

# Notes on the Construction of Demand & Supply Schedules

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# Clarification of Terminology

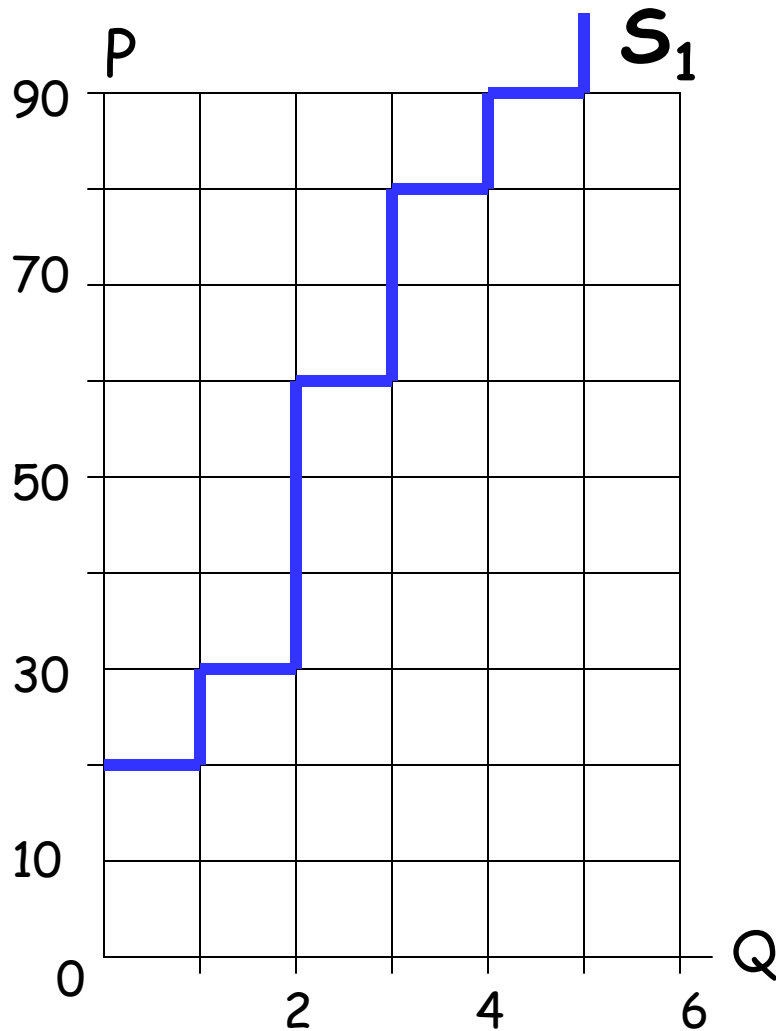
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- In market analyses:
  - *Ordinary* supply and demand schedules give *quantity for each (per unit) price*:  $Q = S^o(P)$ ;  $Q = D^o(P)$
  - *Inverse* supply and demand schedules give *(per unit) price for each quantity*:  $P = S(Q)$ ;  $P = D(Q)$ .
  
- 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)

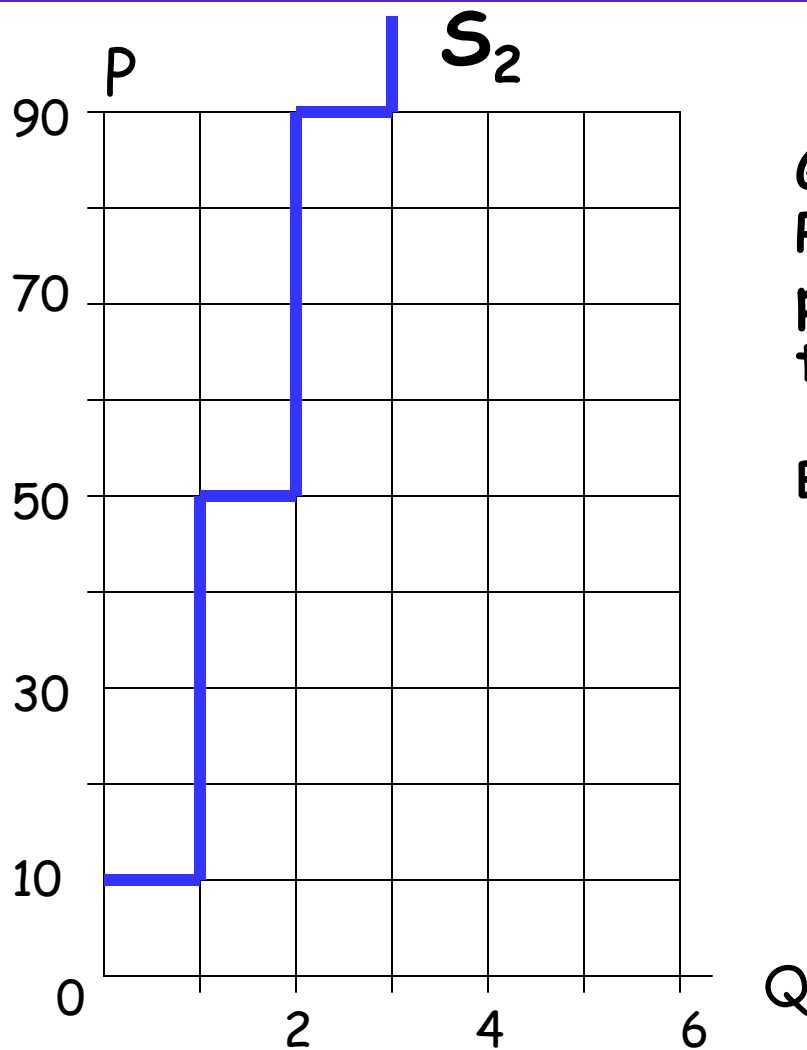
Given any  $Q$ , the function  $P=S_1(Q)$  gives Seller 1's minimum per-unit sale price (\$/bushel) for the "last" unit supplied at this  $Q$ .

**Bushel Unit      Seller 1 Min Sale Price**

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

# Seller 2 Supply Schedule

## Inverse Form $P = S_2(Q)$



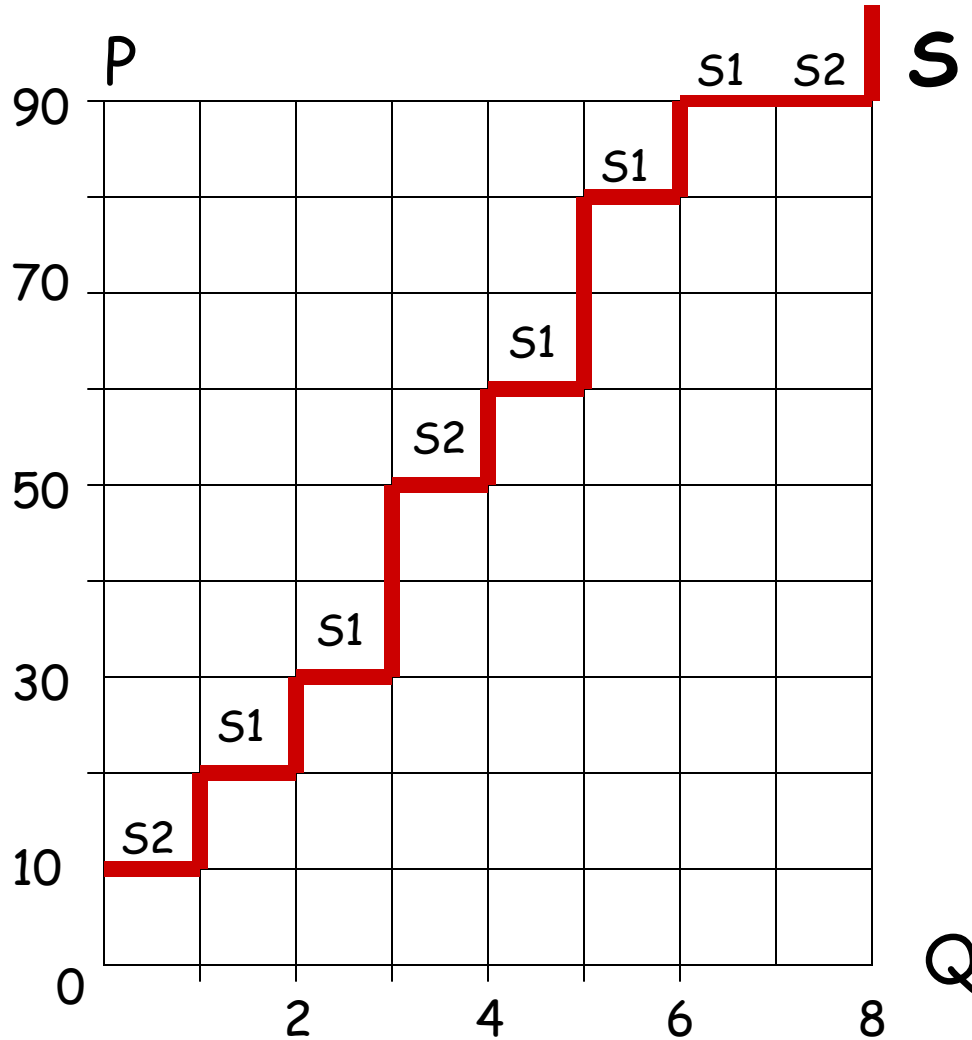
Given any  $Q$ , the function  $P=S_2(Q)$  gives Seller 2's minimum per-unit sale price (\$/bushel) for the "last" unit supplied at this  $Q$ .

