Leigh Tesfatsion/16 February 2009

MARKET BASICS FOR PRICE-SETTING AGENTS

- **Market:** Any context in which the selling and buying of a commodity takes place. Hereafter, the symbol Q will be used to denote a particular quantity of the commodity, and P will be used to denote a (per-unit) price for this commodity.

  EXAMPLE:
  Q = 10 bushels of apples,
  P = \$2.00 per bushel of apples.

- **Market Structure:** Properties of a market that are closely tied to ownership of resources and technology.

  Examples: Number of sellers; number of buyers; seller production functions; seller production costs; buyer/seller initial resource endowments, etc.

- **A Seller's True (Inverse) Supply Schedule:** A schedule giving the MINIMUM price P (i.e., the *reservation price*) that a seller would be willing to accept for each successive quantity unit he supplies.

- **Net Seller Surplus on a Sold Quantity Unit:** The difference between the price actually received by the seller for this quantity unit and the reservation price the seller would have been willing to receive for this quantity unit.

- **A Buyer's True (Inverse) Demand Schedule:** A schedule giving the MAXIMUM price P (i.e., the *reservation price*) that a buyer would be willing to pay for each successive quantity unit he demands.

- **Net Buyer Surplus on a Purchased Quantity Unit:** The di erence between the reservation price that the buyer would have been willing to pay for this quantity unit and the price the buyer actually paid for this quantity unit.

Note on terminology:

In market analyses, “inverse” supply and demand schedules give price for each quantity, whereas “direct” supply and demand schedules give quantity for each price.

These notes use the “inverse” form because the stress is on price-setting sellers and buyers who actively make price o ers for different considered quantities. The “direct” form is commonly used when the stress is on “competitive” sellers and buyers who make quantity decisions taking prices as given.

For expositional simplicity, the qualifier “inverse” for supply and demand schedules will be omitted in the remainder of these notes.

- **True Total Supply Schedule:** A schedule $P = S(Q)$ giving the minimum seller reservation price P for the "last" quantity unit supplied at each quantity amount Q.

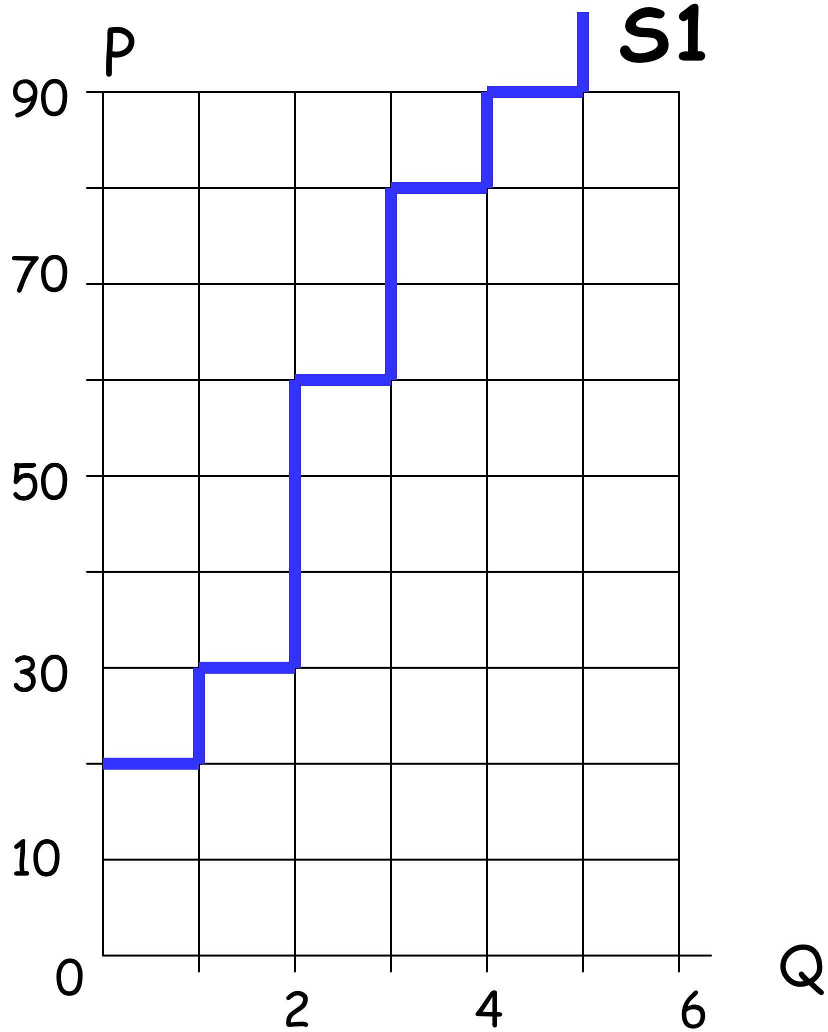
  NOTE: As will be illustrated below, the true total supply schedule $P = S(Q)$ is constructed from the individual sellers' true supply schedules by placing the sellers' reservation prices in *ascending* order, from the lowest to the highest.

- **True Total Demand Schedule:** A schedule $P = D(Q)$ giving the maximum buyer reservation price P for the "last" quantity unit demanded at each quantity amount Q.

  NOTE: As will be illustrated below, the true total demand schedule $P = D(Q)$ is constructed from the individual buyers' true demand schedules by placing the buyers' reservation prices in *descending* order, from the highest to the lowest.

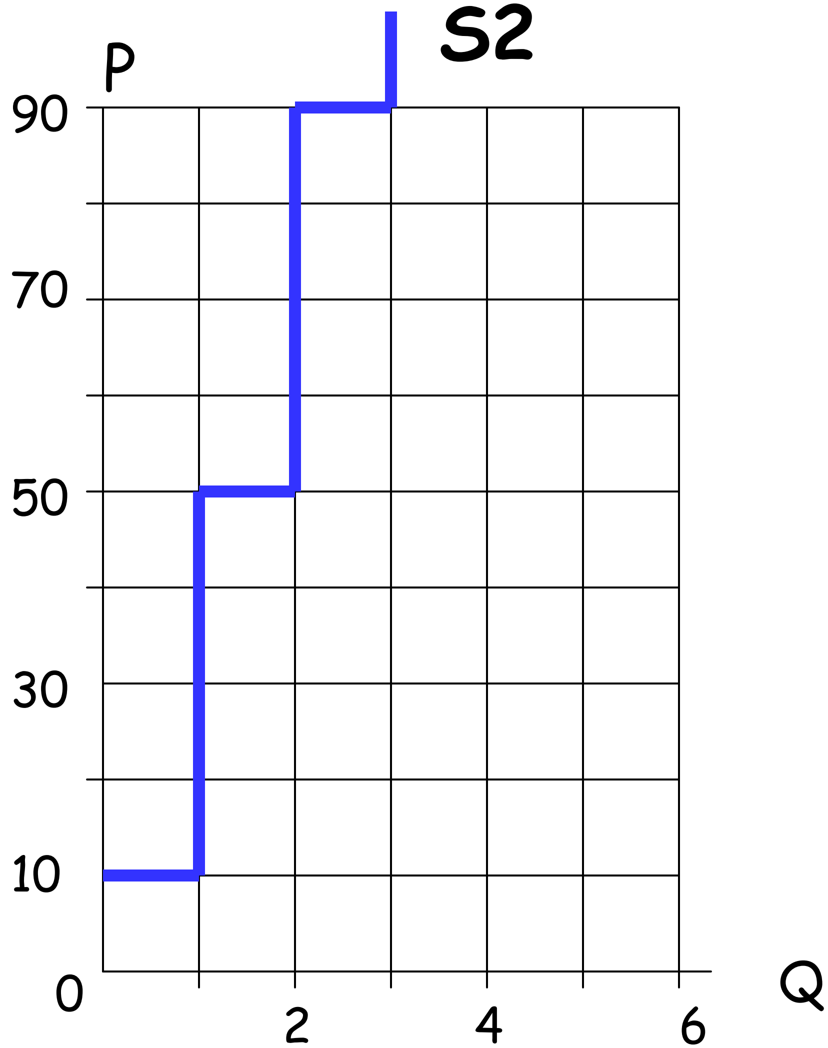
Illustrative Construction of Total Supply and Demand Schedules

