

Supply & Demand

APEC 3001

Summer 2007

Readings: Chapter 2 in Frank

Objectives

- Demand & Supply and Law of Demand & Supply
- Describing Markets
- Market Equilibrium & The Function of Price
- Consumer & Producer Surplus and the Efficiency of Market Equilibrium
- Equity of Market Equilibrium
- Effect of Taxes & Subsidies On Market Equilibrium & Efficiency
- Determinants of Supply & Demand and Quantity Supplied & Demanded
- Predicting Price & Quantity Changes for Changes in Market Conditions

General Definitions

- Product:
 - A good or service.
- Real Price:
 - The price of a product relative to the price of other products.
- Buyer:
 - A person who wants to purchase a product.
- Seller:
 - A person who wants to sell a product.

Demand & Supply Definitions

- Demand (Curve/Function):
 - The relationship between the price of a product and the quantity buyers want to purchase.
- Quantity Demanded:
 - The amount of product buyers want to purchase at a given price.
- Supply (Curve/Function):
 - The relationship between the price of a product and the quantity sellers want to offer.
- Quantity Supplied:
 - The amount of product sellers want to offer at a given price.

Law of Demand & Supply

- Law of Demand:
 - The observation that when the price of a product falls, people buy more of it.
- Law of Supply:
 - The observation that when the price of a product rises, people sell more of it.

Describing Demand & Supply

- Tabular
- Graphical
- Specific Function
- General Linear Function
- Really General Function

Tabular Example

Demand

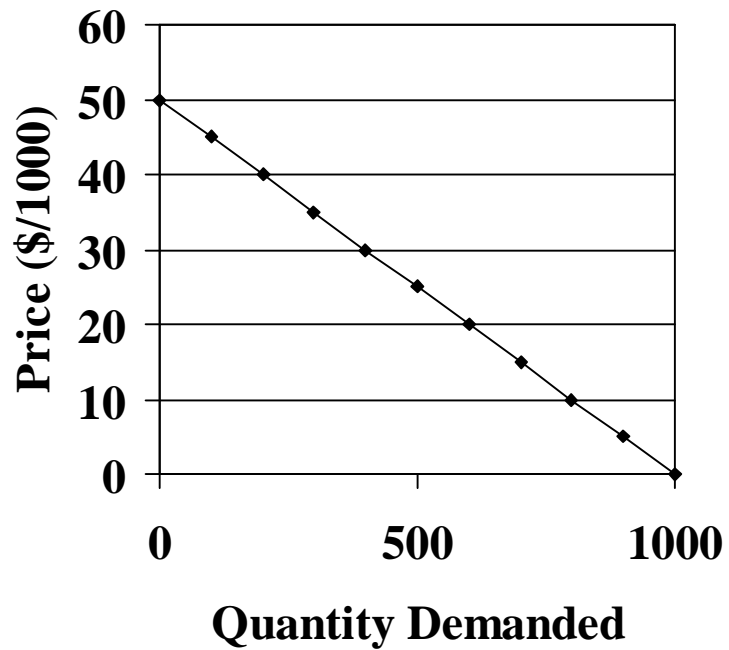
Price (P/1000)	Quantity Demanded (Q_D)
\$50	0
\$45	100
\$40	200
\$35	300
\$30	400
\$25	500
\$20	600
\$15	700
\$10	800
\$5	900
\$0	1,000

Supply

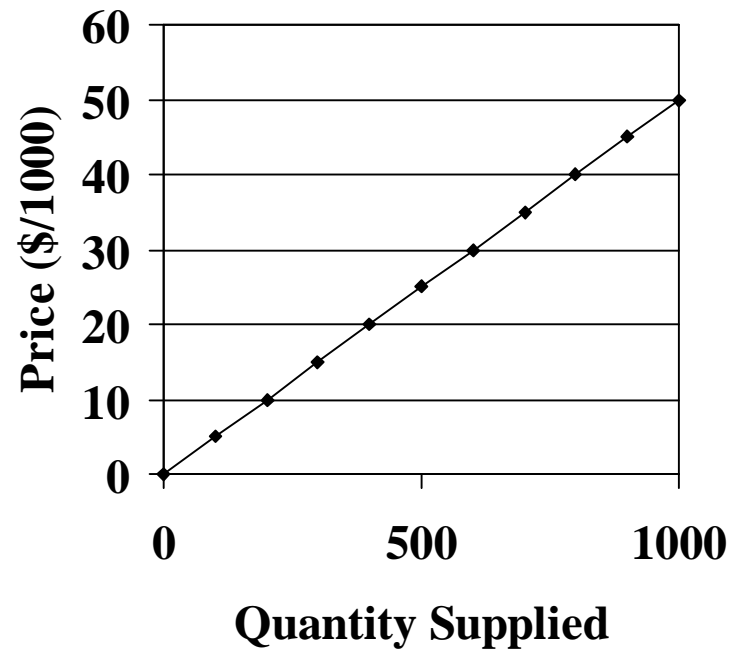
Price (P/1000)	Quantity Supplied (Q_S)
\$50	1,000
\$45	900
\$40	800
\$35	700
\$30	600
\$25	500
\$20	400
\$15	300
\$10	200
\$5	100
\$0	0

Graphical Example

Demand



Supply



Function Examples

- Demand
 - Specific
 - $Q_D = 1,000 - 20P$
 - $P = 50 - 0.05Q_D$
 - General Linear
 - $Q_D = a_D - b_DP$
 - $P = a_D/b_D - Q_D/b_D$
 - Really General
 - $Q_D = D(P)$
 - $P = D^{-1}(Q_D)$
- Supply
 - Specific
 - $Q_S = 20P$
 - $P = 0.05Q_S$
 - General Linear
 - $Q_S = a_S + b_S P$
 - $P = a_S/b_S + Q_S/b_S$
 - Really General
 - $Q_S = S(P)$
 - $P = S^{-1}(Q_S)$

Implications of the Law of Supply & Demand

- Law of Demand
 - Negative Relationship Between Quantity Demanded & Price
 - Demand Downward Sloping
 - $b_D < 0$
 - $D'(P) < 0$
 - $D^{-1}'(Q_D) < 0$
- Law of Supply
 - Positive Relationship Between Quantity Supplied & Price
 - Supply Upward Sloping
 - $b_S > 0$
 - $S'(P) > 0$
 - $S^{-1}'(Q_S) > 0$

Describing Markets

Definition

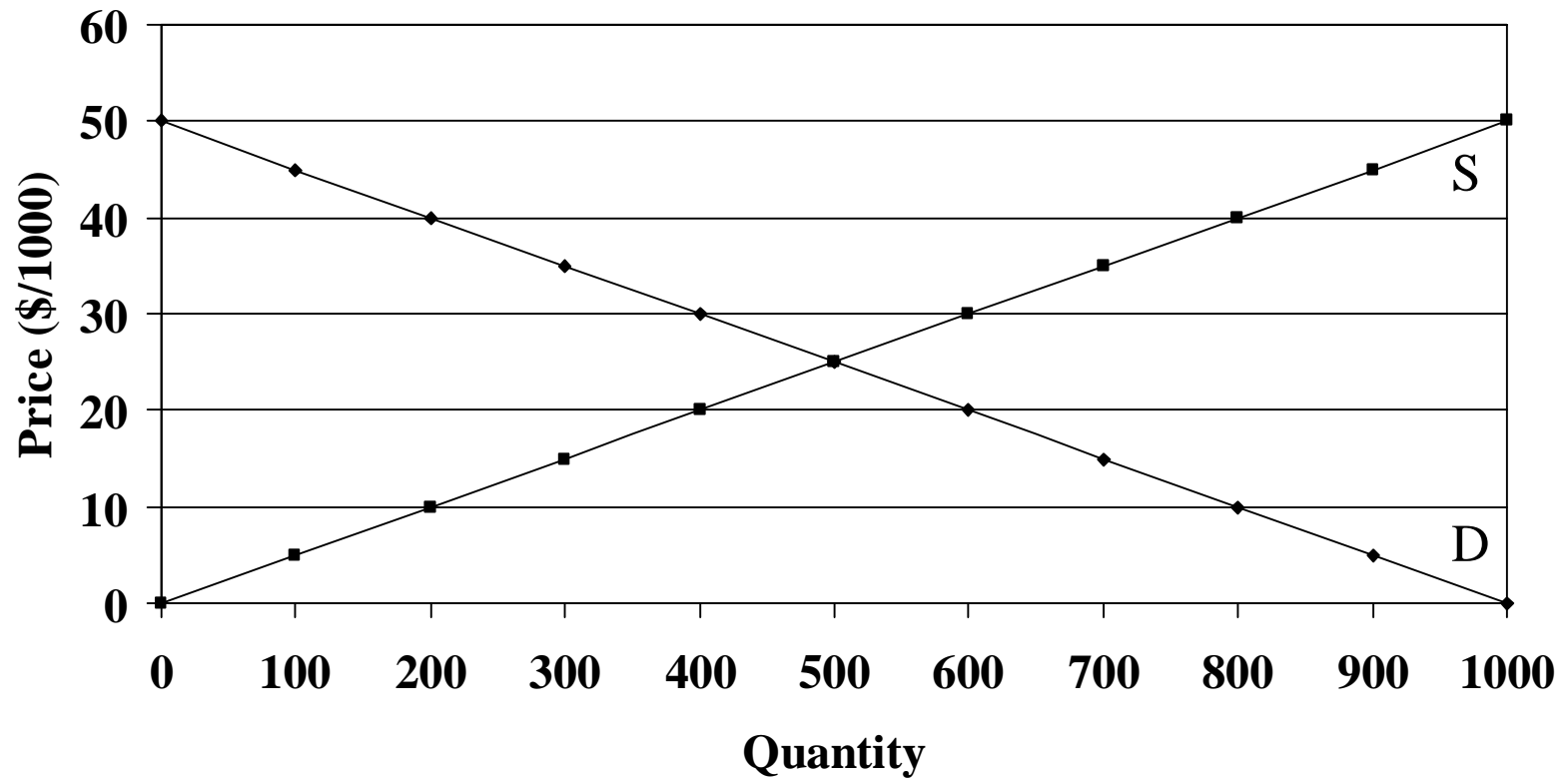
- Market:
 - A collection of buyers and sellers voluntarily exchanging a product.

Important: Exchange Is Voluntary

Tabular Market Example

Price (P)	Quantity Demanded (Q_D)	Quantity Supplied (Q_S)
\$50	0	1,000
\$45	100	900
\$40	200	800
\$35	300	700
\$30	400	600
\$25	500	500
\$20	600	400
\$15	700	300
\$10	800	200
\$5	900	100
\$0	1,000	0

Graphical Market Example



Function Market Example

- Specific
 - $Q_D = 1,000 - 20P$
 - $Q_S = 20P$
- General Linear
 - $Q_D = a_D - b_D P$
 - $Q_S = a_S + b_S P$
- Really General
 - $Q_D = D(P)$
 - $Q_S = S(P)$

