Notes on the Construction of Demand & Supply Schedules

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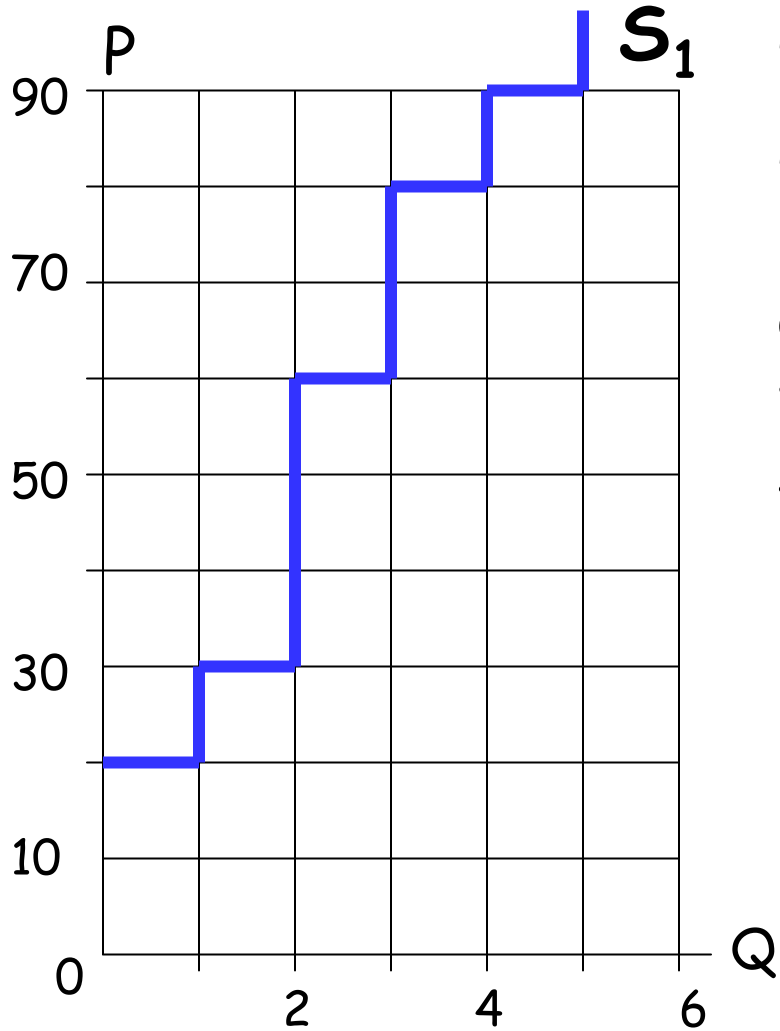
Clarification of Terminology

- 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 $P = S_1(Q)$



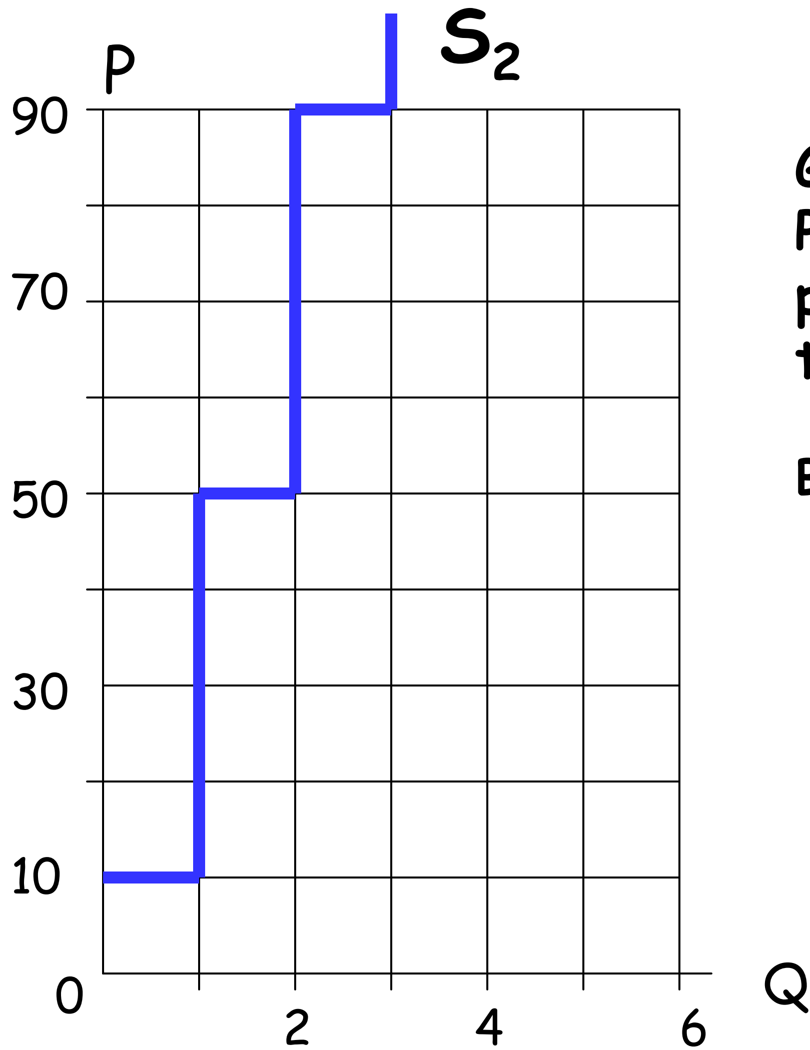
Let Q = Apple Amount (in bushels)

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	∞

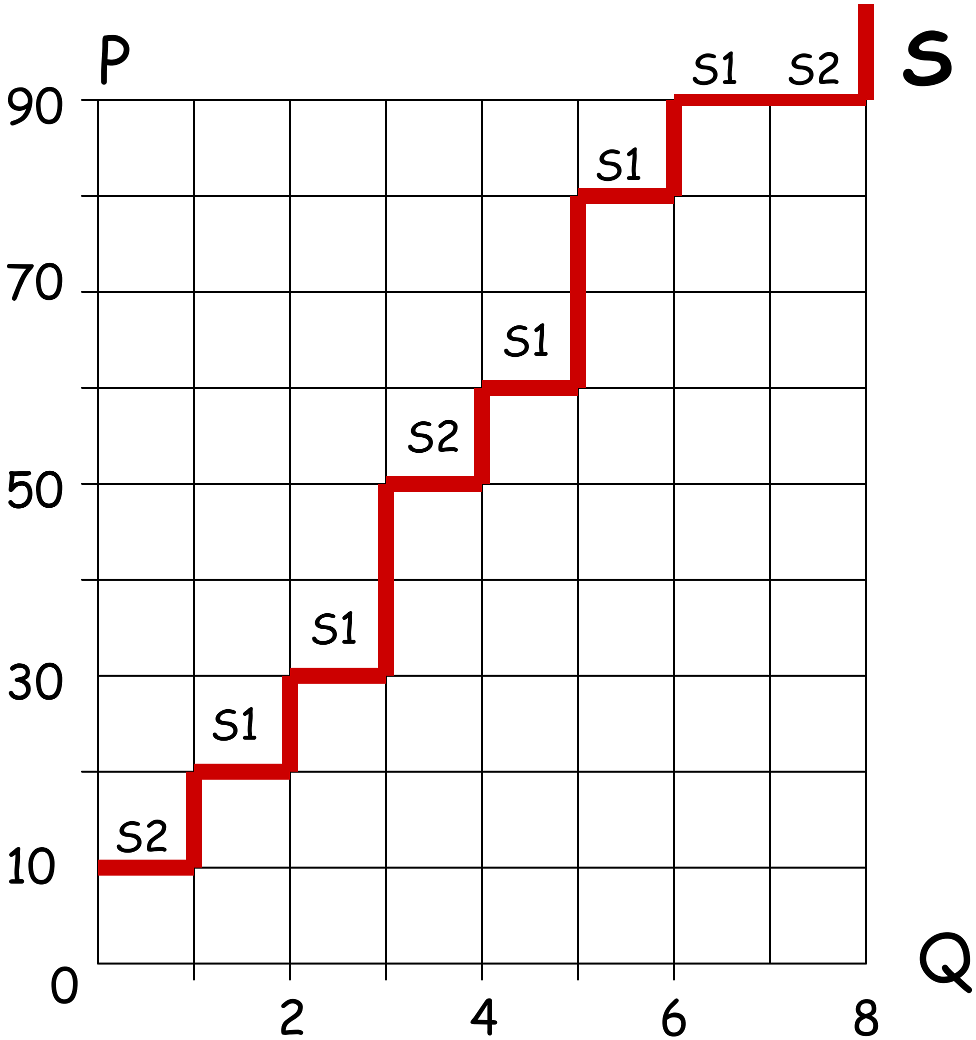
Seller 2 Supply Schedule
Inverse Form $P = S_2(Q)$



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	∞

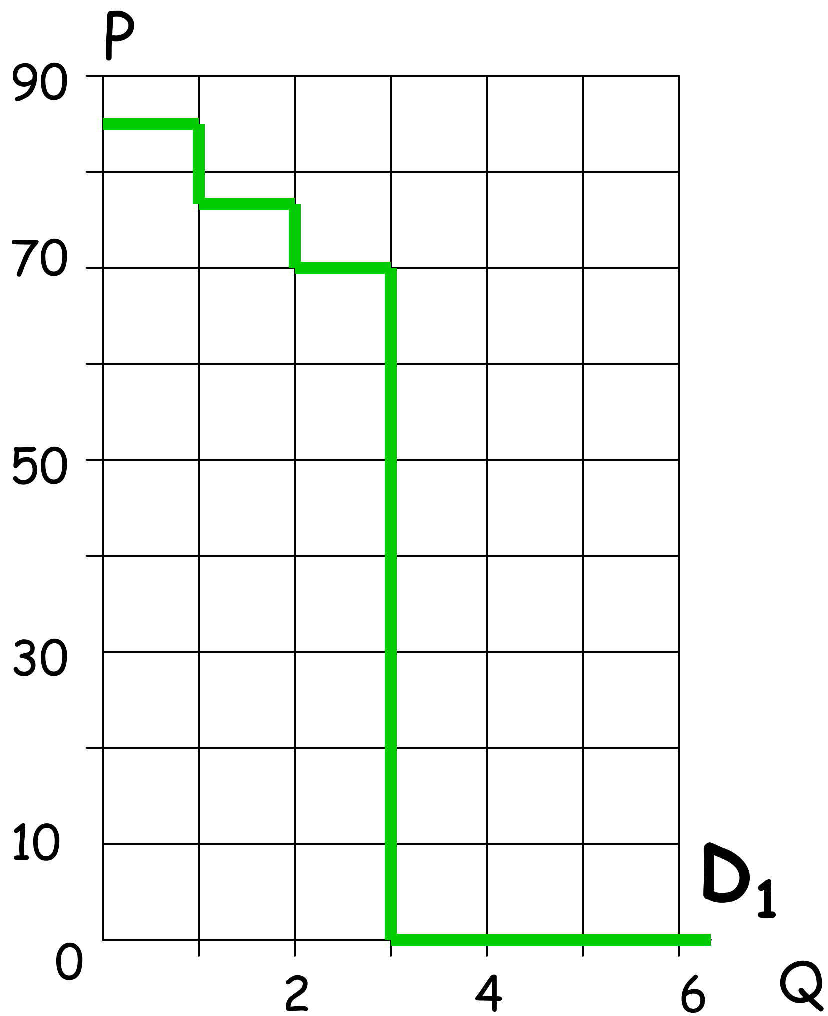
Total Supply Schedule (Sellers 1 & 2)
Inverse Form P = S(Q)



