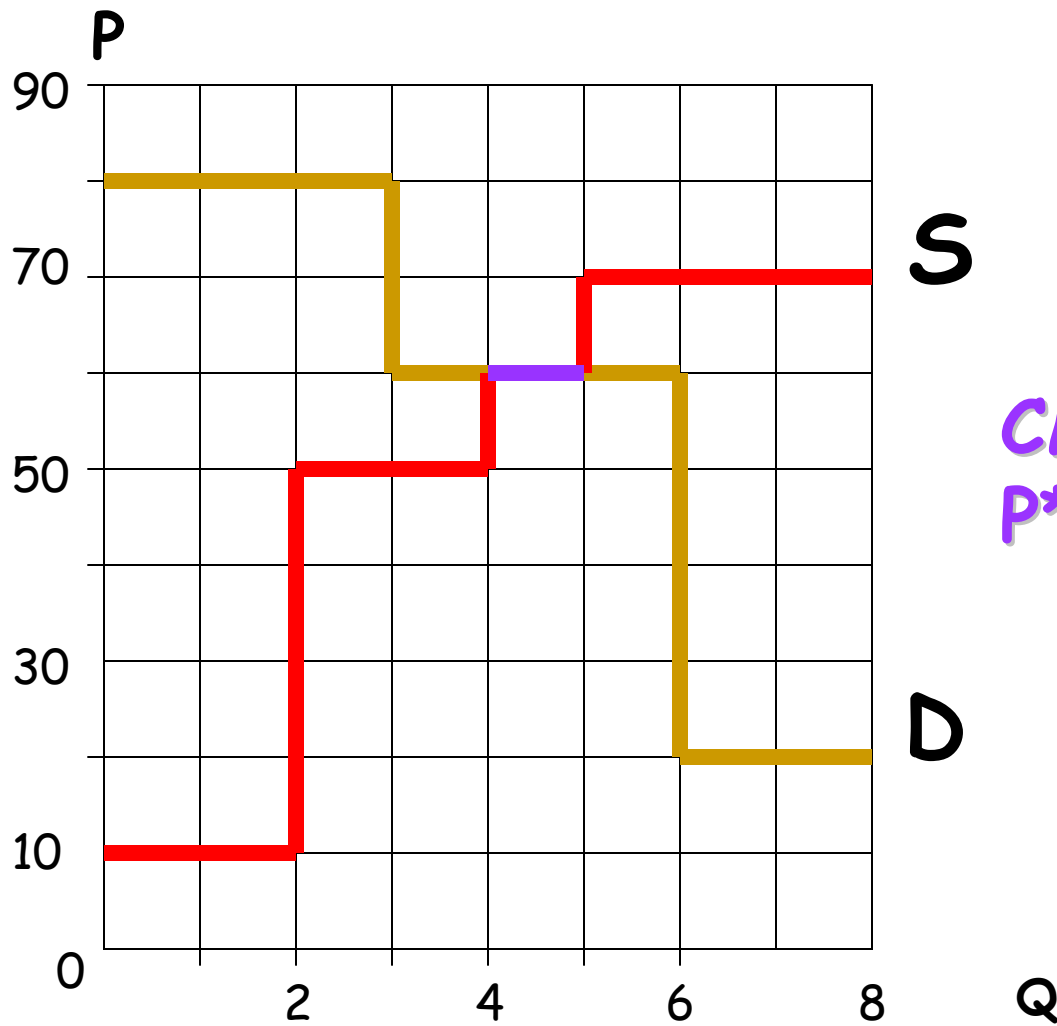


Unique CMC Pt: $Q^*=4$, $P^*=\$20$

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	∞

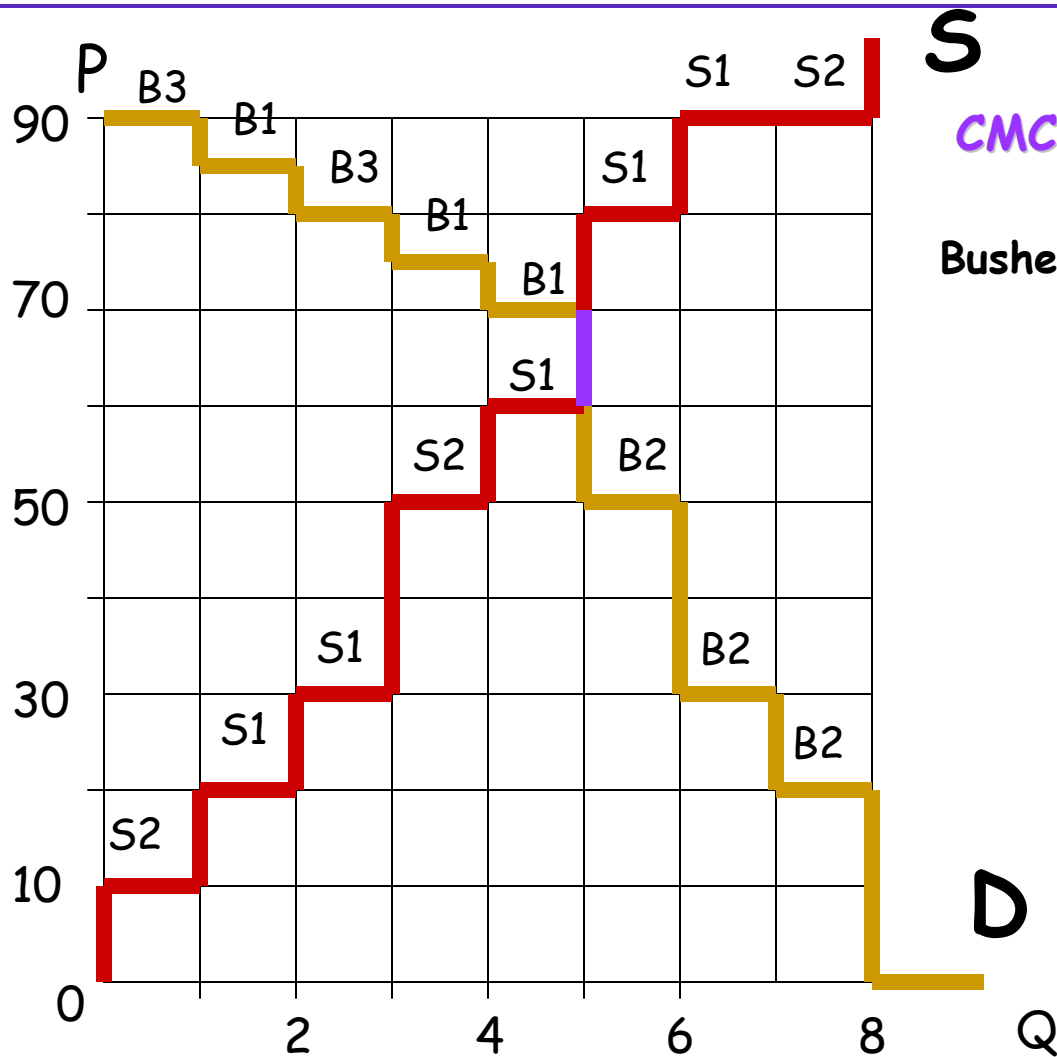
Bushel Unit	MaxBuyPrice	MinSellPrice
1	\$30	\$5
2	\$30	\$5
3	\$30	\$15
4	\$30	\$20
5	\$10	\$20
6	\$10	\$25
7	0	∞
8	0	∞