Market Equilibrium & The Function of Price

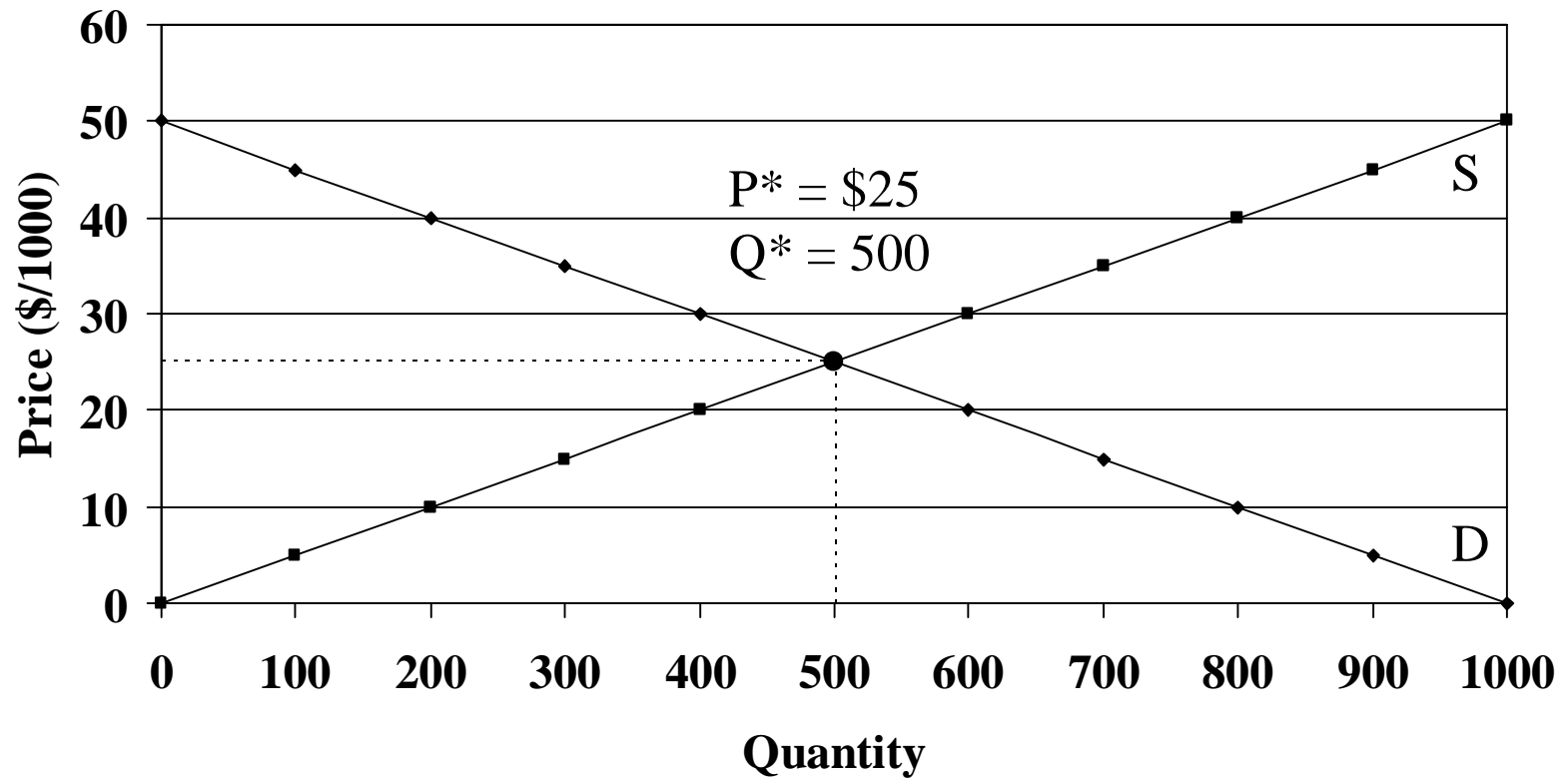
Definitions

- **Excess Demand/Shortage:**
 - The amount by which the quantity demanded exceeds the quantity supplied at a given price.
- **Excess Supply/Surplus:**
 - The amount by which the quantity supplied exceeds the quantity demanded at a given price.
- **Equilibrium Price:**
 - The price at which there is no surplus or shortage.
- **Equilibrium Quantity:**
 - The quantity at which there is no surplus or shortage.

Tabular Example of Market Equilibrium

Price (P)	Quantity Demanded (Q _D)	Quantity Supplied (Q _S)	Shortage	Surplus
\$50	0	1,000	-	1,000
\$45	100	900	-	800
\$40	200	800	-	600
\$35	300	700	-	400
\$30	400	600	-	200
P*=\$25	Q*=500	Q*=500	0	0
\$20	600	400	200	-
\$15	700	300	400	-
\$10	800	200	600	-
\$5	900	100	800	-
\$0	1,000	0	1000	-

Graphical Example of Market Equilibrium



Specific Function Example

$$Q_D^* = Q_S^* = Q^* \text{ for } Q_D^* = 1,000 - 20P^* \text{ \& } Q_S^* = 20P^* \Rightarrow$$

$$1,000 - 20P^* = 20P^* \Rightarrow$$

$$1,000 - 20P^* + 20P^* = 20P^* + 20P^* \Rightarrow$$

$$1,000 = 40P^* \Rightarrow$$

$$P^* = 25 \Rightarrow$$

$$Q^* = Q_D^* = 1,000 - 20 \times 25 = 500$$

$$Q^* = Q_S^* = 20 \times 25 = 500$$

General Linear Function Example

$$Q_D^* = Q_S^* = Q^* \text{ for } Q_D^* = a_D - b_D P^* \text{ \& } Q_S^* = a_S + b_S P^* \Rightarrow$$

$$a_D - b_D P^* = a_S + b_S P^* \Rightarrow$$

$$a_D - a_S - b_D P^* + b_D P^* = a_S - a_S + b_S P^* + b_D P^* \Rightarrow$$

$$a_D - a_S = (b_S + b_D) P^* \Rightarrow$$

$$P^* = (a_D - a_S) / (b_S + b_D) \Rightarrow$$

$$Q^* = Q_D^* = a_D - b_D ((a_D - a_S) / (b_S + b_D)) = (a_D b_S + a_S b_D) / (b_S + b_D)$$

$$Q^* = Q_S^* = a_S + b_S ((a_D - a_S) / (b_S + b_D)) = (a_D b_S + a_S b_D) / (b_S + b_D)$$

Really General Function Example

$$Q_D^* = Q_S^* = Q^* \text{ for } Q_D^* = D(P^*) \text{ \& } Q_S^* = S(P^*) \Rightarrow$$

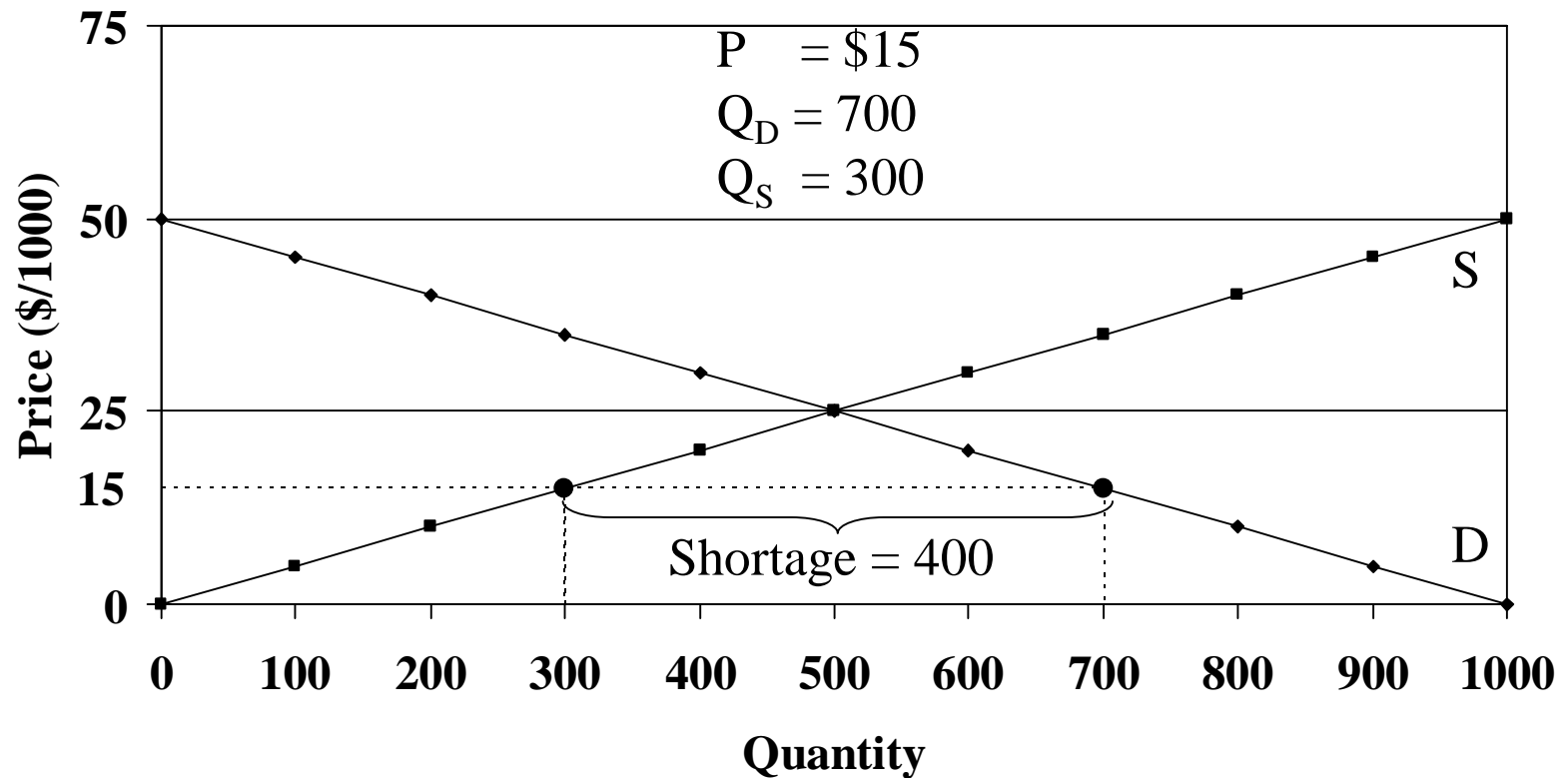
$$D(P^*) = S(P^*)$$

With really general function, we cannot solve explicitly for P^* and Q^* .

How do markets find equilibrium?

- Suppose the demand and supply for a Prius is
 - $Q_D = 1,000 - 20P$
 - $Q_S = 20P$
- Further suppose the price on the table for a Prius is \$15K.
 - $Q_D = 1,000 - 20 \times 15 = 700$
 - $Q_S = 20 \times 15 = 300$
 - $Q_D > Q_S$ means there is a shortage, so all interested sellers can make their sales, but all interested buyers will not find an agreeable seller.
 - If you are a buyer who values a Prius more than \$15K, wouldn't you be willing to offer a price higher than \$15K?
 - As long as there is a shortage, some buyers are willing to pay a higher price in order to make a purchase.

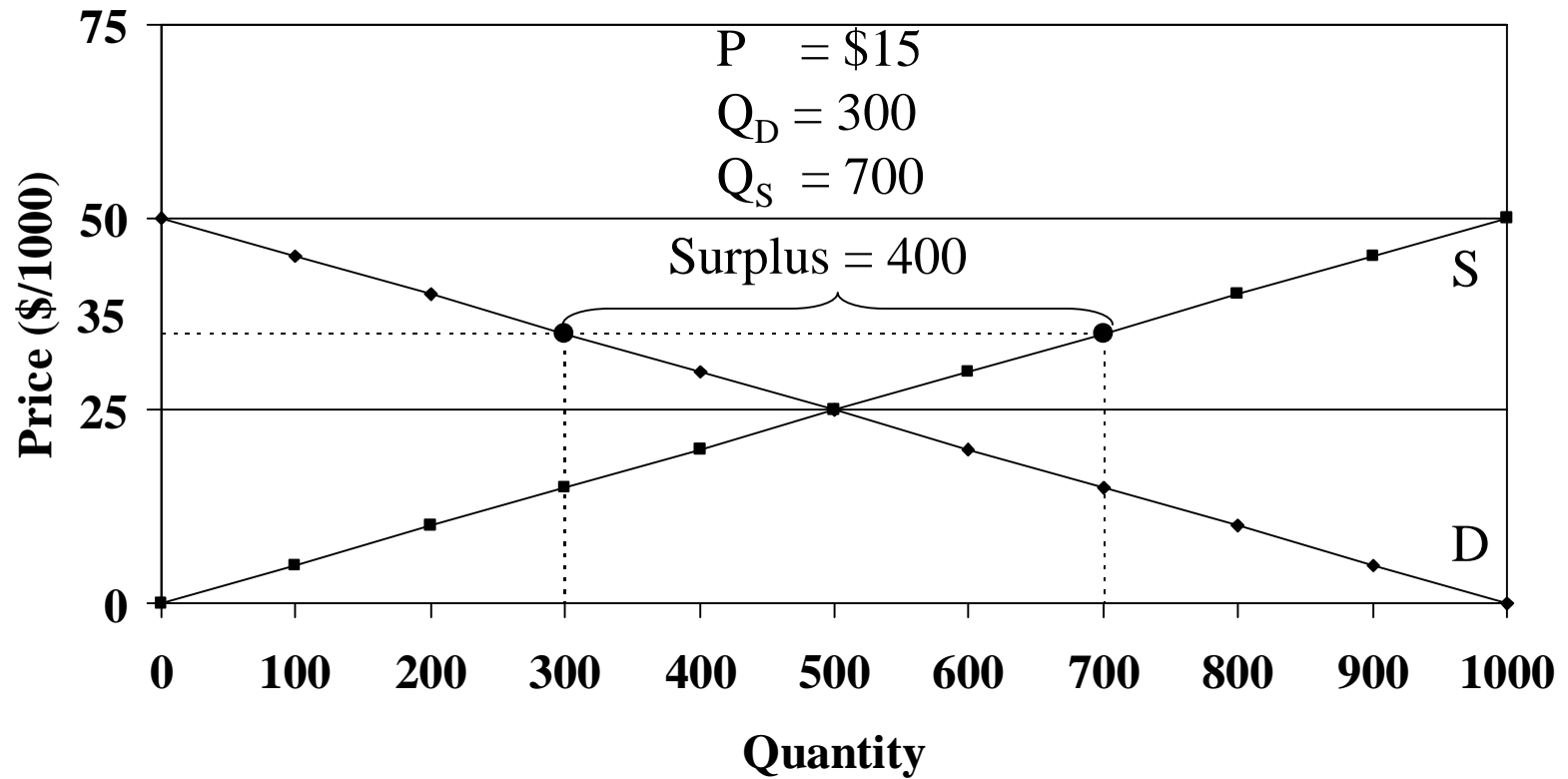
Graphical Example of a Market Shortage



How do markets find equilibrium?