Seller 1 Supply Schedule S1



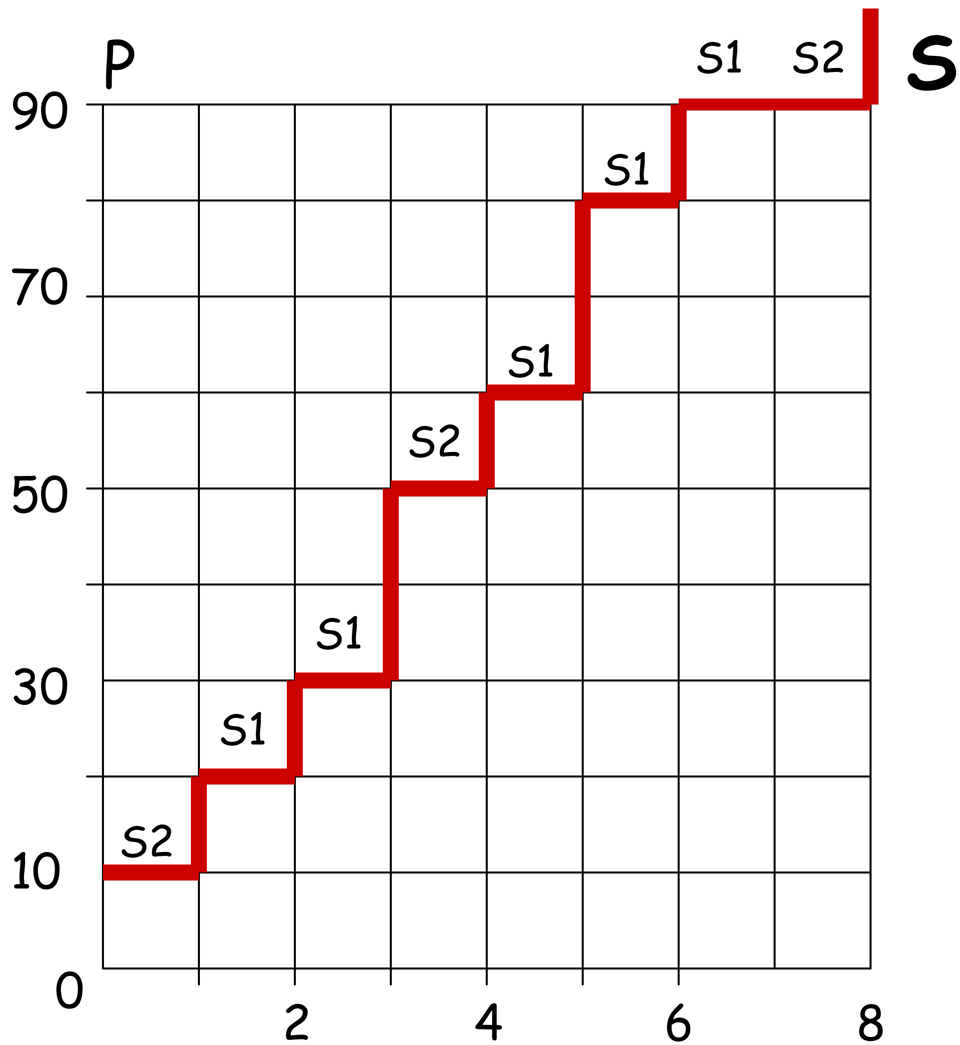
Bushel Unit	Seller 1 Price
1	$20
2	$30
3	$60
4	$80
5	$90
6	∞

Seller 2 Supply Schedule S2



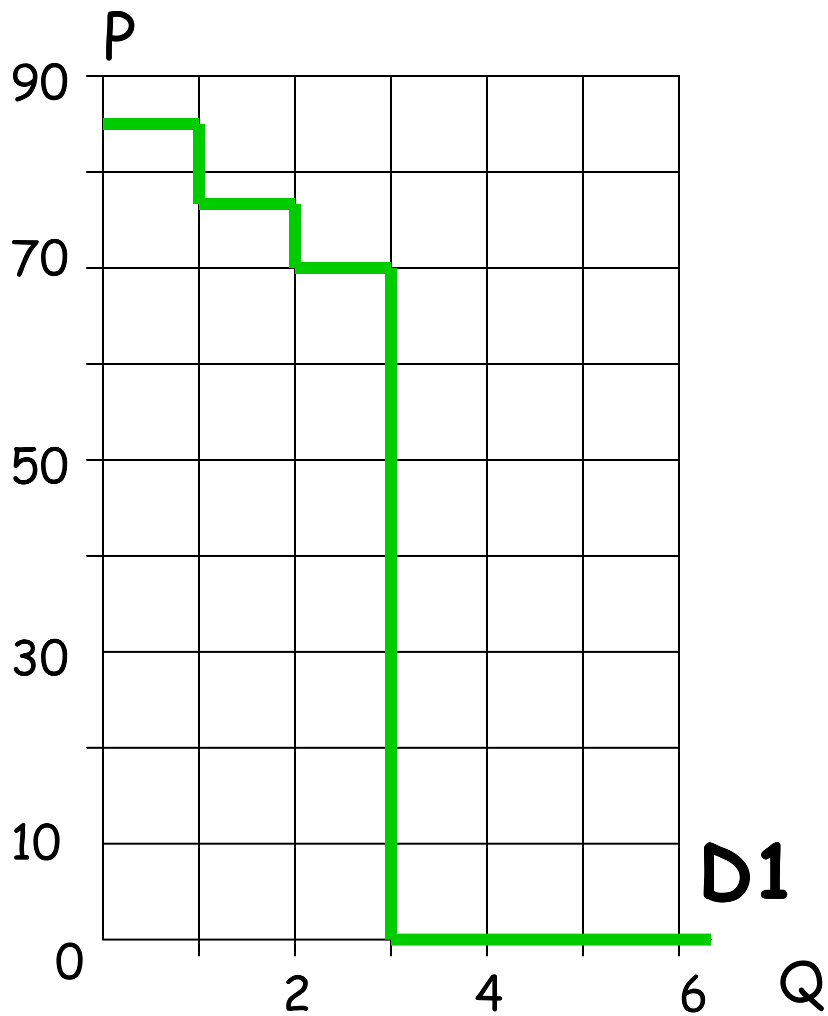
Bushel Unit	Seller 2 Price
1	$10
2	$50
3	$90
4	∞