Bushel Unit      Seller 2 Min Sale Price

1	\$10
2	\$50
3	\$90
4	$\infty$

# Total Supply Schedule (Sellers 1 & 2)

## Inverse Form $P = S(Q)$

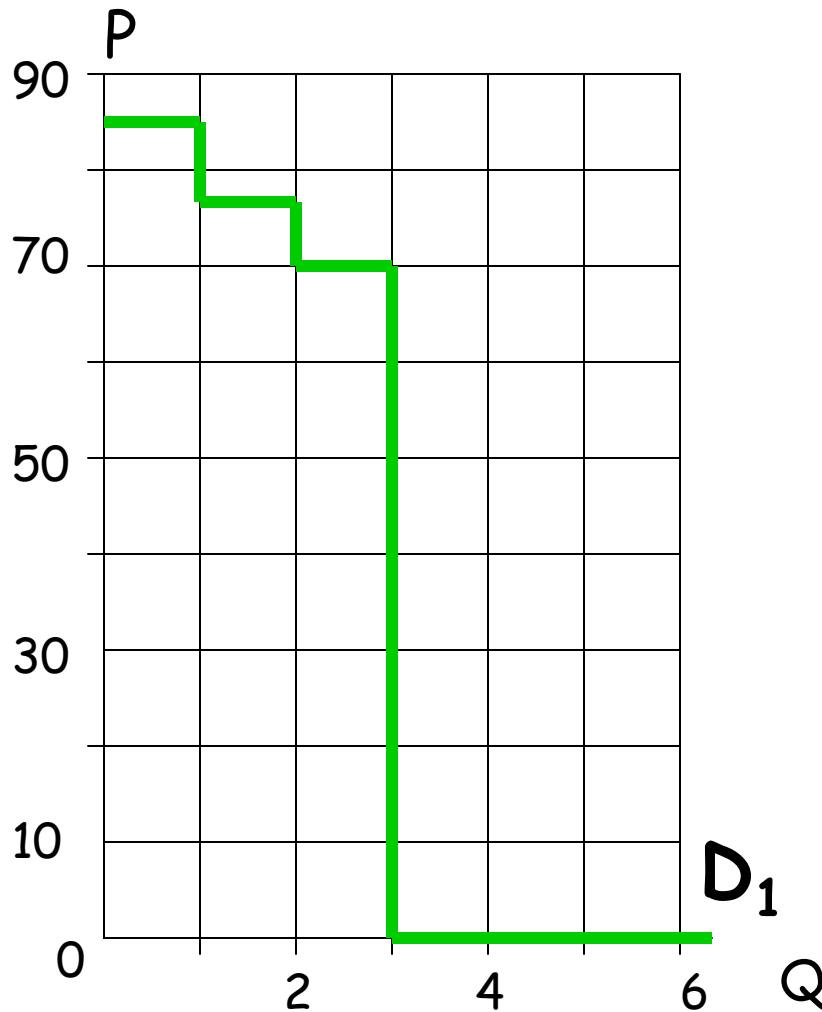


**Bushel Unit    Min Seller Price**

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	$\infty$

# Buyer 1 Demand Schedule

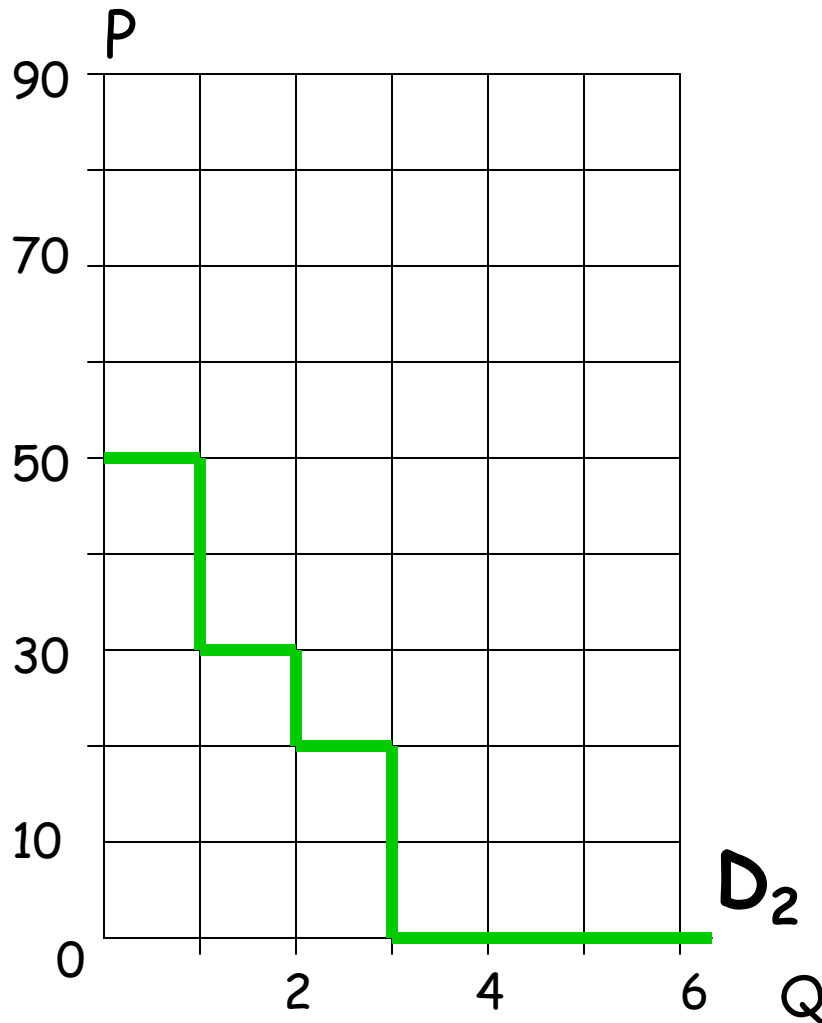
Inverse Form  $P = D_1(Q)$



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

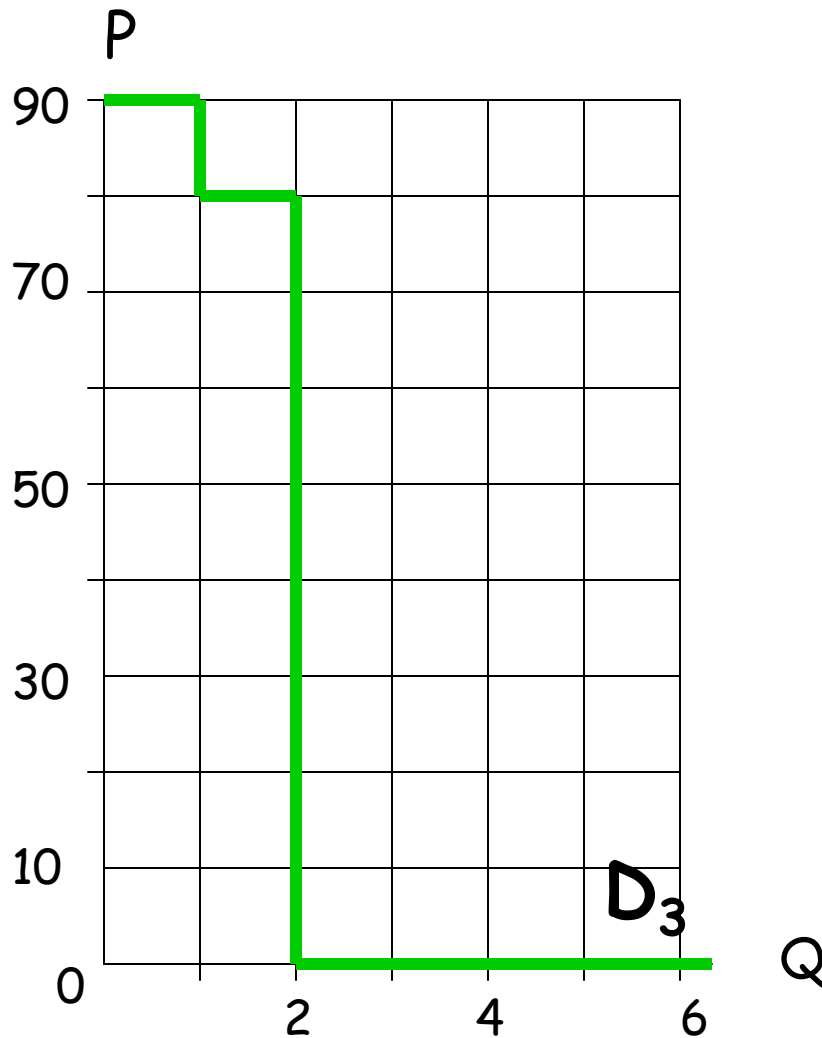
## Buyer 2 Demand Schedule Inverse Form $P = D_2(Q)$



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 $P = D_3(Q)$



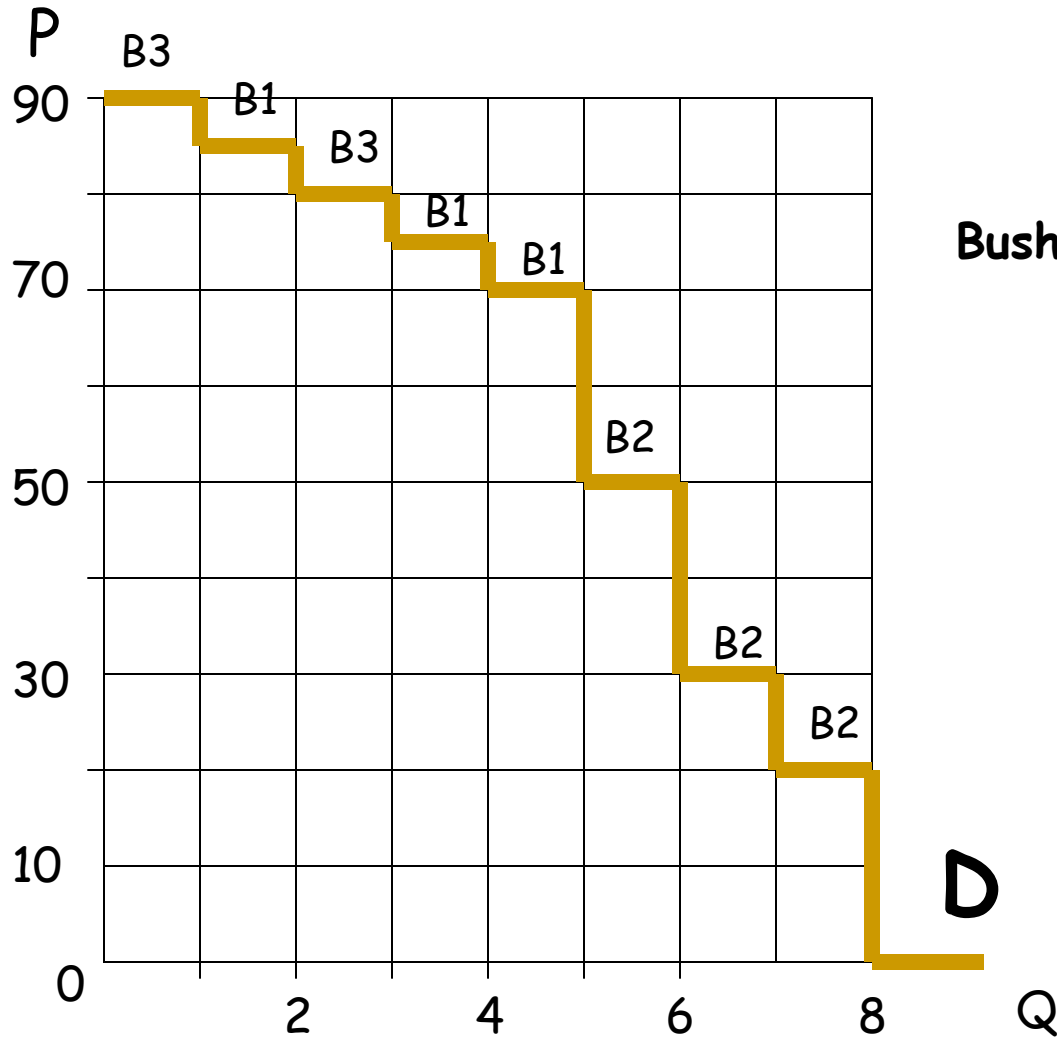
Given any  $Q$ , the function  $P=D_3(Q)$  gives Buyer 3's maximum per-unit purchase price (\$/bushel) for the "last" unit purchased at this  $Q$ .