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

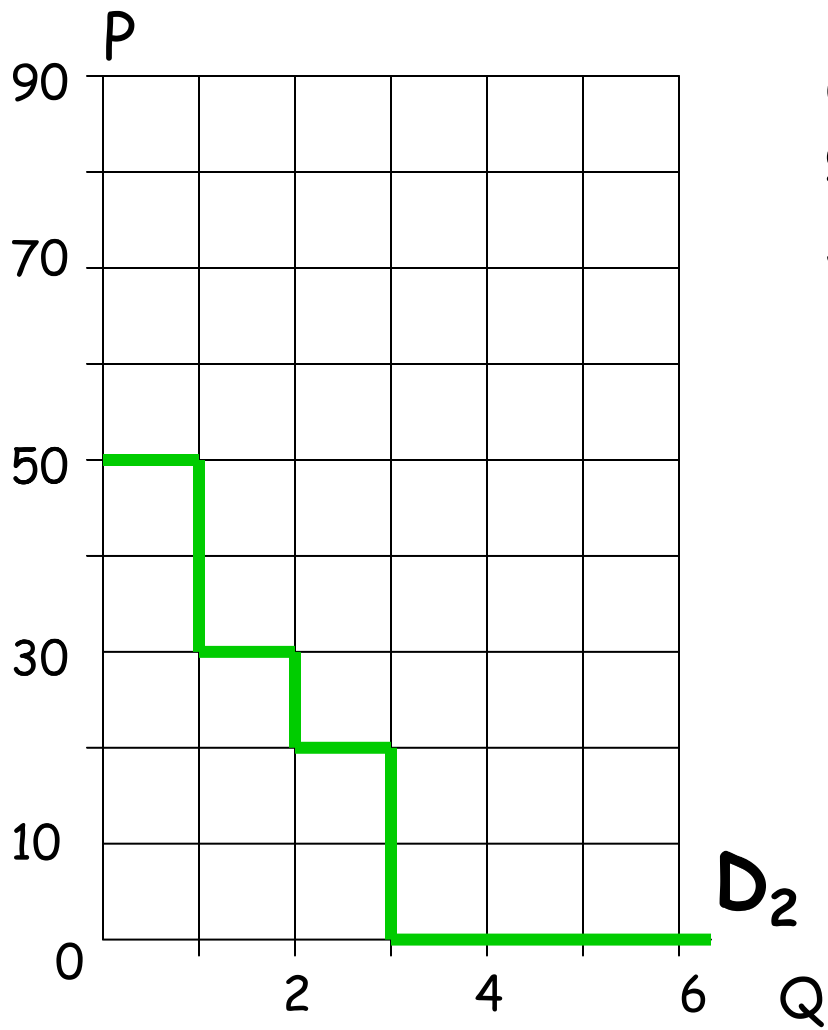
Inverse Form $P = D_1(Q)$



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

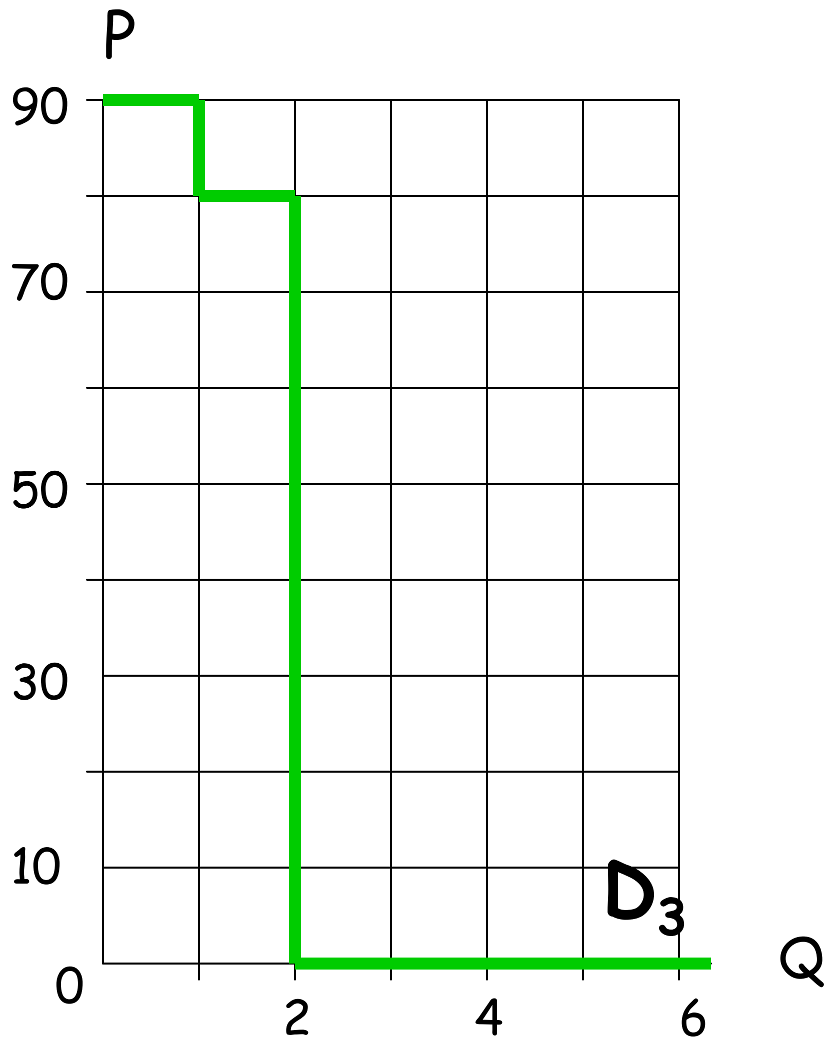
Buyer 2 Demand Schedule
Inverse Form $P = D_2(Q)$



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 $P = D_3(Q)$

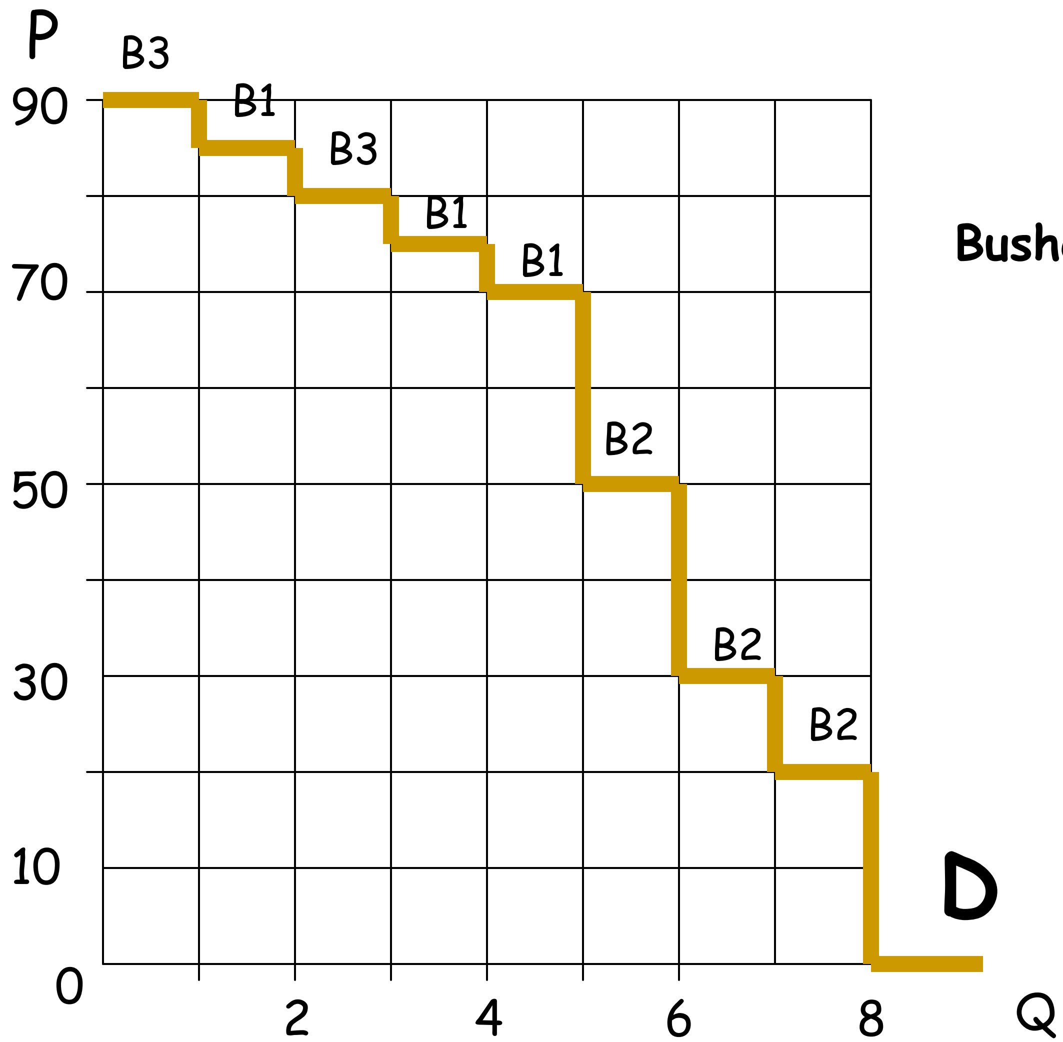


Given any Q, the function $P=D_3(Q)$ gives Buyer 3's maximum per-unit purchase price ($/bushel) for the "last" unit purchased at this Q.

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

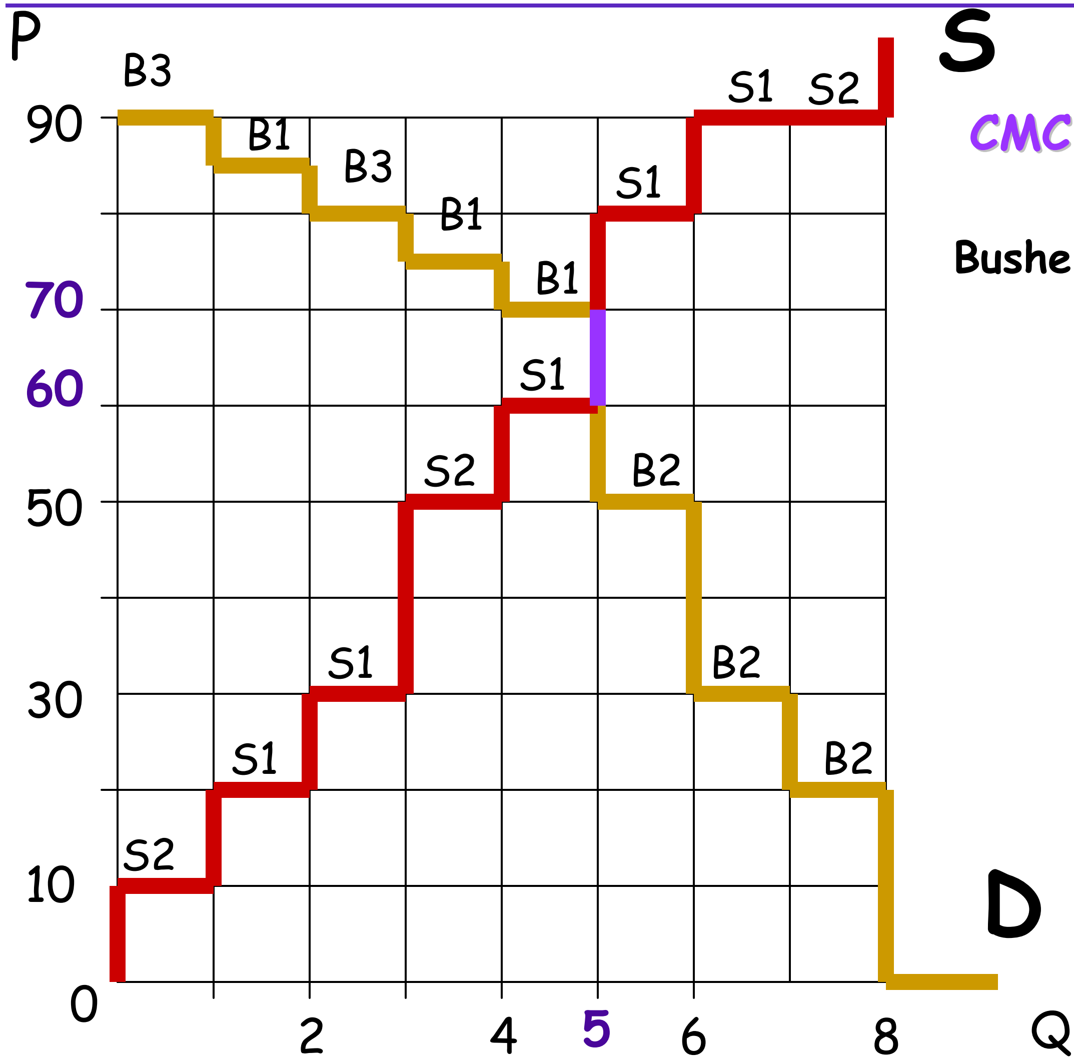
Total Demand Schedule (Buyers 1,2,& 3)