- Again, suppose the demand and supply for a Prius is
 - $Q_D = 1,000 - 20P$
 - $Q_S = 20P$
- Further suppose the price on the table for a Prius is \$35K.
 - $Q_D = 1,000 - 20 \times 35 = 300$
 - $Q_S = 20 \times 35 = 700$
 - $Q_S > Q_D$ means there is a surplus, so all interested buyers can make a purchase, but all interested sellers cannot find an agreeable buyer.
 - If you are a seller who values a Prius less than \$35K, wouldn't you be willing to offer a price lower than \$35K?
 - As long as there is a surplus, some sellers are willing to accept a lower price in order to make a sale.

Graphical Example of a Market Surplus



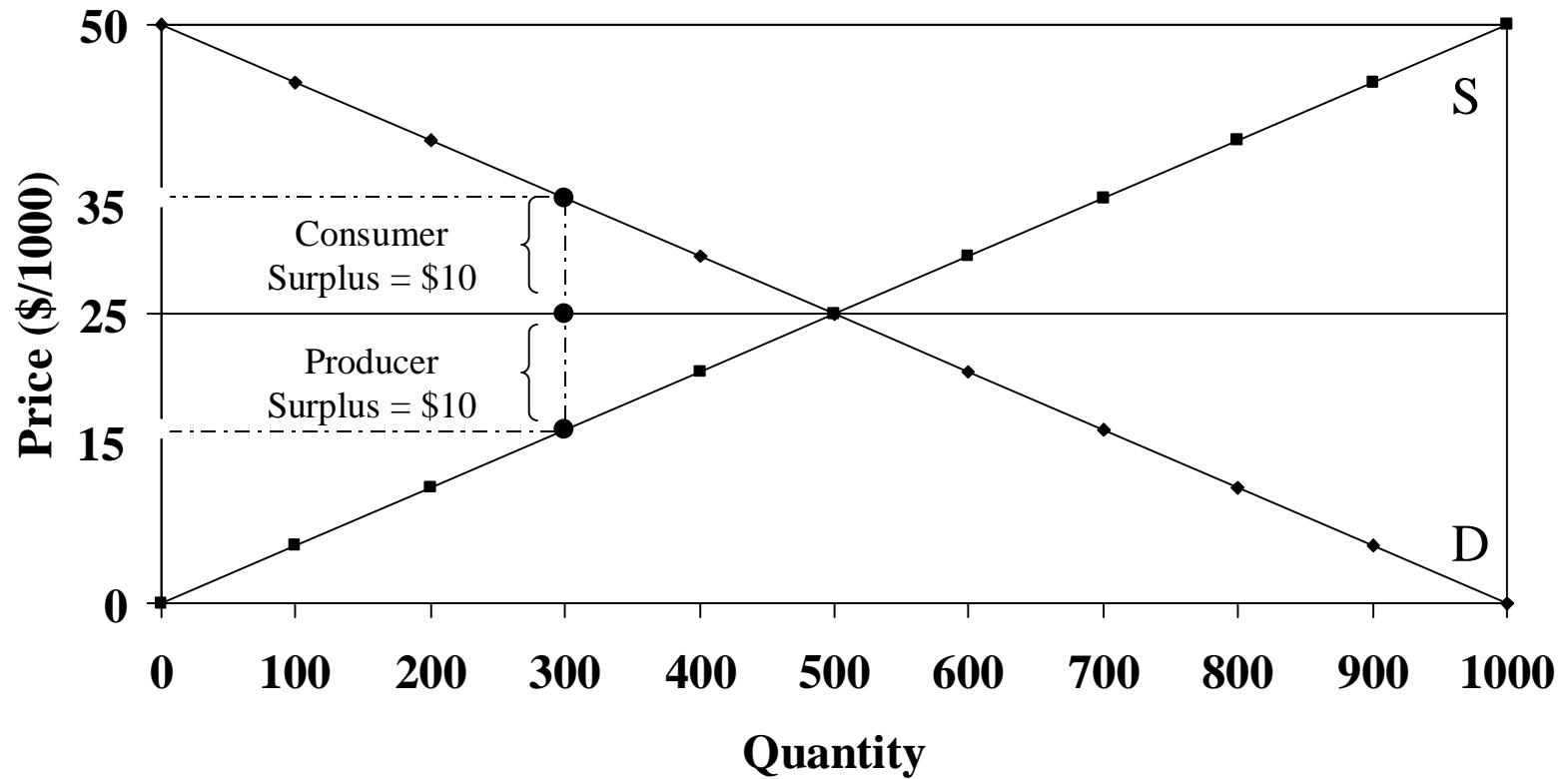
Functions of Price

- *Rationing Function*
 - directs the existing supply of product to those who value it most.
- *Allocative Function*
 - directs resources toward the production of product whose price exceeds cost and away from product whose cost exceeds price.

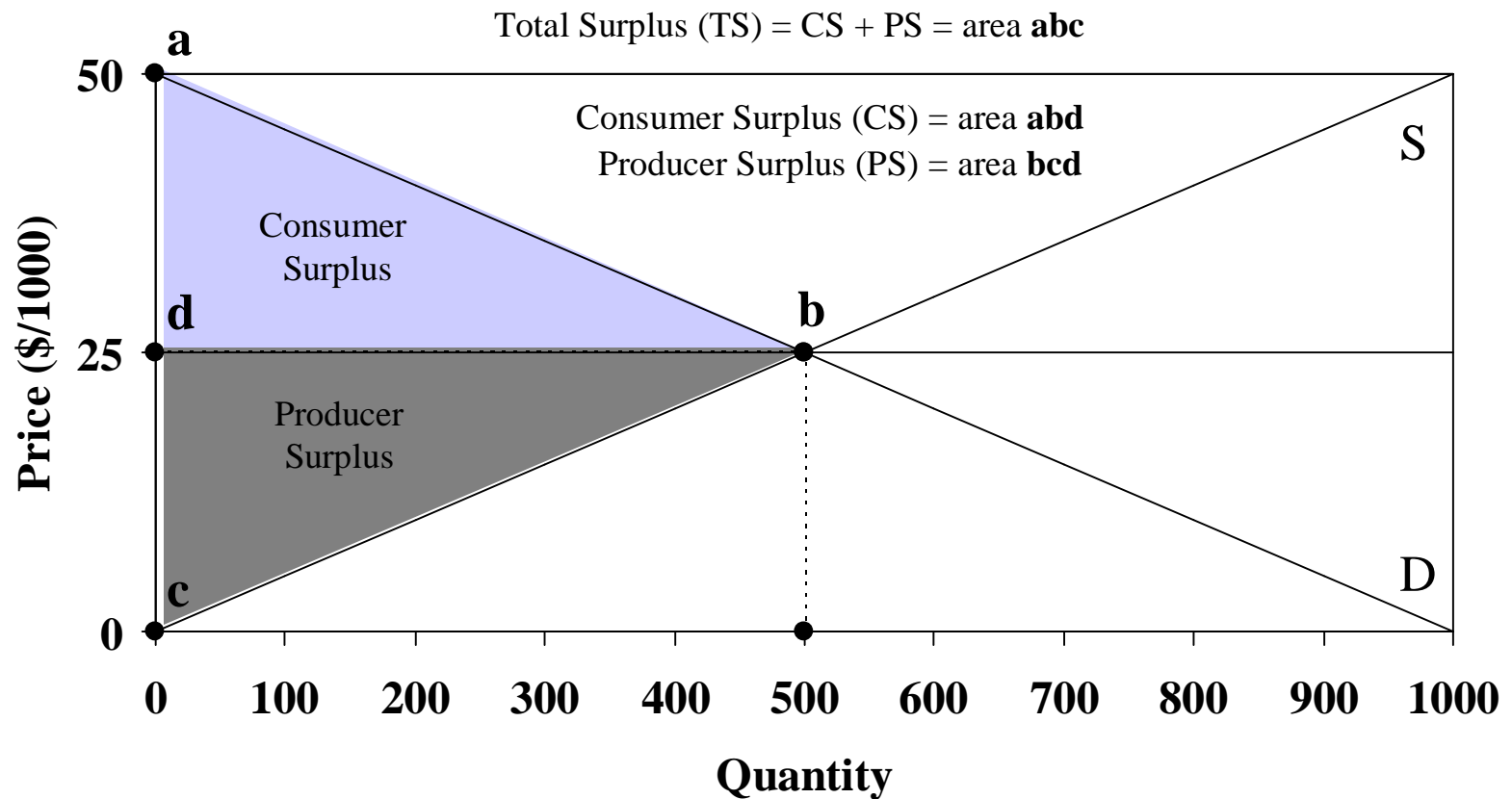
Consumer & Producer Surplus and the Efficiency of Market Equilibrium Definitions

- Efficiency:
 - People doing the best they can with what they have.
- Consumer Surplus:
 - The dollar amount consumers benefit from purchases.
- Producer Surplus:
 - The dollar amount sellers benefit from sales.

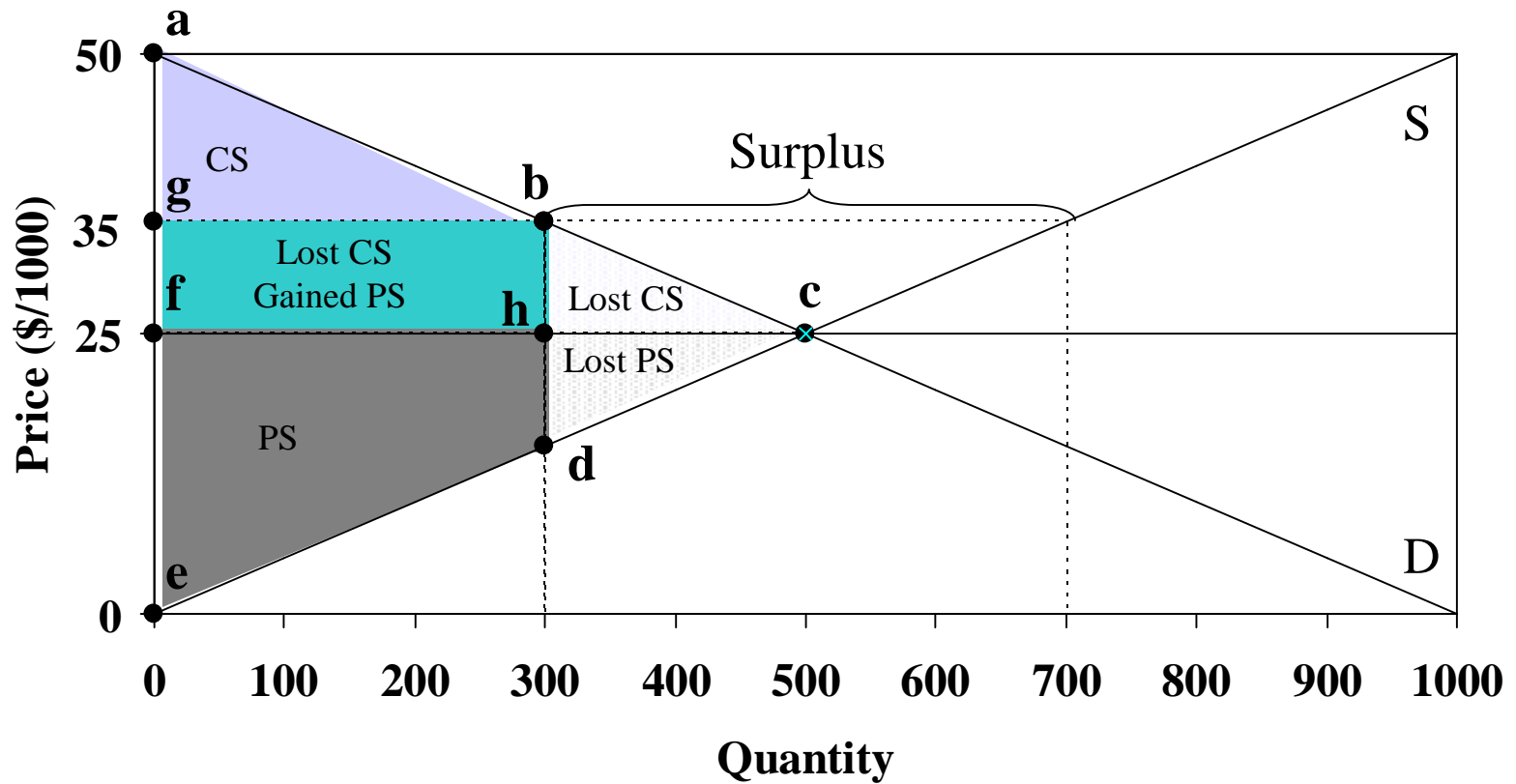
Consumer & Producer Surplus for Individual Trade



Consumer & Producer Surplus for Market Equilibrium



Consumer & Producer Surplus for Market Surplus



Effect of Market Surplus on Consumer & Producer Surplus

- Consumer Surplus
 - With Market Equilibrium
 - area **acf**
 - With Market Surplus
 - area **abg**
 - Change
 - Loss
 - area **bch**
 - area **bhfg**
- Producer Surplus
 - With Market Equilibrium
 - area **cef**
 - With Market Surplus
 - area **bdeg**
 - Change
 - Loss
 - area **cdh**
 - Gain
 - area **bhfg**