True Total Supply Schedule S



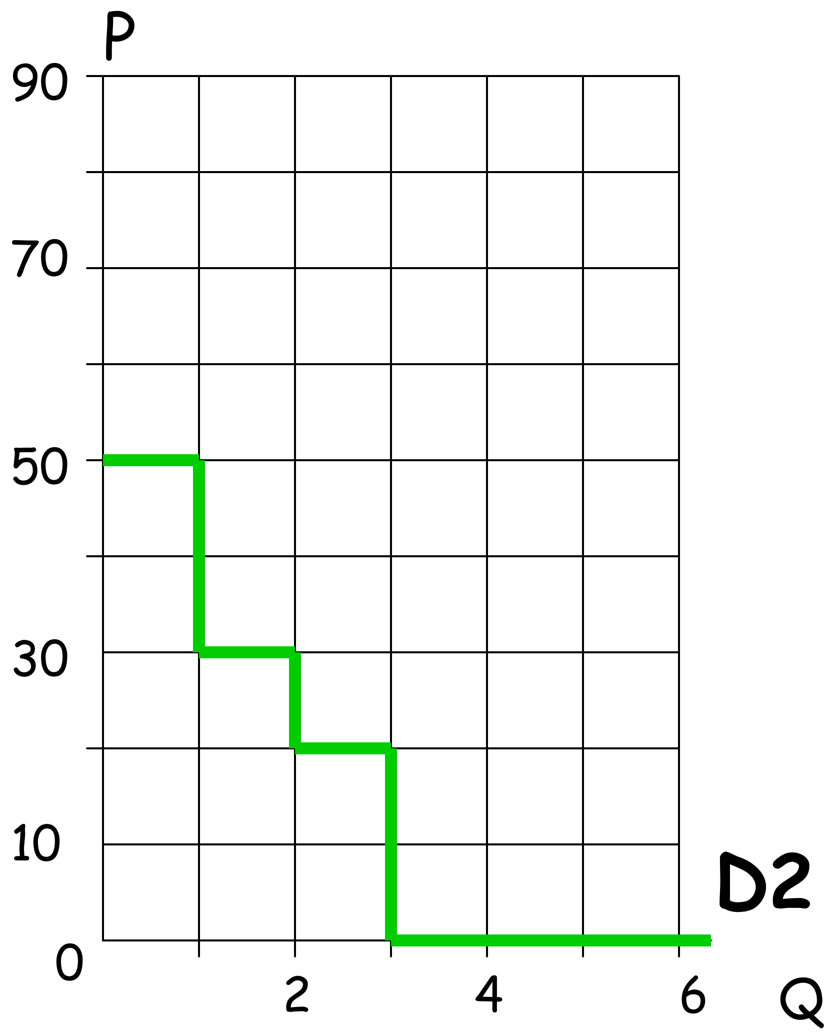
Bushel Unit	Min Seller Price
1	\$10 (S2)
2	\$20 (S1)
3	\$30 (S1)
4	\$50 (S2)
5	\$60 (S1)
6	\$80 (S1)
7	\$90 (S1/S2)
8	\$90 (S2/S1)
9	∞

Buyer 1 Demand Schedule D1



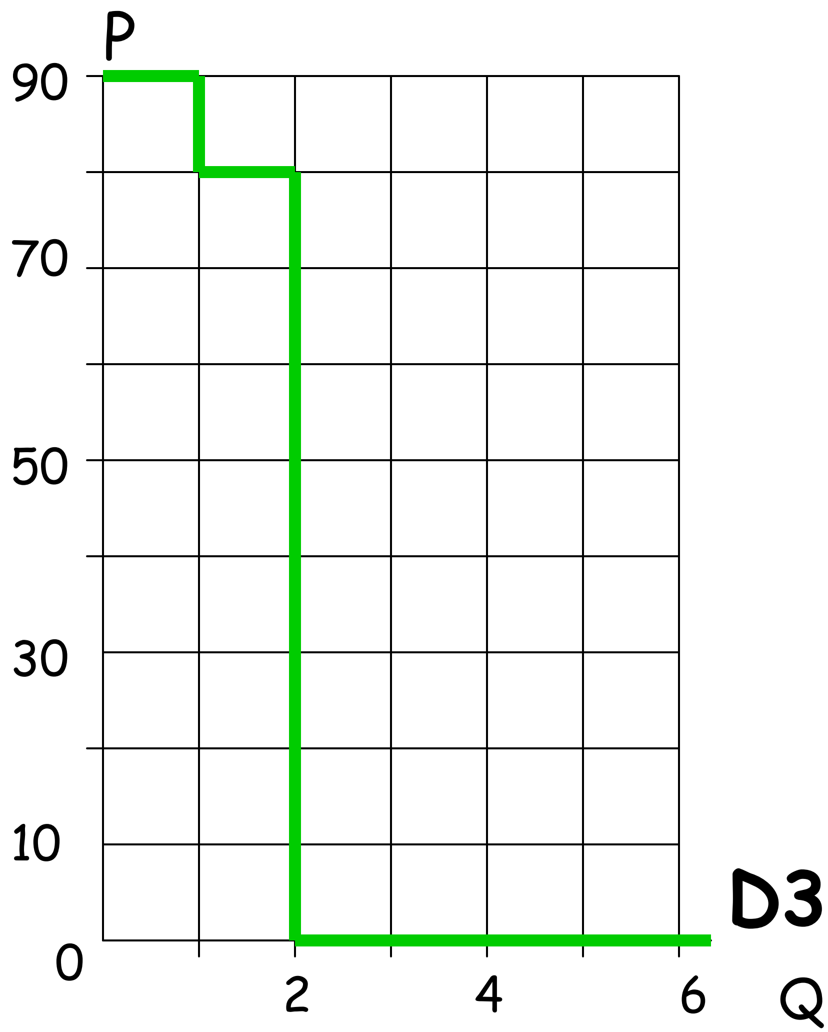
Bushel Unit	Buyer 1 Price
1	$84
2	$76
3	$70
4	$ 0

Buyer 2 Demand Schedule D2



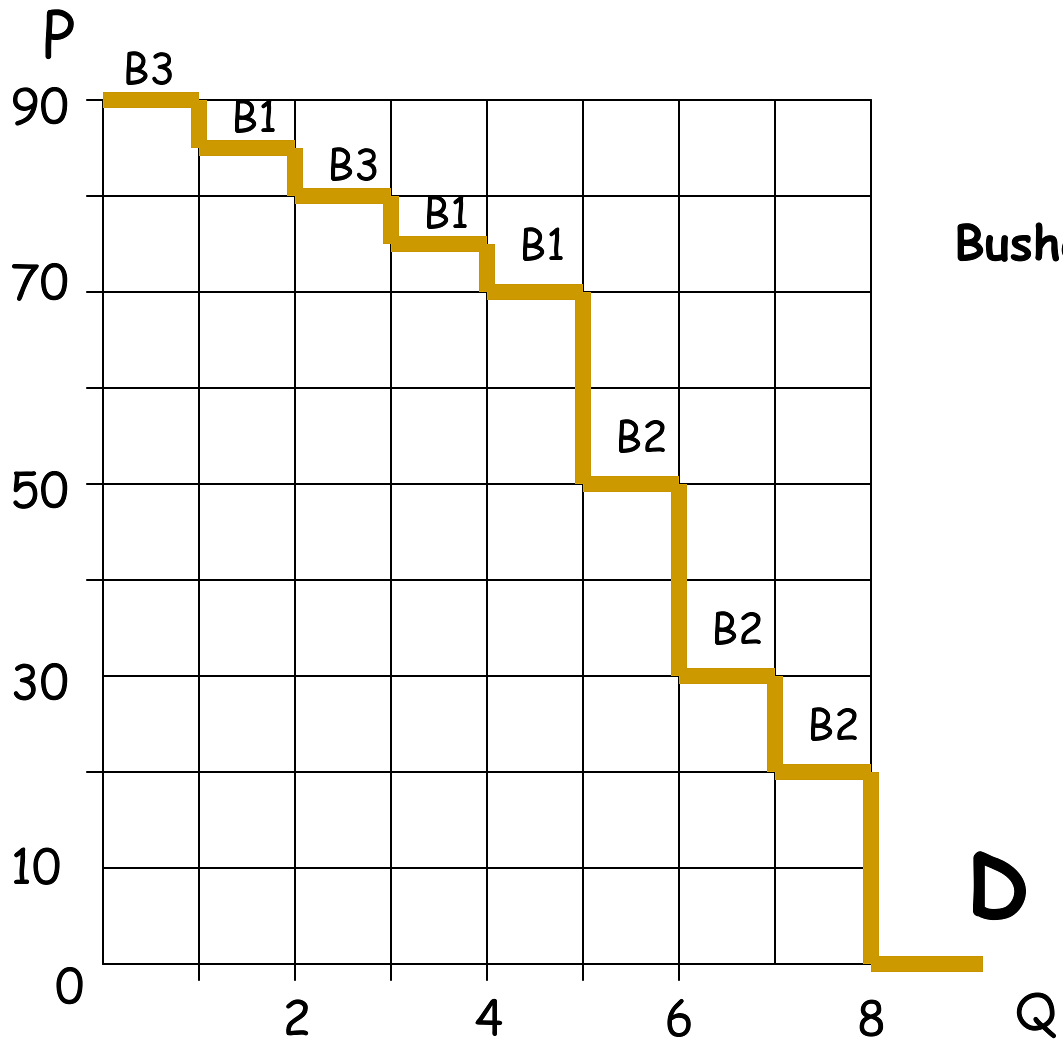
Bushel Unit	Buyer 2 Price
1	$50
2	$30
3	$20
4	$ 0