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



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

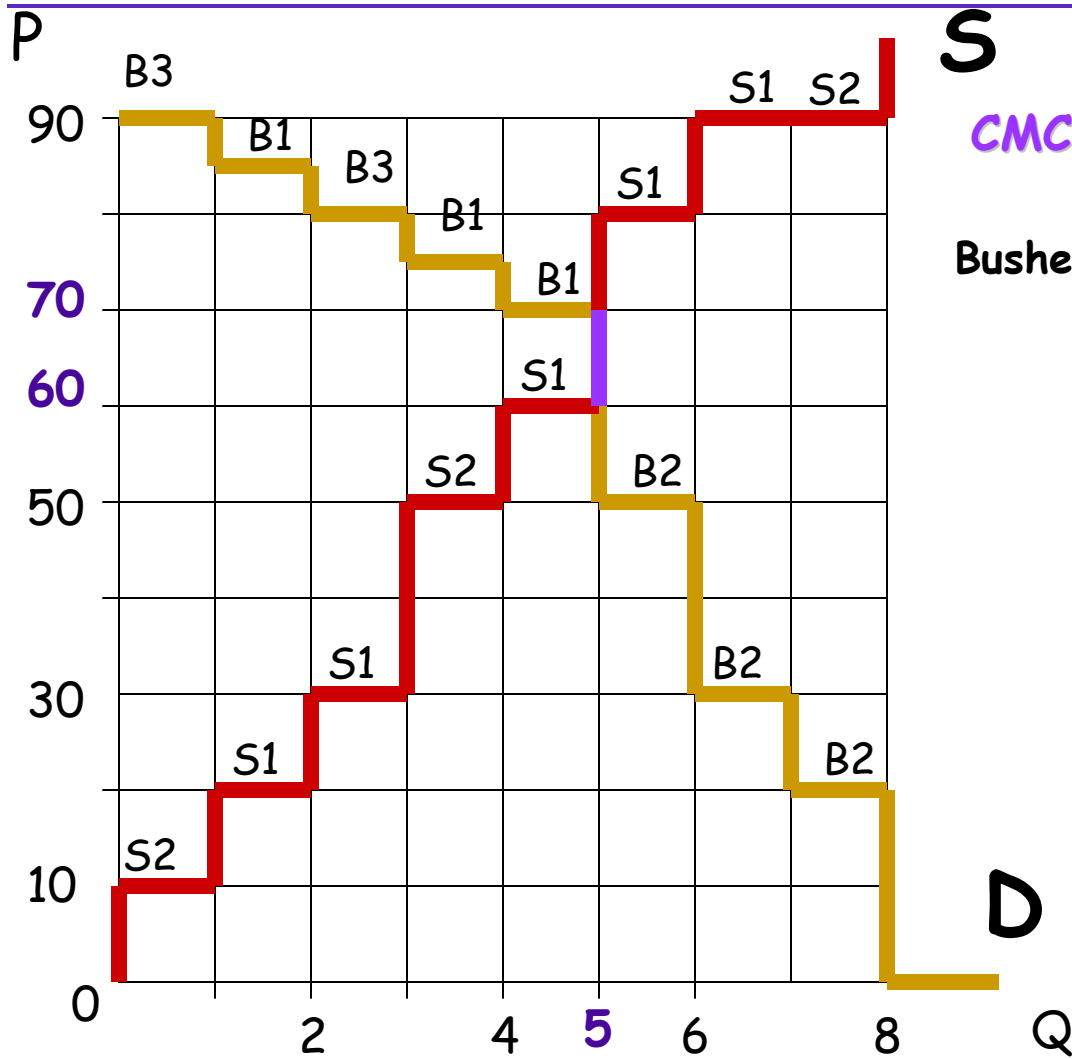
## Inverse Form $P = D(Q)$



**Bushel Unit**      **Max Buyer**  
**Per-Unit Price**

1	\$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)



**S**

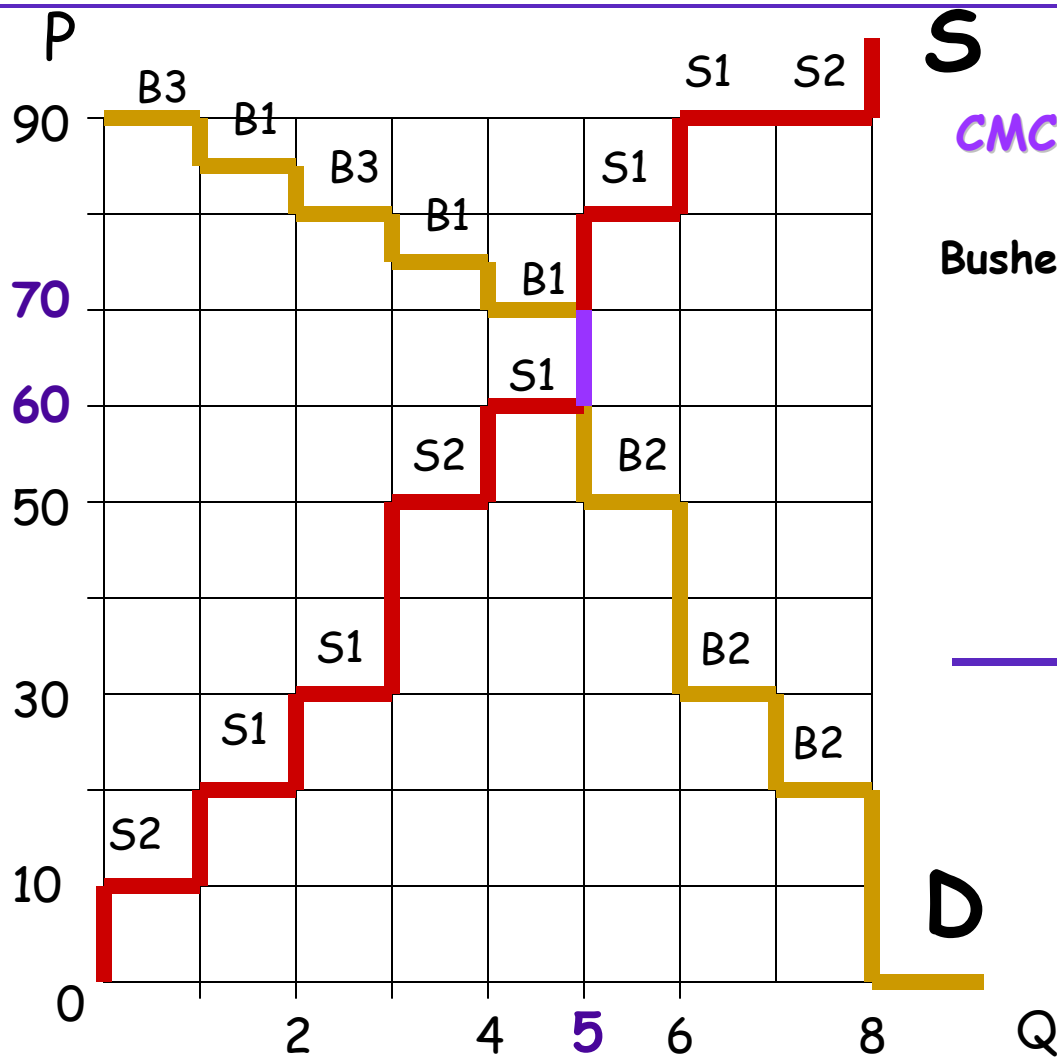
CMC Pts:  $Q^*=5, \$60 \leq P^* \leq \$70$

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	$\infty$

**D**

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



**S**

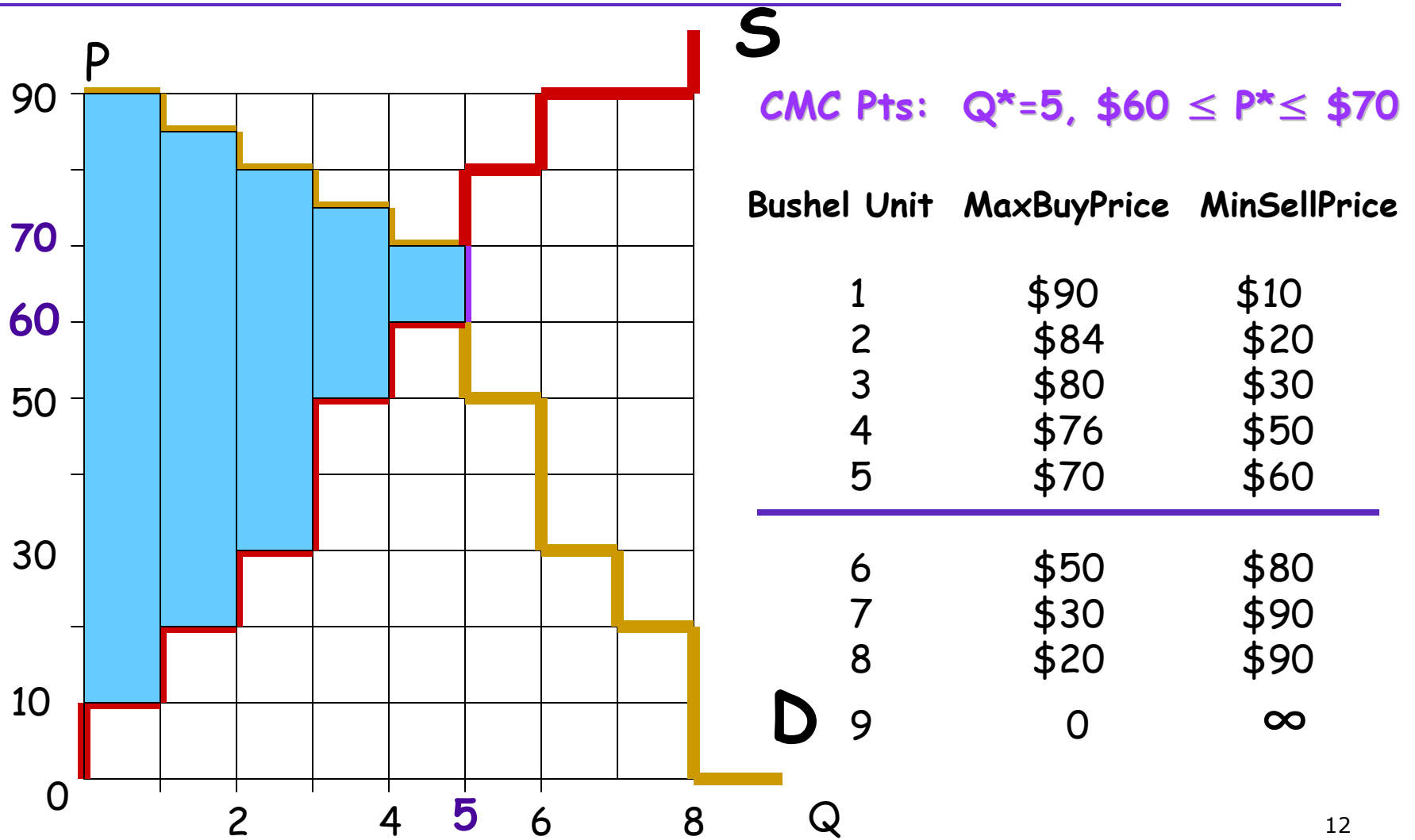
CMC Pts:  $Q^*=5, \$60 \leq P^* \leq \$70$

Bushel Unit    MaxBuyPrice    MinSellPrice

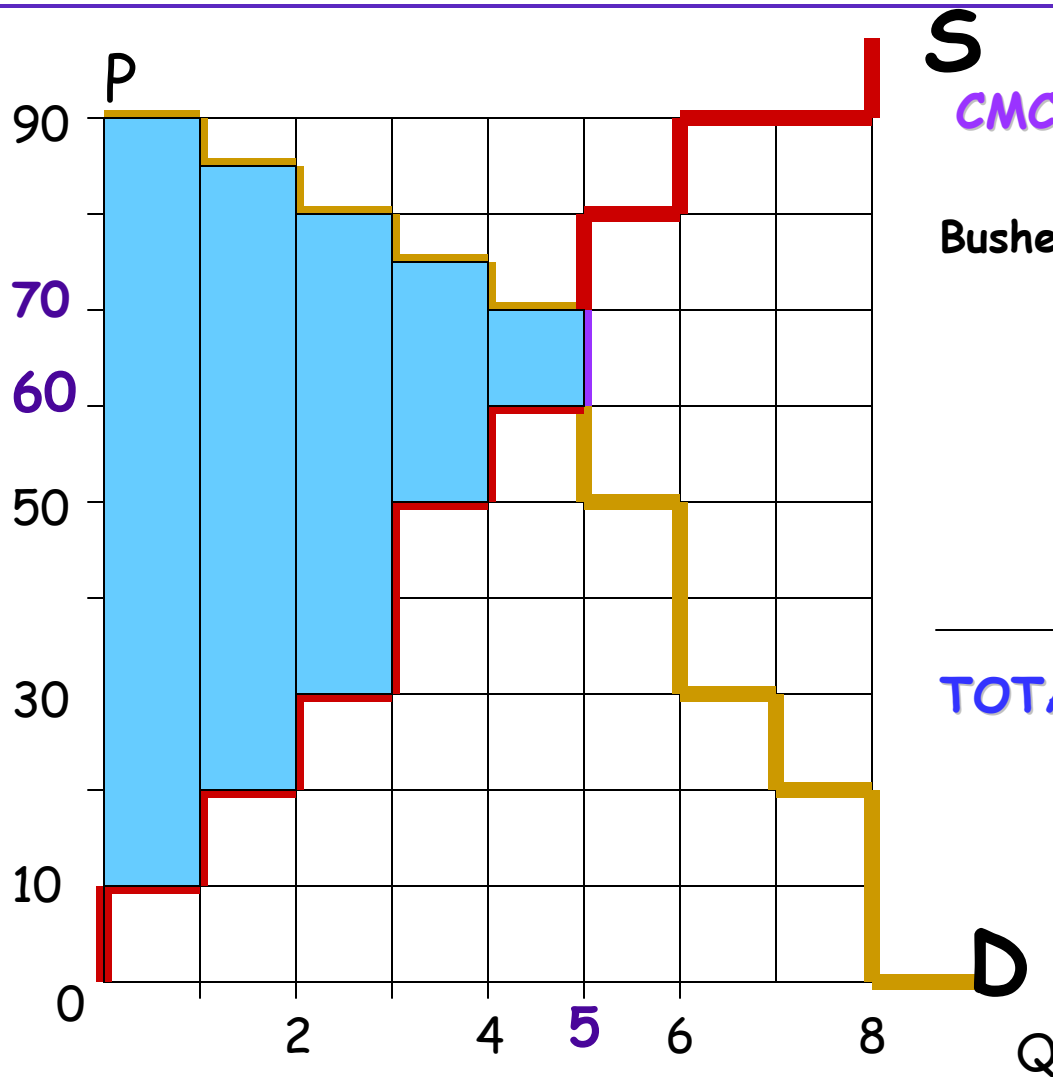
1	\$90	\$10
2	\$84	\$20
3	\$80	\$30
4	\$76	\$50
5	\$70	\$60
<hr/>		
6	\$50	\$80
7	\$30	\$90
8	\$20	\$90
9	0	$\infty$