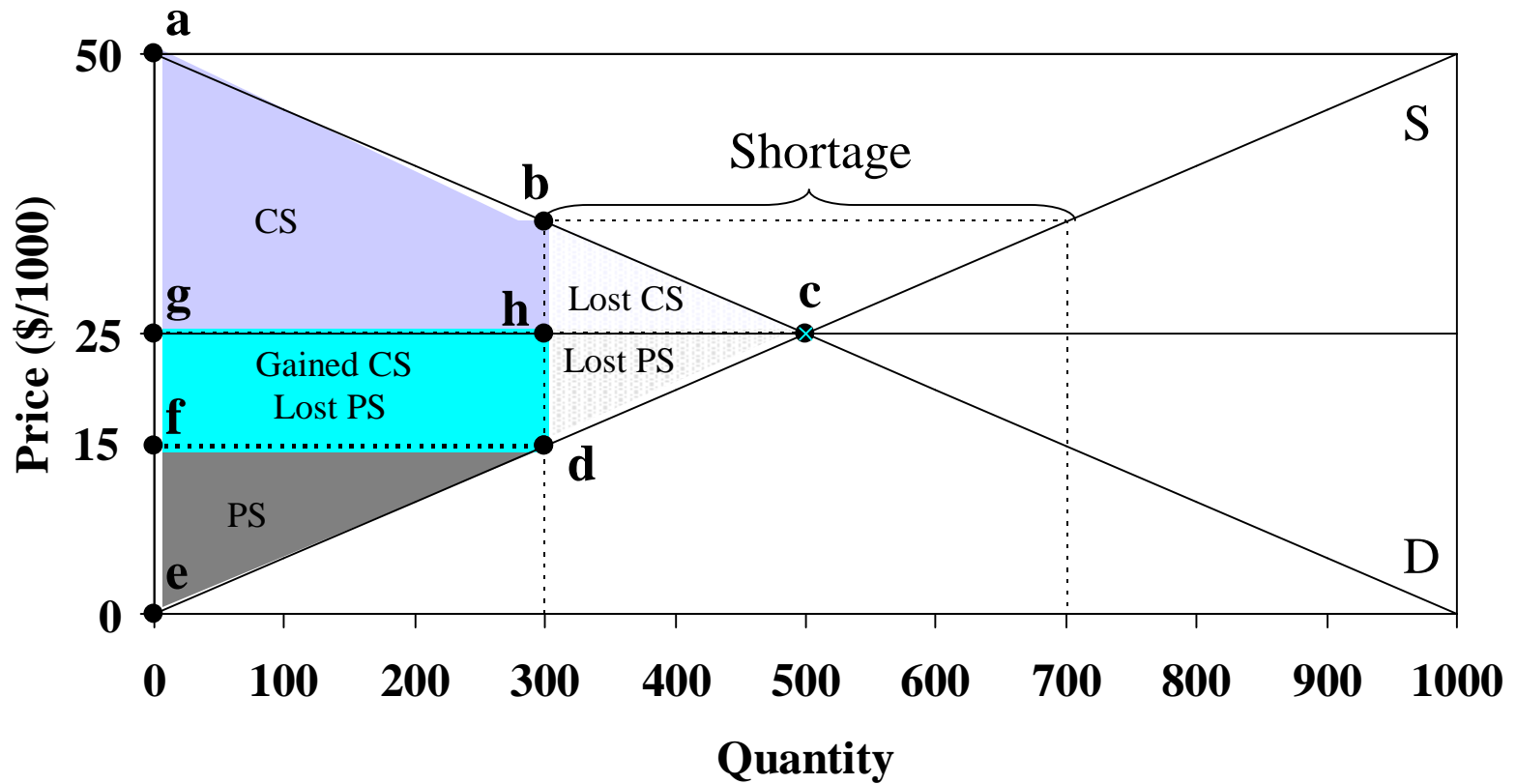
Effect of Market Surplus on Total Surplus

- With Market Equilibrium
 - area **ace**
- With Market Surplus
 - area **abde**
- Change
 - Loss
 - area **bcd**

Winners & Losers with Market Surplus

- Consumers (CS)
 - Loser (**abg** < **acf**)
- Producer (PS)
 - Winner if **bhfg** > **cdh**
 - Loser if **bhfg** < **cdh**
- Consumers & Producers (TS)
 - Loser (**abde** < **ace**)

Consumer & Producer Surplus for Market Shortage



Effect of Market Shortage on Consumer & Producer Surplus

- Consumer Surplus
 - With Market Equilibrium
 - area **acg**
 - With Market Surplus
 - area **abdf**
 - Change
 - Loss
 - area **bch**
 - Gain
 - area **dfgh**
- Producer Surplus
 - With Market Equilibrium
 - area **ceg**
 - With Market Surplus
 - area **def**
 - Change
 - Loss
 - area **cdh**
 - area **dfgh**

Effect of Market Shortage on Total Surplus

- With Market Equilibrium
 - area **ace**
- With Market Surplus
 - area **abde**
- Change
 - Loss
 - area **bcd**

Winners & Losers with Market Shortage

- Consumers (CS)
 - Winner if $dfgh > bch$
 - Loser if $dfgh < bch$
- Producer (PS)
 - Loser ($def < ceg$)
- Consumers & Producers (TS)
 - Loser ($abde < ace$)

Summary

- If the price is above the equilibrium price, a market surplus occurs:
 - Consumers are worse off.
 - Producers may be better or worse off.
 - Even if producers are better off, their gain is less than consumer losses.
 - Inefficient!
- If the price is below the equilibrium price, a market shortage occurs:
 - Consumers may be better or worse off.
 - Producers are worse off.
 - Even if consumers are better off, their gain is less than producer losses.
 - Inefficient!
- Conclusion:
 - The equilibrium market price results in an efficient allocation of resources.

Equity of Market Equilibrium Definitions

- Equity:
 - The state of being fair or reasonable.
- Price Floor:
 - Minimum statutory price.
- Price Ceiling:
 - Maximum statutory price.

Are price floors & ceilings equitable?

- Price floors create a market surplus:
 - Consumers are worse off.
 - Producers may be better or worse off.
 - If producers are better off & we want them to be better off this outcome may be more equitable.
- Price ceilings create a market shortage:
 - Consumers may be better or worse off.
 - Producers are worse off.
 - If consumers are better off & we want them to be better off this outcome may be more equitable.
- Conclusion:
 - Price floors & ceilings may or may not be more equitable. There are no guarantees!

Are price floors & ceilings efficient?

- Price floors create a market surplus:
 - Consumers are worse off.
 - Producers may be better or worse off.
 - Even if producers are better off, their gain is less than consumer losses.
 - Inefficient!
- Price ceilings create a market shortage:
 - Consumers may be better or worse off.
 - Producers are worse off.
 - Even if consumers are better off, their gain is less than producer losses.
 - Inefficient!
- Conclusion:
 - Price floors & ceilings definitely result in an inefficient allocation of resources.

Effect of Taxes & Subsidies On Market Equilibrium & Efficiency Definitions

- Sales Tax:
 - Charge to a buyer/seller collected by government for the purchase/sale of a product.
- Sales Subsidy:
 - Payment to a buyer/seller from government for the purchase/sale of a product.

More Definitions

- Unit Tax (t_U):
 - A tax per unit purchased/sold.
- Unit Subsidy (s_U):
 - A subsidy per unit purchased/sold.
- Ad Valorem Tax (t_A):
 - A tax that is proportional to the price of the product purchased/sold.
- Ad Valorem Subsidy (s_A):
 - A subsidy that is proportional to the price of the product purchased/sold.

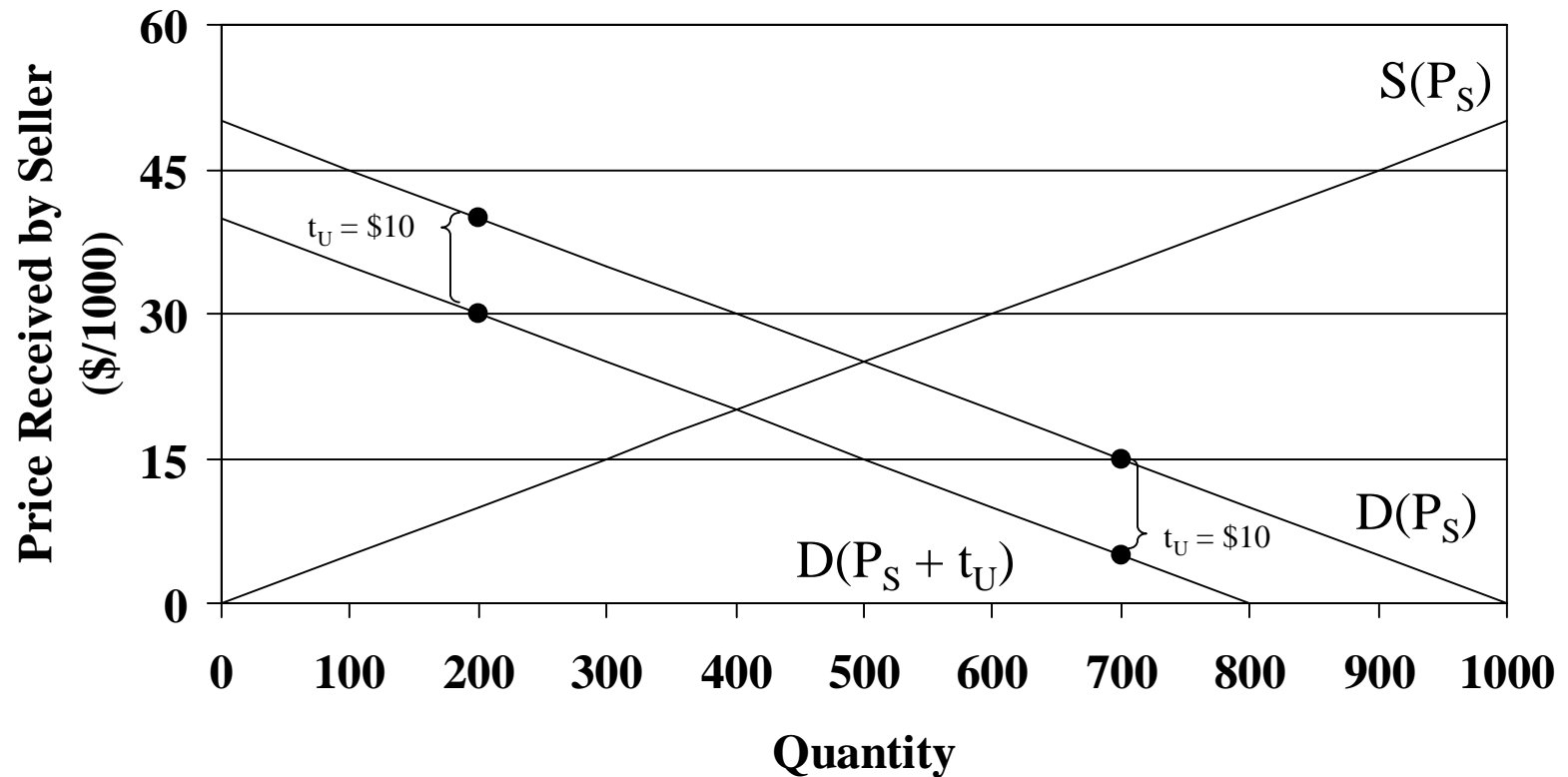
Price Relationships With Taxes & Subsidies

- Tax ($P_S > P_D$)
 - Unit
 - $P_S = P_D - t_U$
 - $P_S + t_U = P_D$
 - Ad Valorem
 - $P_S = P_D(1 - t_A)$
 - $P_S / (1 - t_A) = P_D$
- Subsidy ($P_S < P_D$)
 - Unit
 - $P_S = P_D + s_U$
 - $P_S - s_U = P_D$
 - Ad Valorem
 - $P_S = P_D(1 + s_A)$
 - $P_S / (1 + s_A) = P_D$

