Construction of Demand & Supply Schedules: Illustrative Examples

Lecture Notes

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Presentation Outline

- Introduction
- Double Auction Basics:
  - Supply
  - Demand
  - Supply = Demand Equilibrium
  - Net Surplus Extraction
- Market efficiency

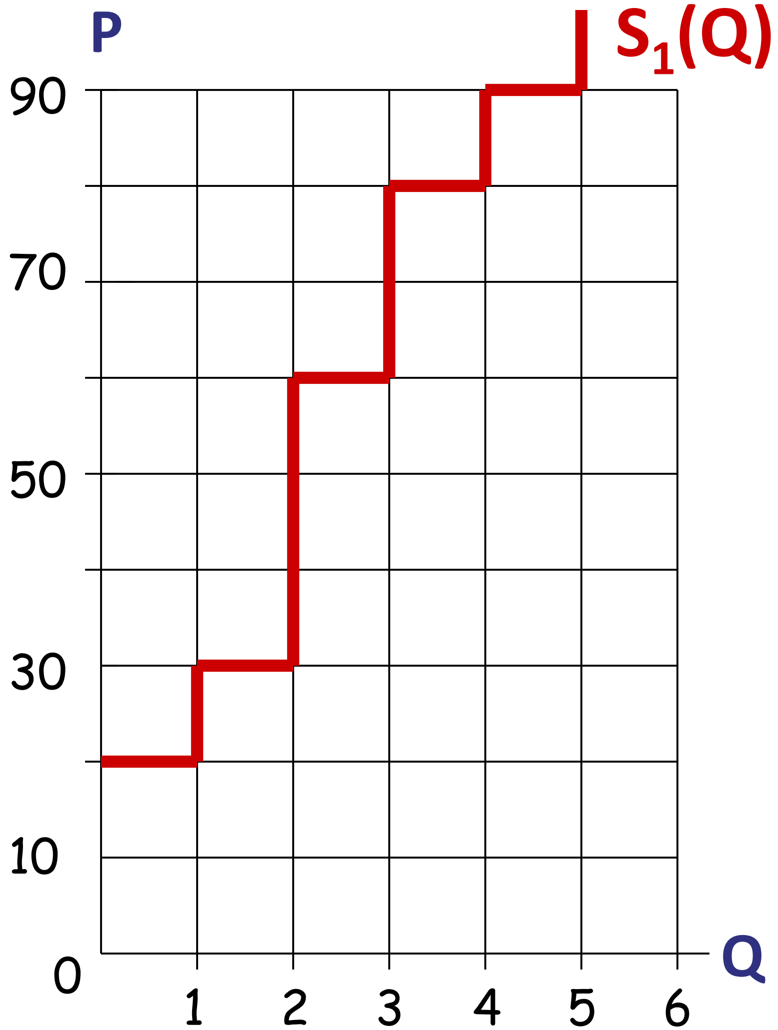
Introduction

Double Auction = A centrally-cleared market in which sellers make supply offers & buyers make demand bids.

- These introductory notes will focus on markets taking a double-auction ("two-sided") form.

Double-Auction Illustration with Two Suppliers and Three Buyers

Seller 1's Supply Offer: $P = S_1(Q)$, where P = Price and Q = Quantity



Q = Quantity of specialty apples (in bushels)
P = Price of specialty apples ($ per bushel)

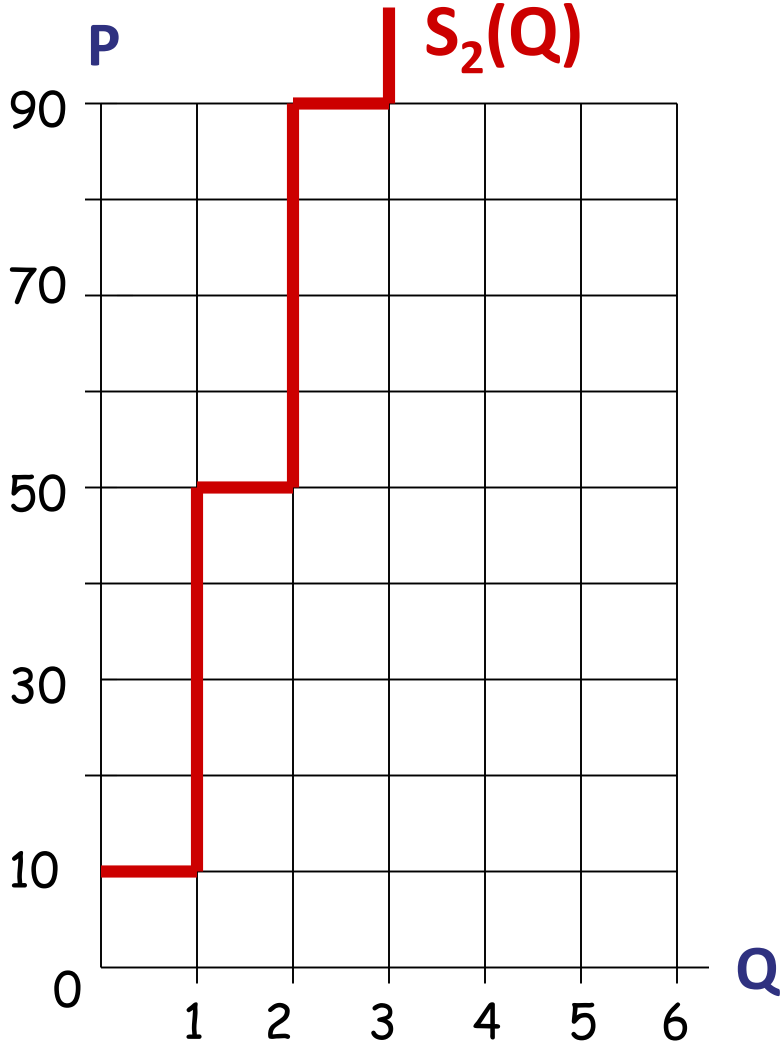
For each Q: $P=S_1(Q)$ is Seller 1's ***minimum acceptable sale price*** for the "last" bushel it supplies at Q.

Bushels Q	Price $P = S_1(Q)$
1	$20
2	$30
3	$60
4	$80
5	$90
6	∞

5 bushels = Seller S_1's max possible supply.

Note: ***"Minimum acceptable sale price"*** is also called a ***"(sale) reservation value"***