Inverse Form P = D(Q)



Bushel Unit	Max Buyer Per-Unit Price
1	$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

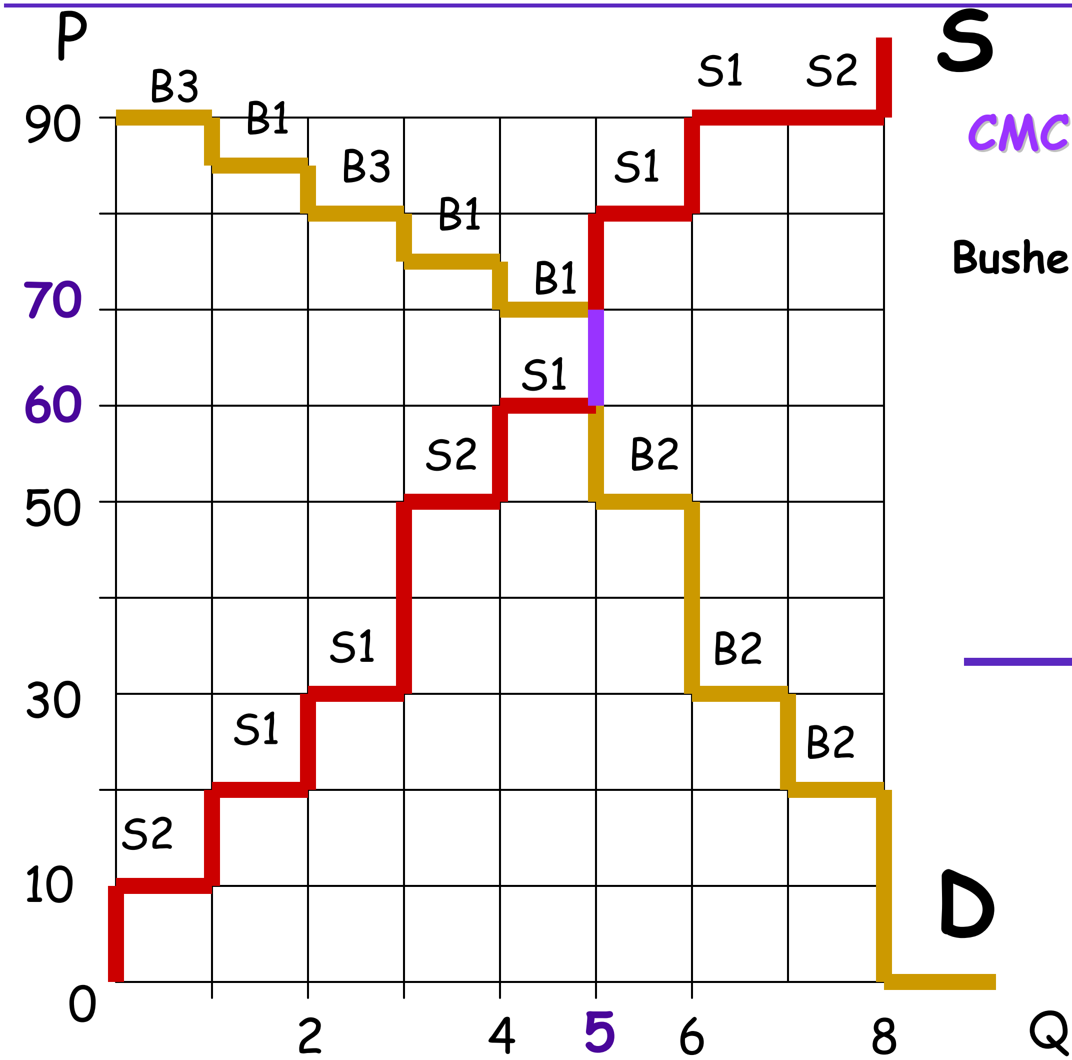
CMC Points (S=D)



CMC Pts: Q*=5, $60 ≤ P*≤ $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	∞

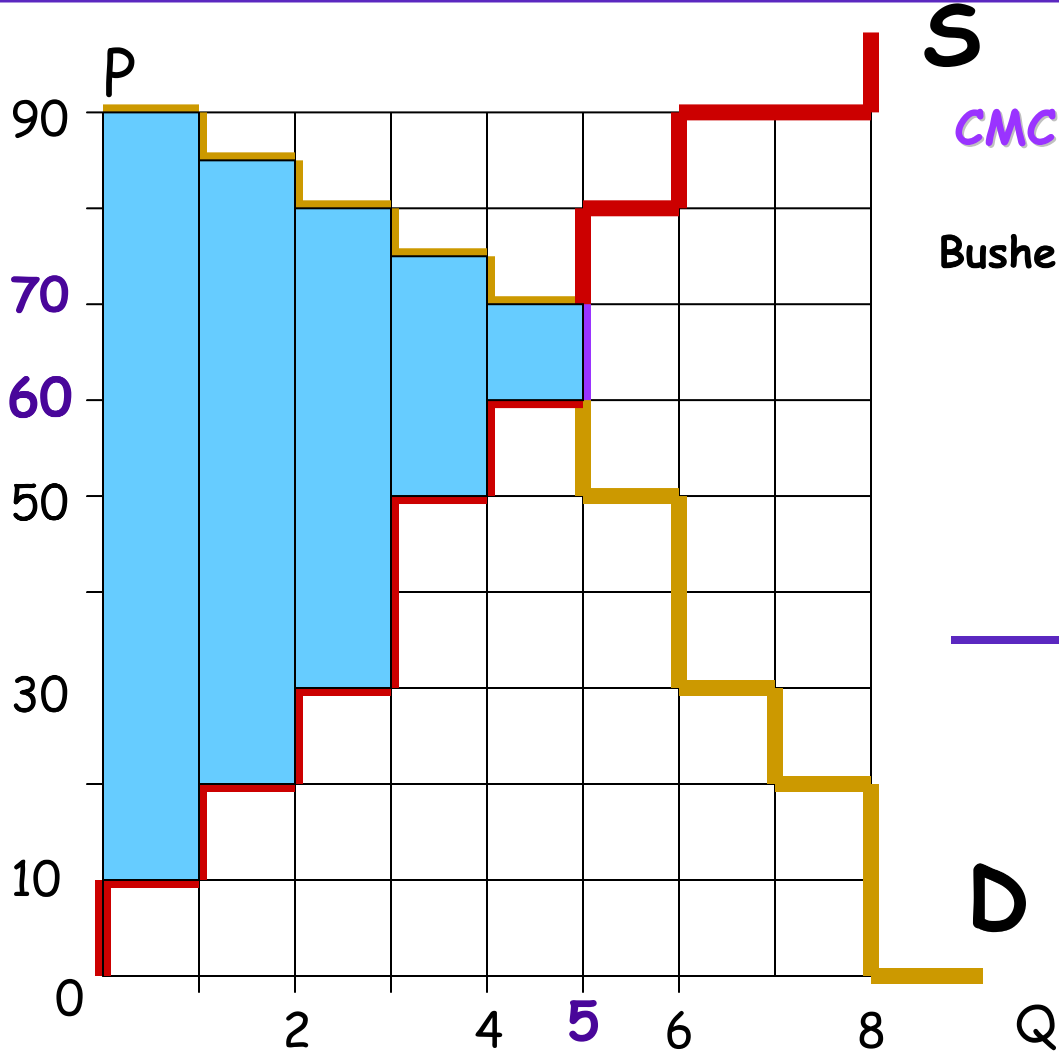
Remark: *Inframarginal* (traded) units versus *extramarginal* (non-traded) units at CMC Pts



CMC Pts: Q*=5, \$60 ≤ P*≤ \$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)



CMC Pts: Q*=5, $60 ≤ P* ≤ $70

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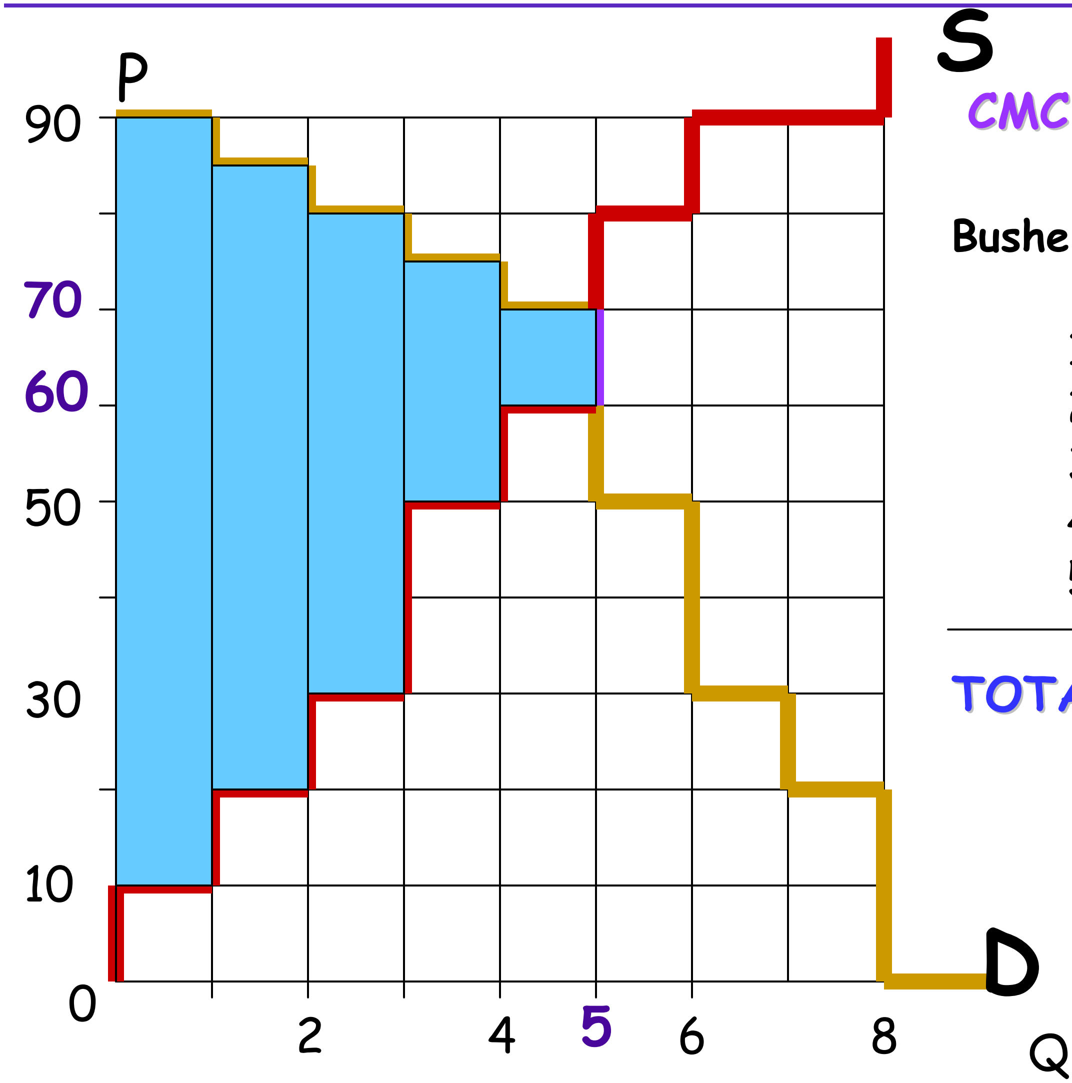
4	$76	$50
5	$70	$60
6	$50	$80
7	$30	$90
8	$20	$90
9	0	∞