Buyer 3 Demand Schedule D3



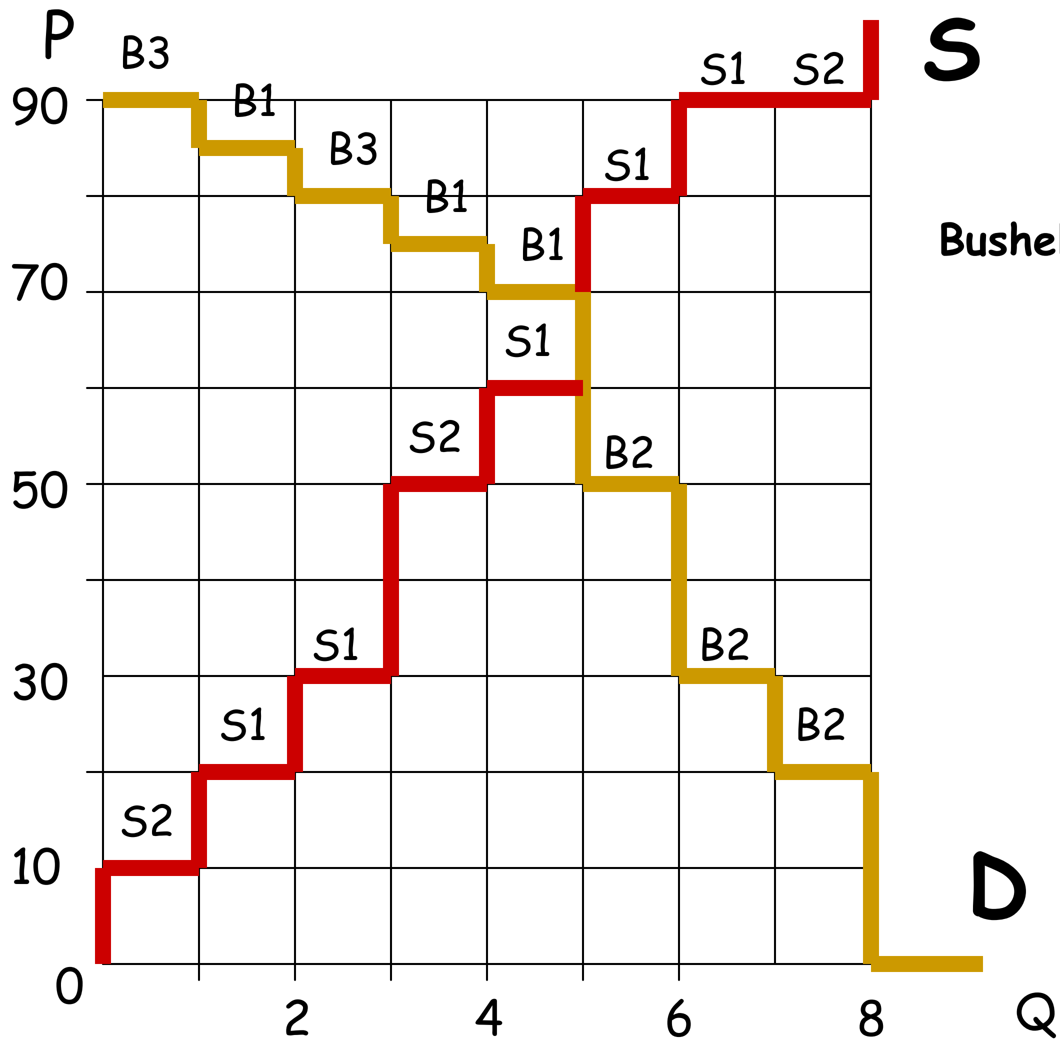
Bushel Unit	Buyer 3 Price
1	$90
2	$80
3	$ 0

True Total Demand Schedule D



Bushel Unit	Max Buyer 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

Depicting True Total Supply Schedule and True Total Demand Schedule on One Graph



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	∞

- Competitive Market Clearing (CMC) Point (Q^*, P^*):

A quantity-price point (Q^*, P^*) is called a *Competitive Market Clearing (CMC) Point* if the following condition holds:

> Graphical plots of the True Total Supply Schedule $P = S(Q)$ and the True Total Demand Schedule $P = D(Q)$ (with vertical segments included) intersect at the quantity-price point (Q^*, P^*). That is,
>
> $$P^* = S(Q^*) = D(Q^*) \quad (1)$$

The price P^* is called a *Competitive Market Clearing (CMC) price for Q*.

The quantity Q^* is called a *Competitive Market Clearing (CMC) output level* for Q.

ECONOMIC INTERPRETATION OF CMC POINTS:

Geometrically speaking, CMC points are intersection points of the True Total Demand Schedule and True Total Supply Schedule (with vertical portions included). But what does this mean expressed in more direct economic terms?

Consider the following alternative dynamically-expressed definition for CMC points.

A point (Q^*, P^*) is a CMC point if and only if the following two conditions hold at this point:

– Taking P^* as the given market price, no seller perceives an opportunity at (Q^*, P^*) to STRICTLY increase his extracted Net Surplus either by offering to sell additional quantity units or by withdrawing quantity units from sale.

– Taking P^* as the given market price, no buyer perceives an opportunity at (Q^*, P^*) to STRICTLY increase his extracted Net Surplus either by offering to buy additional quantity units or by buying fewer quantity units.