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

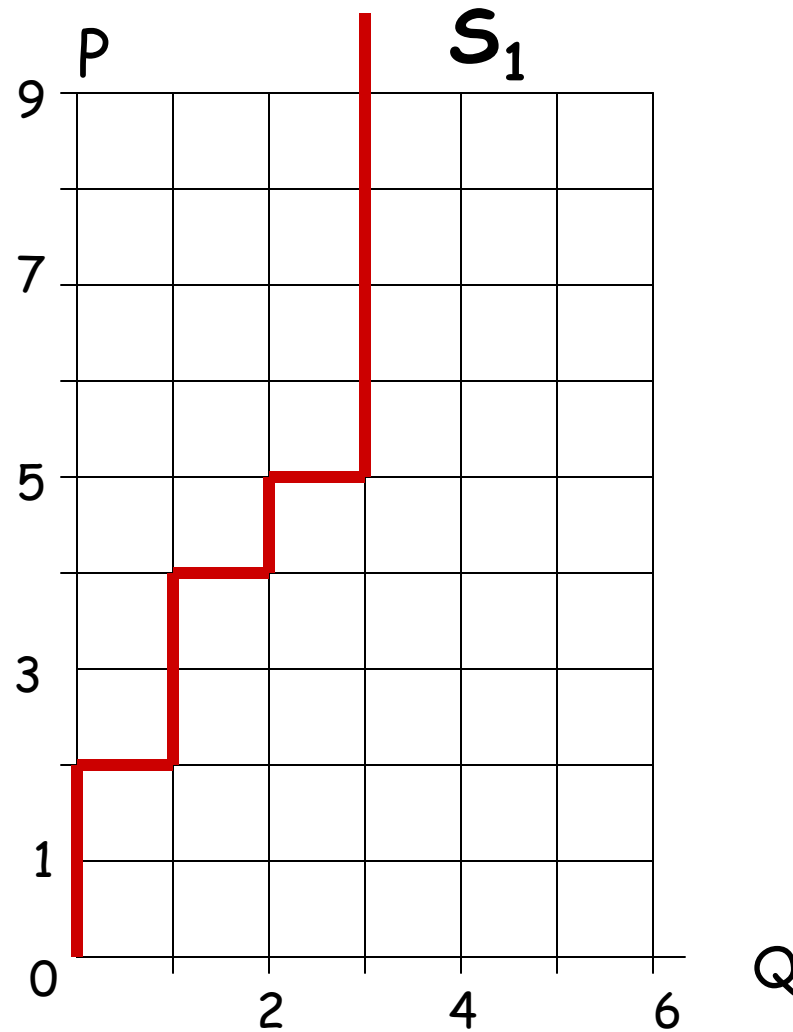
1	\$90	\$10
2	\$84	\$20
3	\$80	\$30
4	\$76	\$50
5	\$70	\$60
6	\$50	\$80
7	\$30	\$90
8	\$20	\$90
9	0	∞