Seller 2's Supply Offer: $P = S_2(Q)$, where P = Price and Q = Quantity

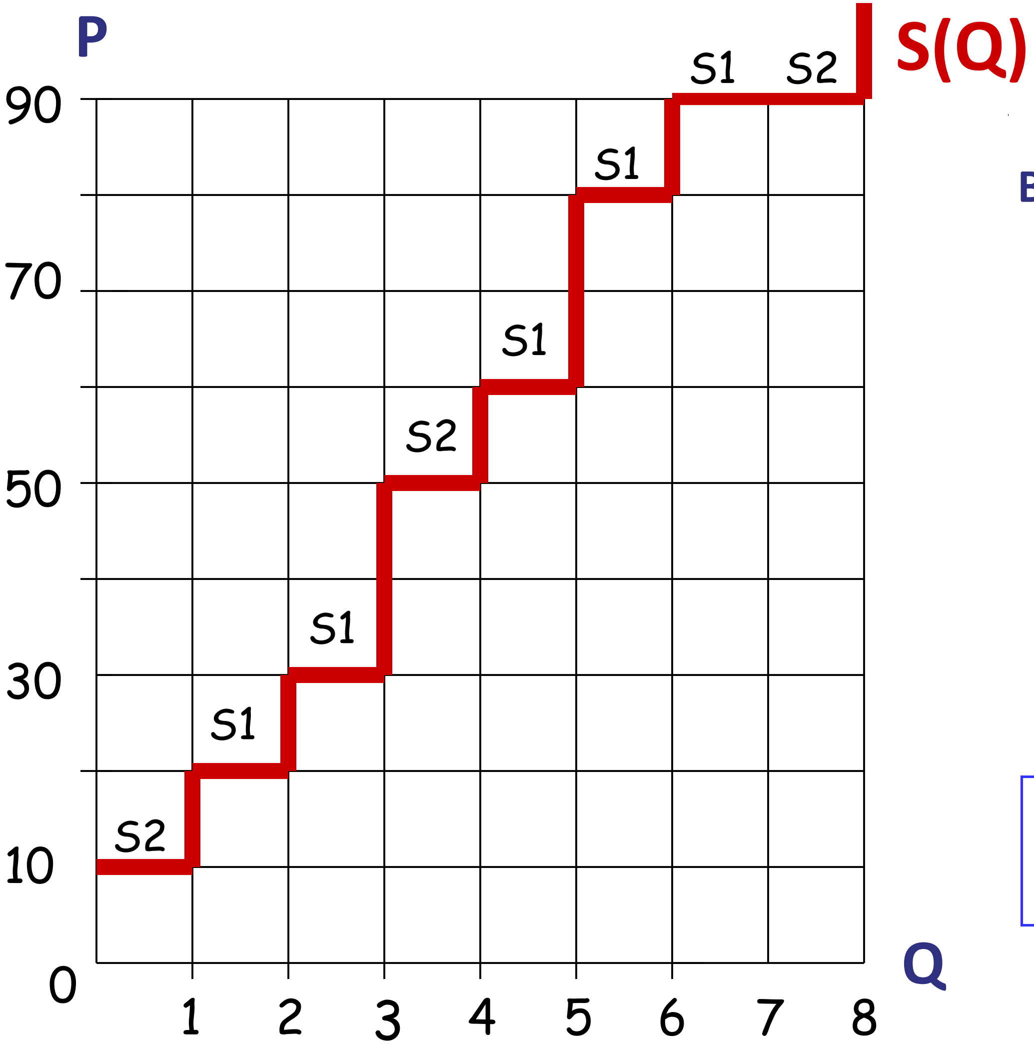


For each Q: $P = S_2(Q)$ is Seller 2's ***minimum acceptable sale price*** for the last bushel it supplies at Q.

Bushels Q	Price $P = S_2(Q)$
1	\$10
2	\$50
3	\$90
4	∞

3 bushels = Seller S_2's max possible supply.

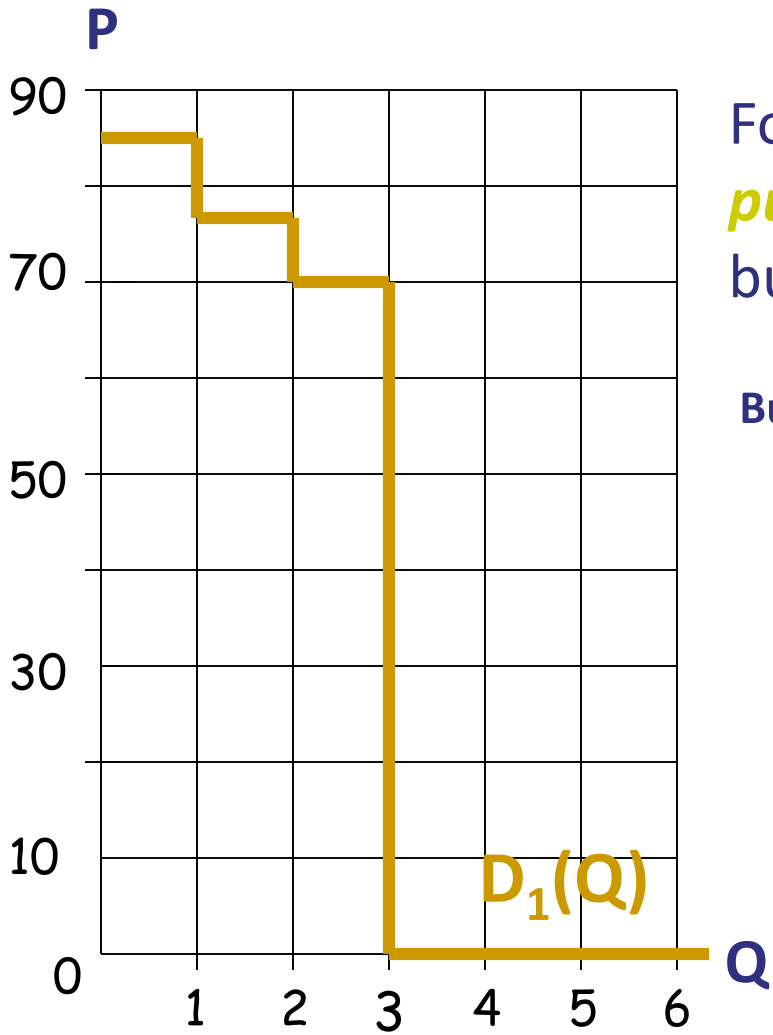
Total System (Inverse) Supply Function: P = S(Q)



Bushels Q	Price P = S(Q)
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	∞

Max possible total market supply = 8 bushels of apples.

Buyer 1's Demand Bid: $P = D_1(Q)$, where P = Price and Q = Quantity



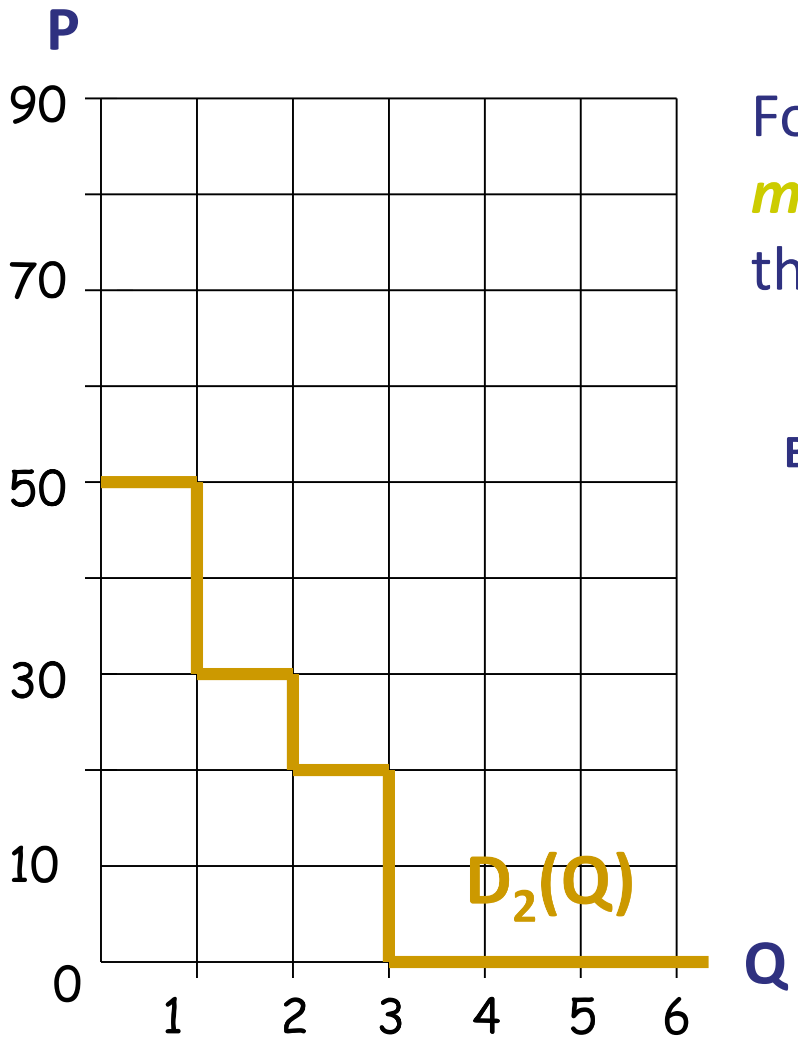
For each Q: $P = D_1(Q)$ is Buyer 1's ***max purchase price*** (\$/bushel) for the last bushel it purchases at Q.

Bushels Q	Price $P = D_1(Q)$
1	\$84
2	\$76
3	\$70
4	\$ 0

Buyer 1's demand for apples is "satiated" at 3 bushels.