Total Net Surplus at CMC Points…

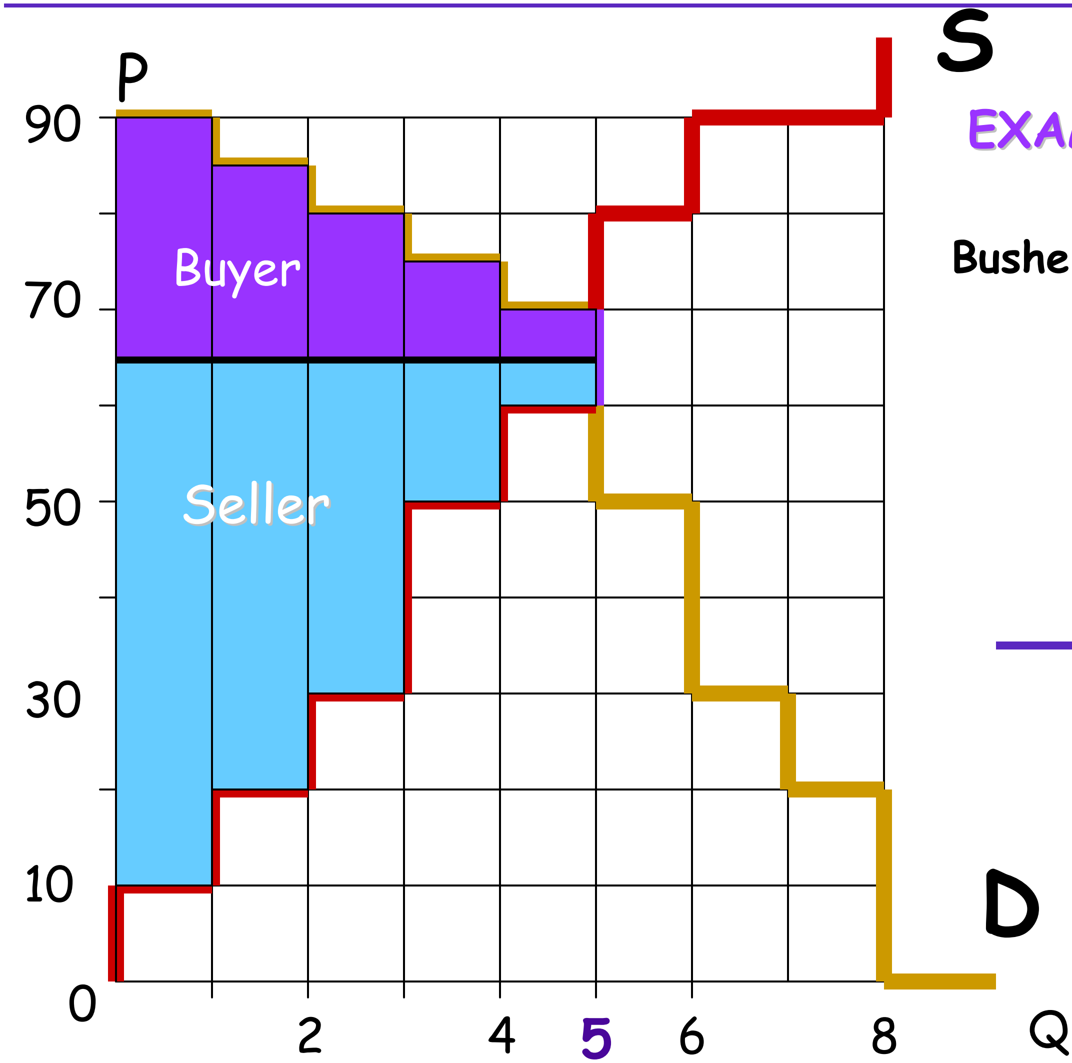


CMC Pts: Q*=5, $60 ≤ P* ≤ $70

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

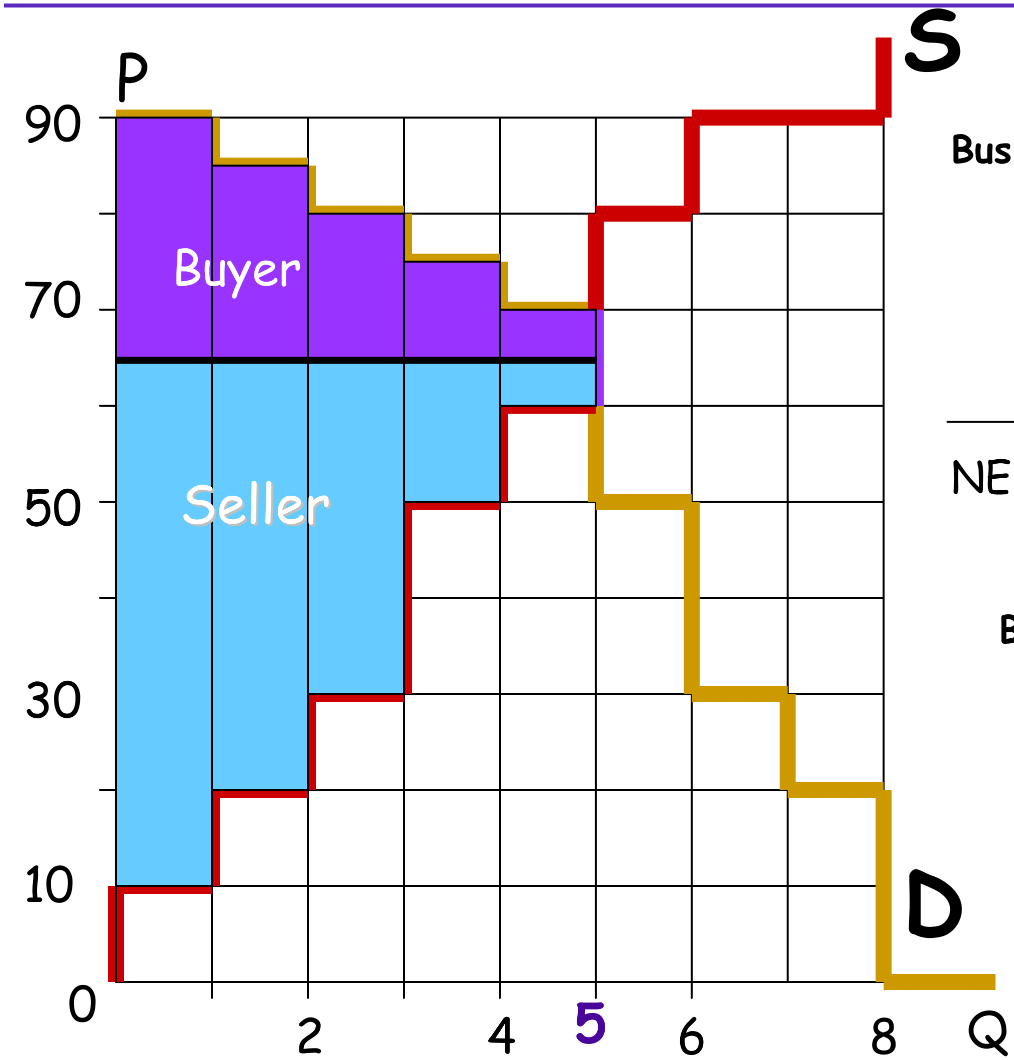
Net Buyer/Seller Surplus at CMC Points
(surplus division DOES depend on CMC point)



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	∞

Net Buyer/Seller Surplus at CMC Points…



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

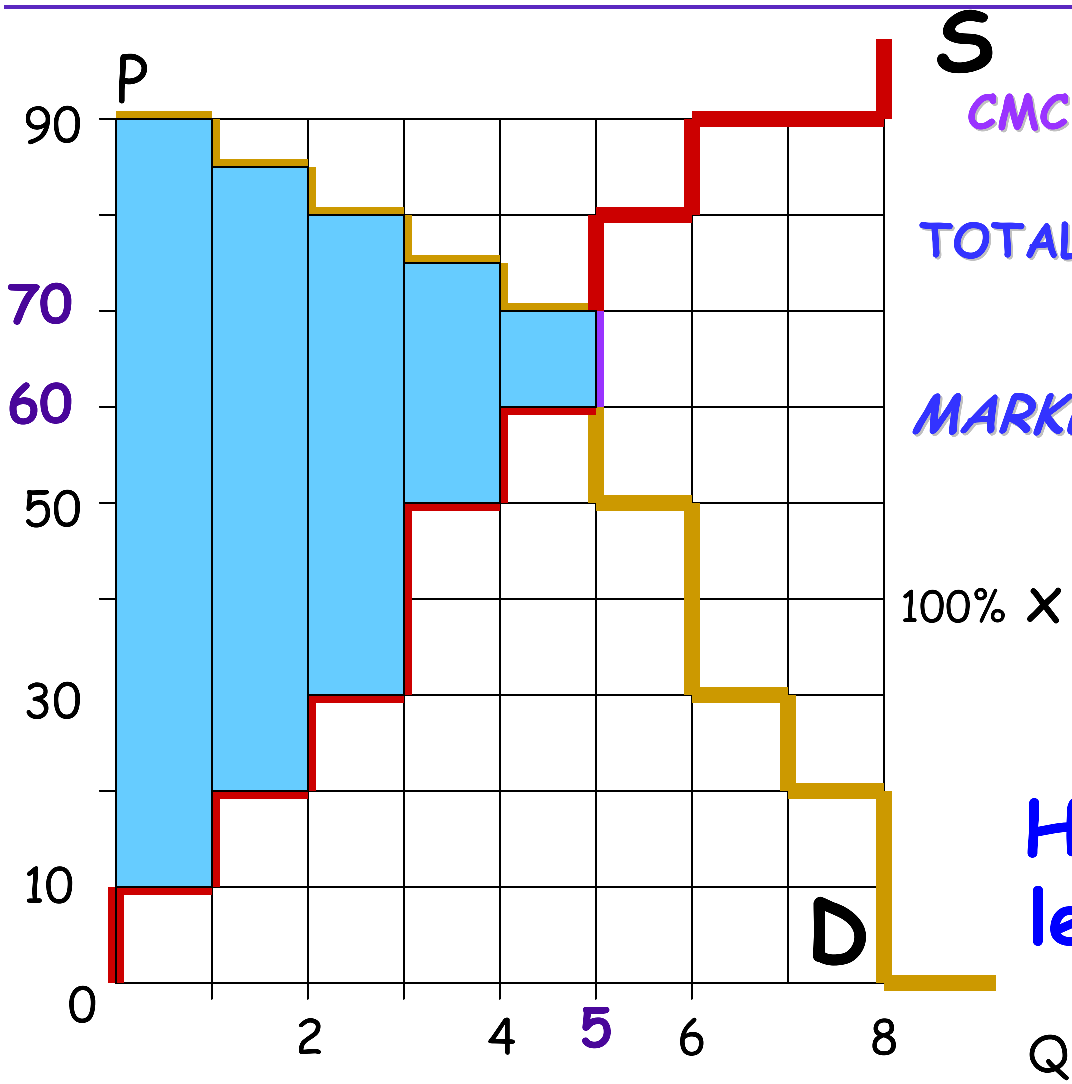
BushelUnit	MaxBPrice		P*=65		BuySurplus
1	$90	-	$65	=	$25
2	$84	-	$65	=	$19
3	$80	-	$65	=	$15
4	$76	-	$65	=	$11
5	$70	-	$65	=	$ 5

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)



CMC Pts: Q*=5, $60 ≤ P*≤ $70

TOTAL NET SURPLUS (TNS): $230

MARKET EFFICIENCY (ME) =

$$100\% \times \frac{\text{Actual Extracted Surplus}}{\text{Max Possible TNS}}$$

How could ME be less than 100% ?

ME < 100% under What Conditions?