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 $P = S_1(Q)$



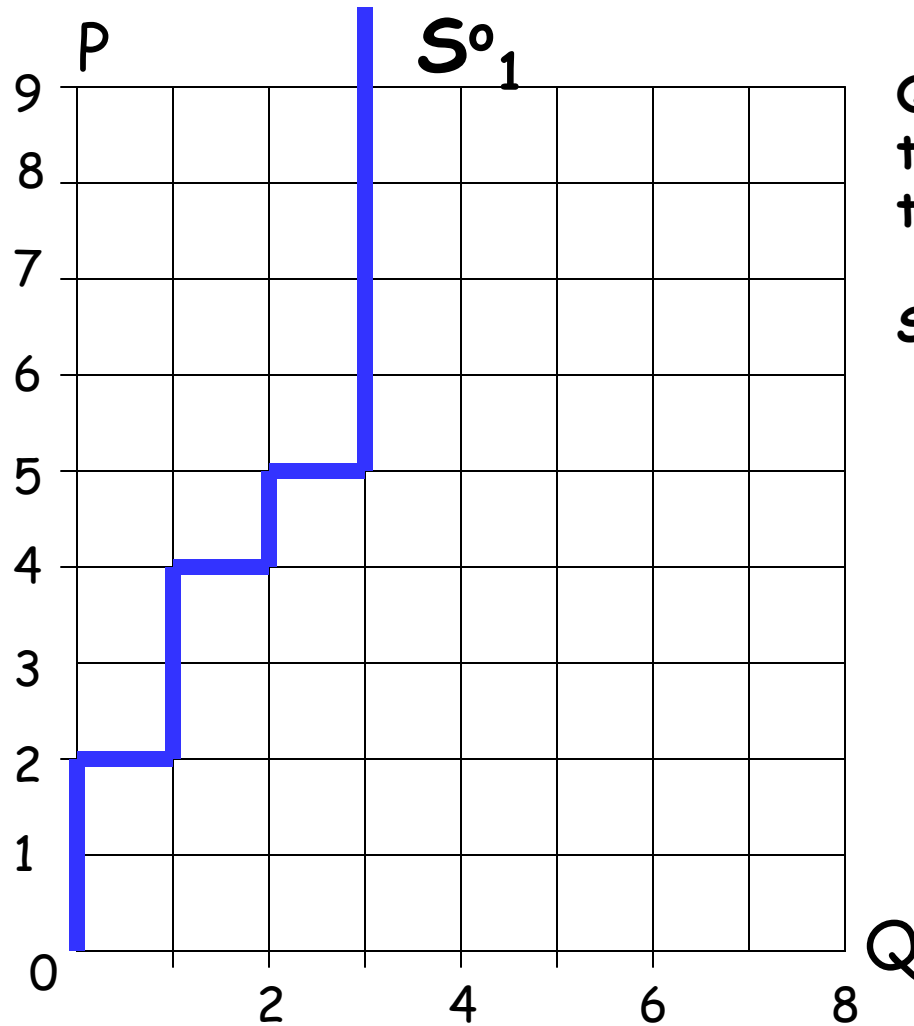
Supply Unit

Seller 1 Min
per-Unit Sale Price

0
1
2
3
4
5
6

\$0
\$2
\$4
\$5
 ∞
 ∞
 ∞