Note: ***"Maximum purchase price"*** ≡ ***"maximum willingness to pay"*** is also called a ***"(purchase) reservation value."***

Buyer 2's Demand Bid: $P = D_2(Q)$, where P = Price and Q = Quantity

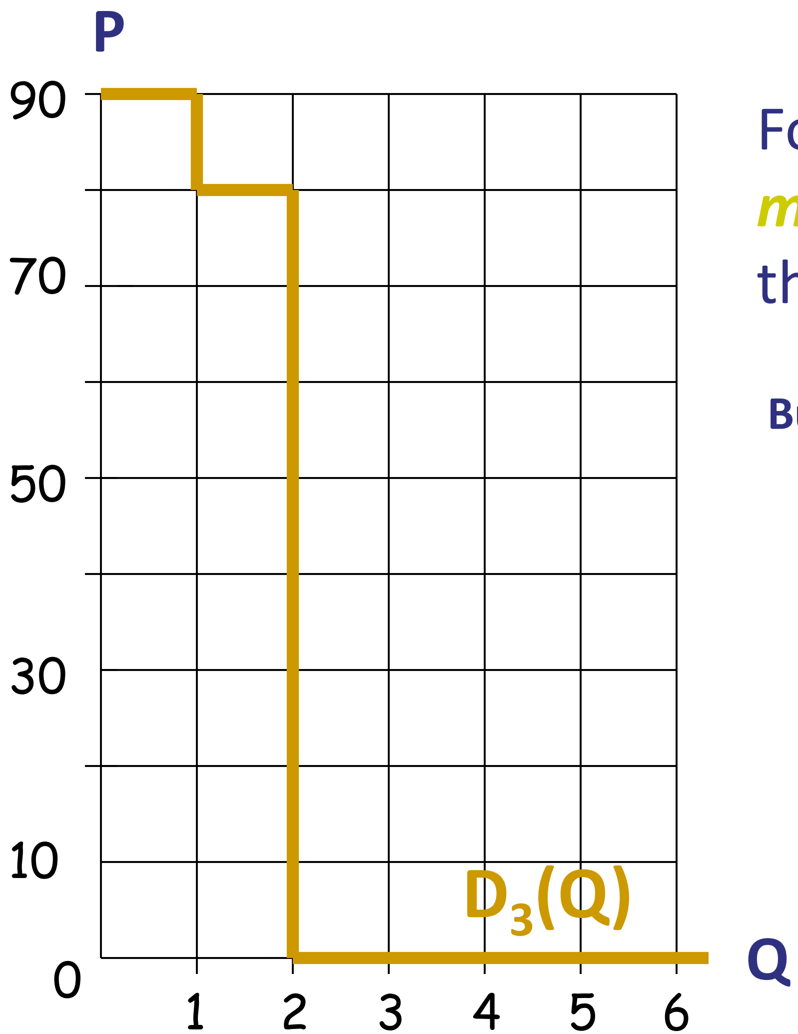


For each Q: $P = D_2(Q)$ is Buyer 2's ***max purchase price*** ($/bushel) for the last bushel it purchases at Q.

Bushels Q	Price $P = D_2(Q)$
1	$50
2	$30
3	$20
4	$ 0

Buyer 2's demand for apples is "satiated" at 3 bushels.

Buyer 3's Demand Bid: $P = D_3(Q)$, where P=Price and Q = Quantity

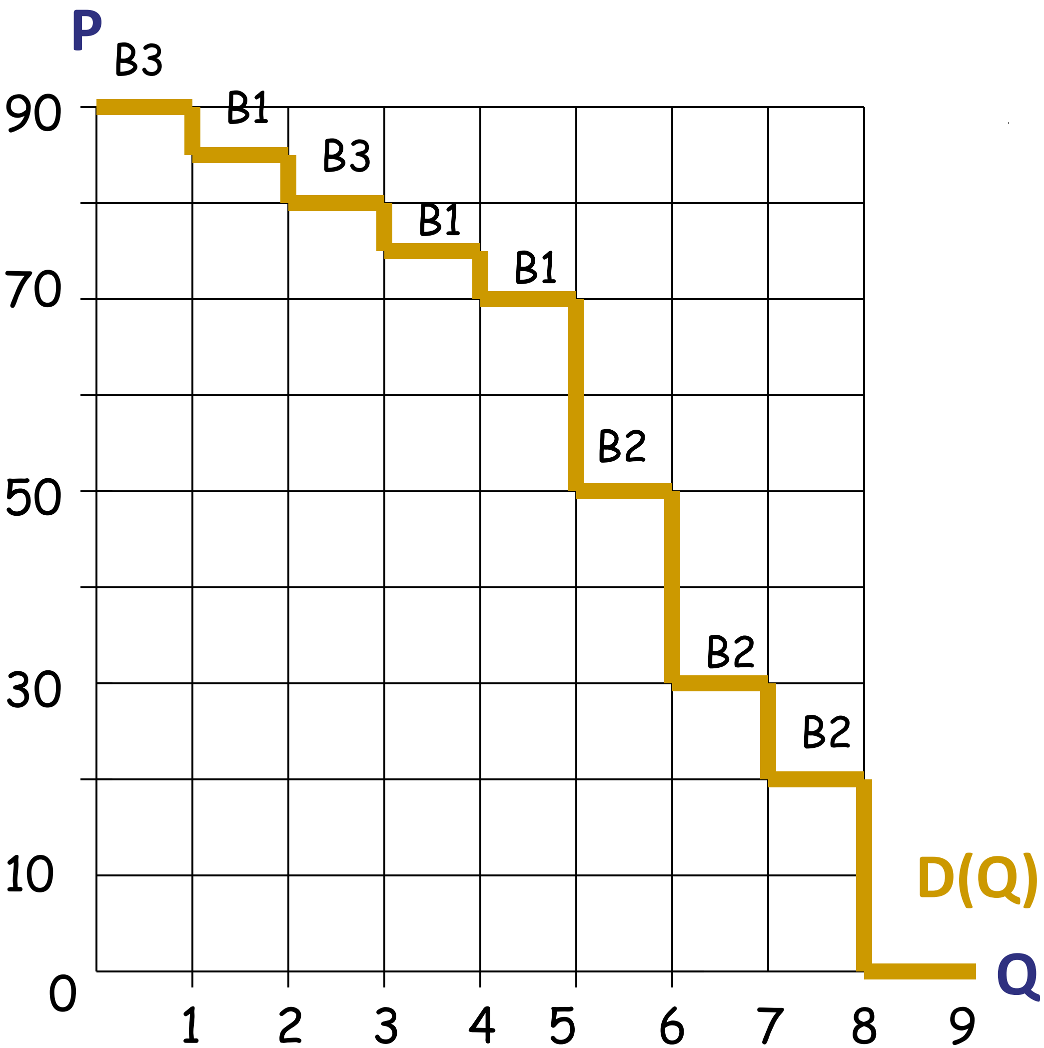


For each Q: $P = D_3(Q)$ is Buyer 3's ***max purchase price*** (\$/bushel) for the last bushel it purchases at Q

Bushels Q	Price $P = D_3(Q)$
1	\$90
2	\$80
3	\$ 0

Buyer 3's demand for apples is "satiated" at 2 bushels.