**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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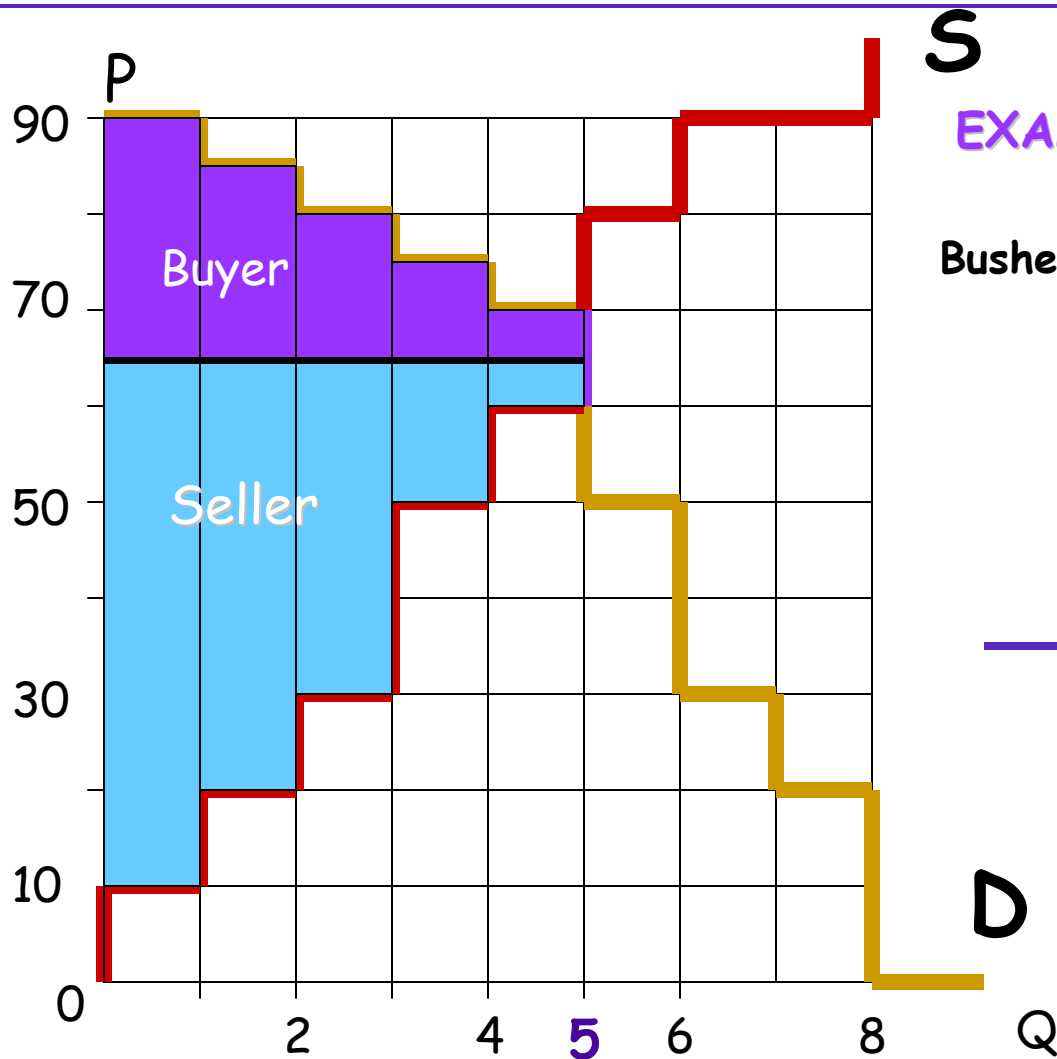
4	\$76	- \$50	= \$26
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5	\$70	- \$60	= \$10
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**TOTAL NET SURPLUS: \$230**

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



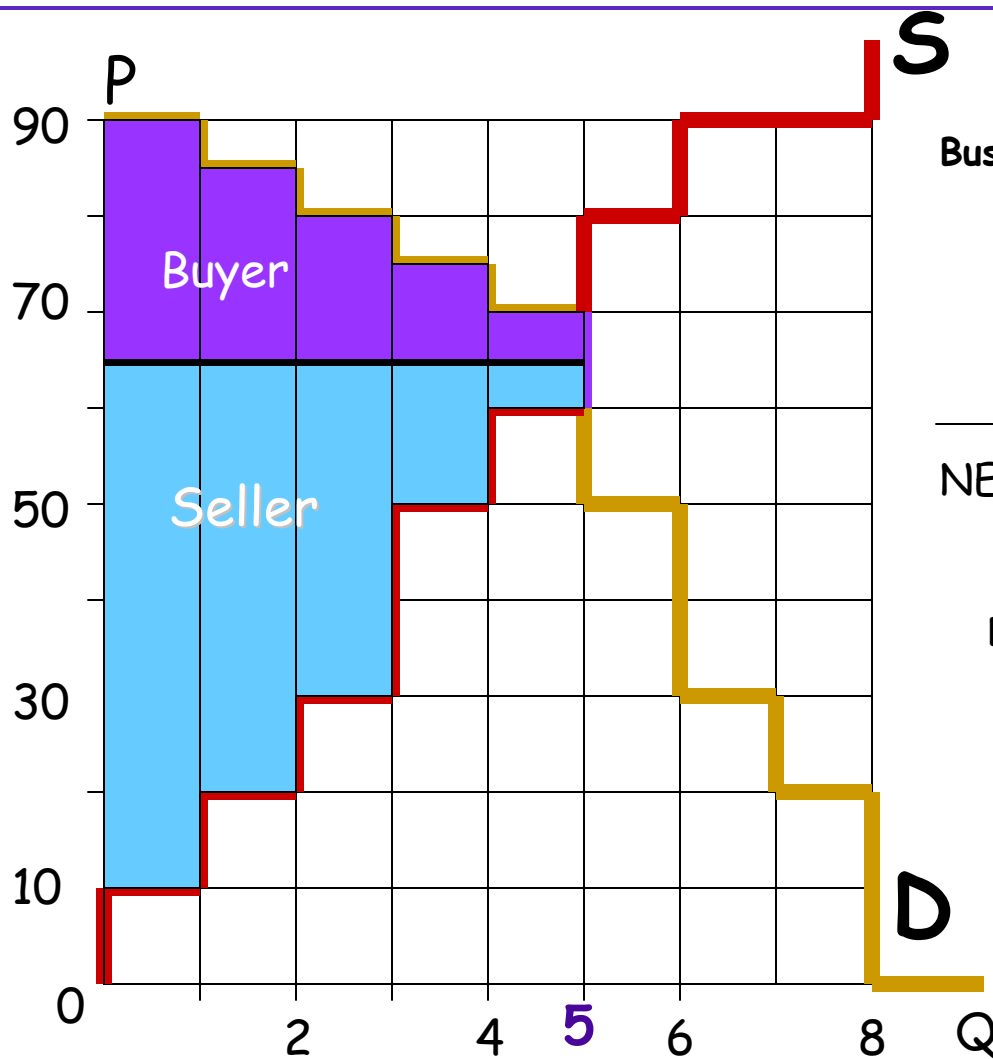
**S**

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	$\infty$

**D**

# Net Buyer/Seller Surplus at CMC Points...



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

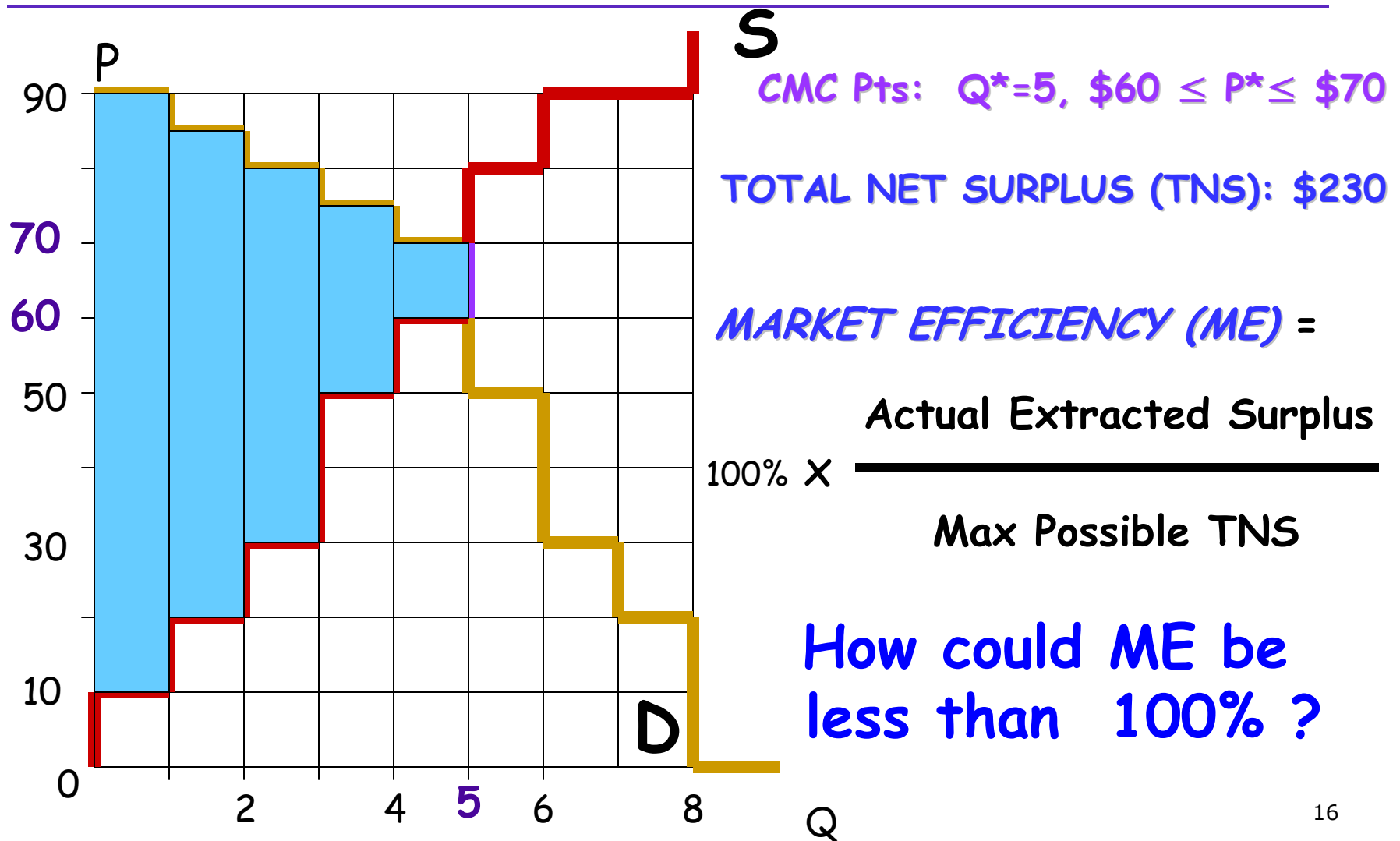
BushelUnit	MaxBPrice	$P^*=65$	BuySurplus
1	\$90	- \$65	= \$25
2	\$84	- \$65	= \$19
3	\$80	- \$65	= \$15
4	\$76	- \$65	= \$11
5	\$70	- \$65	= \$5

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?