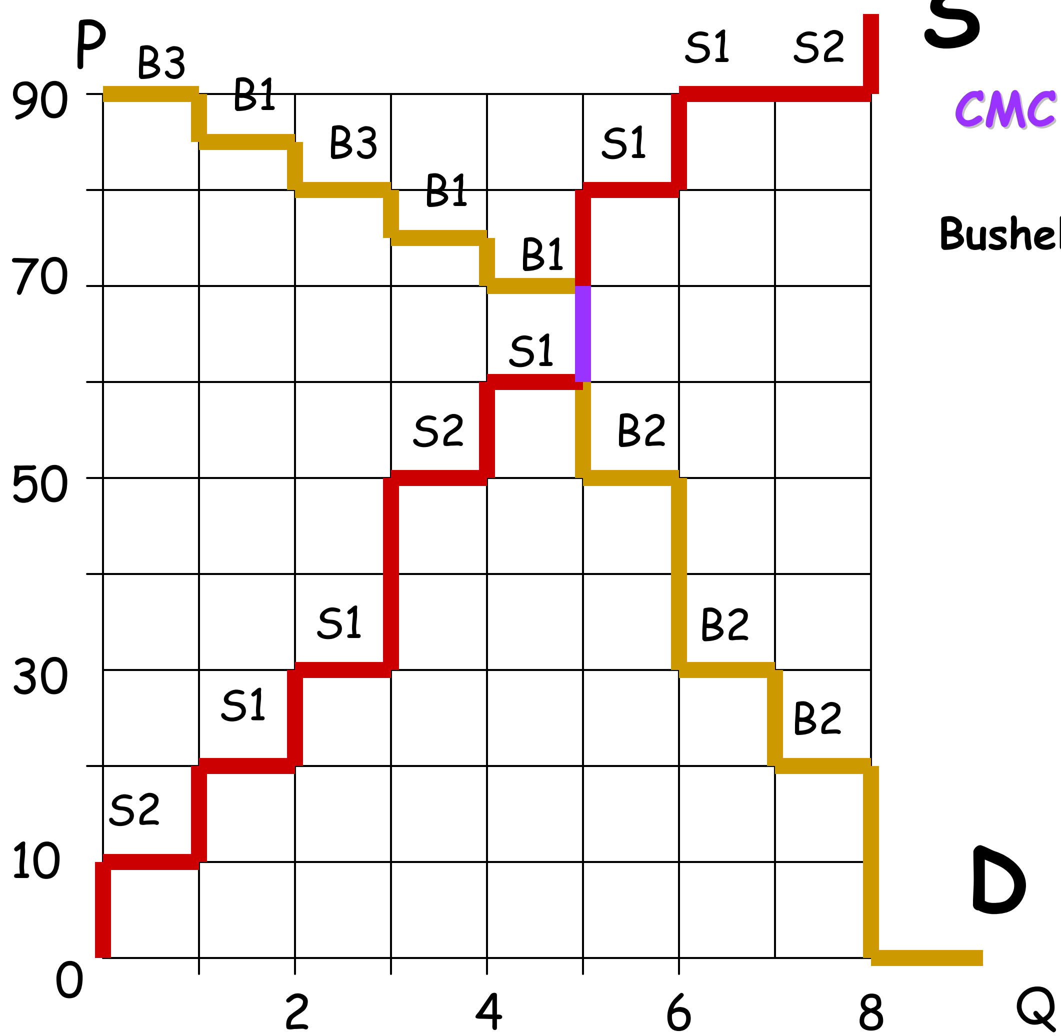
The (Q, P) points satisfying these two “no-more-surplus” conditions are precisely the intersection points of the True Total Demand Schedule and True Total Supply Schedule (with vertical portions included).

Such intersection points can either be unique, or multiple in number, or fail to exist.

Multiplicity of intersection points becomes a possibility only for “step function” demand and supply schedules that have flat segments (either horizontally or vertically).

Illustrative examples of total demand and supply schedules are given on the following pages. For each example, try to determine how at least one of the above “no-more-surplus” conditions FAILS to hold at any point OTHER than the indicated CMC (intersection) points.

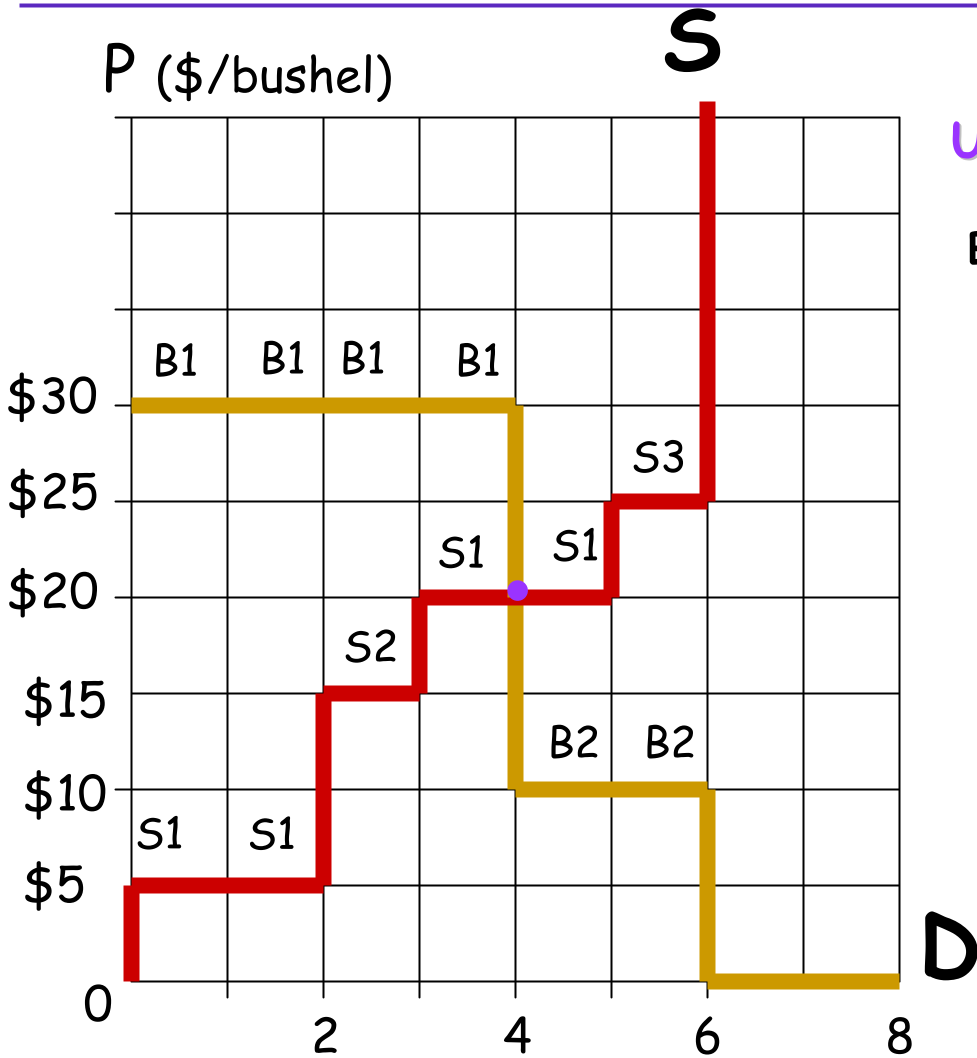
Calculating CMC Points: Illustrative Example 1