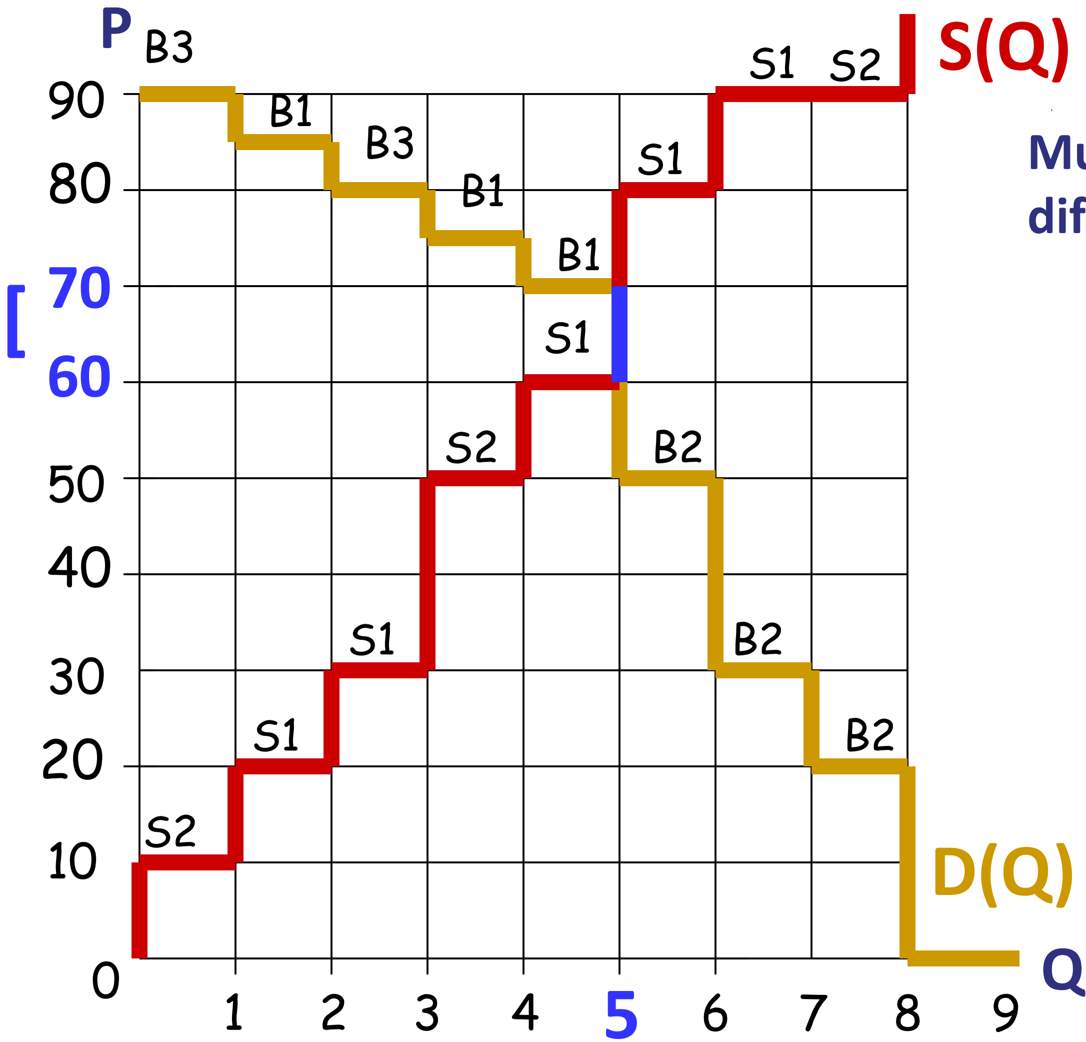
Total System (Inverse) Demand Function: P = D(Q)



Bushels Q	Price P = D(Q)
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

Competitive Market Clearing (CMC) Points

Points (Q,P) where the aggregate supply curve P = S(Q) intersects the aggregate demand curve P = D(Q): P = S(Q) = D(Q)



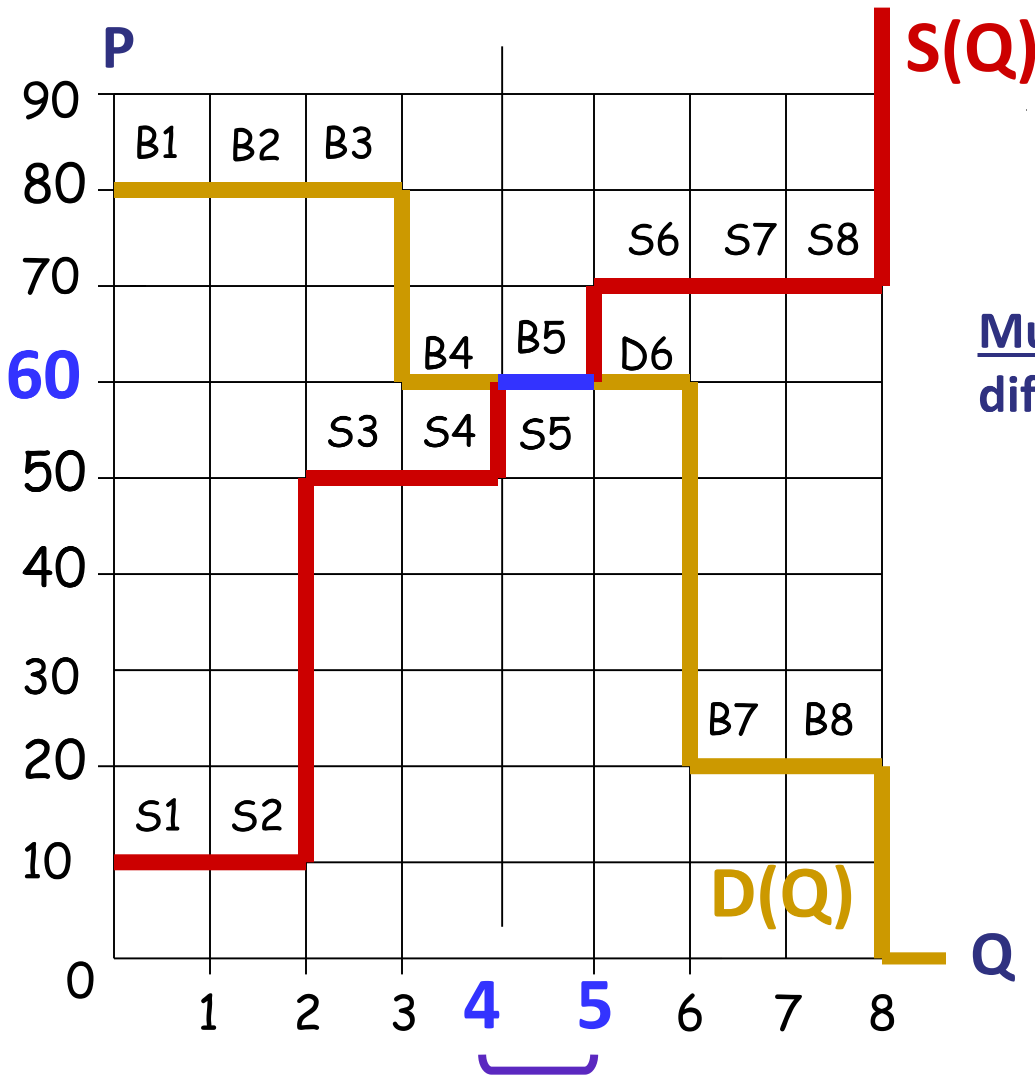
Multiple CMC points (Q*,P*) with different CMC prices P*:

Q*=5, \$60 ≤ P*≤ \$70

Bushels Q	Max Buy P	Min Sell P
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	∞

No bushel sales are possible beyond five bushels !