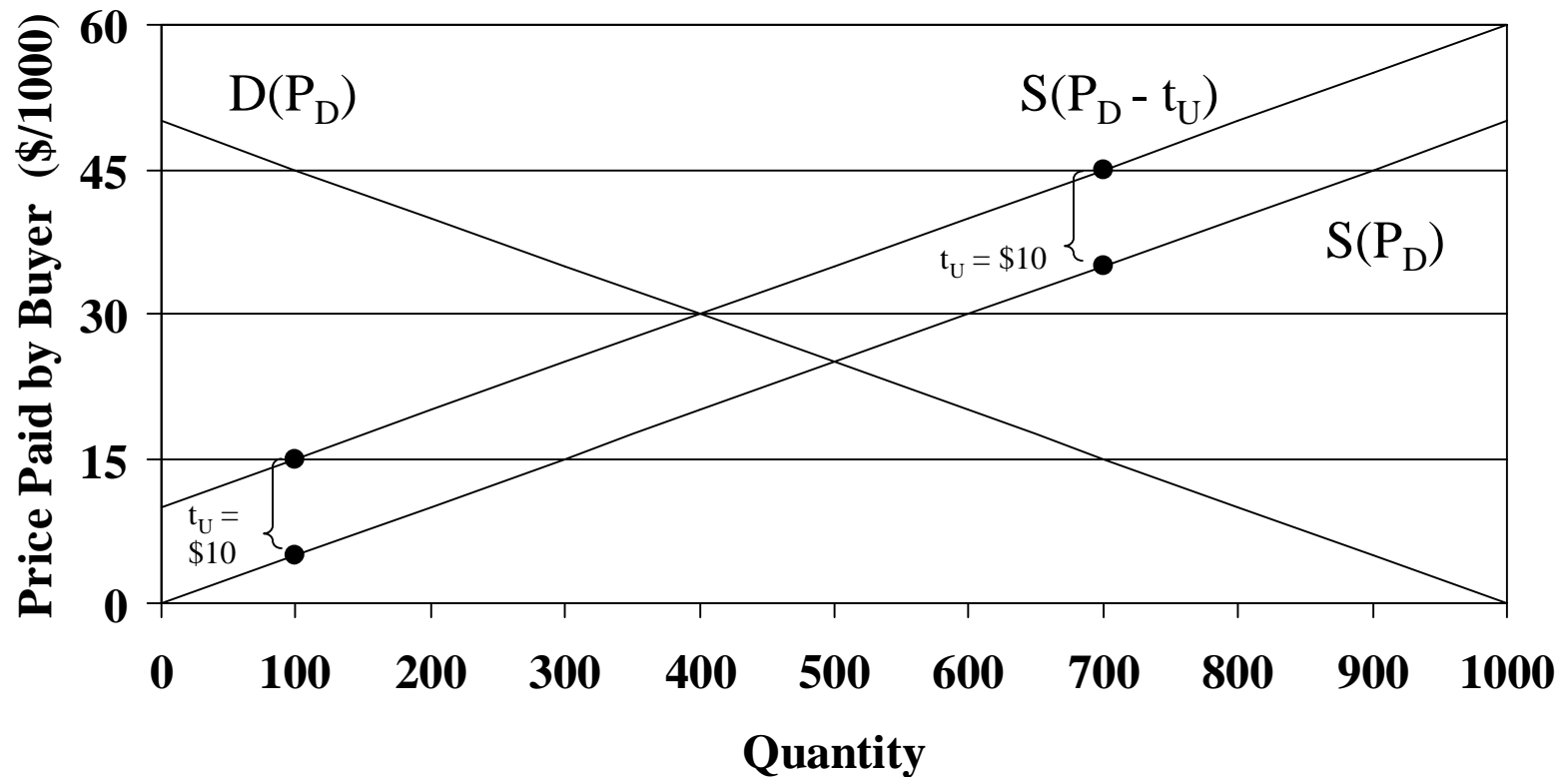
Tabular Example of Unit Tax ($t_U = \$10K$)

P_S	t_U	P_B	Q_D	Q_S	Shortage	Surplus
\$50	\$10	\$60	0	1,000	-	1,000
\$45	\$10	\$55	0	900	-	900
\$40	\$10	\$50	0	800	-	800
\$35	\$10	\$45	100	700	-	600
\$30	\$10	\$40	200	600	-	400
\$25	\$10	\$35	300	500	-	200
\$20	\$10	\$30	400	400	0	0
\$15	\$10	\$25	500	300	200	-
\$10	\$10	\$20	600	200	400	-
\$5	\$10	\$15	700	100	600	-
\$0	\$10	\$10	800	0	800	-

Graphical Example of Unit Tax ($t_U = \$10K$)



Graphical Example of Unit Tax ($t_U = \$10K$) Another Perspective



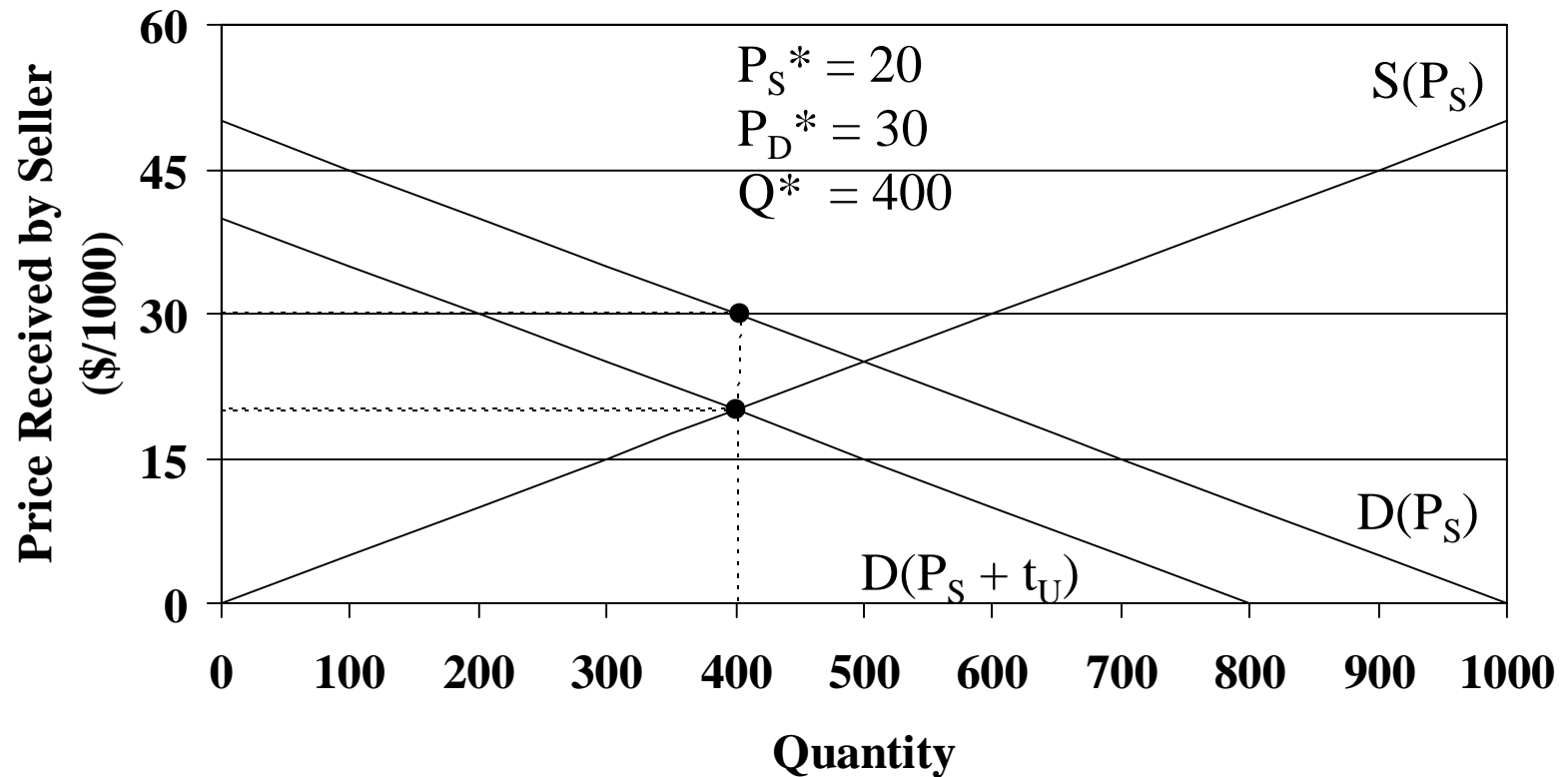
Function Examples With Unit Tax (t_U)

- Specific
 - $Q_D = 1,000 - 20P_D$
 - $Q_S = 20P_S$
 - $P_S + 10 = P_D$
- General Linear
 - $Q_D = a_D - b_D P_D$
 - $Q_S = a_S + b_S P_S$
 - $P_S + t_U = P_D$
- Really General
 - $Q_D = D(P_D)$
 - $Q_S = S(P_S)$
 - $P_S + t_U = P_D$

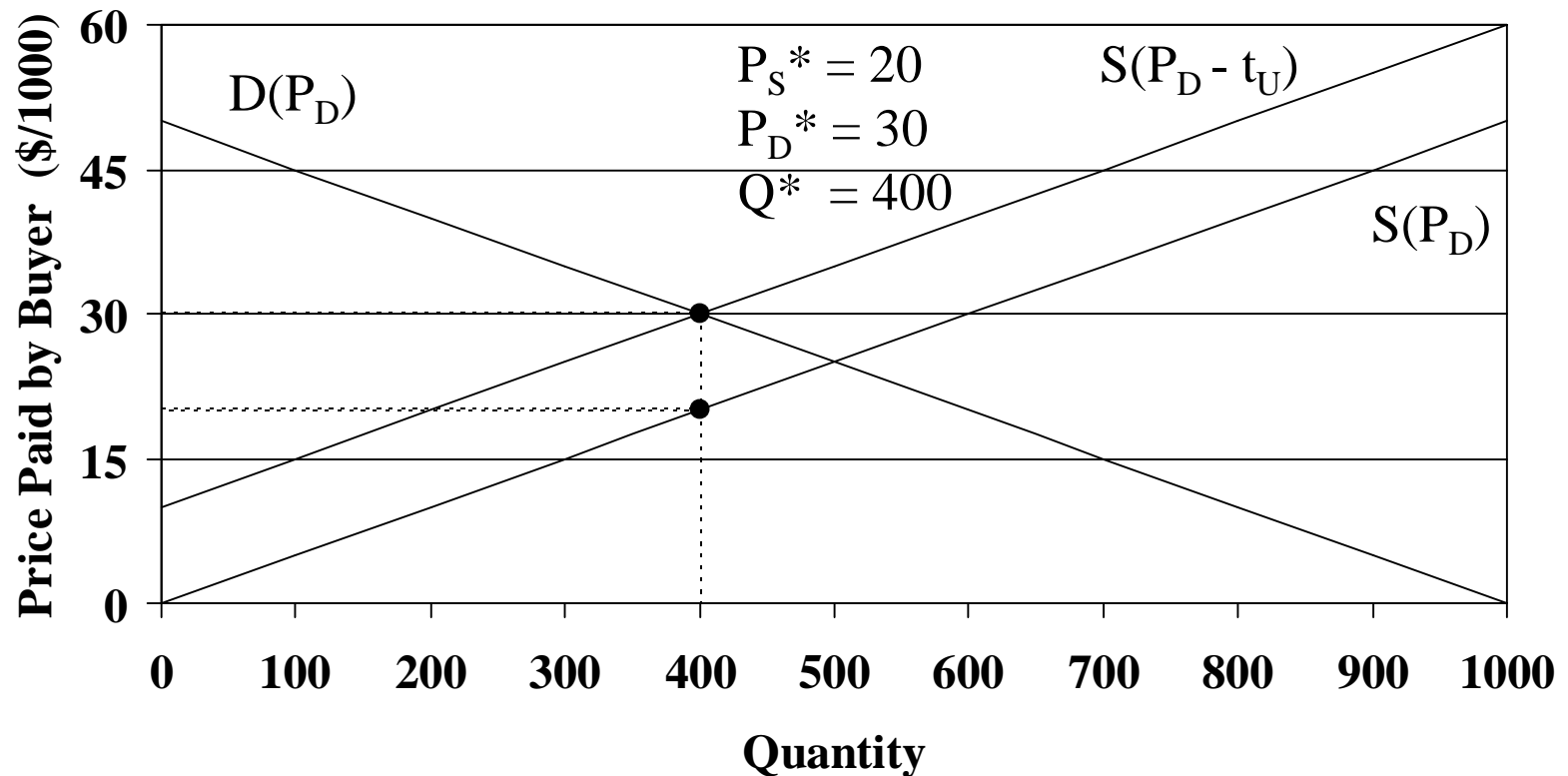
Tabular Example of Market Equilibrium With Unit Tax ($t_U = \$10K$)

P_S	t_U	P_B	Q_D	Q_S	Shortage	Surplus
\$50	\$10	\$60	0	1,000	0	1,000
\$45	\$10	\$55	0	900	0	900
\$40	\$10	\$50	0	800	0	800
\$35	\$10	\$45	100	700	0	600
\$30	\$10	\$40	200	600	0	400
\$25	\$10	\$35	300	500	0	200
$P_S^* = \\$20$	\$10	$P_D^* = \\$30$	$Q^* = 400$	$Q^* = 400$	0	0
\$15	\$10	\$25	500	300	200	0
\$10	\$10	\$20	600	200	400	0
\$5	\$10	\$15	700	100	600	0
\$0	\$10	\$10	800	0	800	0

Graphical Example of Market Equilibrium With Unit Tax ($t_U = \$10K$)



Graphical Example of Market Equilibrium With Unit Tax ($t_U = \$10K$) Another Perspective



Specific Function Example of Market Equilibrium With Unit Tax ($t_U = \$10K$)

$$Q^* = Q_D^* = Q_S^* \text{ for } Q_D^* = 1,000 - 20P_D^*, Q_S^* = 20P_S^*, \text{ and } P_S^* + 10 = P_D^* \Rightarrow$$

$$1,000 - 20(P_S^* + 10) = 20P_S^* \Rightarrow$$

$$1,000 - 20P_S^* - 200 = 20P_S^* \Rightarrow$$

$$800 = 40P_S^* \Rightarrow$$

$$P_S^* = 20 \Rightarrow$$

$$P_D^* = 20 + 10 = 30 \Rightarrow$$

$$Q^* = 1,000 - 20 \times 20 = 20 \times 20 = 400$$

General Linear Function Example of Market Equilibrium With Unit Tax (t_U)

$$Q^* = Q_D^* = Q_S^* \text{ for } Q_D^* = a_D - b_D P_D^*, Q_S^* = a_S + b_S P_S^*, \text{ and } P_S^* + t_U = P_D^* \Rightarrow$$

$$a_D - b_D (P_S^* + t_U) = a_S + b_S P_S^*$$

After not too much algebra

$$P_S^* = (a_D - a_S - t_U b_D) / (b_S + b_D)$$

$$P_D^* = (a_D - a_S + t_U b_S) / (b_S + b_D)$$

$$Q^* = (a_S b_D + b_S a_D - b_S t_U b_D) / (b_S + b_D)$$

Really General Function Example of Market Equilibrium With Unit Tax (t_U)

$$Q^* = Q_D^* = Q_S^* \text{ for } Q_D^* = D(P_D^*), Q_S^* = S(P_S^*), \text{ and } P_S^* + t_U = P_D^* \Rightarrow$$

$$D(P_S^* + t_U) = S(P_S^*)$$

Again, with really general function,
we cannot solve explicitly for P_S^* , P_D^* and Q^* .