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	∞

Calculating CMC Points: Illustrative Example 2

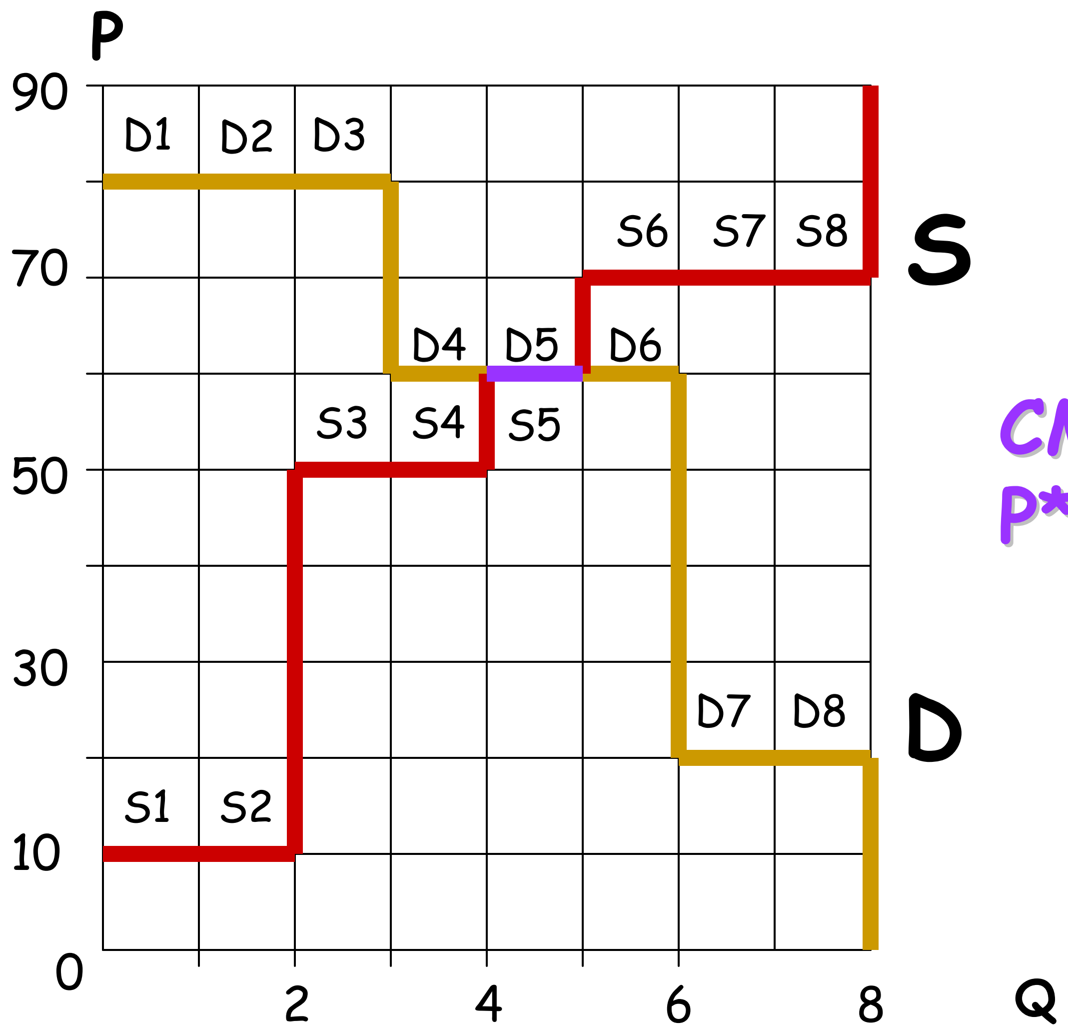


Unique CMC Pt: Q*=4, P*= $20

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	∞

Q (bushels of apples)

Calculating CMC Points: Illustrative Example 3



CMC Points:
P*=$60, 4 ≤ Q*≤ 5

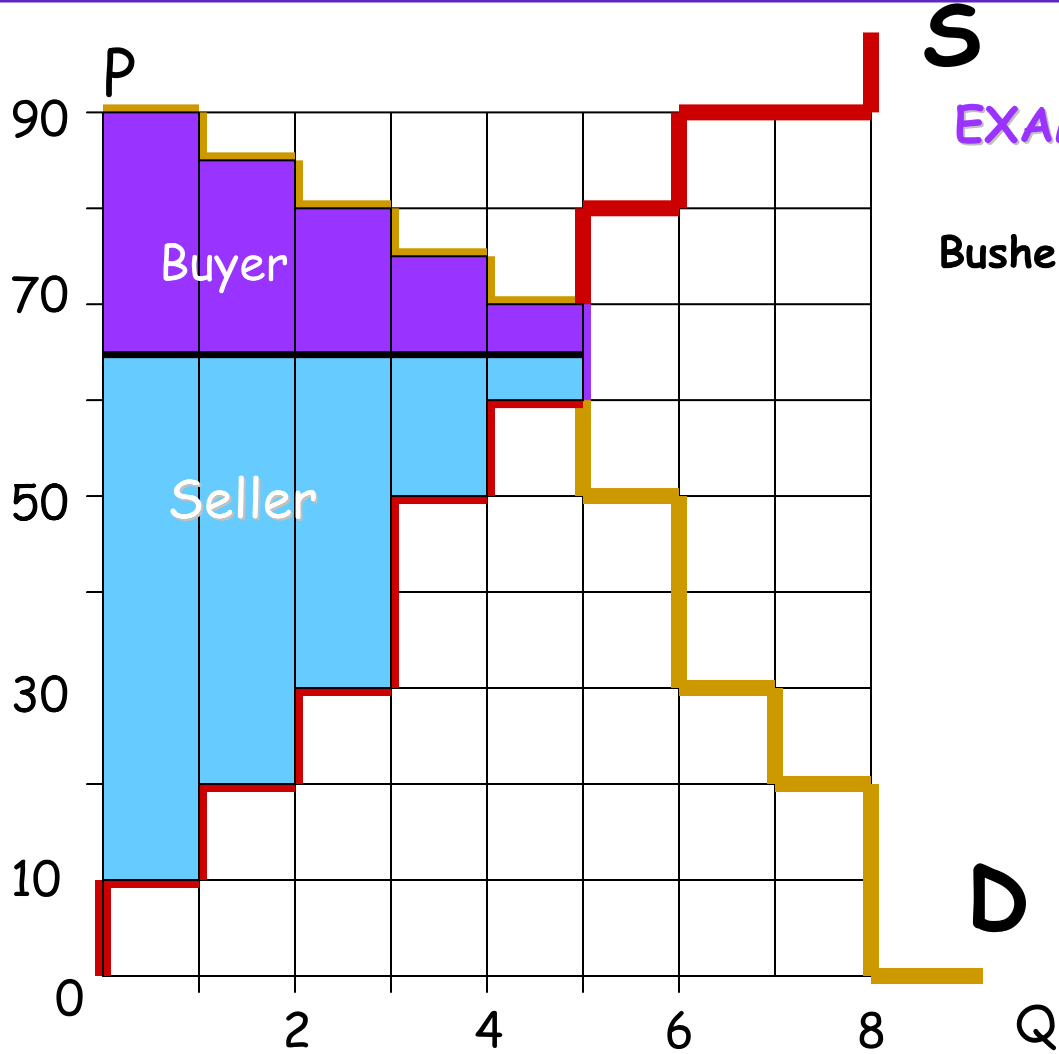
- **Net Seller Surplus at the CMC Point:** The area between the CMC price P^* and the true total supply curve, up to the CMC output level Q^*.

  NOTE: Net seller surplus at the CMC point is a measure of seller welfare at this point. It measures the difference between what sellers would actually receive for the sale of Q^* units at the CMC point and what they would have been willing to receive for each successive unit of Q sold from $Q = 0$ to $Q = Q^*$.

- **Net Buyer Surplus at the CMC Point:** The area between the true total demand curve and the market price P^*, up to the CMC output level Q^*.

  NOTE: Net buyer surplus at the CMC point is a measure of buyer welfare at this point. It measures the difference between what buyers would have been willing to pay for each successive unit of Q bought from $Q = 0$ to $Q = Q^*$ and what they would actually pay for the purchase of Q^* units at the CMC point.