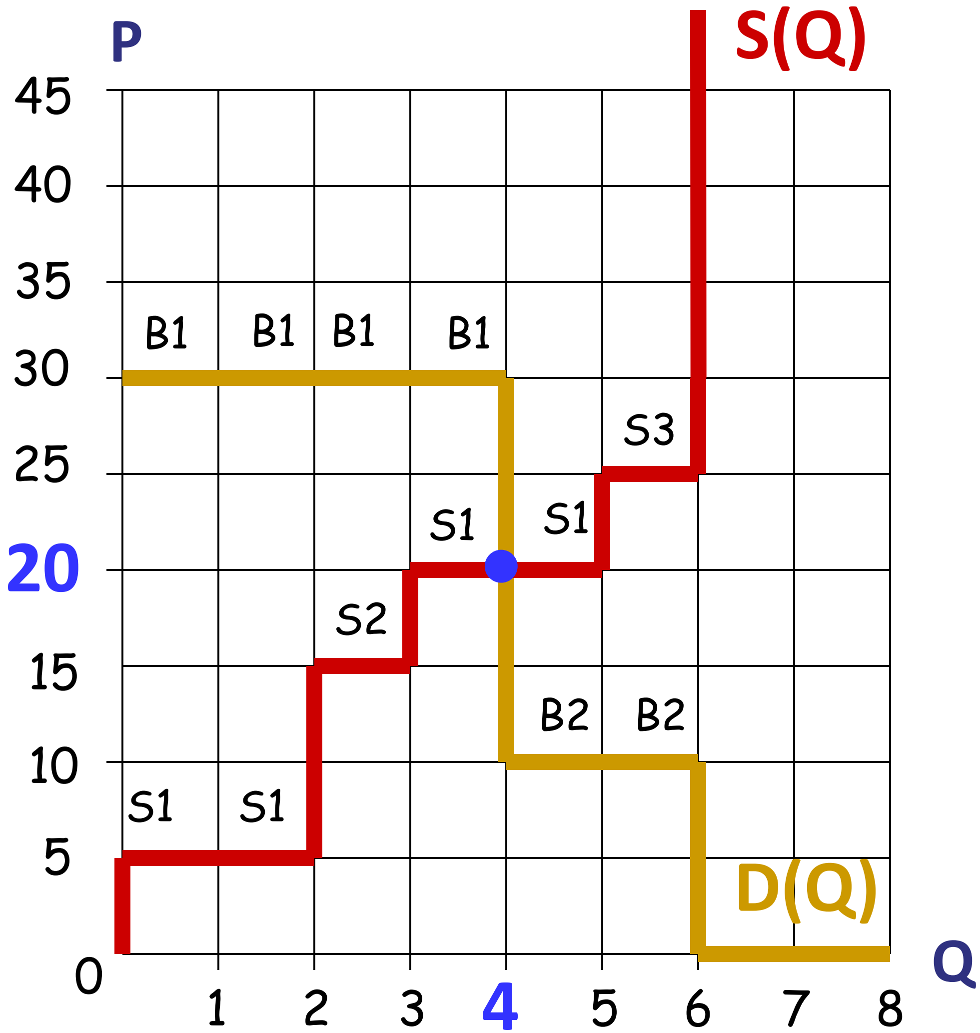
Can also possibly have <u>multiple</u> CMC points with a <u>range</u> of CMC quantities



<u>Multiple</u> CMC points (Q*,P*) with different CMC <u>quantities</u> Q*:

4 ≤ Q*≤ 5, P*=$60

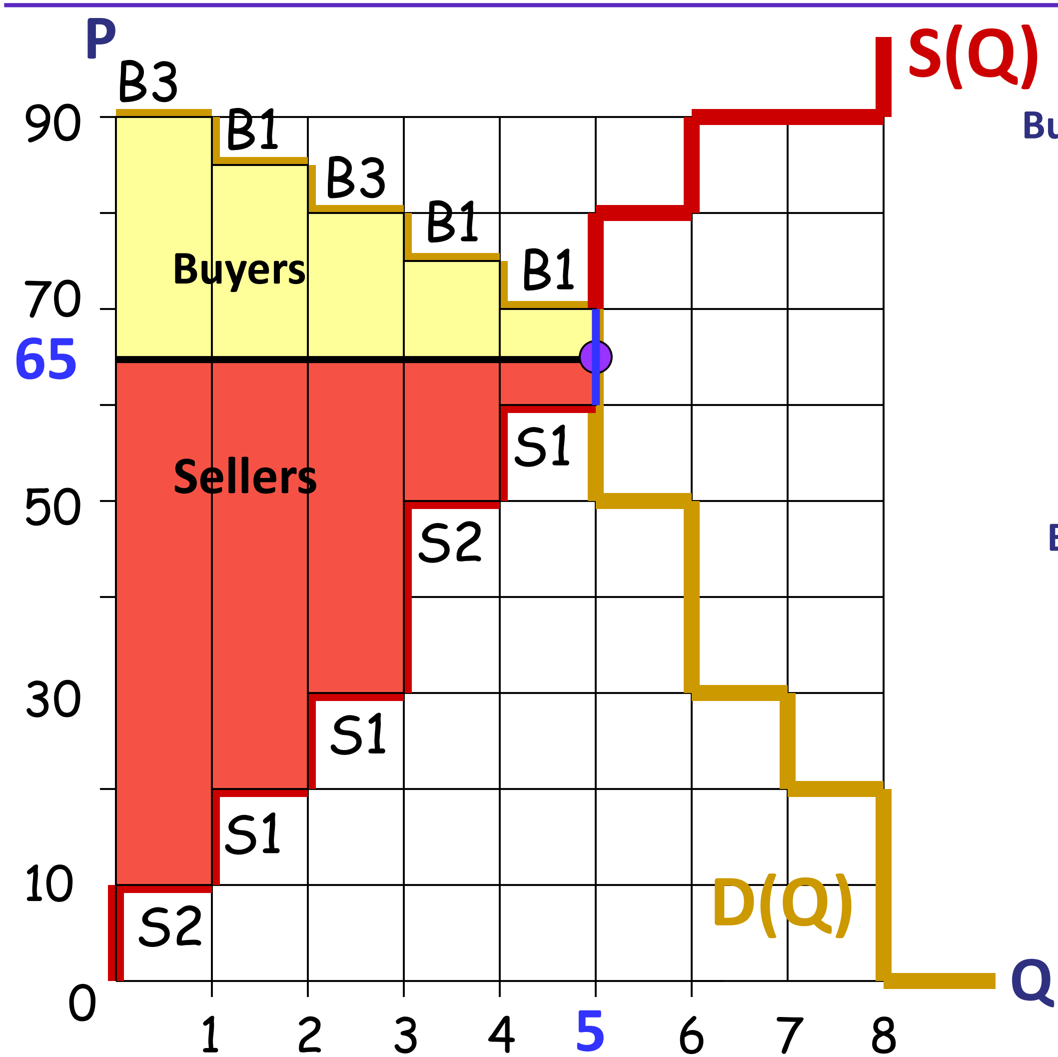
Can also possibly have a unique CMC point



Unique CMC Point:

Q*=4, P*= $20

Seller & Buyer Net Surplus Amounts at CMC Points



Ex 1: CMC Point Q*=5, P*=$65

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

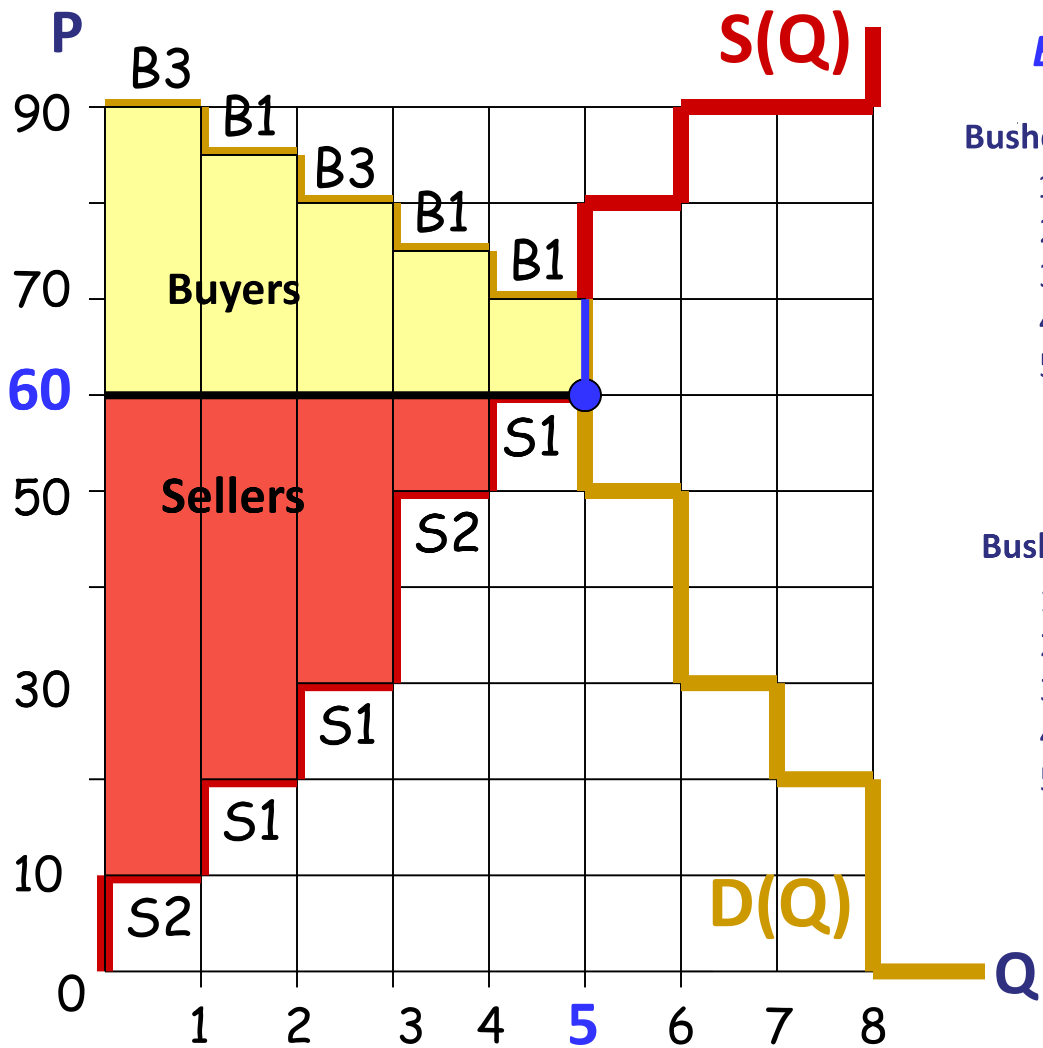
BUYER NET SURPLUS: $75

Bushels Q	P*=65		MinSPrice		SellNetSur
1	$65	-	$10	=	$55
2	$65	-	$20	=	$45
3	$65	-	$30	=	$35
4	$65	-	$50	=	$15
5	$65	-	$60	=	$ 5

SELLER NET SURPLUS: $155

Total Net Surplus: $230

A *different* selected CMC point
➔ *different* seller & buyer net surplus amounts



Ex 2: CMC Point Q*=5, P*=$60

Bushels Q	MaxBuyPrice		P*=60		BuyNetSurplus
1	$90	-	$60	=	$30
2	$84	-	$60	=	$24
3	$80	-	$60	=	$20
4	$76	-	$60	=	$16
5	$70	-	$60	=	$10

BUYER NET SURPLUS: $100

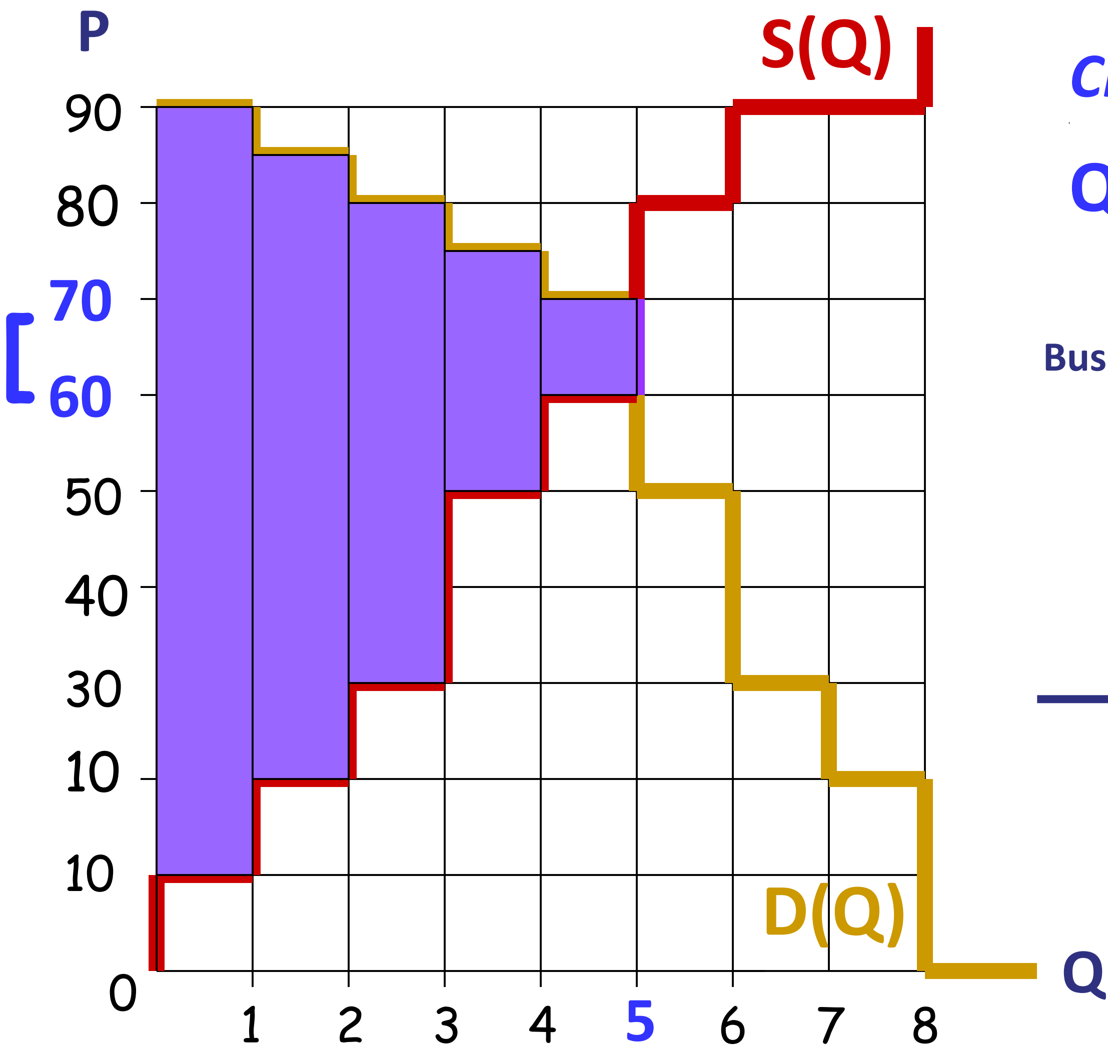
Bushels Q	P*=65		MinSellPrice		SellNetSurplus
1	$60	-	$10	=	$50
2	$60	-	$20	=	$40
3	$60	-	$30	=	$30
4	$60	-	$50	=	$10
5	$60	-	$60	=	$ 0

SELLER NET SURPLUS: $130

Total Net Surplus: $230

Total Net Surplus at a CMC Point

(*If multiple CMC points exist, TNS = same for each point.*)



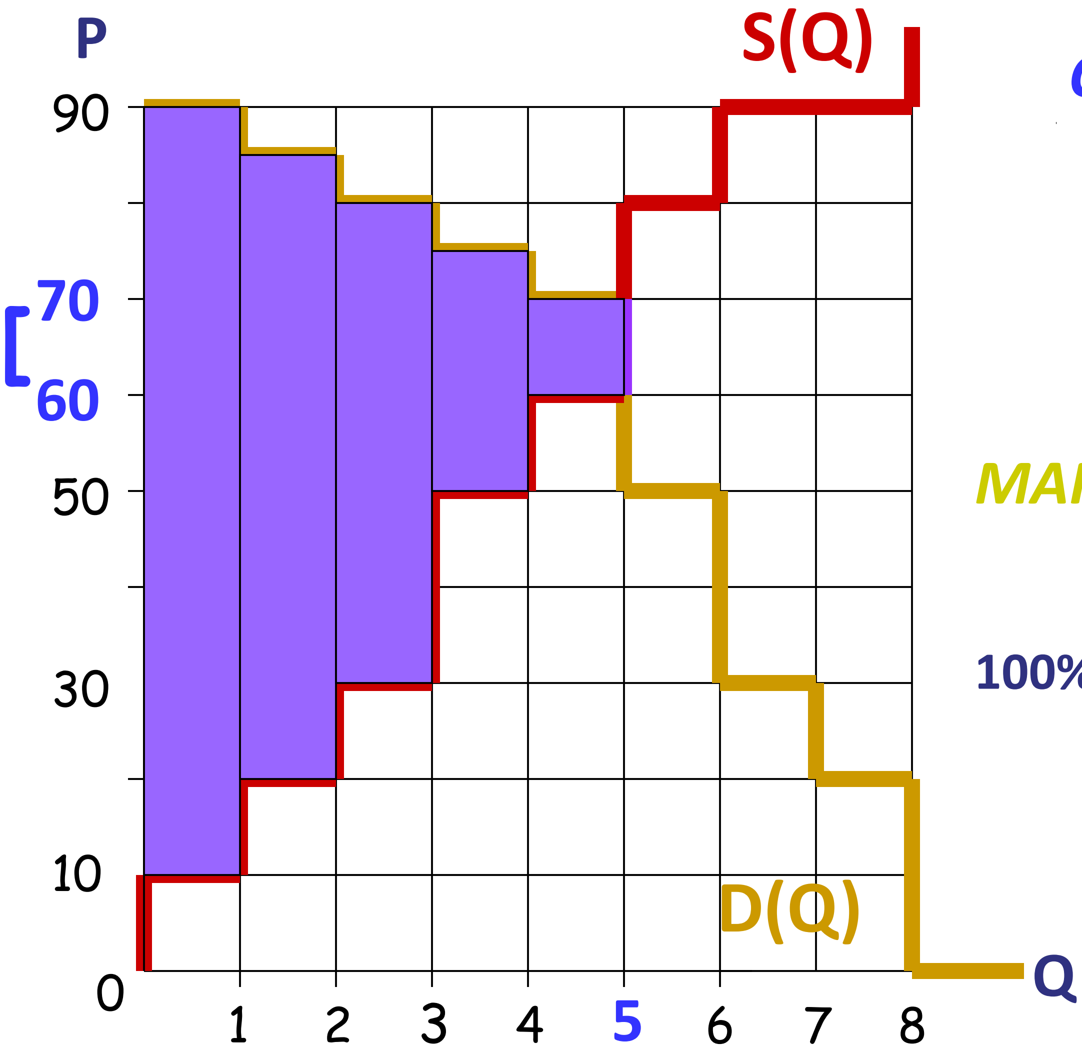
CMC Points:

Q*=5, $60 ≤ P*≤ $70

Bushels Q	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

Standard Measure of Market Efficiency
(Non-Wastage of Resources)



CMC Points:

Q*=5, $60 ≤ P*≤ $70

CMC Total Net Surplus

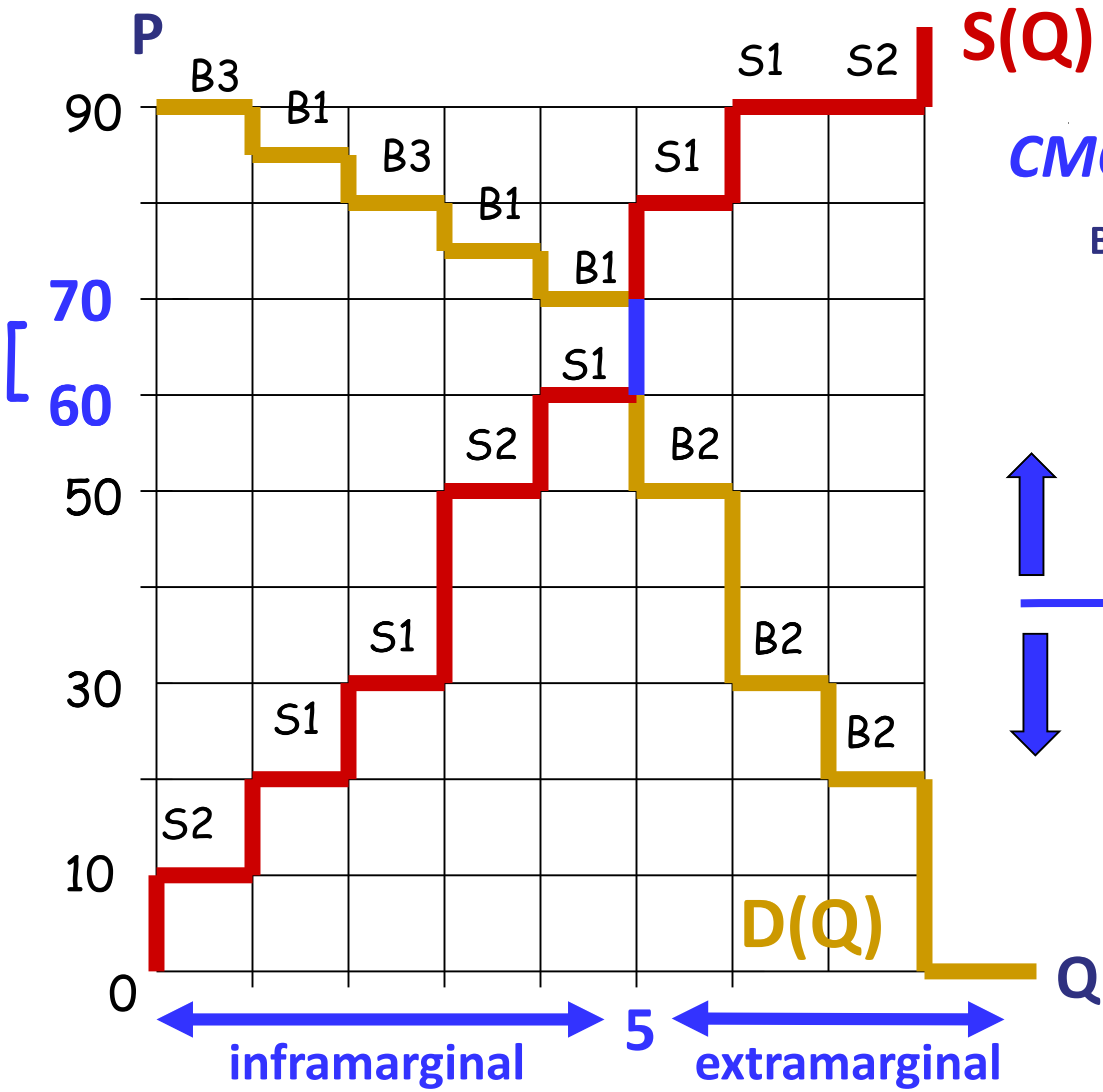
= $230 (Maximum Possible)

MARKET EFFICIENCY (ME):

$$100\% \times \frac{\text{Extracted Total Net Surplus}}{\text{Max Possible Total Net Surplus}}$$

How can ME be less than 100% ?

Inframarginal vs. Extramarginal Quantity Units at CMC Points



CMC Pts: Q*=5, $60 ≤ P*≤ $70

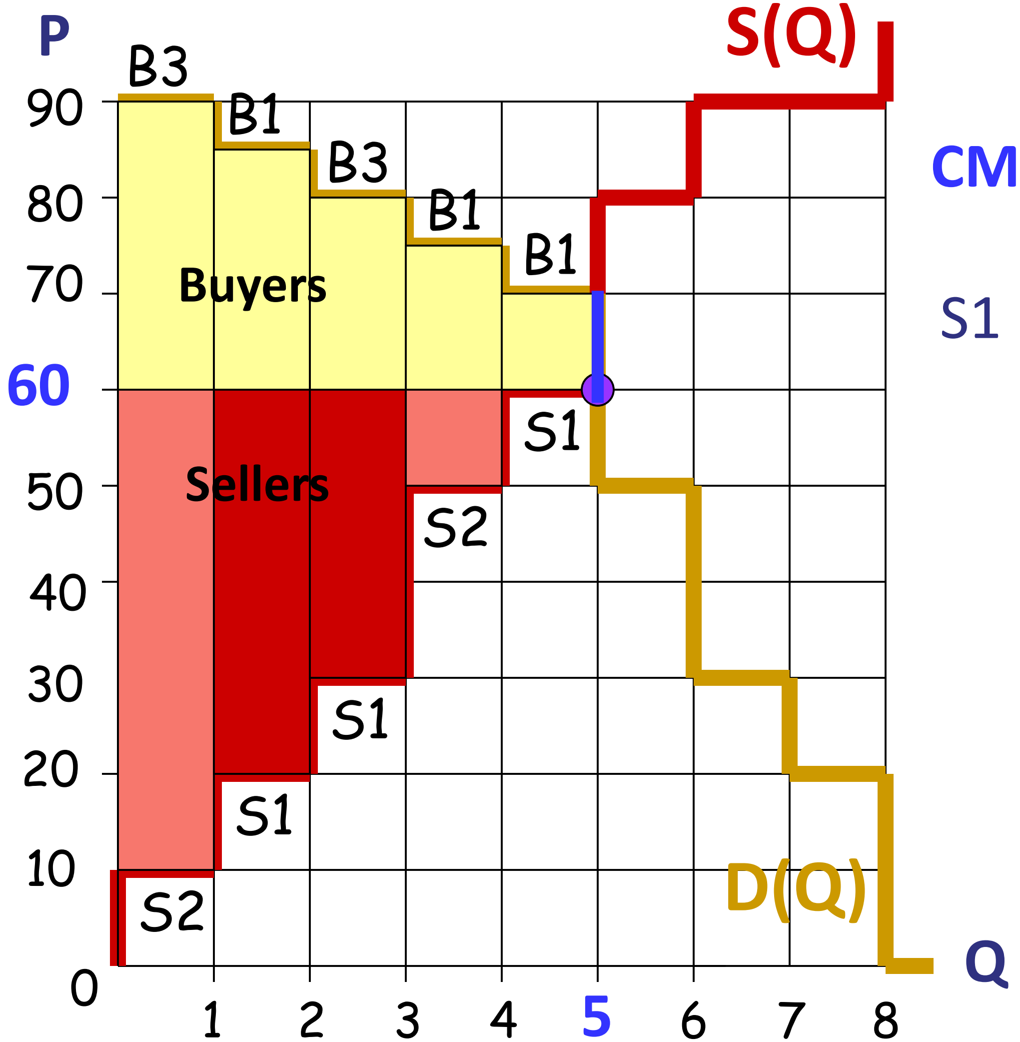
Bushels Q	MaxBuyPrice		MinSellPrice
1	$90	>	$10
2	$84	>	$20
3	$80	>	$30
4	$76	>	$50
5	$70	>	$60
6	$50	<	$80
7	$30	<	$90
8	$20	<	$90
9	$0	<	∞