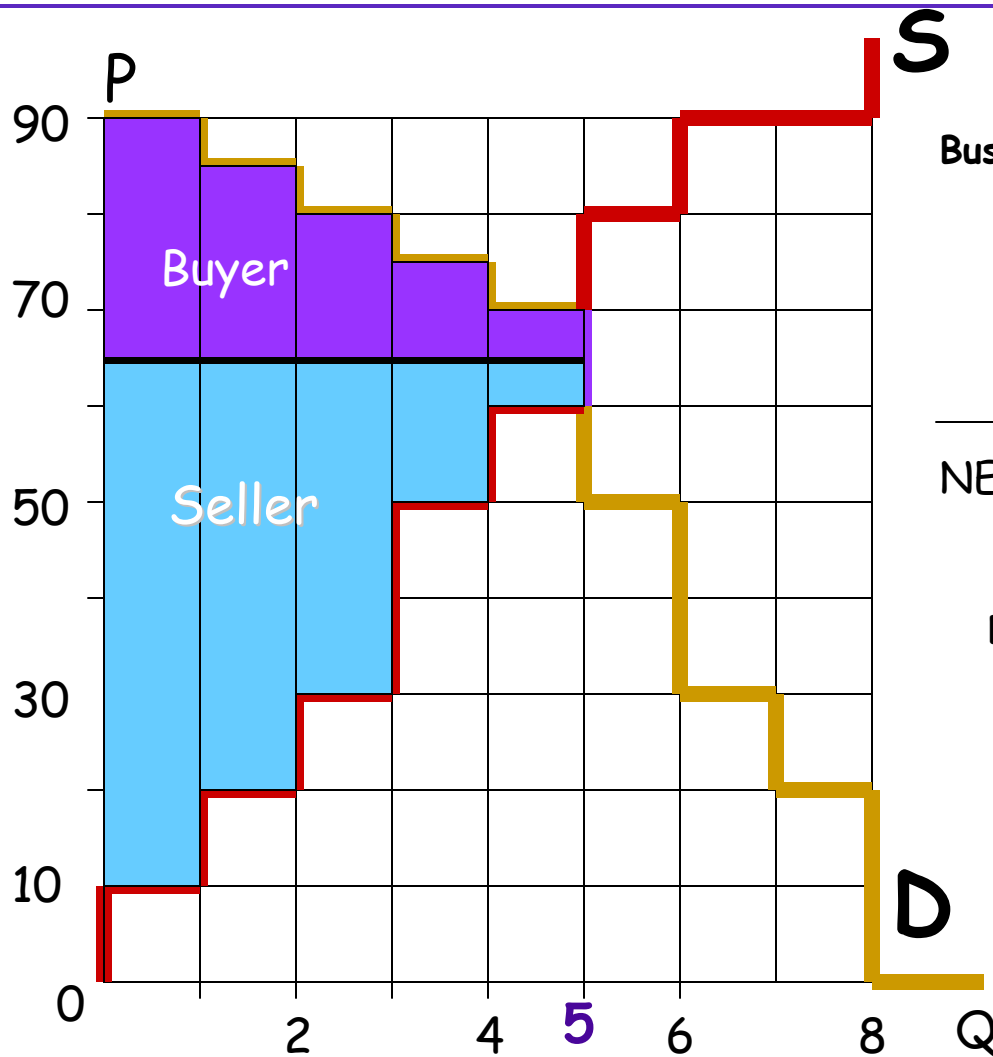
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- ❑ Some "inframarginal" quantity unit FAILS to trade
- ❑ Or some "extramarginal" quantity unit SUCCEEDS in being traded

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

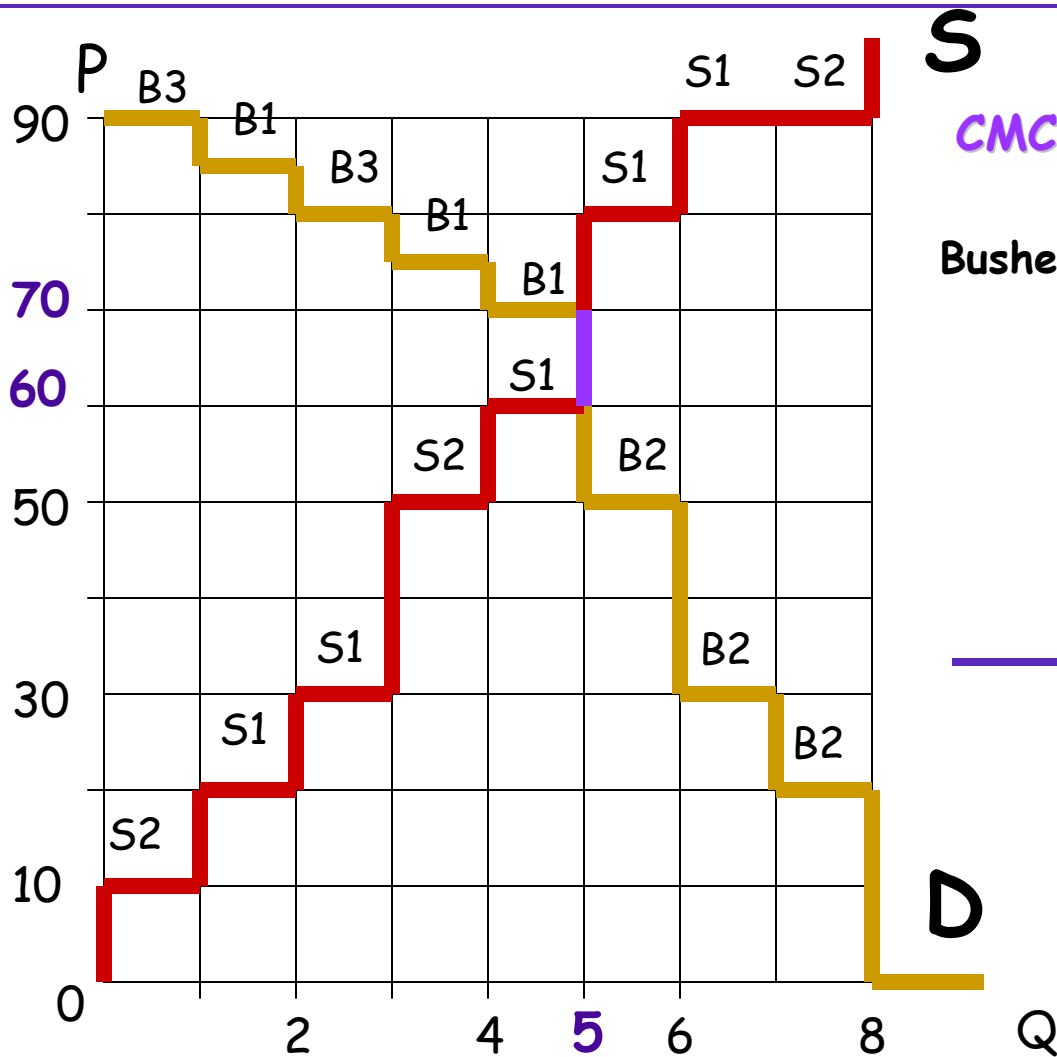
BushelUnit	MaxBPrice	$P^*=65$	BuySurplus
1	\$90	- \$65	= \$25
2	\$84	- \$65	= \$19
3	\$80	- \$65	= \$15
4	\$76	- \$65	= \$11
5	\$70	- \$65	= \$5

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* ?



**S**

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

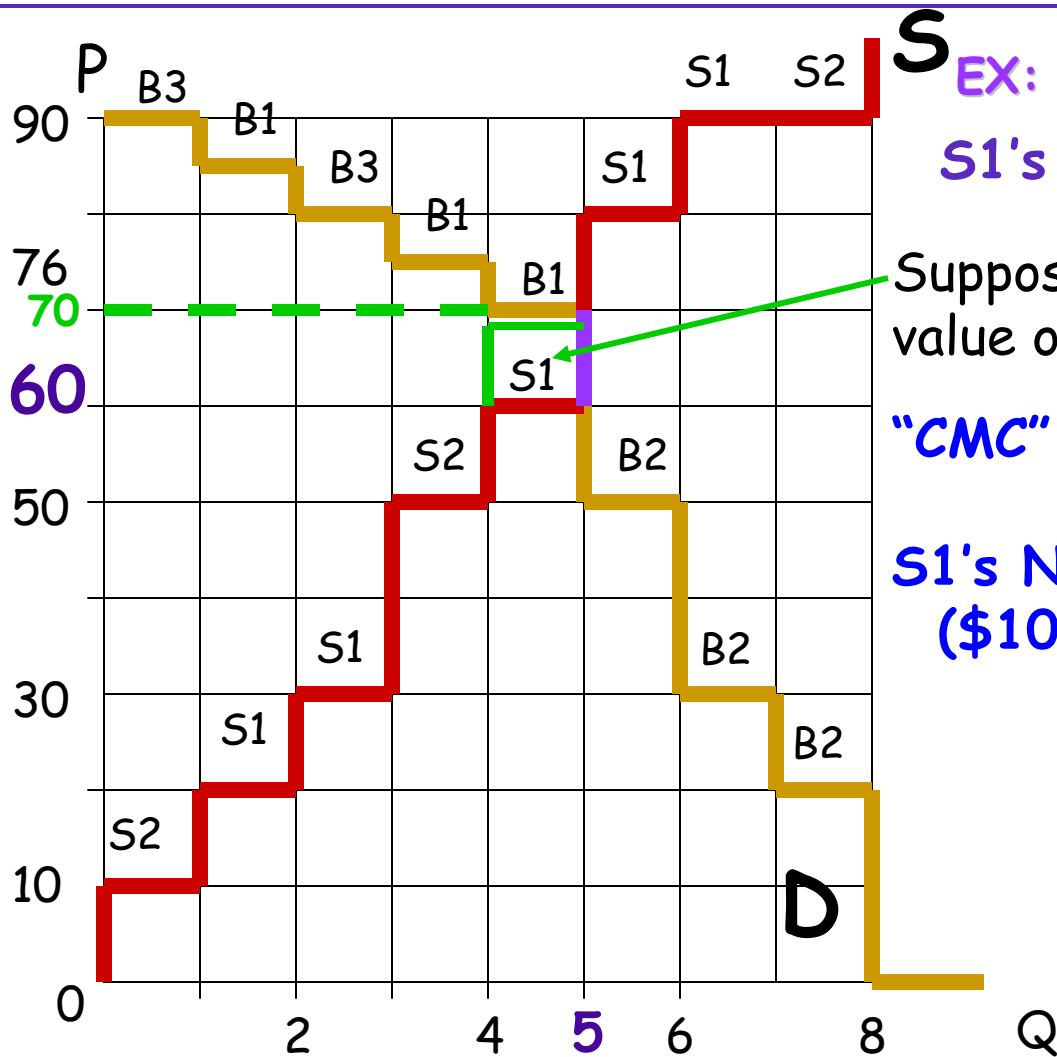
Bushel Unit    MaxBuyPrice    MinSellPrice