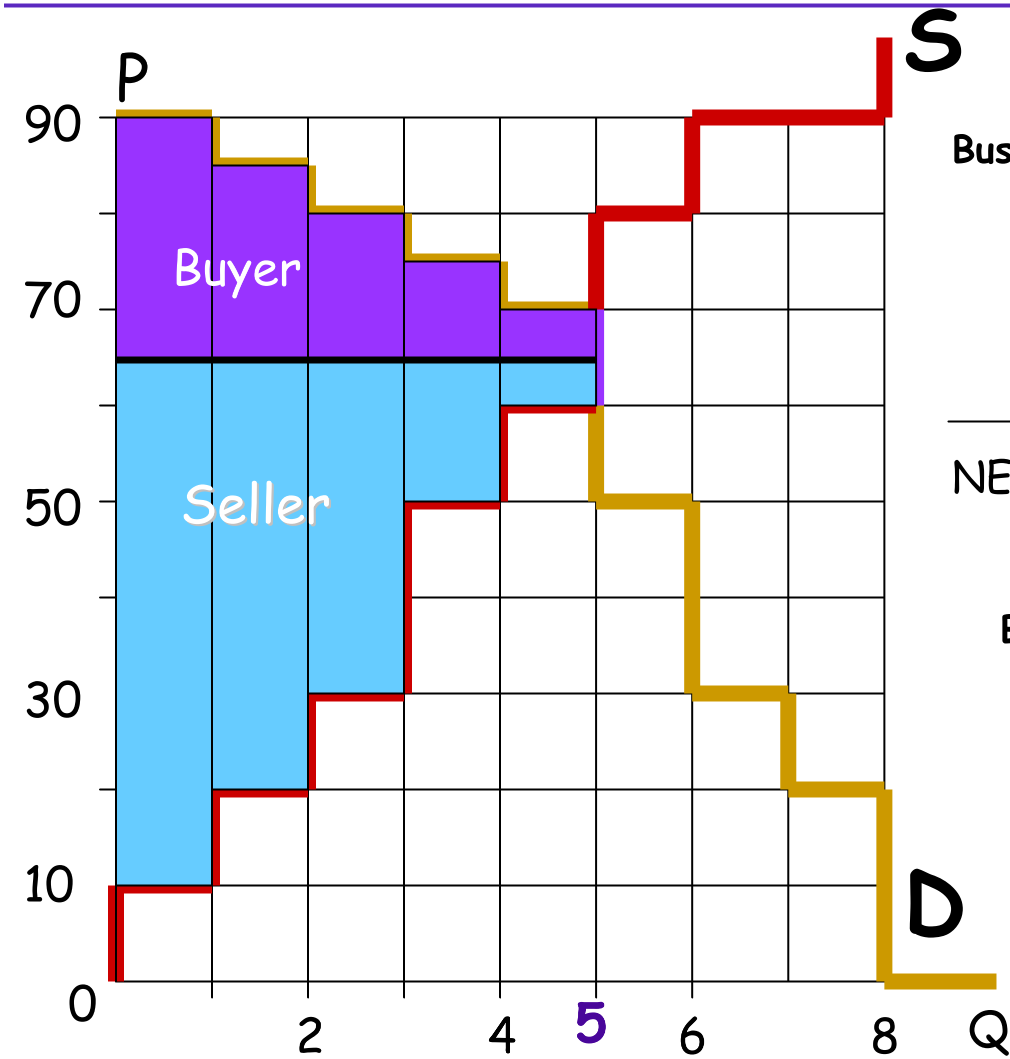
- Some "inframarginal" quantity unit FAILS to trade

- 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

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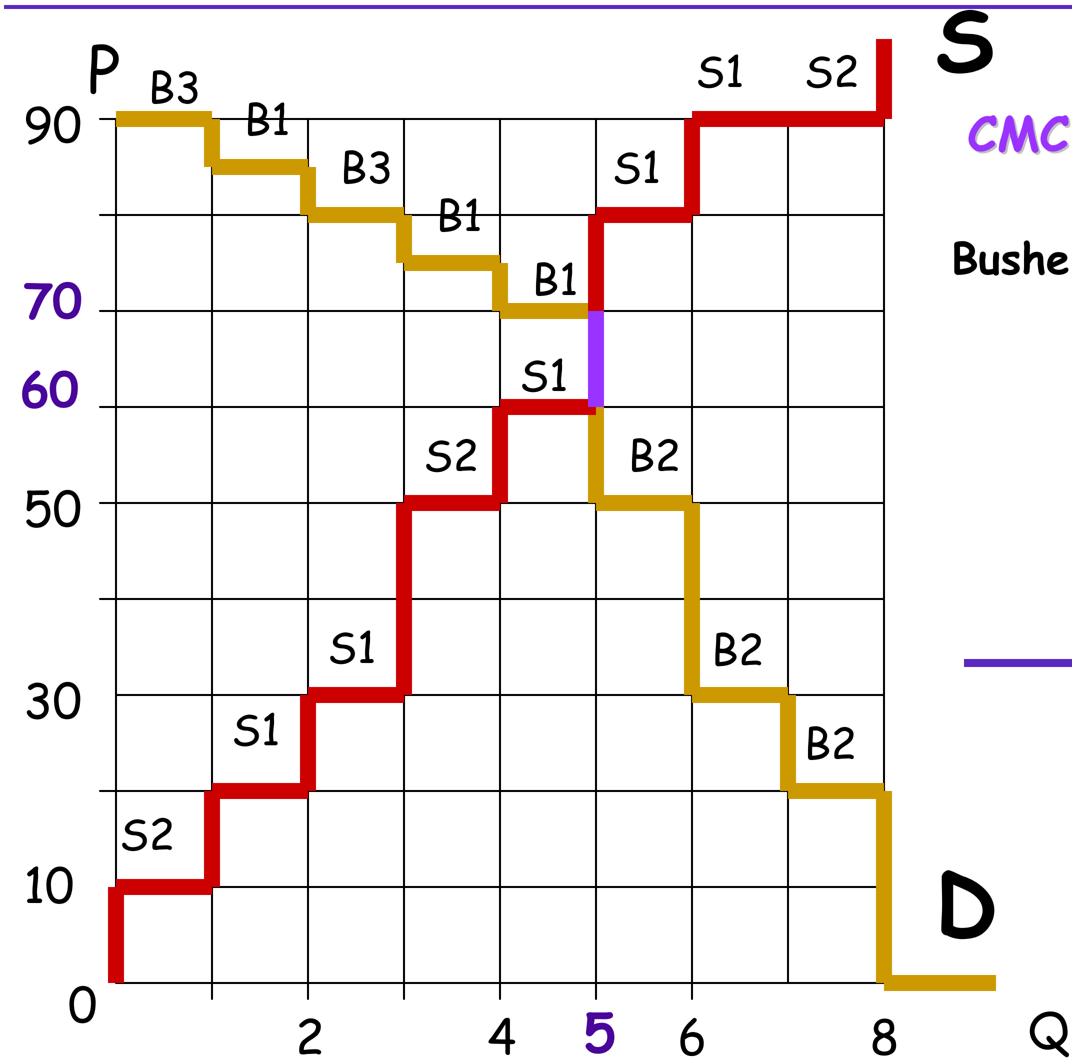
NET SELLER SURPLUS: $155

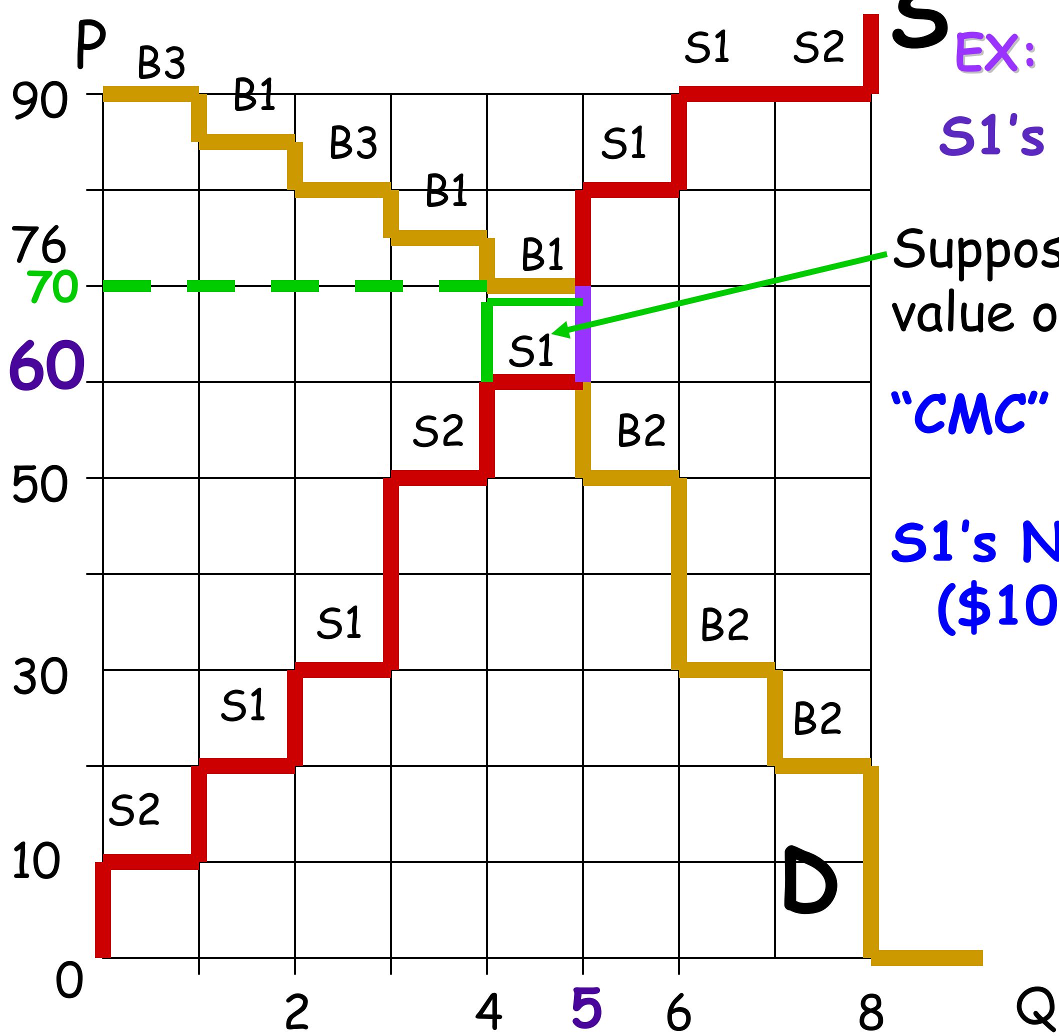
Does any trader below have an incentive to offer or bid ***strategically*** ?



CMC Pts: Q*=5, $60 ≤ P*≤ $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*** ?



