School of Business, Economics and Law
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Perfect Competition:

Partial Equilibrium II

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Agenda

- First hour
  - Justification for equilibrium
  - Comparative statics
    - Increase in population
    - Increase in tax
- Second hour
  - Long-run
  - Welfare and efficiency
  - Welfare effects of a tax
  - Interaction between markets (if times permits)

Justification for equilibrium?

Justification for equilibrium?

- Question
  - Are there any reasons to believe that markets are in equilibrium?
  - Note: the model does not even say who determines prices

Justification for equilibrium?

- Justification 1:
  There is an (un-modeled) competitive *process* that will *eventually* move us to equilibrium
  - P: $Q^D < Q^S$
    => firms unable to sell what they produced
    => they should have incentives to lower their prices
  - P: $Q^D > Q^S$
    => consumers queuing
    => firms should have incentive to increase their prices
  - But this process is not described by the model
    ("Black box")

Justification for equilibrium?

- Justification 2:
  Game-theoretic models of the process
  - There exists (more complicated) models which show how equilibrium can be reached
  - Not part of this course

Justification for equilibrium?

- Justification 3:
  Laboratory experiments show that it works
  - Vernon Smith (1962): "An experimental study of competitive market behavior" *Journal of Political Economy*, 70(2): 111-137.

Justification for equilibrium?

- Experimental procedure
  - Recruit a group of people
  - Divide into “buyers” and “sellers”
  - Let them trade an imaginary good

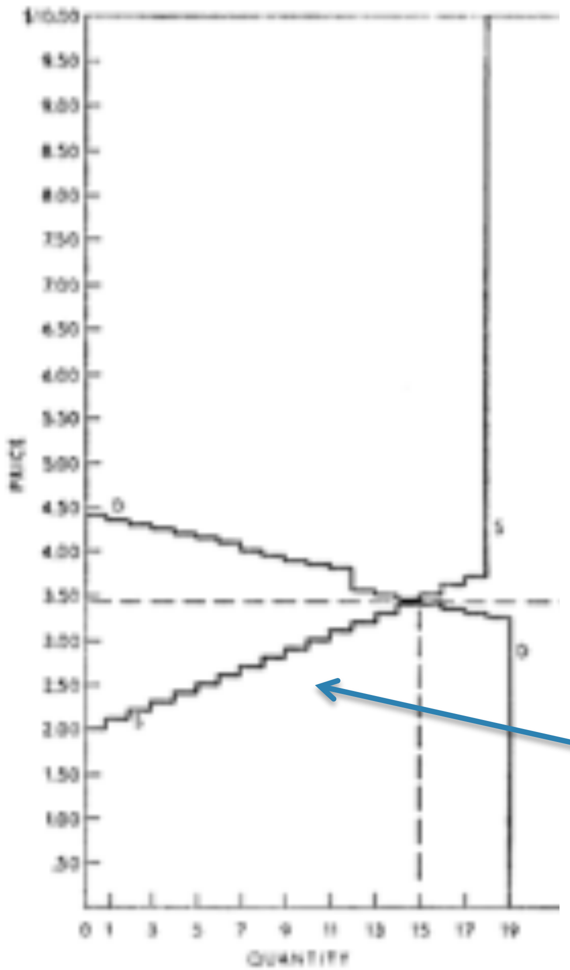
Justification for equilibrium?

- Information
  - Each seller informed about his cost of selling one unit
  - Each buyer informed about his value of buying one unit
  - Costs and valuations are private information

Justification for equilibrium?

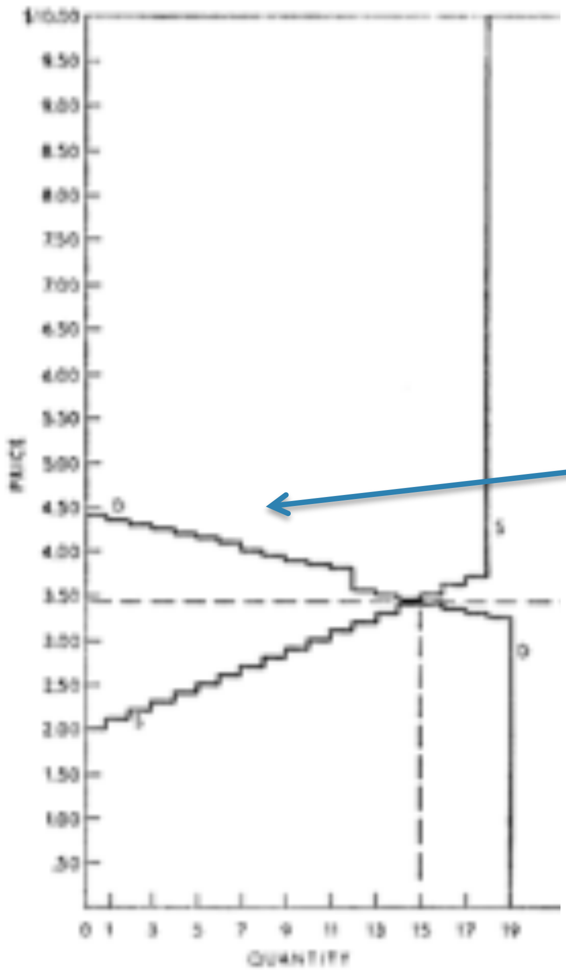
- Payoffs
  - Each agent can trade one unit every "trading period"
  - Buyer utility: V – P (if trade)
  - Seller utility: P – C (if trade)
  - Here: no monetary incentives