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

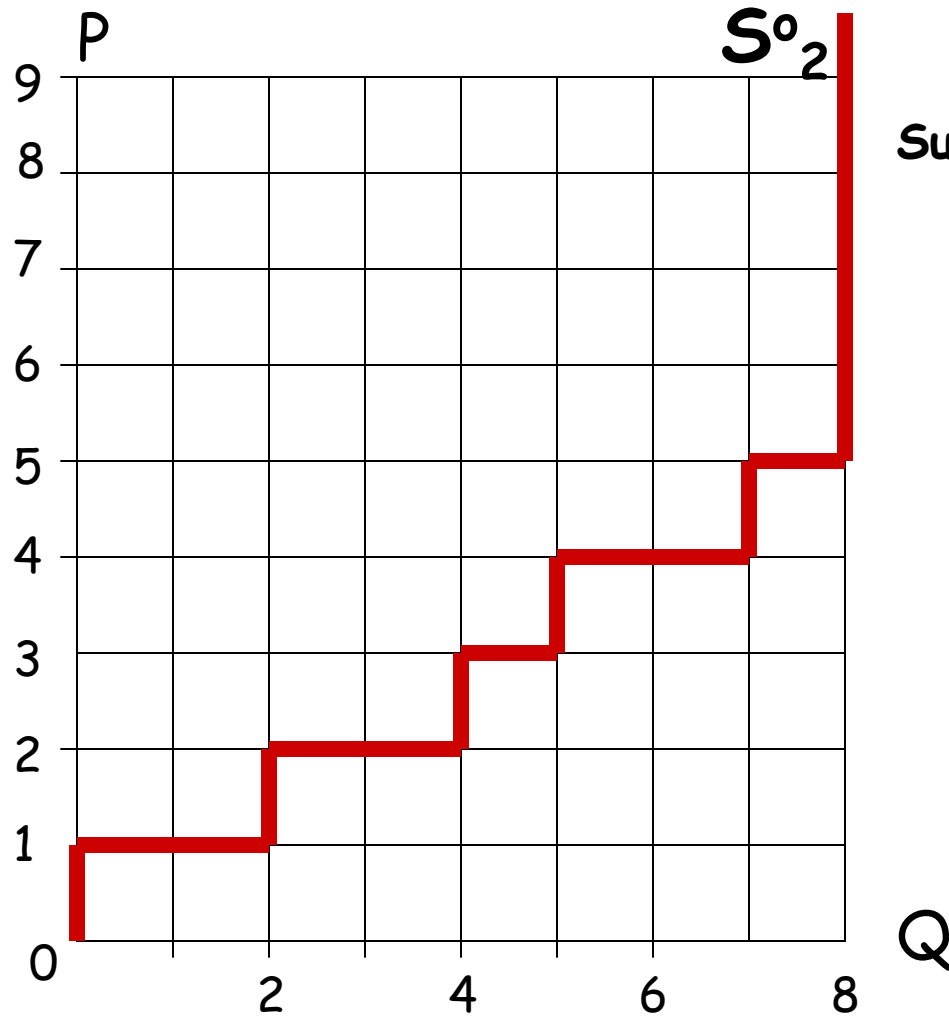
Seller 1 Max Supply

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 $P = S_2(Q)$

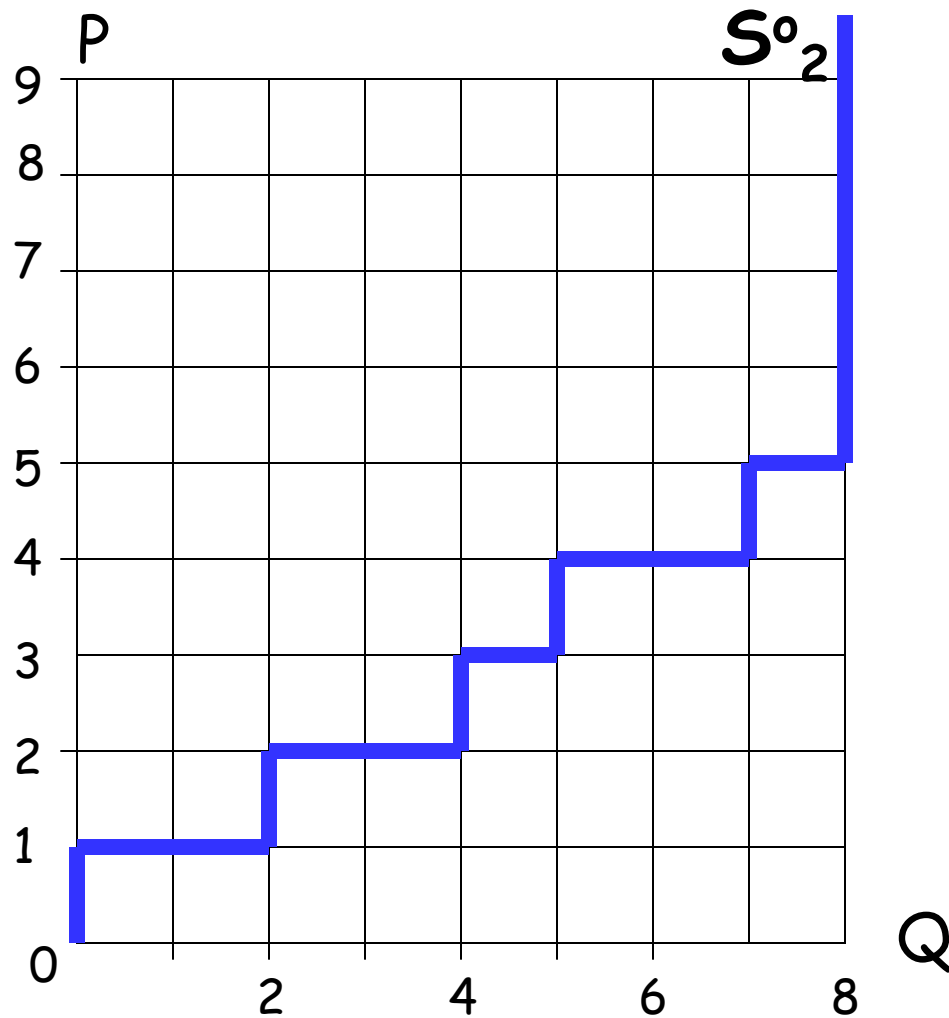


Supply Unit