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	$\infty$

**D**

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



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

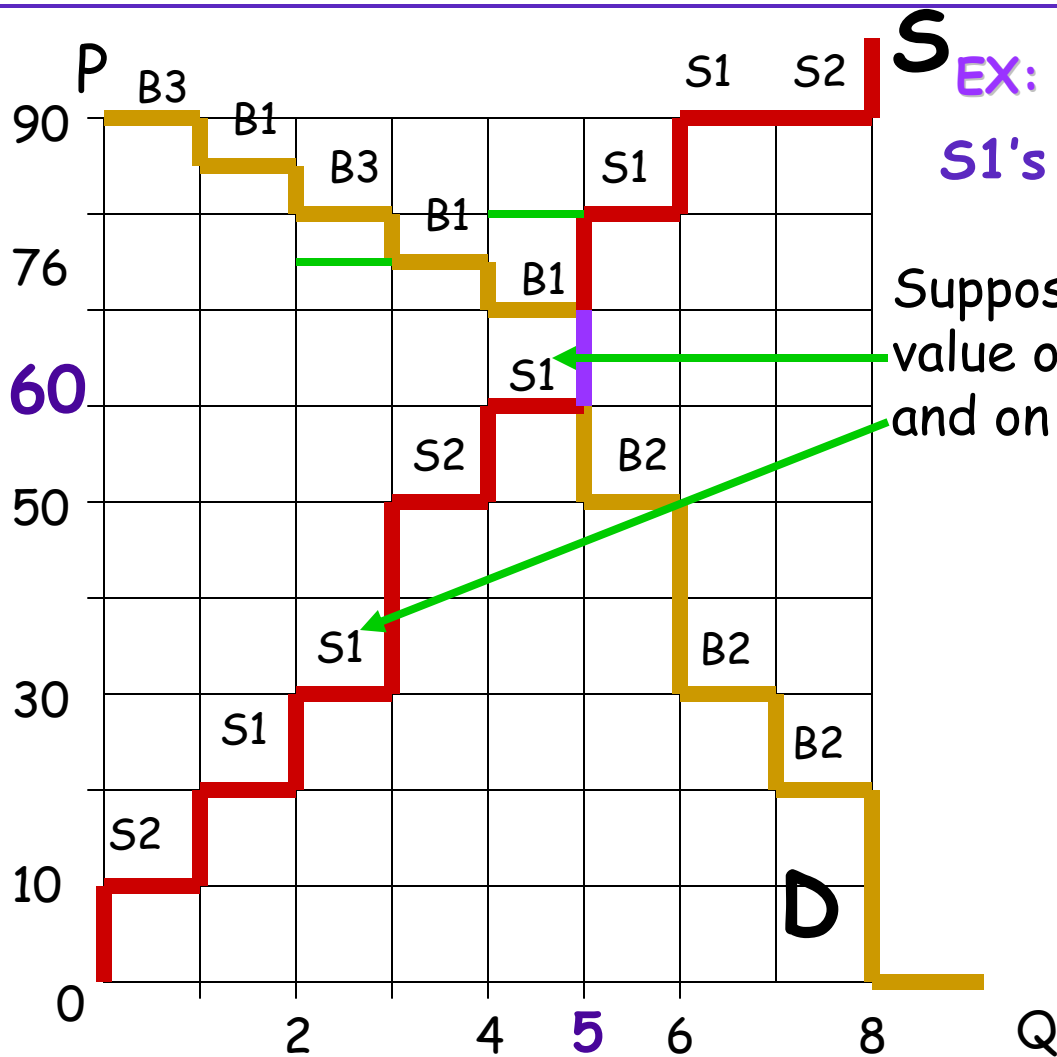
S1's Net Seller Surplus = \$70

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

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

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

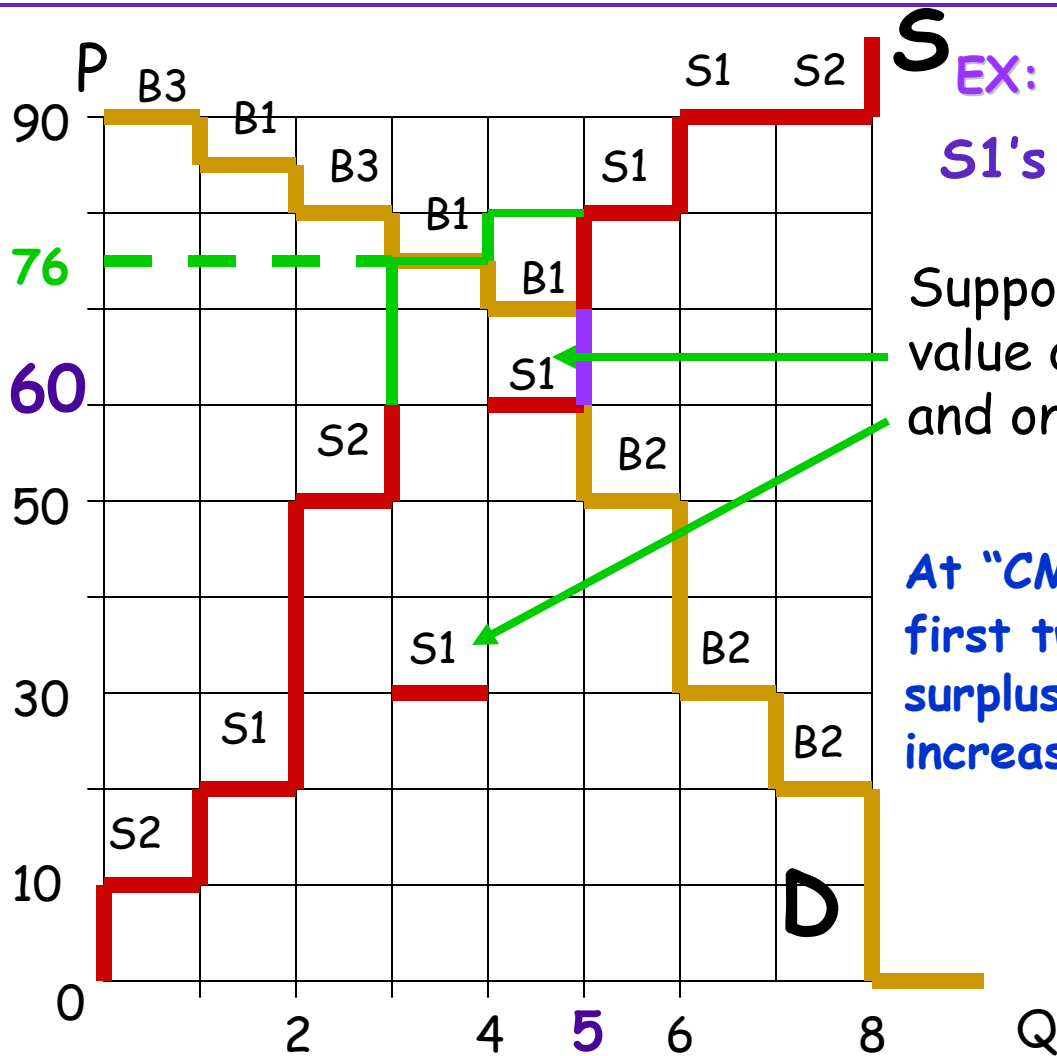
# Does any trader below have an incentive to offer or bid *strategically* ?