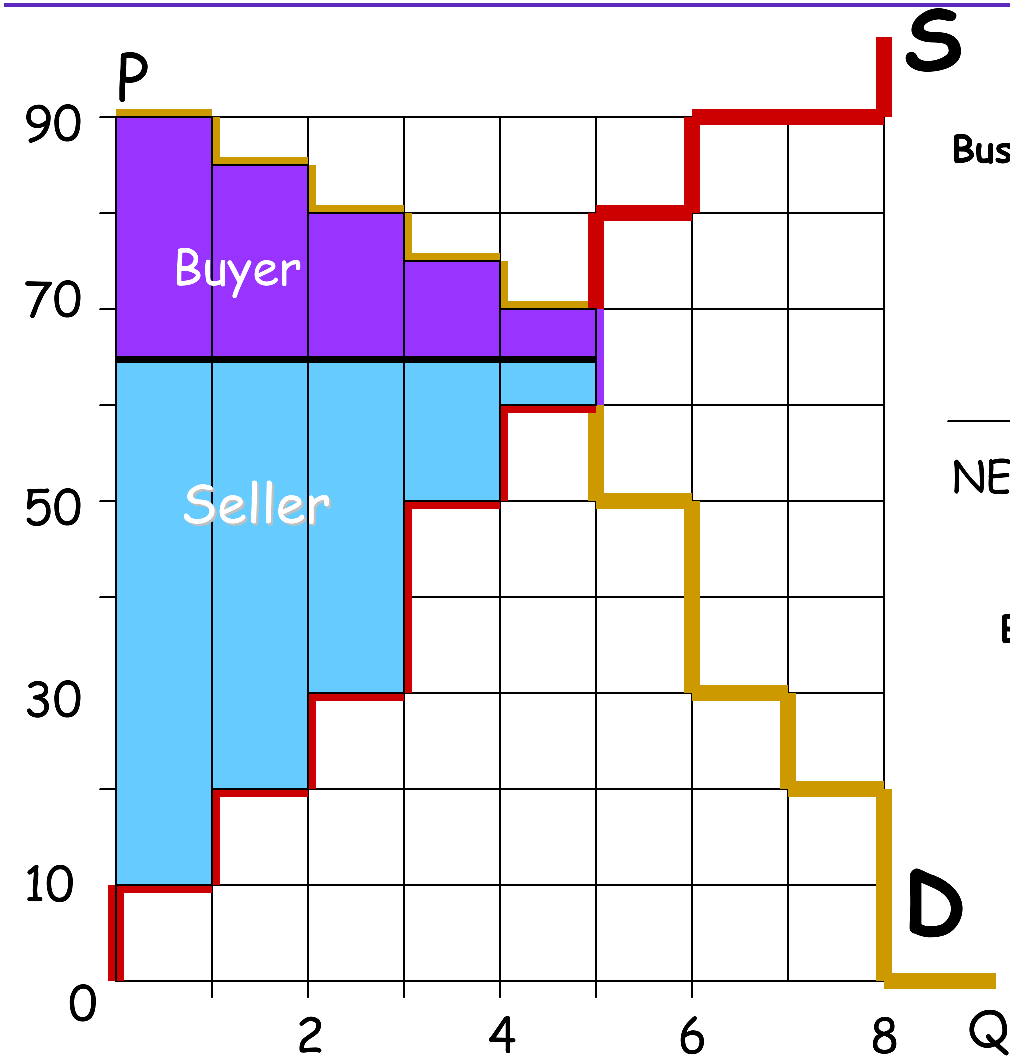
Example: Calculation of Net Buyer/Seller Surplus at CMC Points



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	∞

Example: Calculation of Net Buyer/Seller Surplus at CMC Points … Continued



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

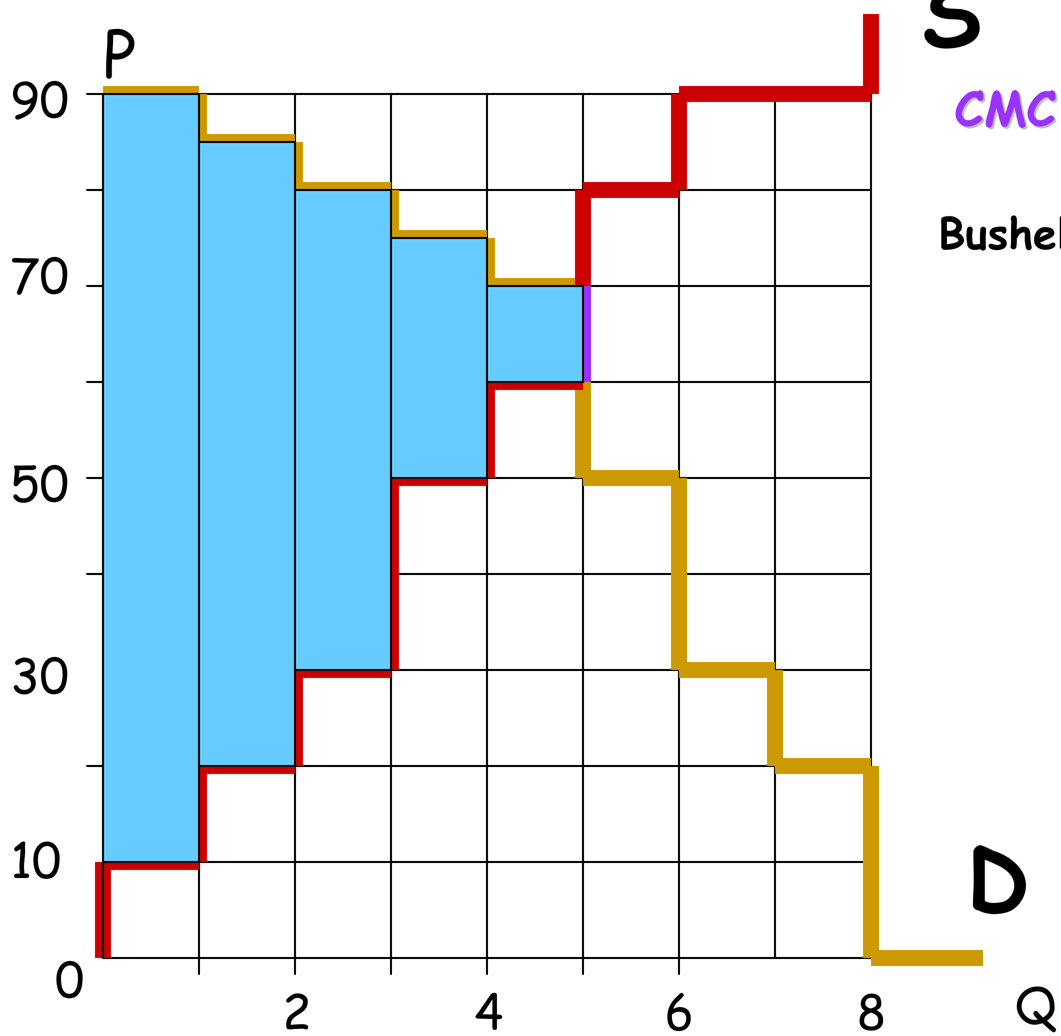
- **Total Net Surplus at the CMC Point:** The sum of net seller surplus and net buyer surplus at the CMC point.

  Important Observation:

  It can be proved, mathematically, that the total net surplus at the CMC point is the MAXIMUM amount of net surplus that can be extracted from the market.

  That is, there is no way to arrange trades among the buyers and sellers so that total net surplus is greater than at the CMC point.

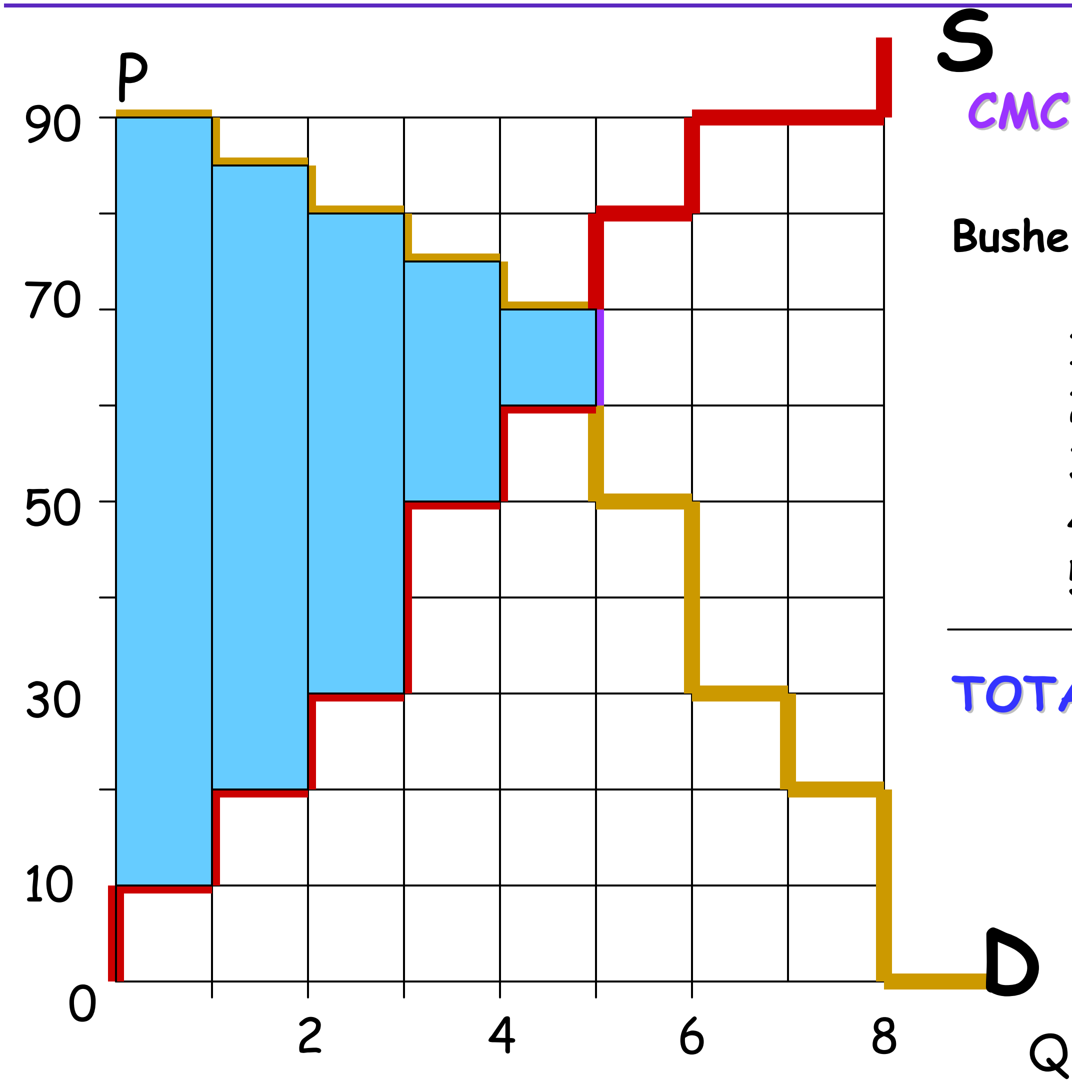
Example: Calculation of Total Net Surplus at CMC Points