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

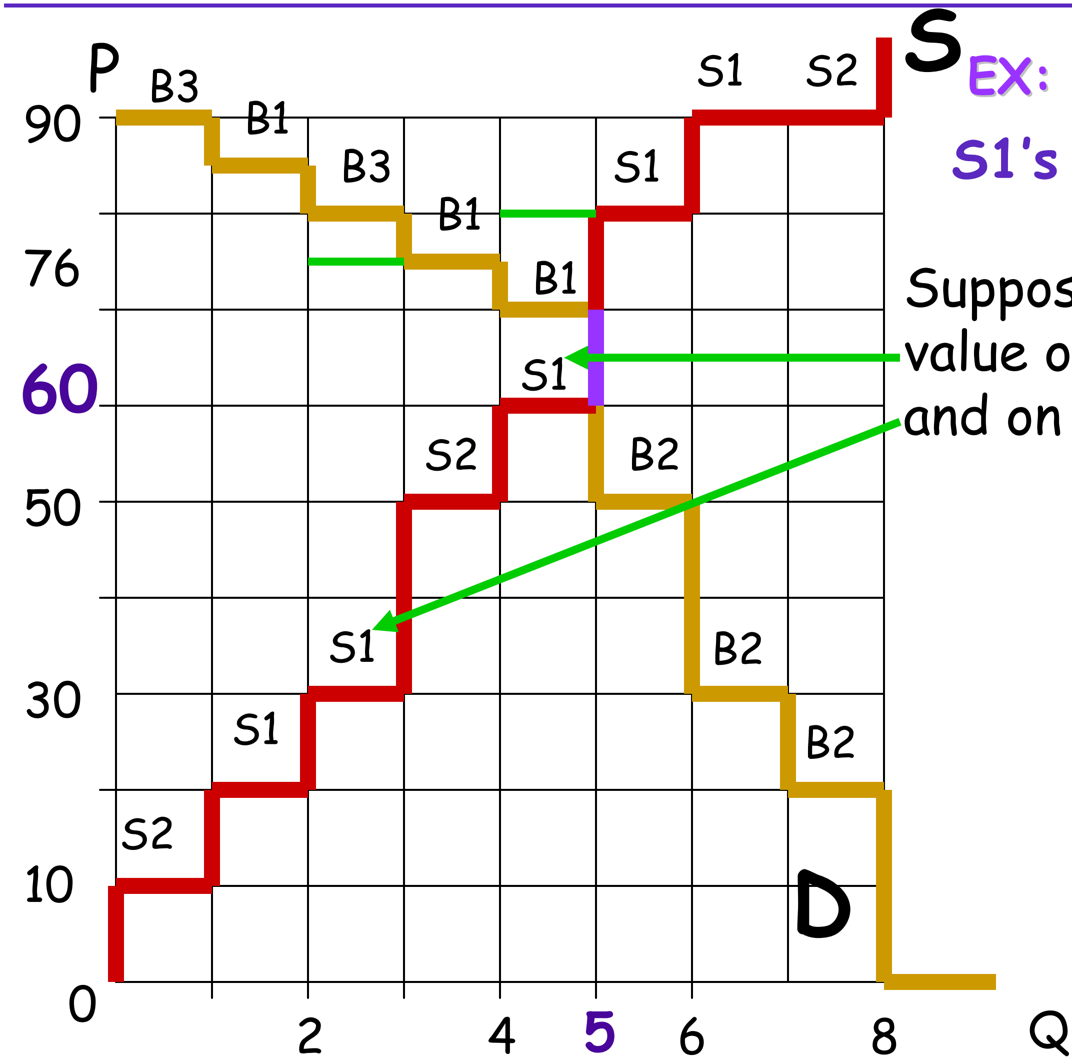
S1's Net Seller Surplus = $70

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*** ?

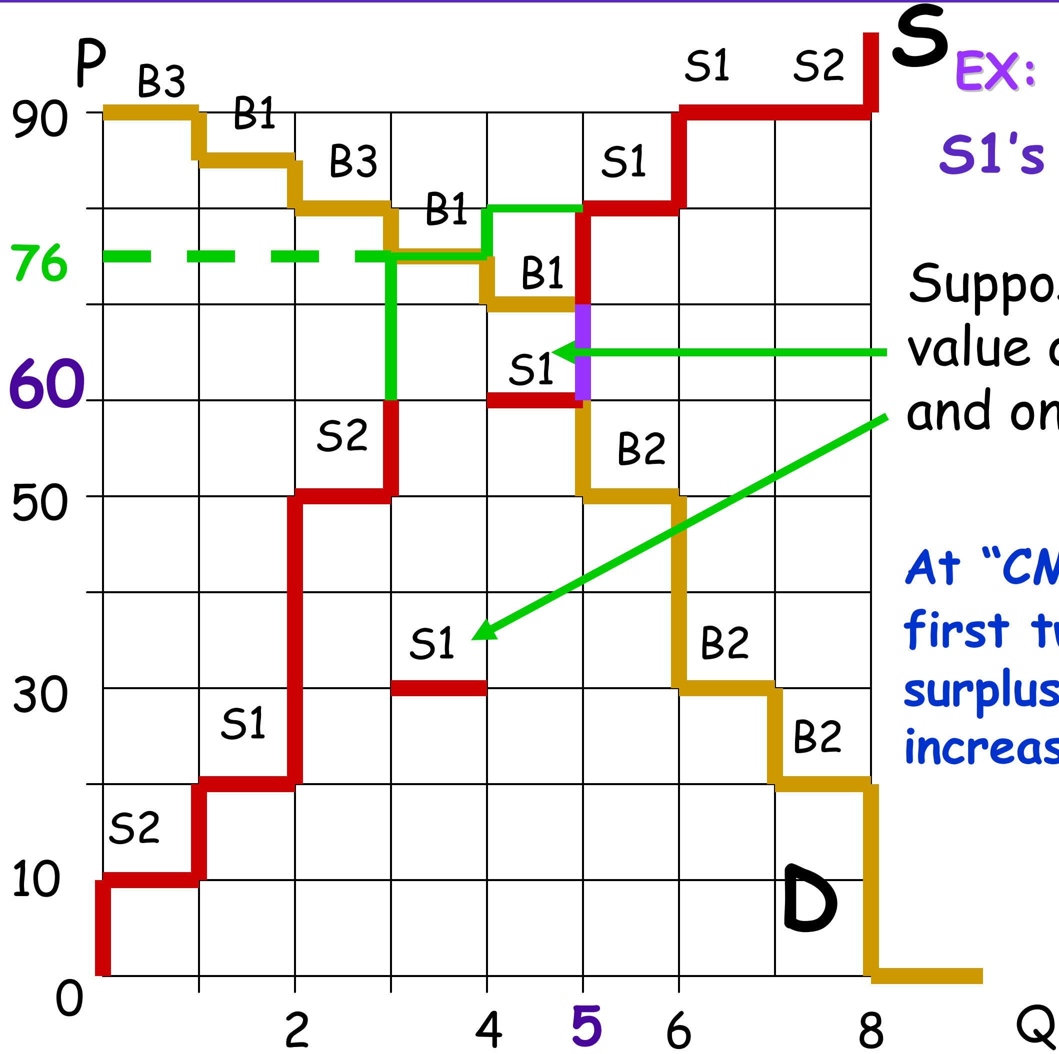


EX: CMC Pt: Q*=5, P*= $60

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*** ?



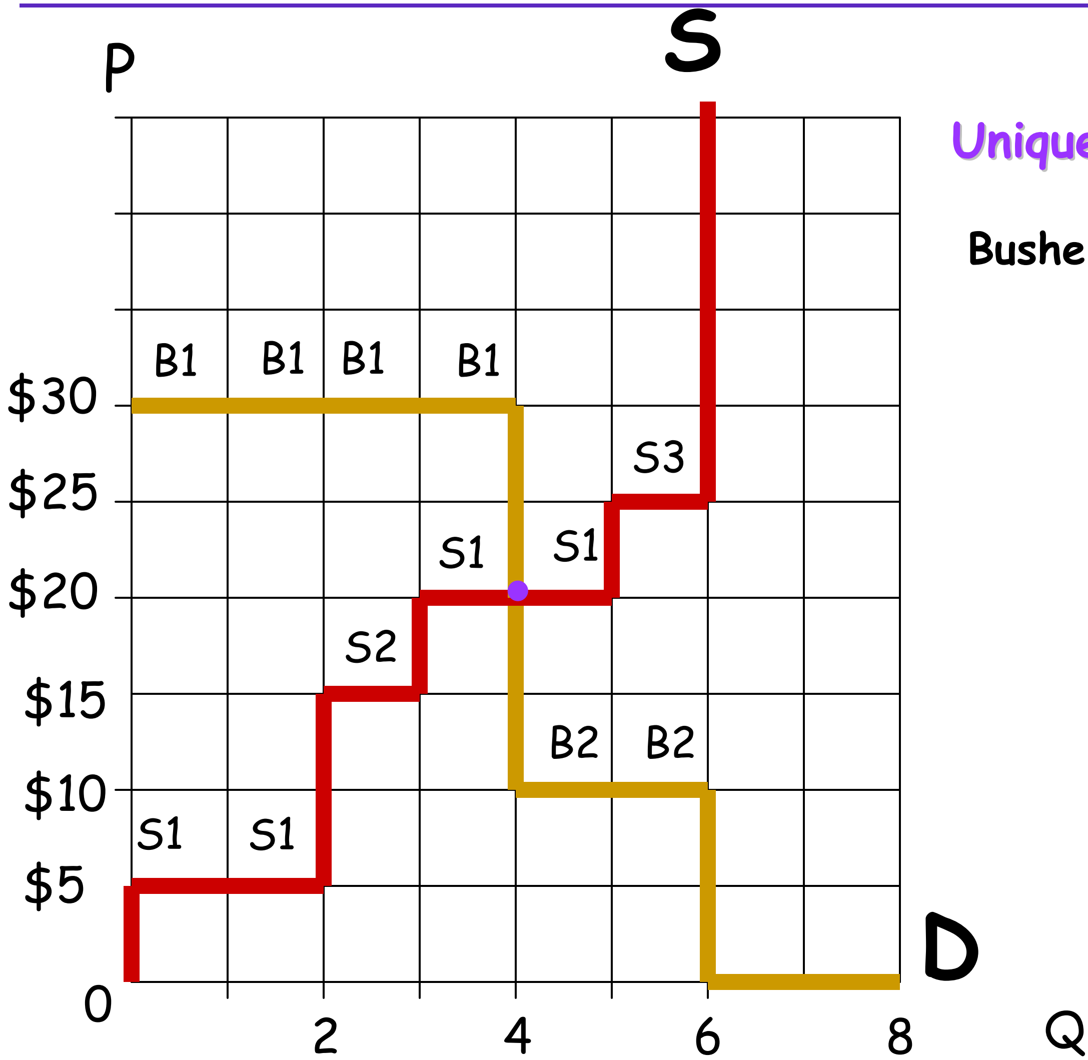
EX: CMC Pt: Q*=5, P*= $60

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] !

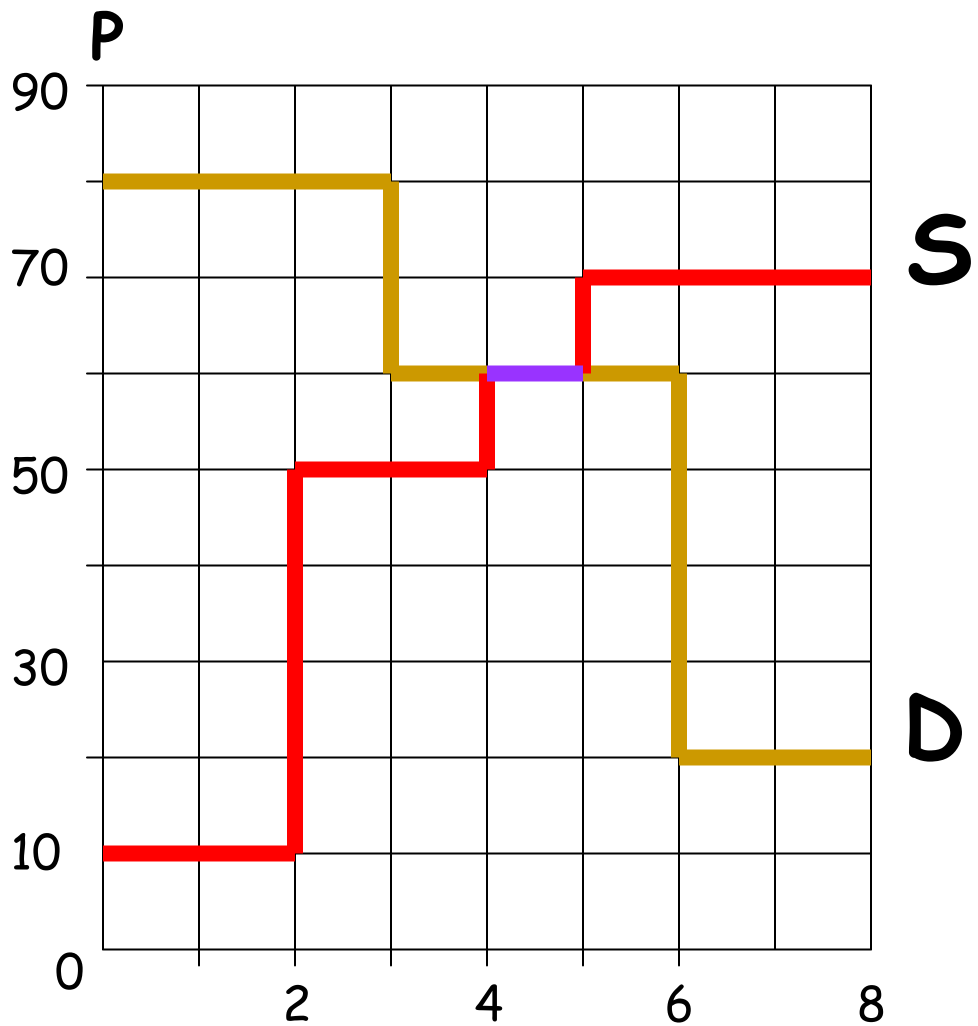
More on CMC Points: Illustrative Example 2