Is market equilibrium different if sellers are required to pay the tax instead of buyers?

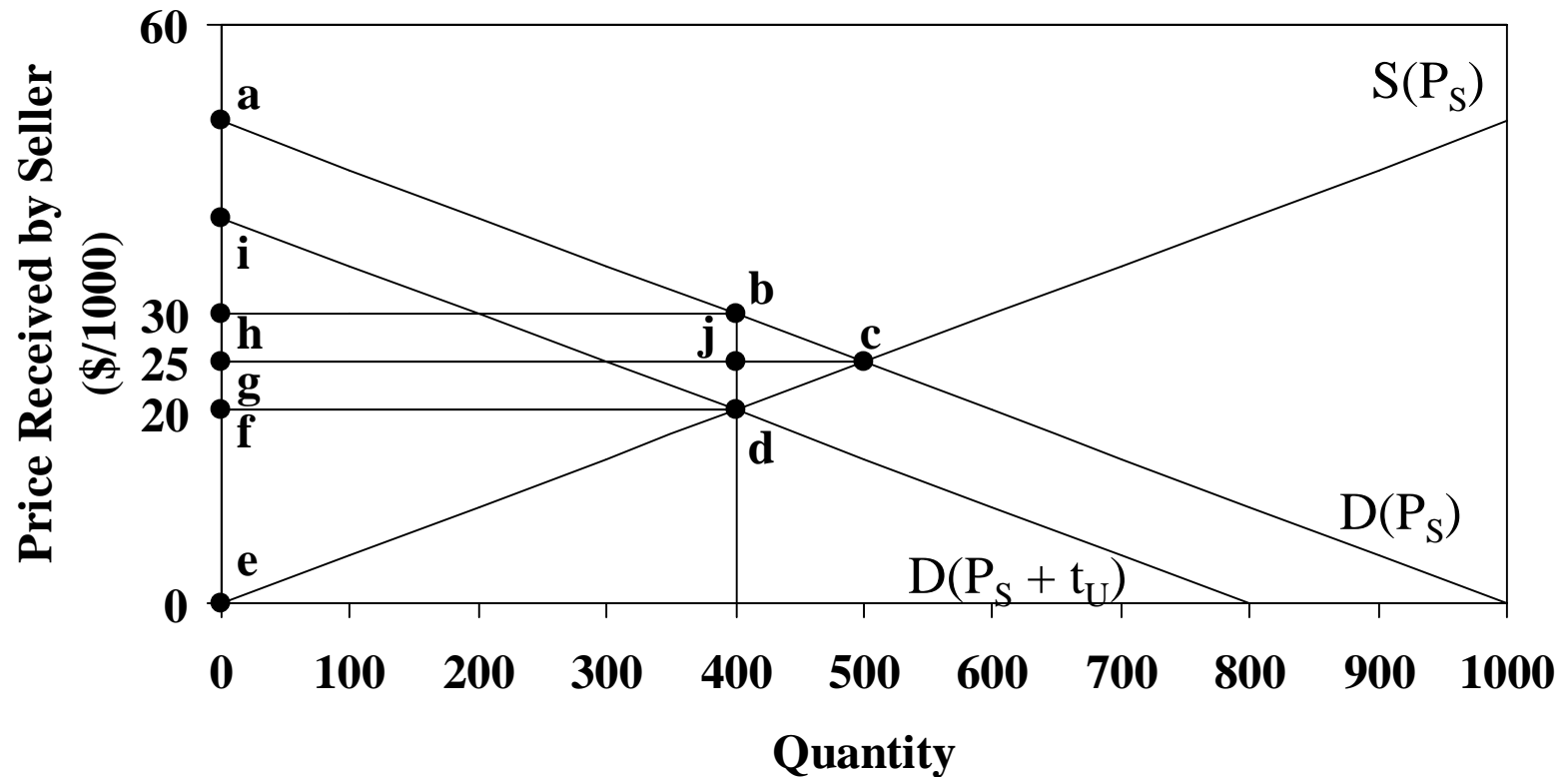
- Legal Incidence of a Tax:
 - People with statutory responsibility for paying the tax.
- Economic Incidence of a Tax:
 - People who actually pay the tax.

Is market equilibrium different if sellers are required to pay the tax instead of buyers?

- Legal Incidence of Minnesota Sales Tax Falls on Buyer (Check your receipt from the grocery store).
- Economic Incidence may fall on buyer and sellers. In our example,
 - the equilibrium price paid by buyers increased by \$5K
 - the equilibrium price received by sellers decreased by \$5K
 - total tax revenues were \$10K per unit

Important Note: The economic incidence of a tax will not always be shared equally.

How does a tax affect the efficiency of market equilibrium?

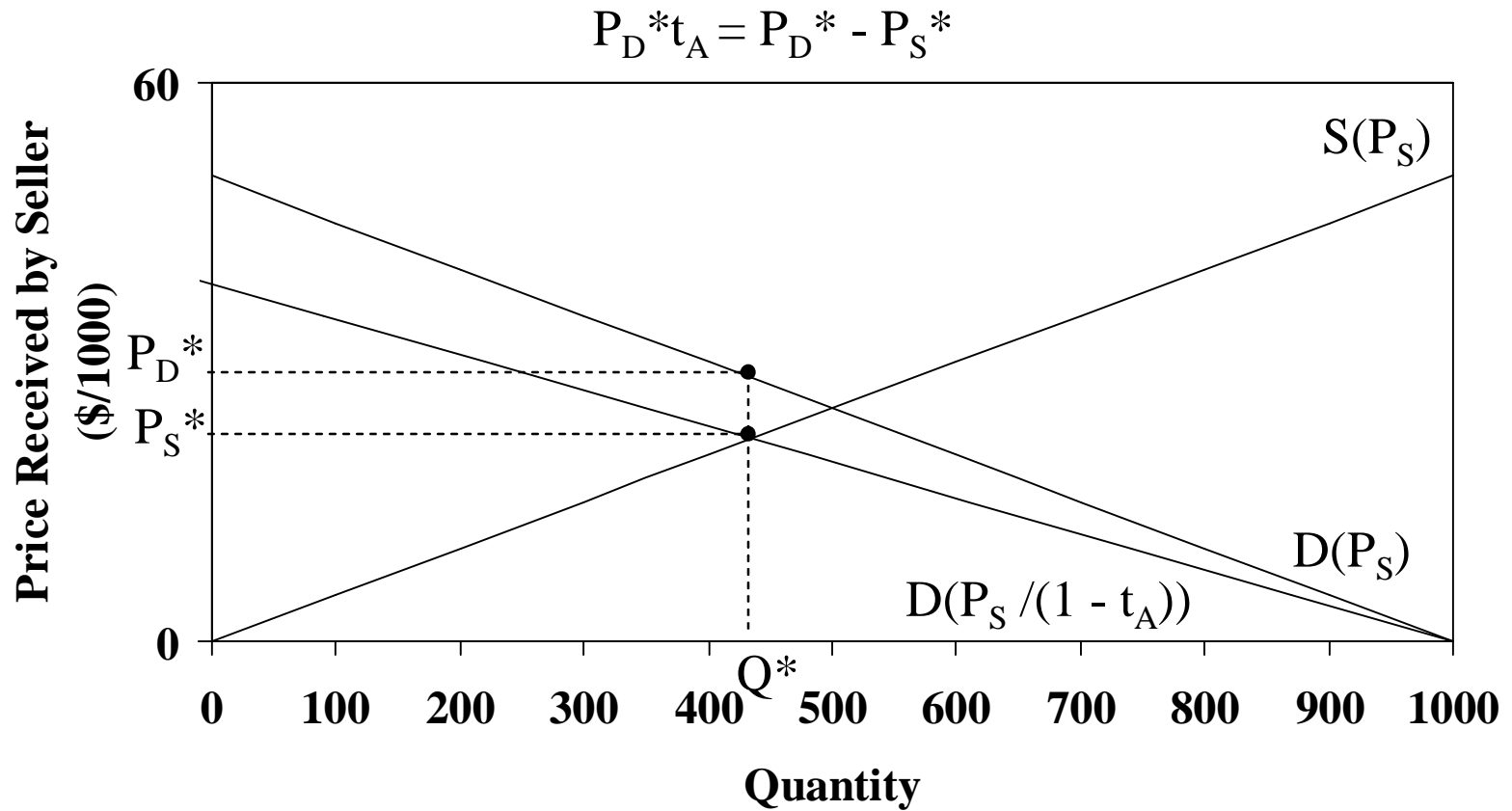


How does a tax affect the efficiency of market equilibrium?

- Without Tax
 - CS
 - area **acg**
 - PS
 - area **ceg**
 - TS
 - area **ace**
- With Tax
 - CS
 - area **idf** = area **abh**
 - PS
 - area **def**
 - Tax Revenue (TR)
 - area **bdfh** = area **abdi**
 - TS
 - area **abde**
 - Loss
 - area **bcd**
 - Lost CS = area **bcgh**
 - Lost PS = area **cdfg**
 - Gained TR = area **bdfh**

Conclusion: Tax results in inefficient market equilibrium.

Graphical Example of an Ad Valorem Tax



Subsidies

- Work the same way as taxes, but increase the equilibrium quantity instead of decreasing it.
- Like a tax,
 - the legal and economic incidence of a subsidy will typically be different.
 - subsidies lead to an inefficient market equilibrium, such that TS is lower.
- Unlike a tax,
 - CS will be higher with the subsidy.
 - PS will be higher with a subsidy.
 - government will pay money instead of collecting it.

You will have a chance to work with subsidies for homework!

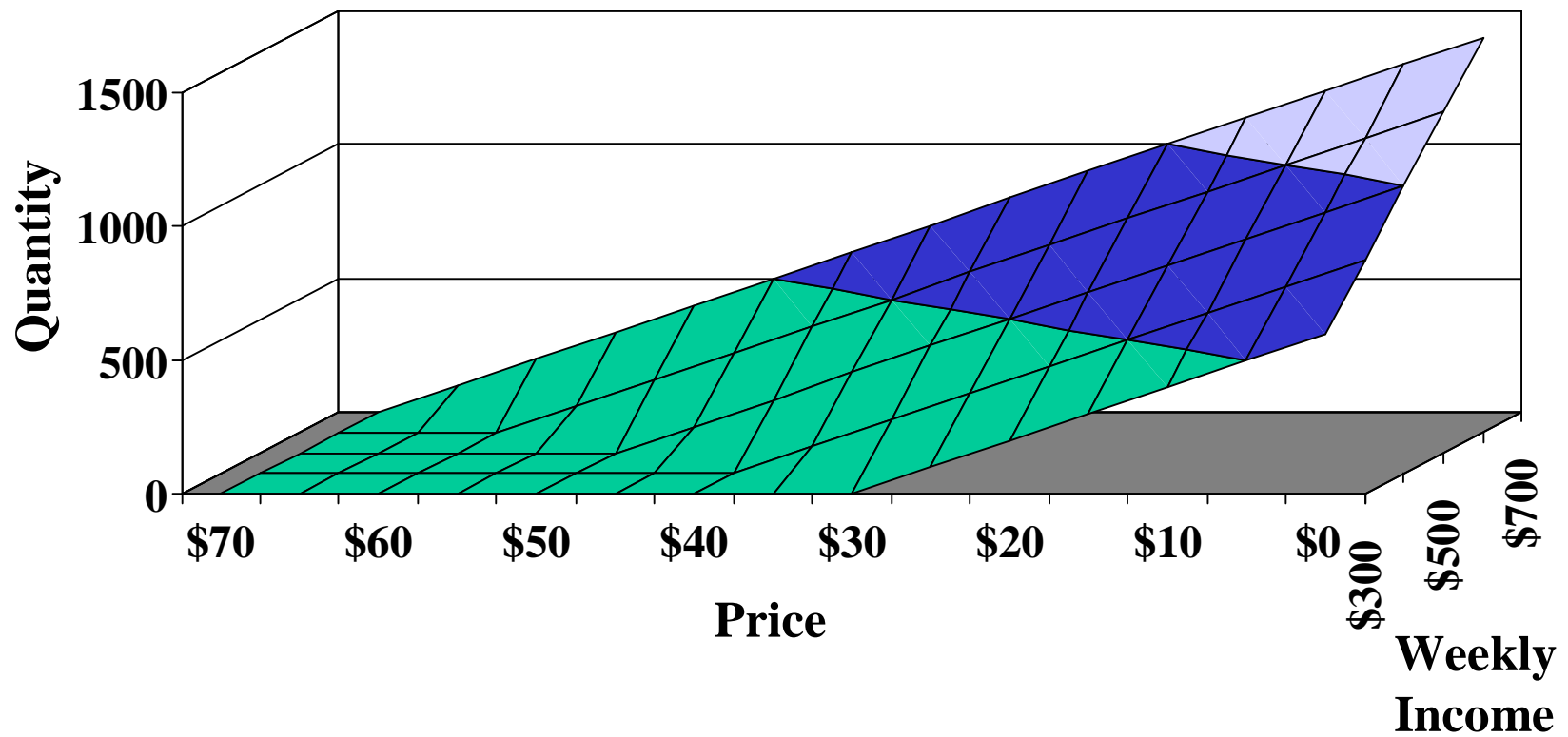
Determinants of Demand & Quantity Demanded

- Question: Is price the only factor that influences demand for a product?
- What else matters?
 - Income
 - Tastes
 - Price of Other Goods
 - Expectations
 - Population
- So how do we incorporate these other factors?