Market Efficiency < 100% can arise if …

- some **inframarginal** quantity unit **fails to trade**
  - E.g., physical capacity withholding (**"market power"** *)
- some **extramarginal** quantity unit **is traded**
  - a more costly unit is sold in place of a less costly unit ("out-of-merit-order dispatch")
  - and/or a less valued unit is purchased in place of a more valued unit ("out-of-merit-order purchase")

* ***Market Power:*** Ability of a seller or buyer to extract more net surplus from a market than they would achieve at a CMC point.

Example: Exercise of market power by Seller S1 that results in ME < 100%



CMC Point: Q*=5, P*=$60

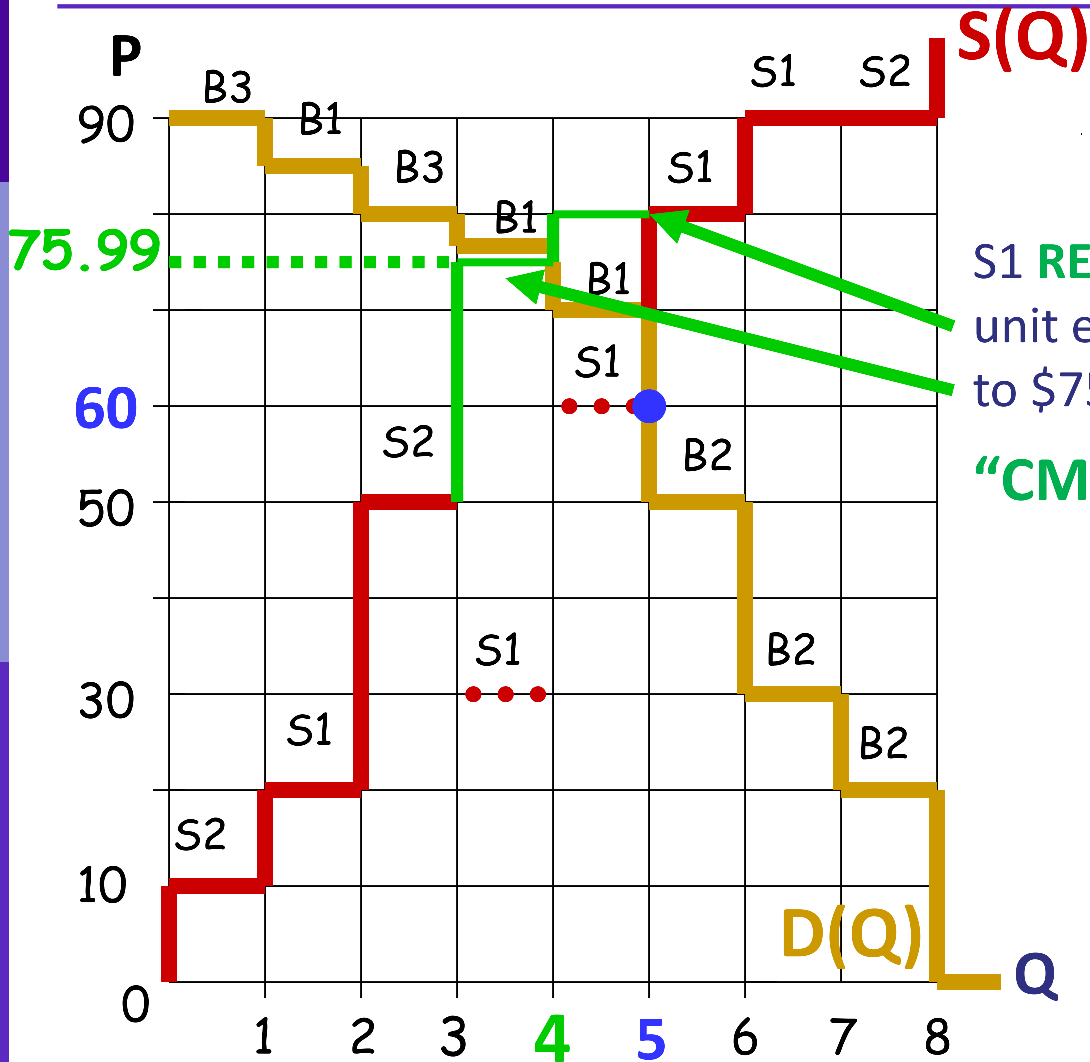
S1 Net Surplus at CMC Point:

$60-$20 = $40
$60-$30 = $30
$60-$60 = $ 0

S1 Net Surplus = $70

Total Net Surplus: $230

Example: ME < 100% … Continued



CMC Point: Q*=5, P*=$60

S1's CMC Net Surplus = $70

S1 **REPORTS** a max sale price on his 3rd unit equal to $80 & on his 2nd unit equal to $75.99.

"CMC" Point: Q'=4, P'≅$76

At new "CMC" point, S1 only sells its first 2 units, but **S1's net surplus increases to ≅ $102 = [$56+$46]**

Extracted total net surplus **DECREASES FROM 230 TO 220** because inframarginal 5th unit now fails to sell.

Market Efficiency vs. Social Welfare

- ***Efficiency*** for one market at one time point is a very narrow measure of resource non-wastage.
- Ideally, ***social*** efficiency should be measured by resource non-wastage across ***all*** markets and across ***all*** current and future time periods.
- Moreover, economists measure ***social welfare*** in terms of the ***"utility" (well-being) of people*** in their roles as consumers/users of final goods and services.
- **Social efficiency** is ***necessary but not sufficient*** for the optimization of **social welfare**.

Market Efficiency, Social Welfare, and the Extraction of Net Surplus by "Third Parties"

- Suppose [price P_S paid to a seller] < [price P_B charged to a buyer] for some quantity unit sold in a market

➔ **Net surplus [P_B-P_S] is extracted by some type of "third party"**

Examples: **(1)** Gov't tax collections; **(2)** Extraction of net surplus ("congestion rents") by the **I**ndependent **S**ystem **O**perators (**ISOs**) that manage grid-supported U.S. wholesale power markets settled by means of **L**ocational **M**arginal **P**ricing. **(This extraction occurs when a transmission grid is "congested" (i.e., the power flowing across some transmission grid line is actively constrained by the line's max transmission capacity).**

- "First order effect" of this **third-party extracted net surplus** is a <u>decrease</u> in the net surplus going to sellers & buyers.

- **Social efficiency/welfare implications** of this third-part extracted net surplus depend on <u>precisely how it is extracted</u> and <u>to what uses the extracted net surplus is subsequently put.</u>