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

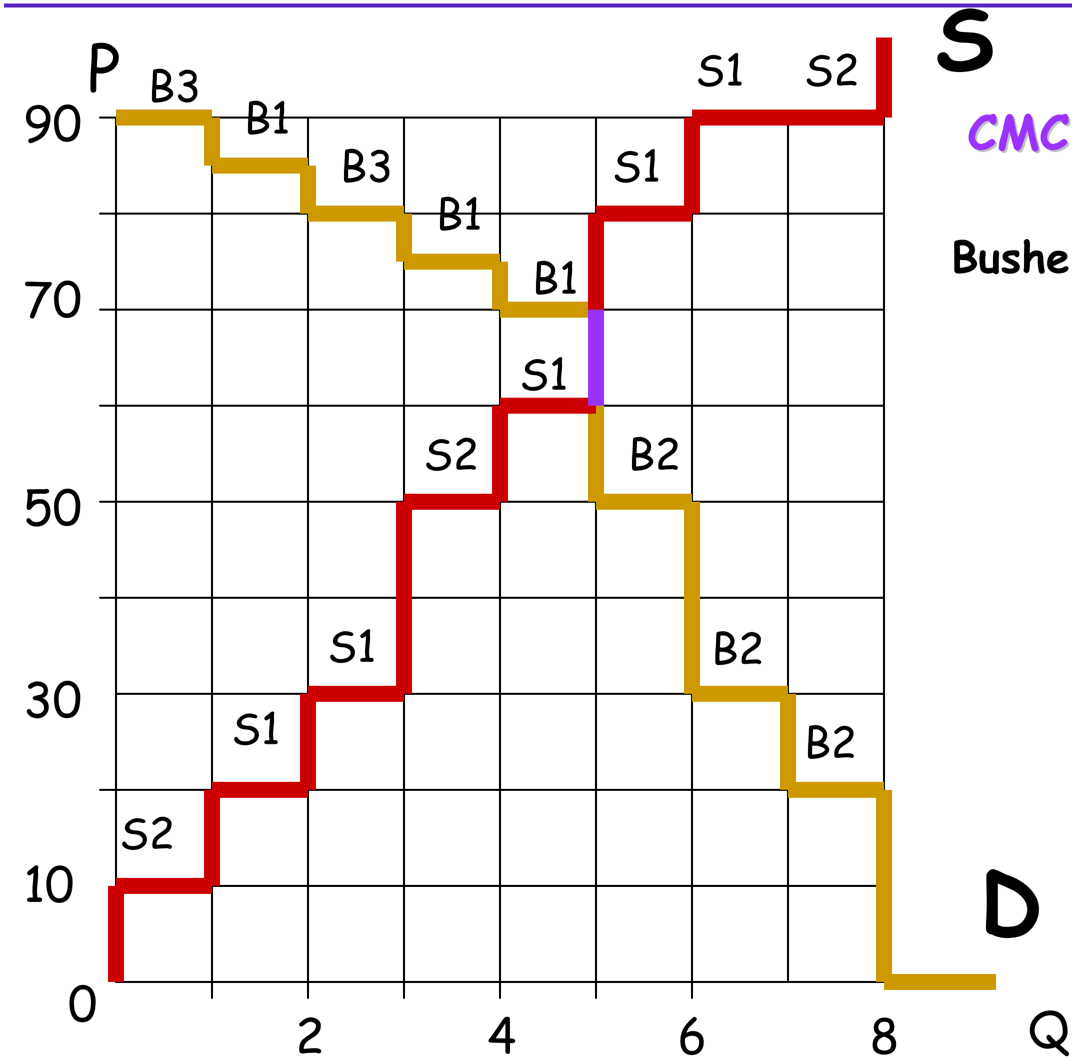
Bushel Unit	MaxBuyPrice	MinSellPrice
1	$30	$5
2	$30	$5
3	$30	$15
4	$30	$20
5	$10	$20
6	$10	$25
7	0	∞
8	0	∞

More on CMC Points: Illustrative Example 3



CMC Points:
P*=$60, 4 ≤ Q*≤ 5

More on CMC Points: Illustrative Example 4



CMC Pts: Q*=5, $60 ≤ P*≤ $70

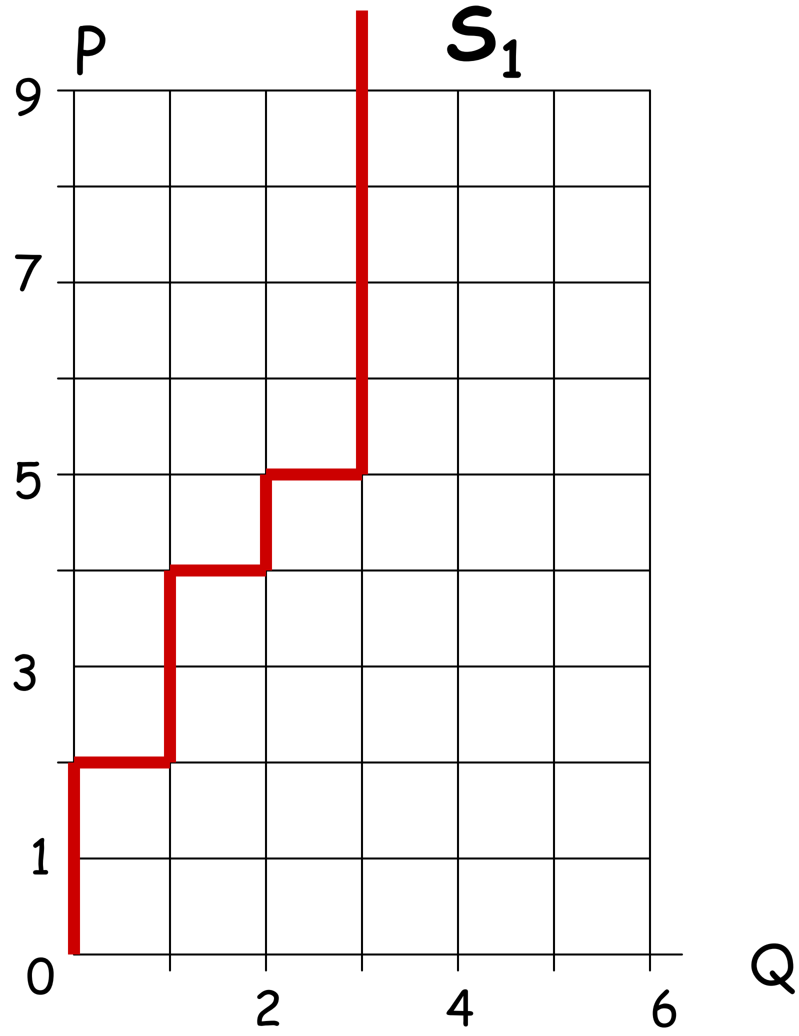
Bushel Unit	MaxBuyPrice	MinSellPrice
1	$90	$10
2	$84	$20
3	$80	$30
4	$76	$50
5	$70	$60
6	$50	$80
7	$30	$90
8	$20	$90
9	0	∞

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,...

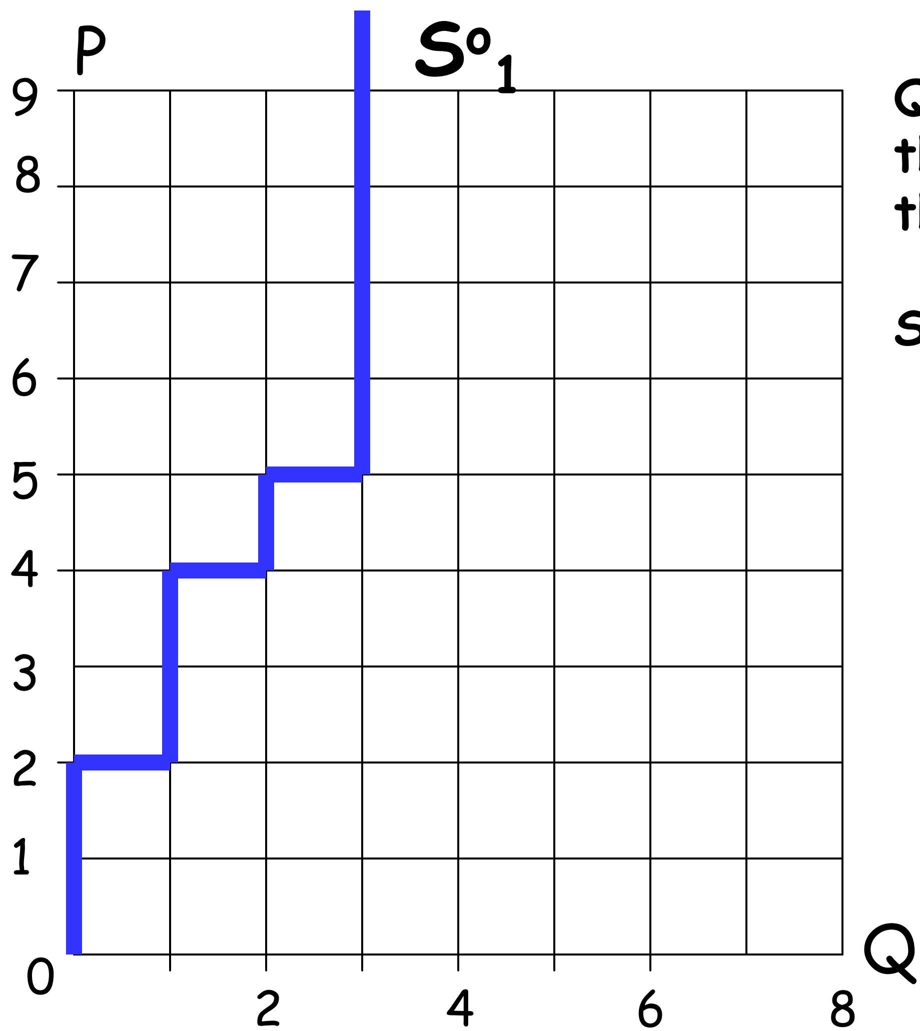
- Conversely, for **"ordinary"** supply and demand, the maximum sale and purchase quantities are given for each successive per-unit price $1, $2, $3,...