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 $Q = S^o_2(P)$



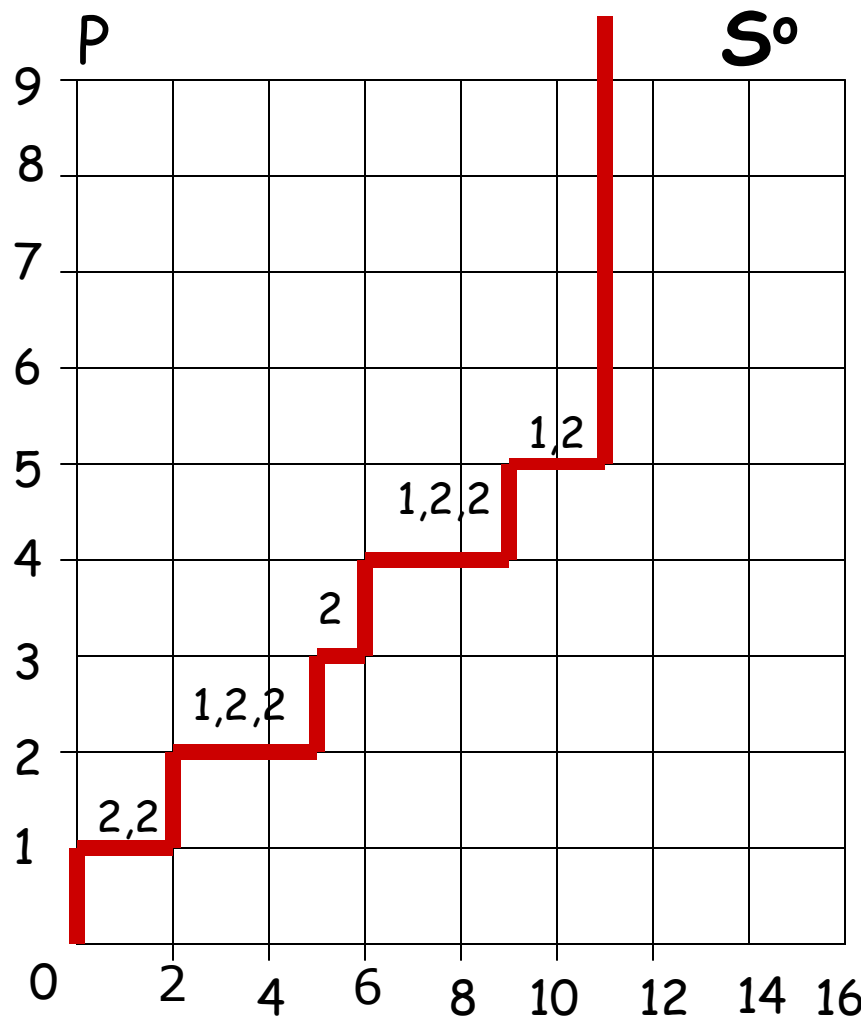
$Q = S^o_2(P)$ = Maximum amount of Q that Seller 2 is willing to supply at per-unit sale price P