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	∞

Example: Calculation of Total Net Surplus at CMC Points…Cont.



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

- **Seller Offer (Ask):** An offer to sell made by a SELLER in a market for some good, service, or financial asset.

  NOTE: Since sellers are interested in obtaining the highest possible price for each quantity unit they sell, seller OFFER prices can differ from seller RESERVATION prices.

  Also, the type of seller offer depends on the pricing system for the market. For example, a seller offer could take the simple form of an offer to sell one quantity unit at some particular unit price, or it could take the form of a supply schedule.

- **Buyer Offer (Bid) for Q:** An offer to buy made by a BUYER in a market for some good, service, or financial asset.

  NOTE: Since buyers are interested in obtaining the lowest possible price for each quantity unit they purchase, buyer OFFER prices can differ from buyer RESERVATION prices.

  Also, the type of buyer offer depends on the pricing system for the market. For example, a buyer offer could take the simple form of an offer to buy one quantity unit at some particular unit price, or it could take the form of a demand schedule.

- Expressed Total Supply Schedule: A schedule giving the minimum seller offer price for each successive quantity unit supplied.

  NOTE: The expressed total supply schedule is constructed from all seller offers by placing the sellers' offer prices in *ascending* order, from the lowest to the highest.

- Expressed Total Demand Schedule: A schedule giving the maximum buyer offer price for each successive quantity unit demanded.

  NOTE: The expressed total demand schedule is constructed from all buyer offers by placing the buyers' offer prices in *descending* order, from the highest to the lowest.

- **Market E ciency:** Market e ciency is a measure of the extent to which total net surplus has been e ectively extracted from a market.

  Let *MaxNetSurplus* denote the MAXIMUM possible total net surplus that sellers and buyers could extract from a market, given the current market structure. If a CMC point exists, then MaxNetSurplus coincides with the total net surplus extracted at the CMC point.

  Let *ActualNetSurplus* denote the ACTUAL total net surplus that sellers and buyers manage to extract in this market.

  Then market e ciency (ME) can be measured by

$$\text{ME} \quad = \quad 100\% \times \frac{\text{ActualNetSurplus}}{\text{MaxNetSurplus}} \qquad (2)$$

It is also useful to have a measure of market efficiency LOSS, i.e., the amount of surplus that sellers and buyers FAIL to extract from a market.

Market efficiency loss can be expressed as

$$\text{MELoss} \quad = \quad 100\% \times \frac{\text{MaxNetSurplus - ActualNetSurplus}}{\text{MaxNetSurplus}} \tag{3}$$

By construction, MELoss is greater or equal to zero.

A positive MELoss can arise if some trades that SHOULD occur do NOT actually take place, or if some trades that should NOT occur DO actually take place.

These situations can arise if the “right” group of sellers and buyers simply fail to locate one another, or if they make such aggressive asks or bids when they do locate one another that they fail to trade.

More precisely, suppose that a CMC point (Q^*, P^*) exists for a market, and that all quantity units with seller reservation price not exceeding P^* would be bought at this CMC point.

Call each quantity unit with a seller reservation price not exceeding P^* an *inframarginal* quantity unit.

Call each quantity unit with a seller reservation price greater than P^* an *extramarginal* quantity unit.

Then a positive MELoss can arise if either:

– Some *infra*marginal quantity unit is NOT bought in the ACTUAL market,

– or some *extra*marginal quantity unit IS bought in the ACTUAL market.

Market e ciency measures the TOTAL amount of net surplus extracted in a market. Another important consideration is the DISTRIBUTION of this net surplus – who gets what? – who secures a greater “market advantage”?

Suppose that a CMC point (Q^{*},P^{*}) exists for some market.

Let i denote any seller or buyer participating in the market.

Let *iCMCNetSurplus* denote the POTENTIAL net surplus that seller or buyer i would obtain at this CMC point.

Let *iActualNetSurplus* denote the ACTUAL net surplus attained by seller or buyer i from participation in this market.

Then the *Market Advantage* of seller or buyer i in this market can be measured by

$$\text{iMAdvantage} = 100\% \times \frac{\text{iActualNetSurplus} - \text{iCMCNetSurplus}}{\text{MaxNetSurplus}}. \tag{4}$$

Let TotMAdvantage denote the sum of iMAdvantage over all sellers and buyers participating in this market, whether they actually succeed in trading or not. Note that

$$\text{TotMAdvantage} \;=\; 100\% \times \frac{\text{ActualNetSurplus - MaxNetSurplus}}{\text{MaxNetSurplus}} \tag{5}$$

Thus, TotMAdvantage = [-1]×MELoss, where MELoss is the measure defined earlier for market e ciency loss.

By construction, TotMAdvantage is at most zero.

This simply says that the total surplus actually extracted by the buyers and sellers in a market cannot exceed the total surplus that they would extract at a CMC point, since this would contradict the fact that maximum market e ciency (maximum extracted surplus) is achieved at any CMC point.

Roughly speaking, a seller or buyer is said to have *MARKET POWER* if they are able to secure for themselves a positive market advantage in the sense defined above; see Holt[1, p. 392].

Typically, however, economists focus on a narrower definition of market power, as follows:

> A market participant has *market power* if they can secure a positive market advantage for themselves through the deliberate manipulation of the actual market price away from the CMC price level.

The measurement of market power is complicated since it refers to a POTENTIAL ability to secure a positive market advantage through DELIBERATE actions.

Thus, traders can possess market power (the POTENTIAL ability to secure market advantage) without ever having EXERCISED this market power to actually secure positive market advantages.

For an excellent discussion of these issues, see Chapter 4 (“Market Power”) by Steven Stoft [2].

References

[1] Charles A. Holt (1995), "Industrial Organization: A Survey of Laboratory Research," pp. 349–443 in John H. Kagel and Alvin E. Roth, *Handbook of Experimental Economics*, Princeton University Press, Princeton, N.J.

[2] Steven Stoft, *Power System Economics: Designing Markets for Electricity*, IEEE Press, Wiley-Interscience, 2002.