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 $Q_1 = S^o(P)$

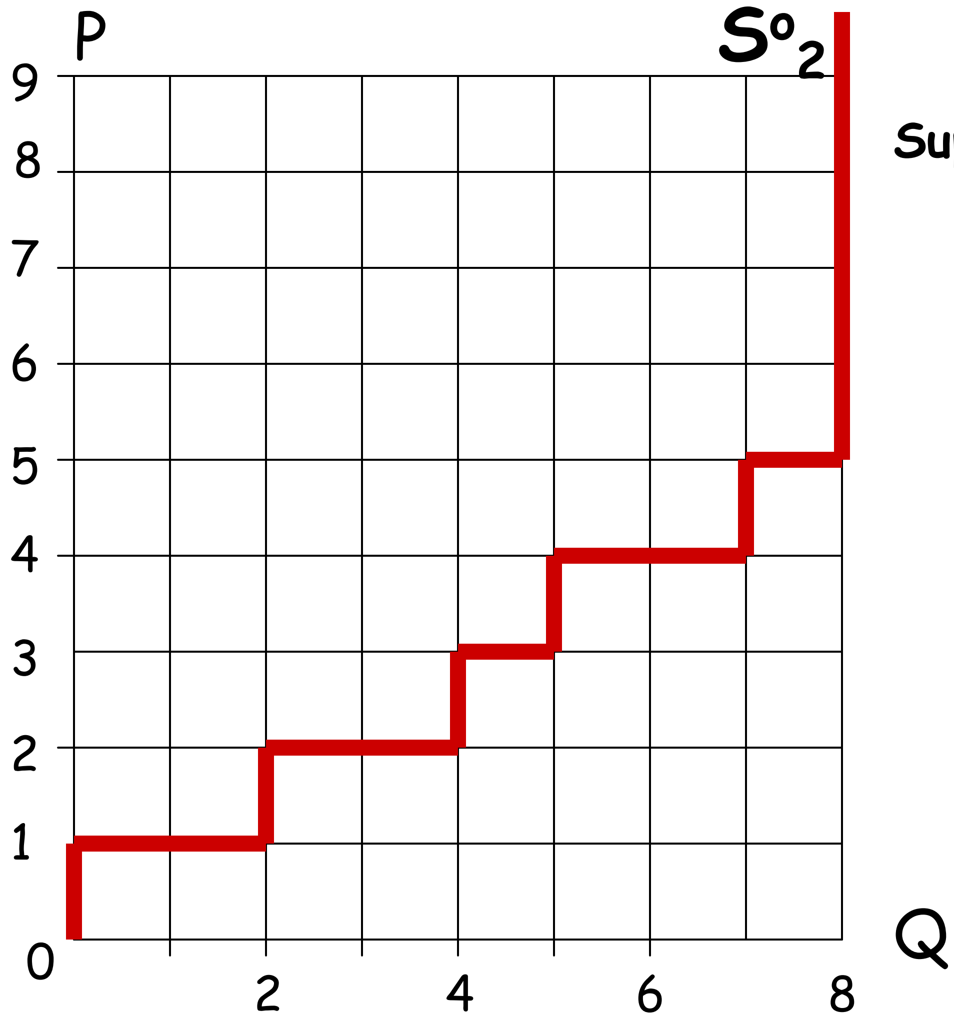


$Q = S^o_1(P)$ = Maximum amount of Q that Seller 1 is willing to supply at the per-unit sale price P

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

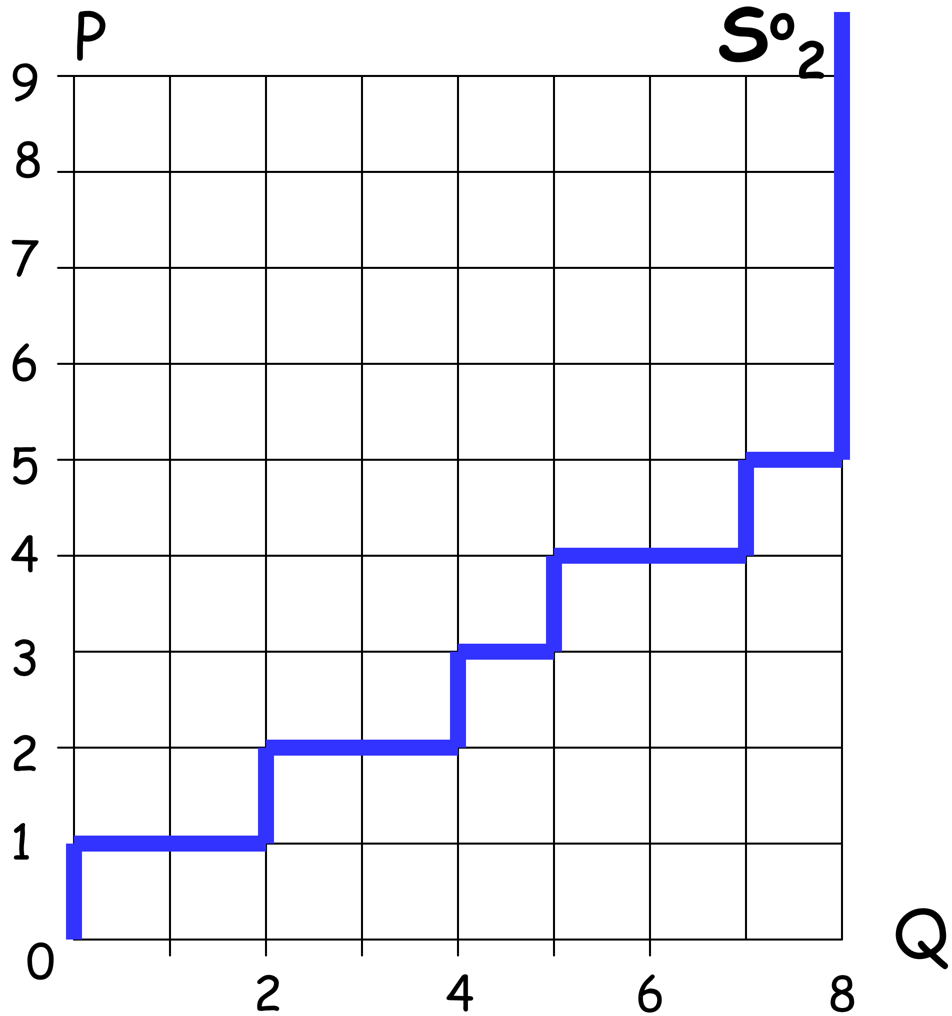
Supply Schedule for Seller 2

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	∞

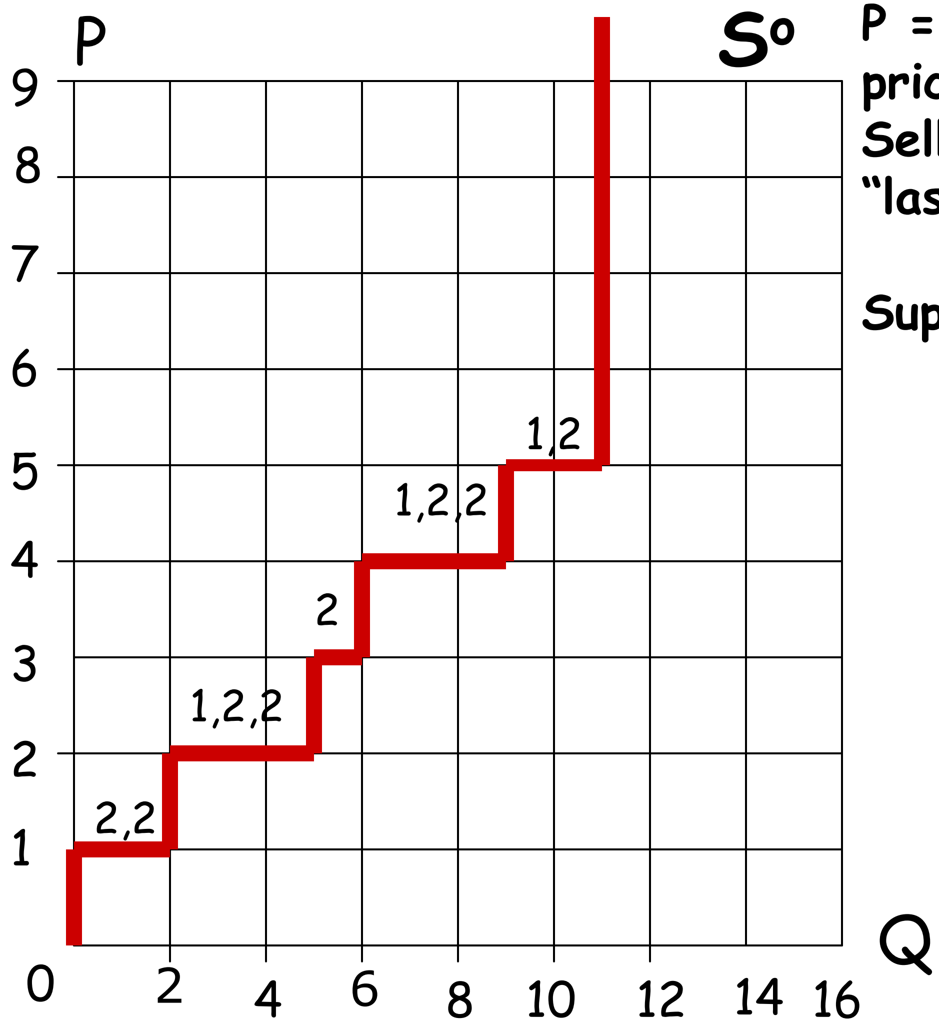
Supply Schedule for Seller 2 Re-Expressed in
Ordinary Form $Q = S^o_2(P)$



$Q = S^o_2(P)$ = 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

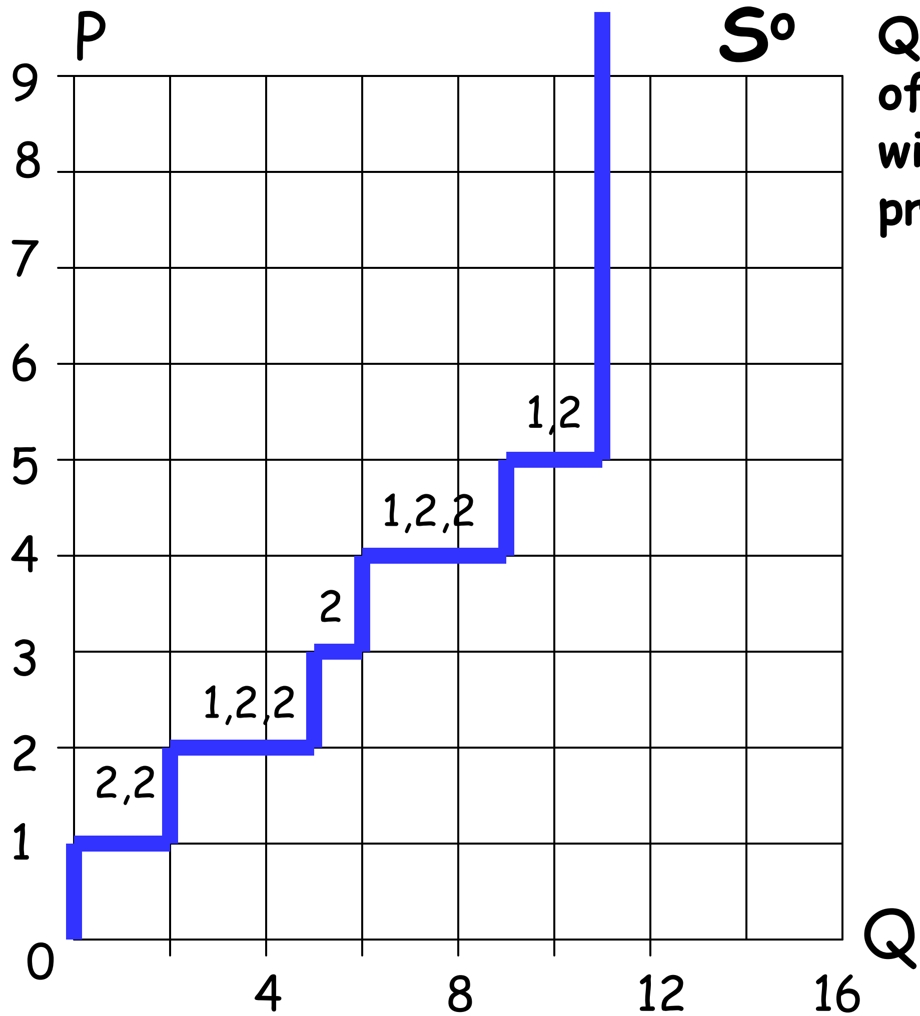
Total Supply Schedule (Sellers 1 & 2)
Inverse Form P = S(Q)



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 (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