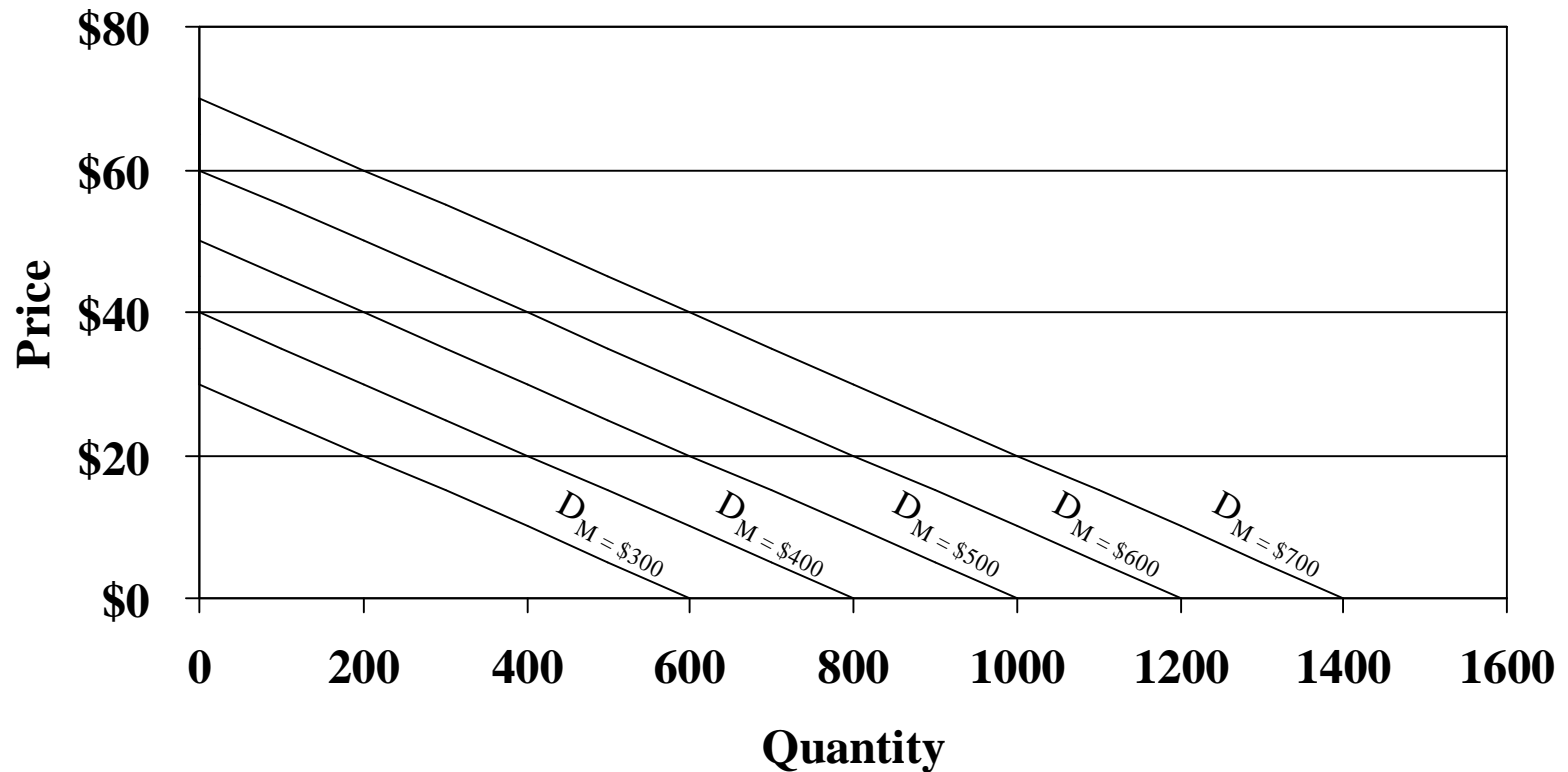
Tabular Example of Demand Curve that also Depends on Income (M)

		Average Weekly Income				
		\$300	\$400	\$500	\$600	\$700
Price (\$/1000)	\$70	0	0	0	0	0
	\$65	0	0	0	0	100
	\$60	0	0	0	0	200
	\$55	0	0	0	100	300
	\$50	0	0	0	200	400
	\$45	0	0	100	300	500
	\$40	0	0	200	400	600
	\$35	0	100	300	500	700
	\$30	0	200	400	600	800
	\$25	100	300	500	700	900
	\$20	200	400	600	800	1,000
	\$15	300	500	700	900	1,100
	\$10	400	600	800	1,000	1,200
	\$5	500	700	900	1,100	1,300
	\$0	600	800	1,000	1,200	1,400

Graphical Example of Demand Curve that also Depends on Income (M)



Graphical Example of Demand Curve that also Depends on Income (M), An Easier Perspective



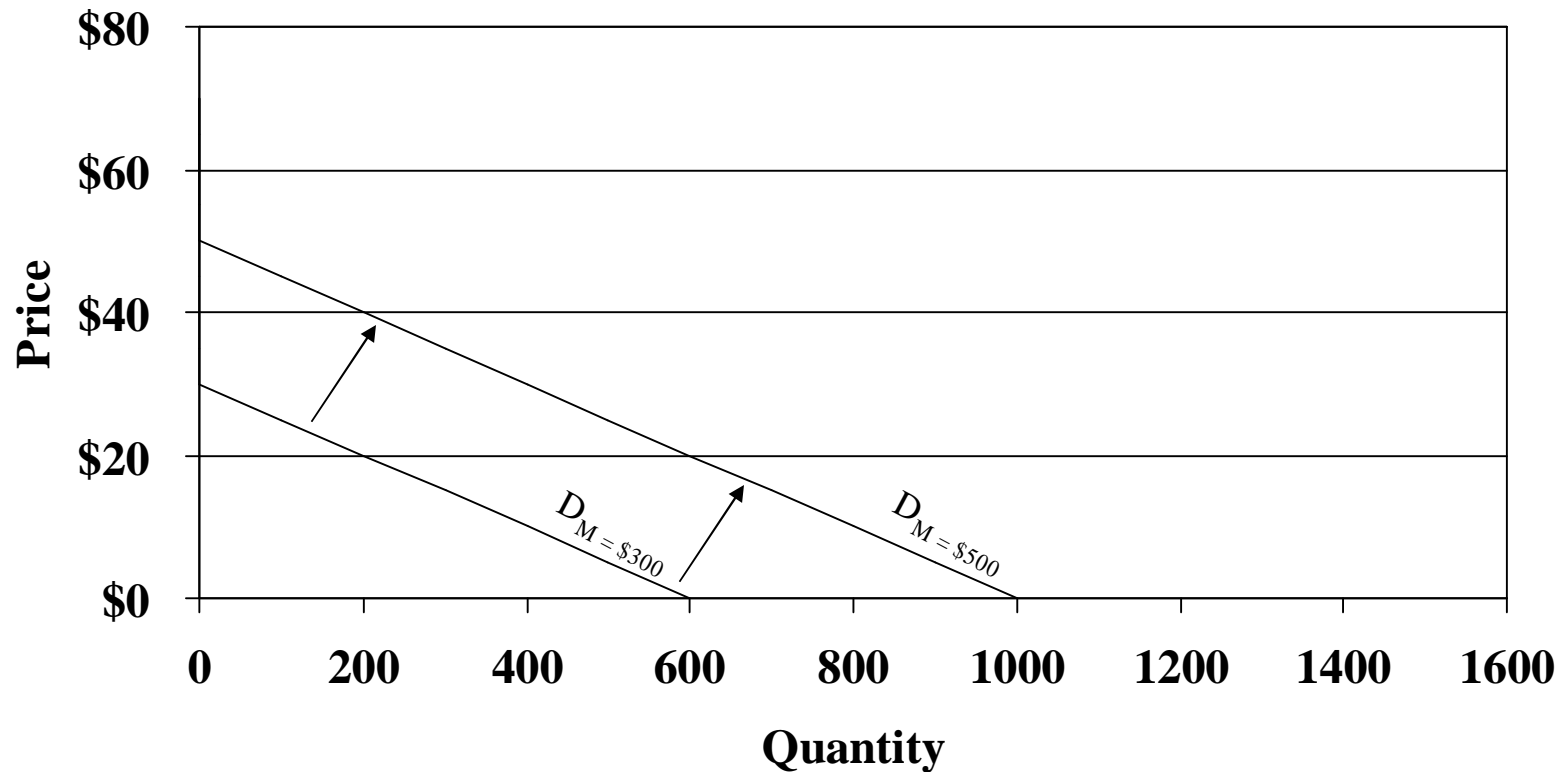
Function Examples of Demand Curve that also Depends on Income

- Specific
 - $Q_D = 2M - 20P$
- General Linear
 - $Q_D = a_D + b_D P + c_D M$
- Really General
 - $Q_D = D(P, M)$

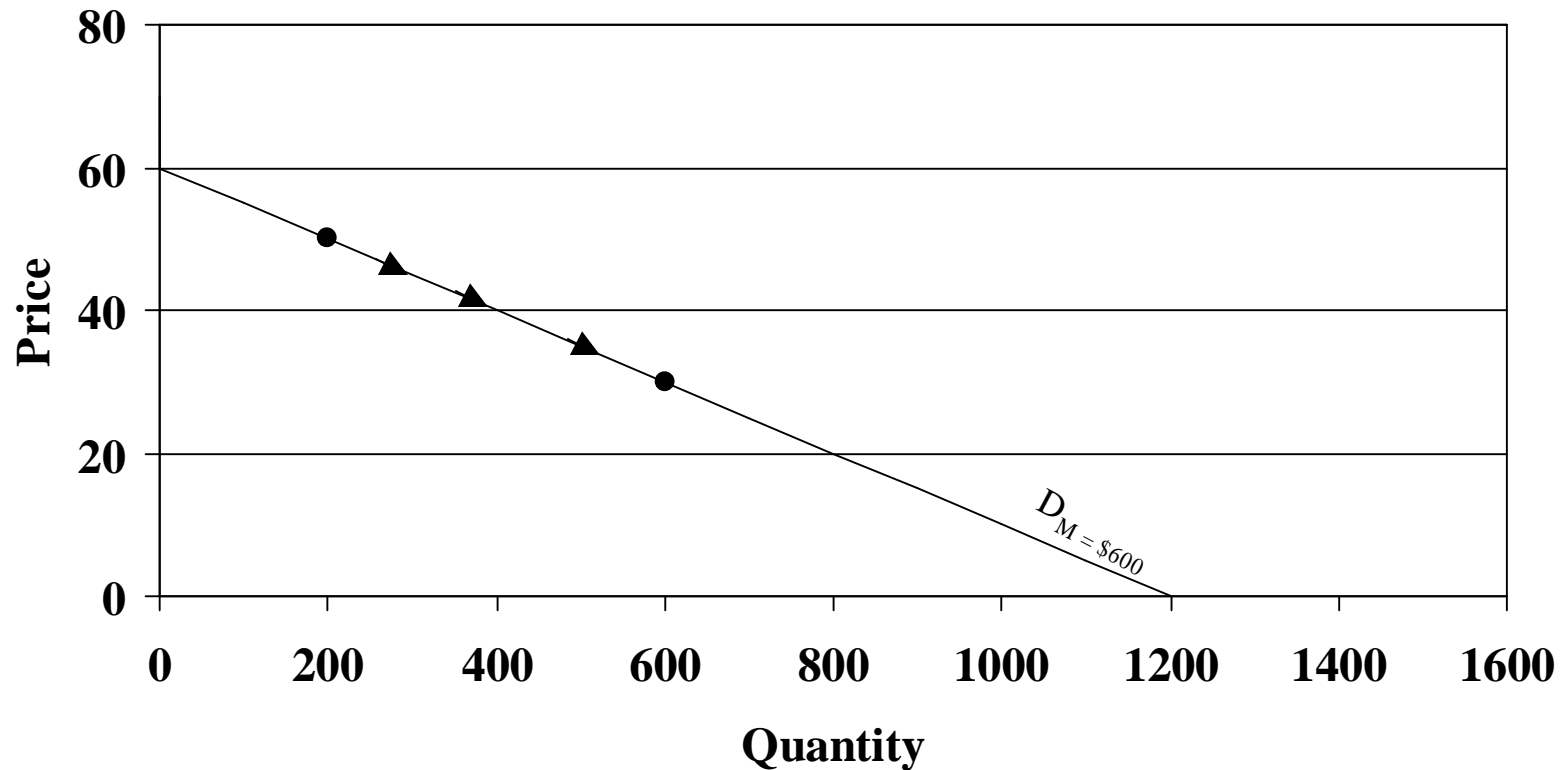
Distinction Between Demand & Quantity Demanded

- Demand
 - Relationship between the price and quantity purchased holding everything else constant (e.g. income, tastes, price of other goods, expectations, & population).
 - If something changes (e.g. income, tastes, price of other goods, expectations, & population), we get a new relationship between price and quantity, which is referred to as a shift in the demand curve.
- Quantity Demanded
 - Quantity purchased given the price holding everything else constant.
 - If the price changes holding everything else constant, we get a change in the quantity demanded, which is referred to as a movement along the demand curve.