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)

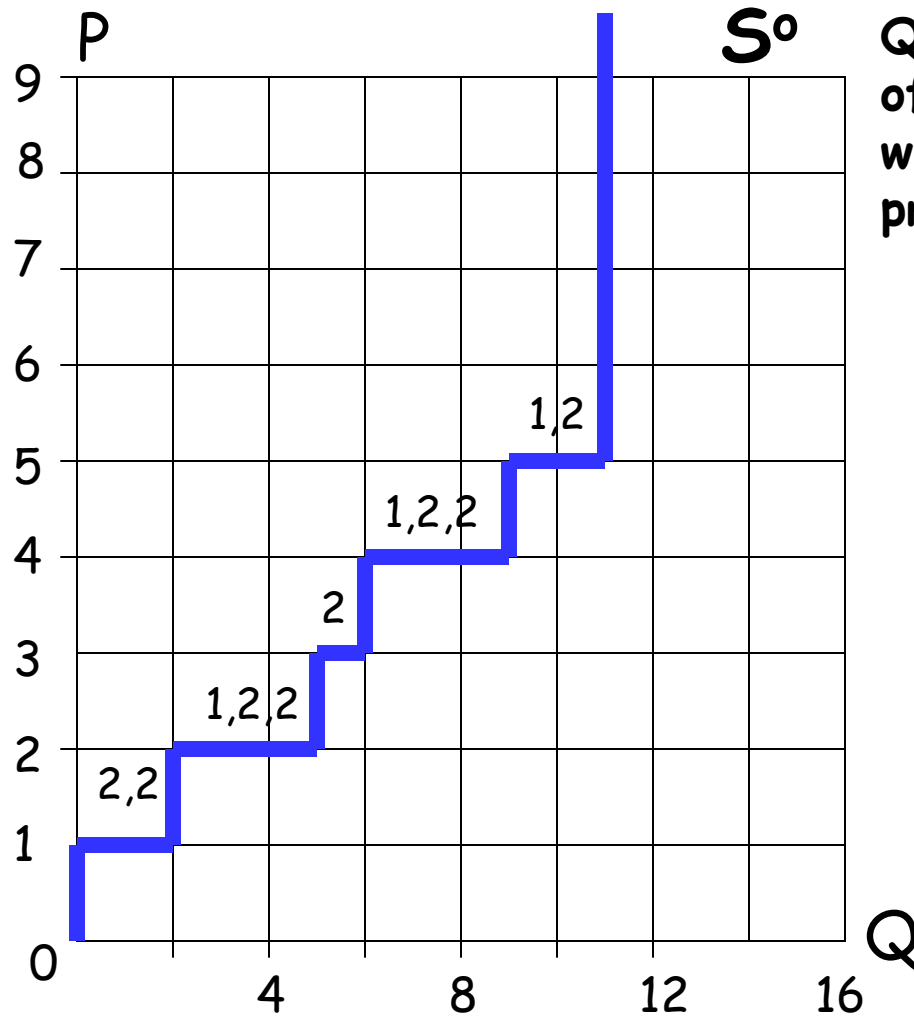
Inverse Form $P = S(Q)$



$P = S(Q)$ = 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 (S2)
2	\$1 (S2)
3	\$2 (S1/S2/S2)
4	\$2 (S1/S2/S2)
5	\$2 (S1/S2/S2)
6	\$3 (S2)
7	\$4 (S1/S2/S2)
8	\$4 (S1/S2/S2)
9	\$4 (S1/S2/S2)
10	\$5 (S1/S2)
11	\$5 (S1/S2)
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