**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* ?

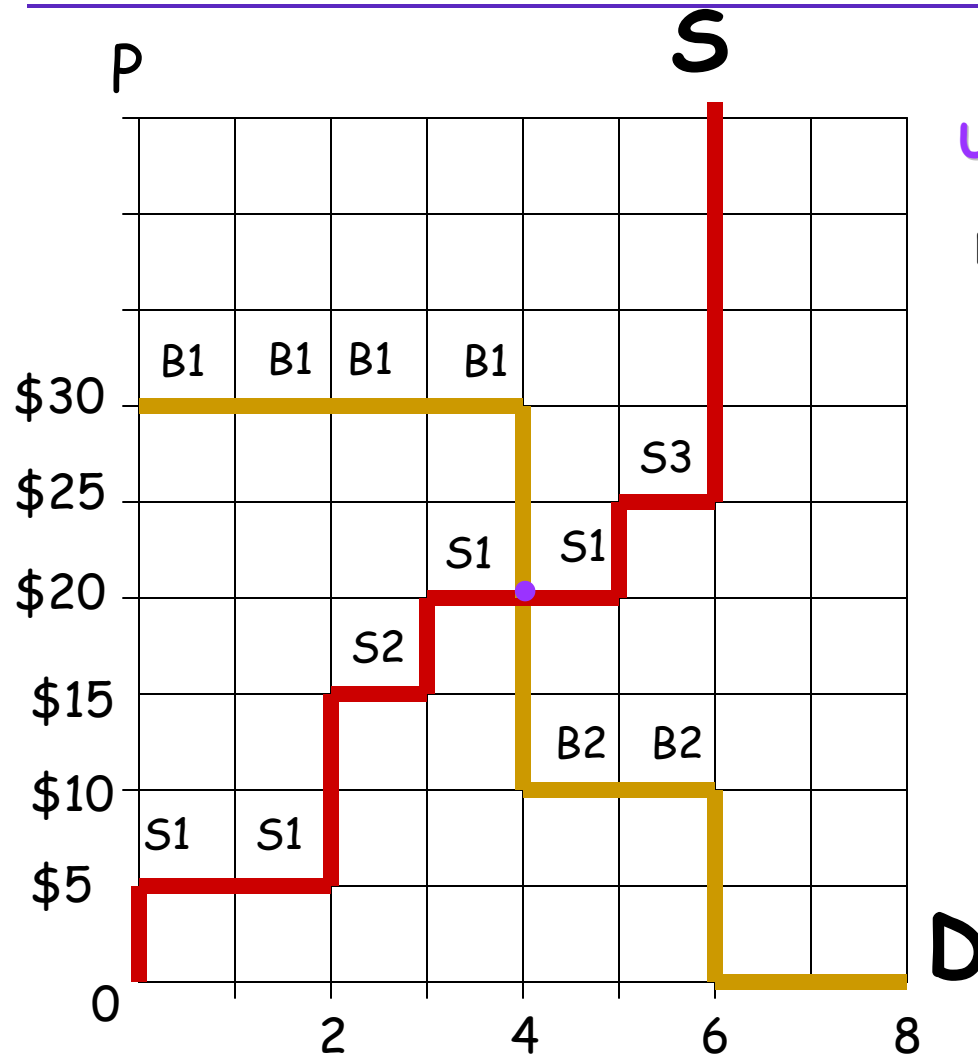


**S** EX: CMC Pt:  $Q^*=5, P^*=\$60$   
 S1's Net Seller Surplus = \$70

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

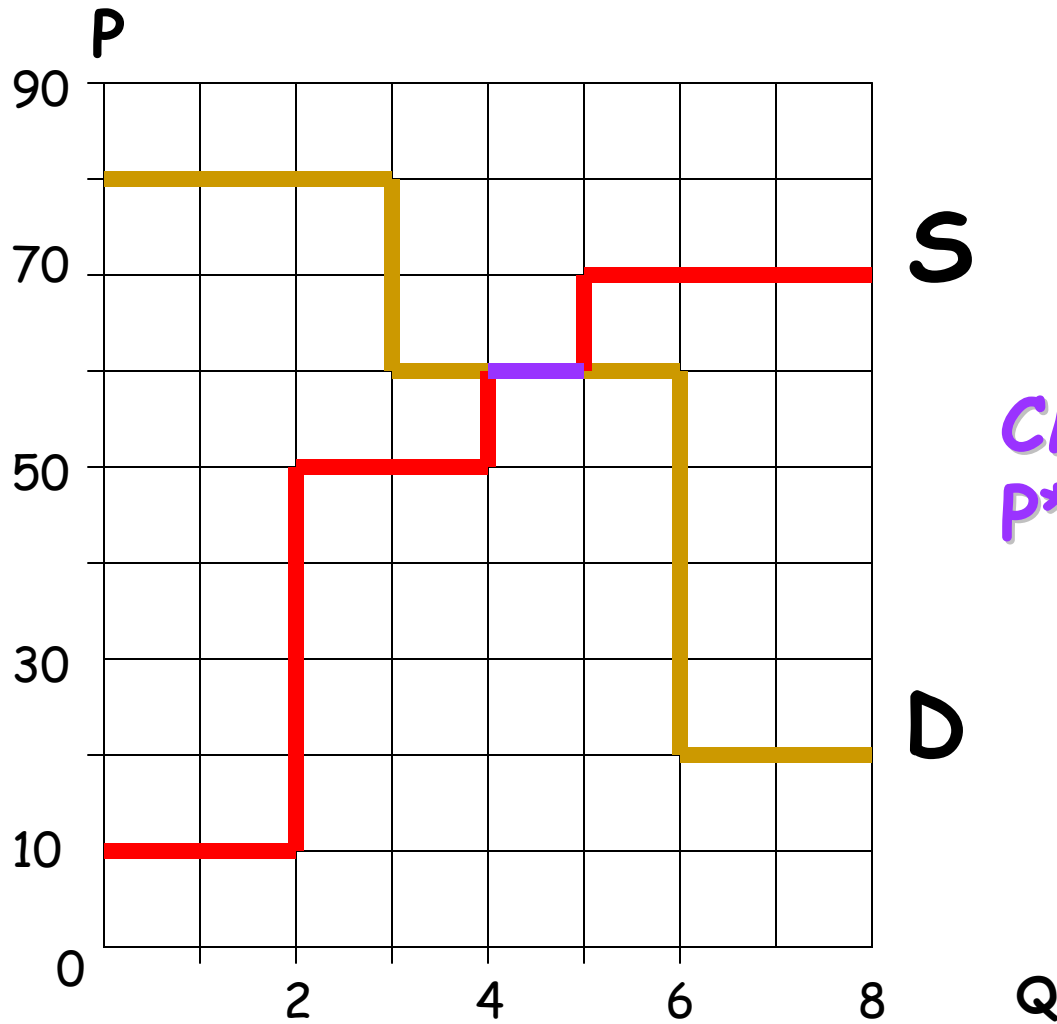


Unique CMC Pt:  $Q^*=4$ ,  $P^*=\$20$

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

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

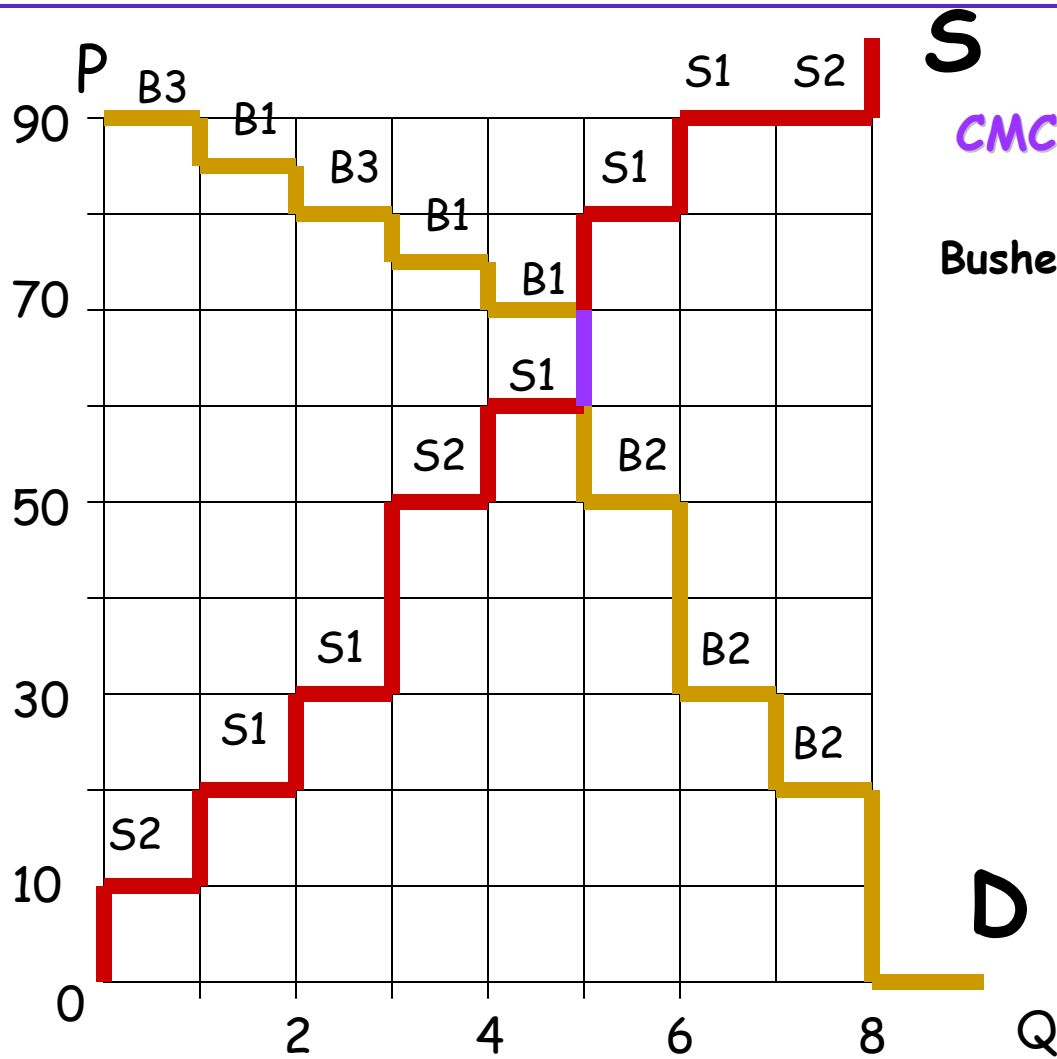
# More on CMC Points: Illustrative Example 3



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	$\infty$

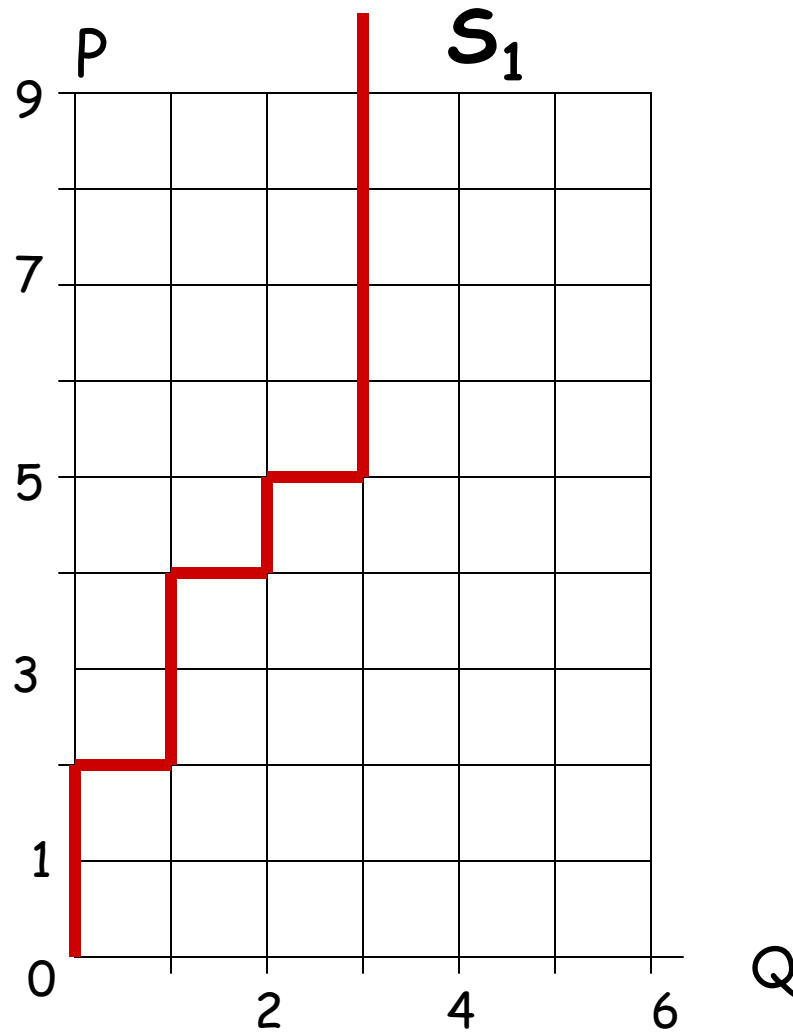
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# Relationship of "Inverse" to "Ordinary" Supply and Demand Schedules

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- ◆ 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 $P = S_1(Q)$