Graphical Example of a Shift in the Demand Curve as Income Increases From \$300 to \$500



Graphical Example of a Movement Along the Demand Curve as Price Falls From \$50 to \$30 Holding Income Constant at \$500



Determinants of Supply & Quantity Supplied

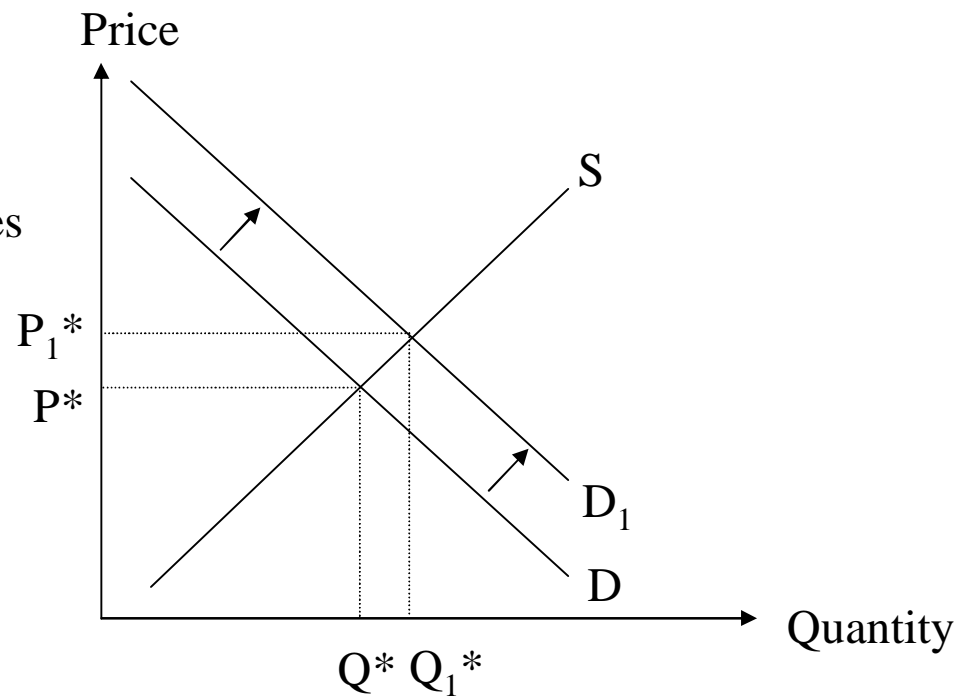
- Question: Is price the only factor that influences supply for a product?
- What else matters?
 - Technology
 - Factor/Input/Raw Material Prices
 - Number of Suppliers
 - Expectations
 - Weather
- So how do we incorporate these other factors?
 - Just as we did with the demand curve.
 - Our tabular relationships include columns for these other factors.
 - Graphically, we can use surface or contour plots.
 - Our supply function has more than one variable in them.

Distinction Between Supply & Quantity Supplied

- Supply
 - Relationship between the price and quantity sold holding everything else constant (e.g. technology, factor/input/raw material prices, number of suppliers, expectation, & weather).
 - If something changes (e.g. technology, factor/input/raw material prices, number of suppliers, expectation, or weather), we get a new relationship between price and quantity, which is referred to as a shift in the supply curve.
- Quantity Supplied
 - Quantity sold given the price holding everything else constant.
 - If the price changes holding everything else constant, we get a change in the quantity supplied, which is referred to as a movement along the supply curve.

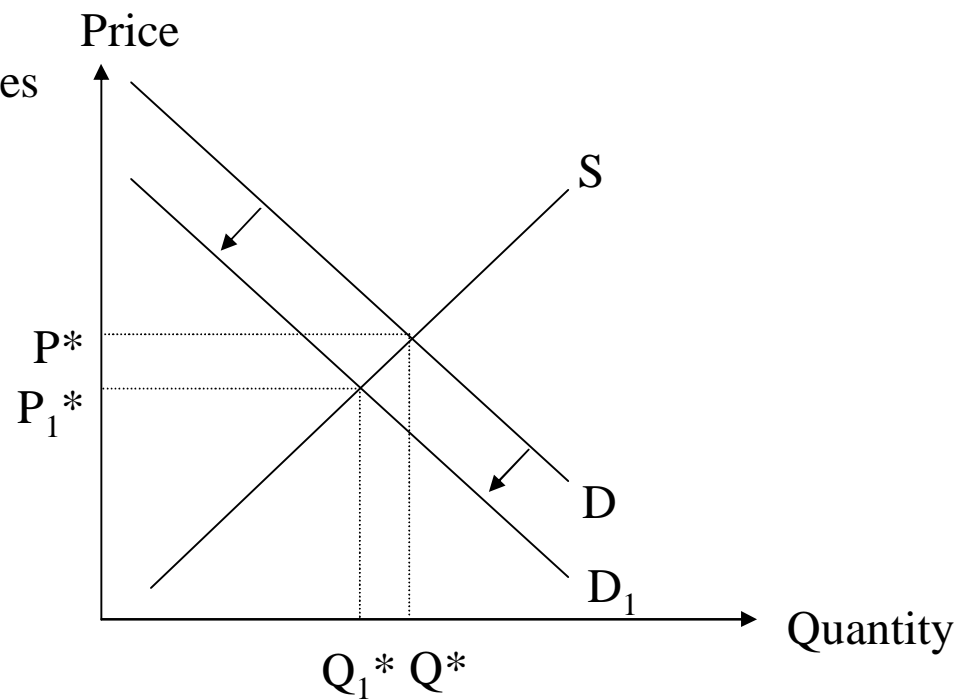
Predicting Price & Quantity Changes for Changes in Market Conditions

- Question: How will the price for the Prius change if an increase in income increases demand?
- Answer
 - Demand Curve Shifts Out/Up
 - Equilibrium Price Increases
 - Equilibrium Quantity Increases



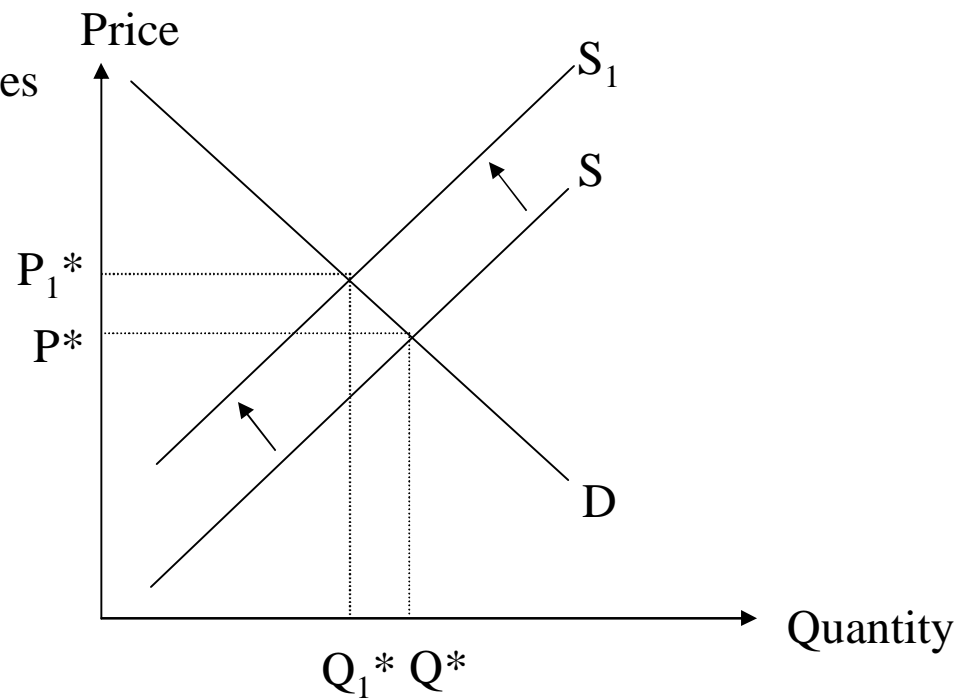
Question: How will the price for the Prius change if an decrease in the price of gas decreases demand?

- Answer
 - Demand Curve Shifts In/Down
 - Equilibrium Price Decreases
 - Equilibrium Quantity Decreases



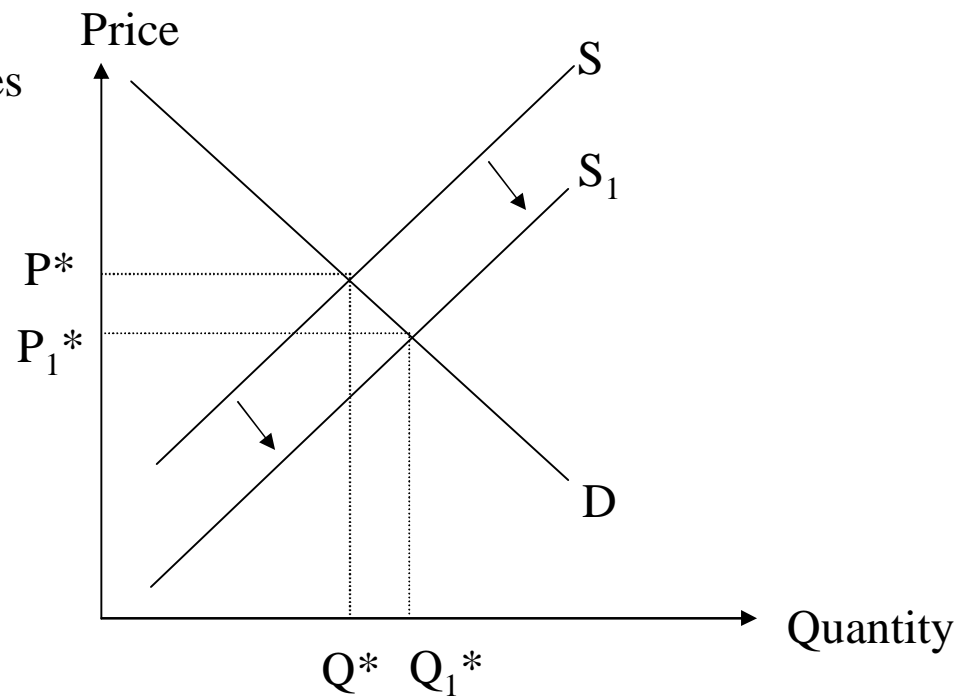
Question: How will the price for the Prius change if an increase in the price of steel decreases supply?

- Answer
 - Supply Curve Shifts Out/Up
 - Equilibrium Price Increases
 - Equilibrium Quantity Decreases



Question: How will the price for the Prius change if an increase in the price of steel increases supply?

- Answer
 - Supply Curve Shifts In/Down
 - Equilibrium Price Decreases
 - Equilibrium Quantity Increases



What Should You Know

- Demand & Supply and Law of Demand & Supply
- What a Market Is
- Market Equilibrium & The Function of Price
- Consumer & Producer Surplus and the Efficiency of Market Equilibrium
- Equity of Market Equilibrium
- Effect of Taxes & Subsidies On Market Equilibrium & Efficiency
- Determinants of Supply & Demand and Quantity Supplied & Demanded
- Predicting Price & Quantity Changes for Changes in Market Conditions