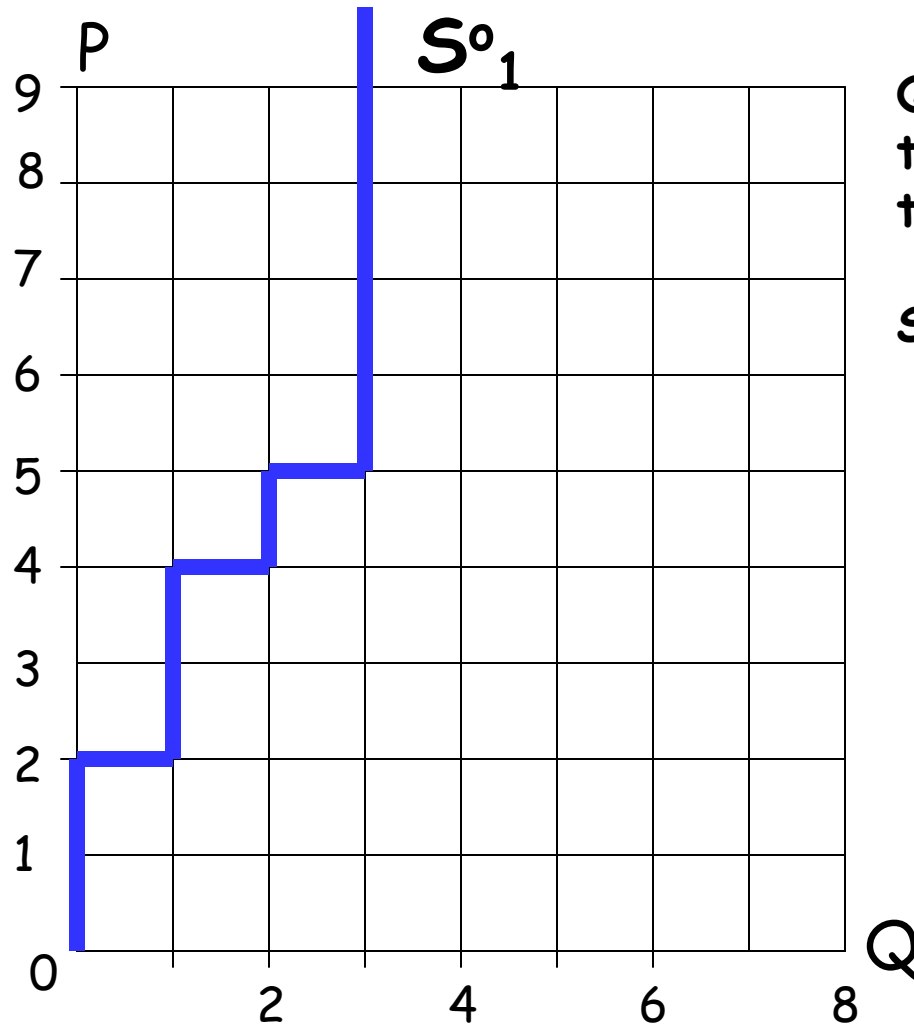
Supply Unit

Seller 1 Min  
per-Unit Sale Price

0  
1  
2  
3  
4  
5  
6

\$0  
\$2  
\$4  
\$5  
 $\infty$   
 $\infty$   
 $\infty$

# 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  $P$

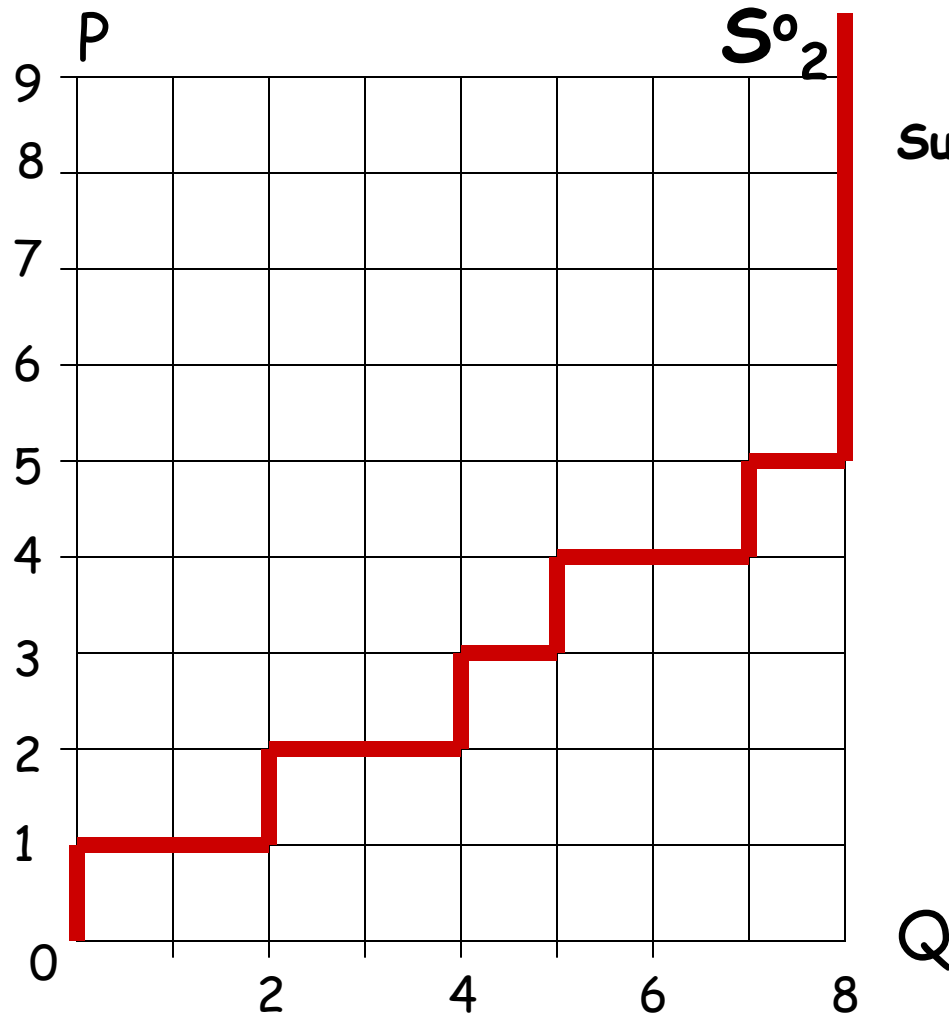
**Seller 1 Max Supply**

**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 $P = S_2(Q)$

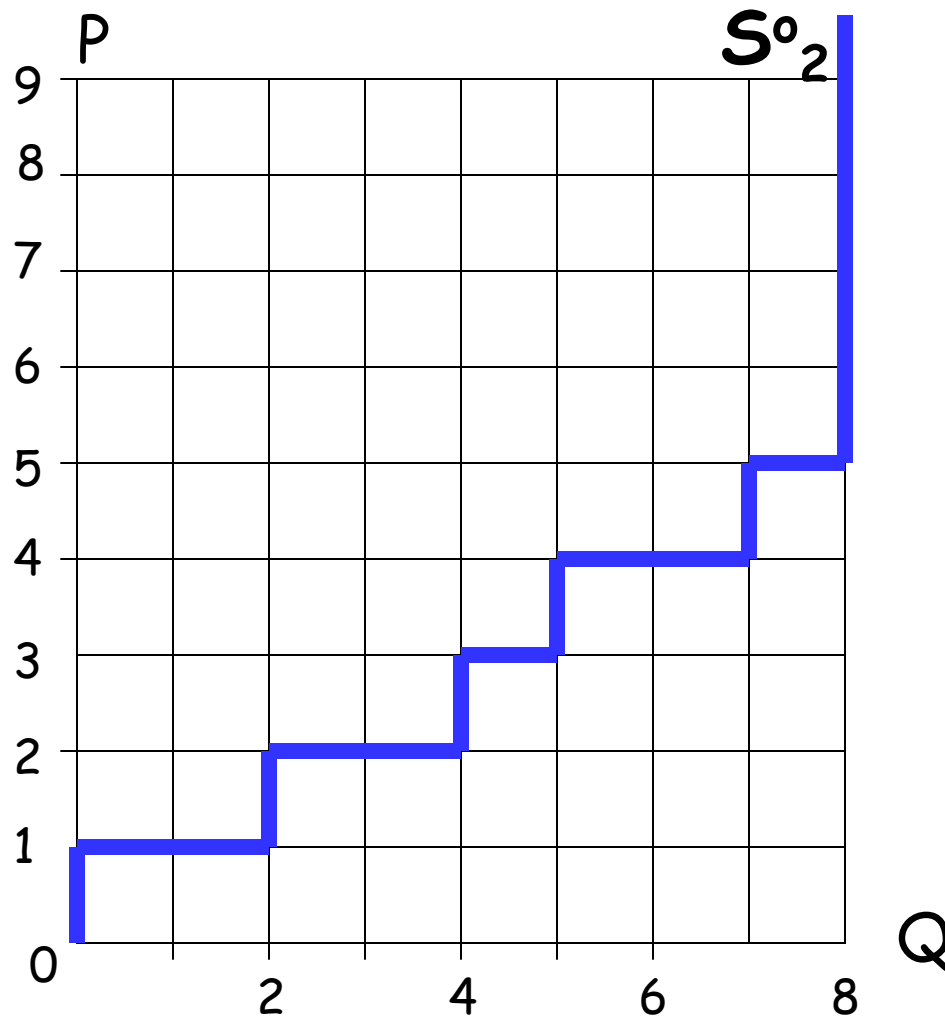


Supply Unit

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	$\infty$

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



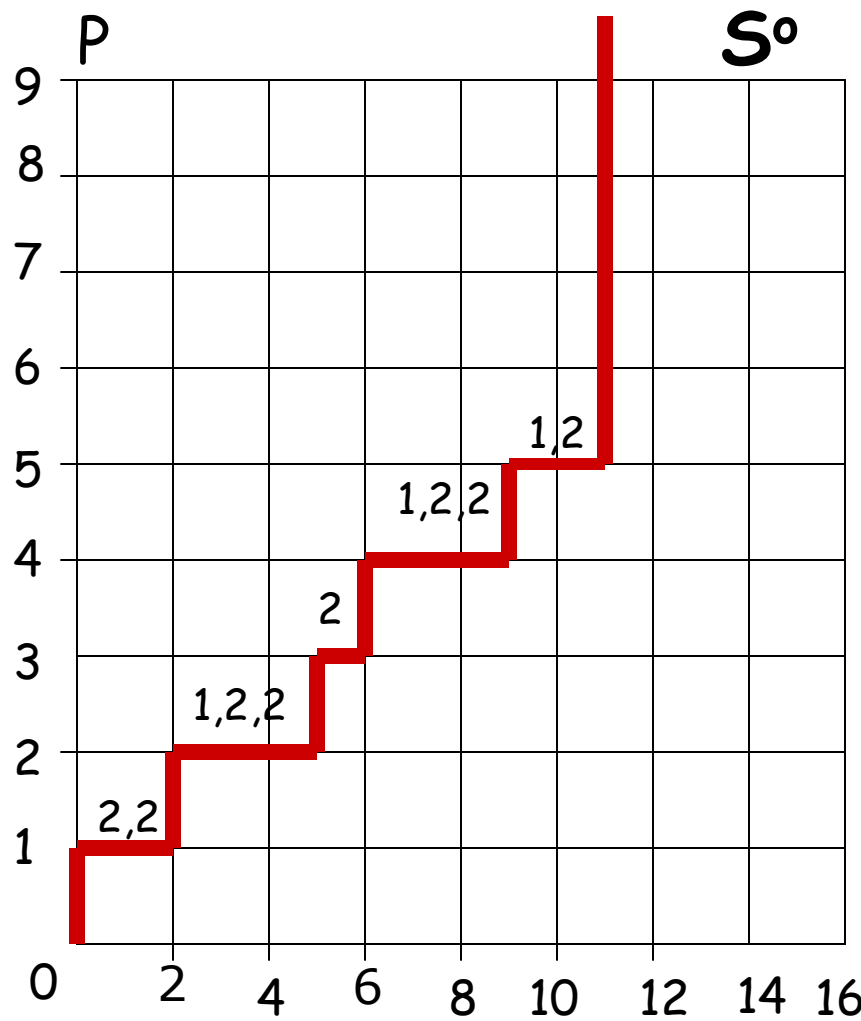
$Q = S^o_2(P)$  = Maximum amount of Q that Seller 2 is willing to supply at per-unit sale price P

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)

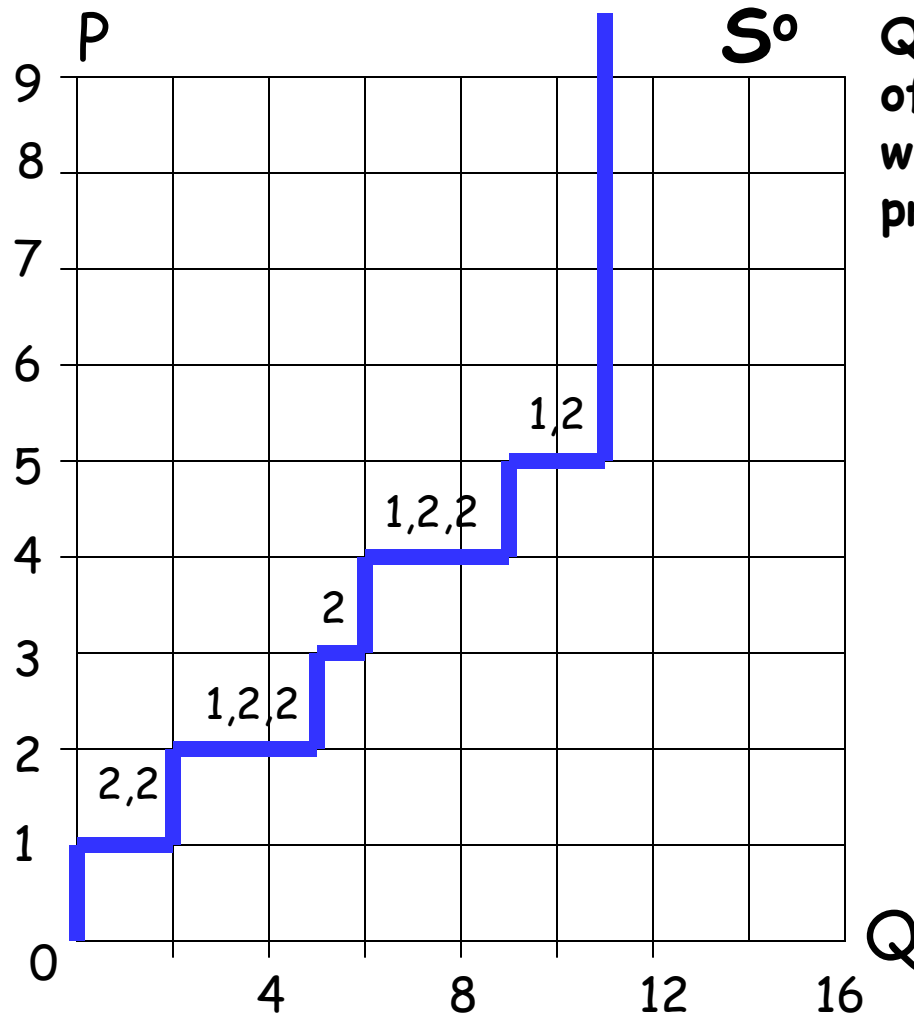
Inverse Form  $P = S(Q)$



$P = S(Q)$  = 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	$\infty$

# 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