Justification for equilibrium?



Supply curve
Defined by sellers costs

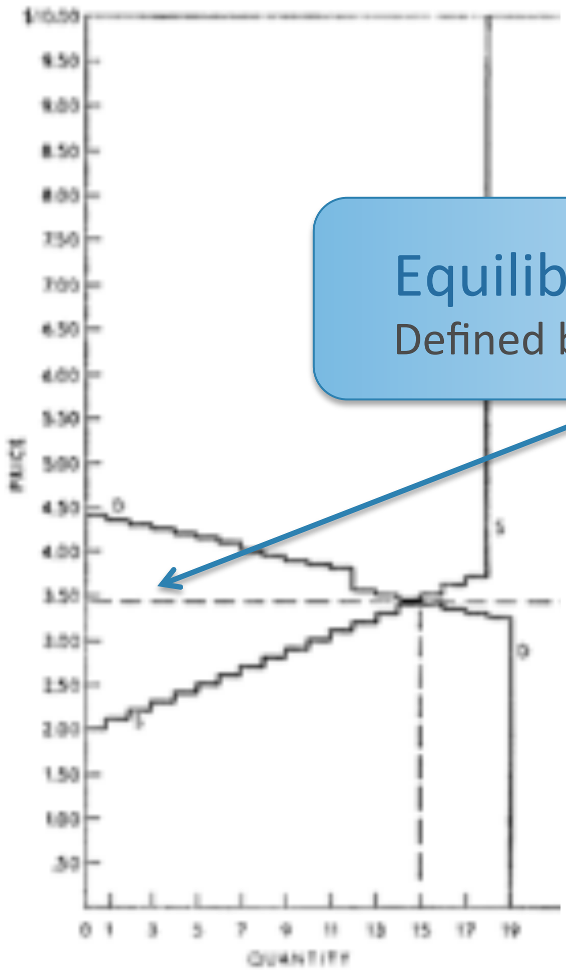
Justification for equilibrium?



Demand curve

Defined by buyers values

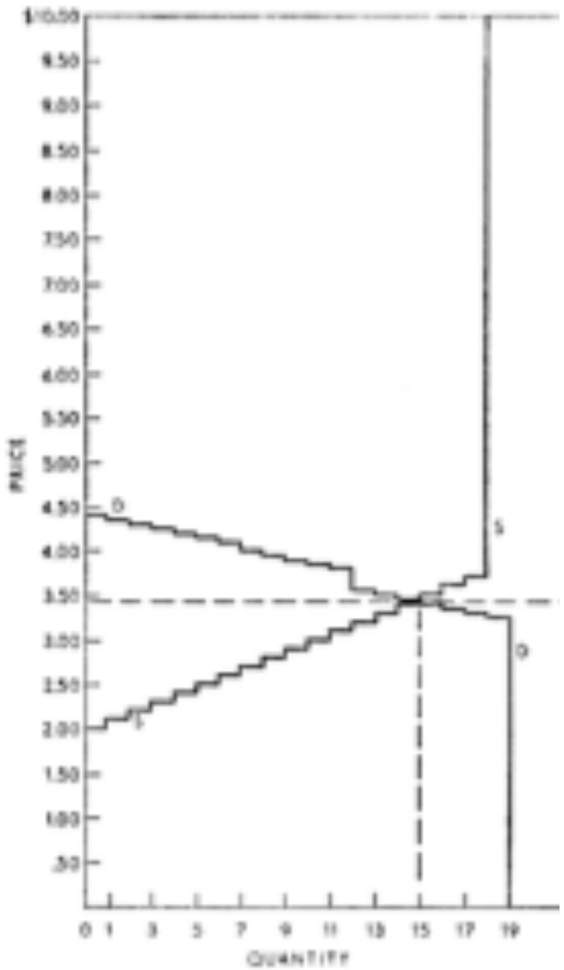
Justification for equilibrium?



Equilibrium price

Defined by buyers values

Justification for equilibrium?



Nobody knows

-Demand

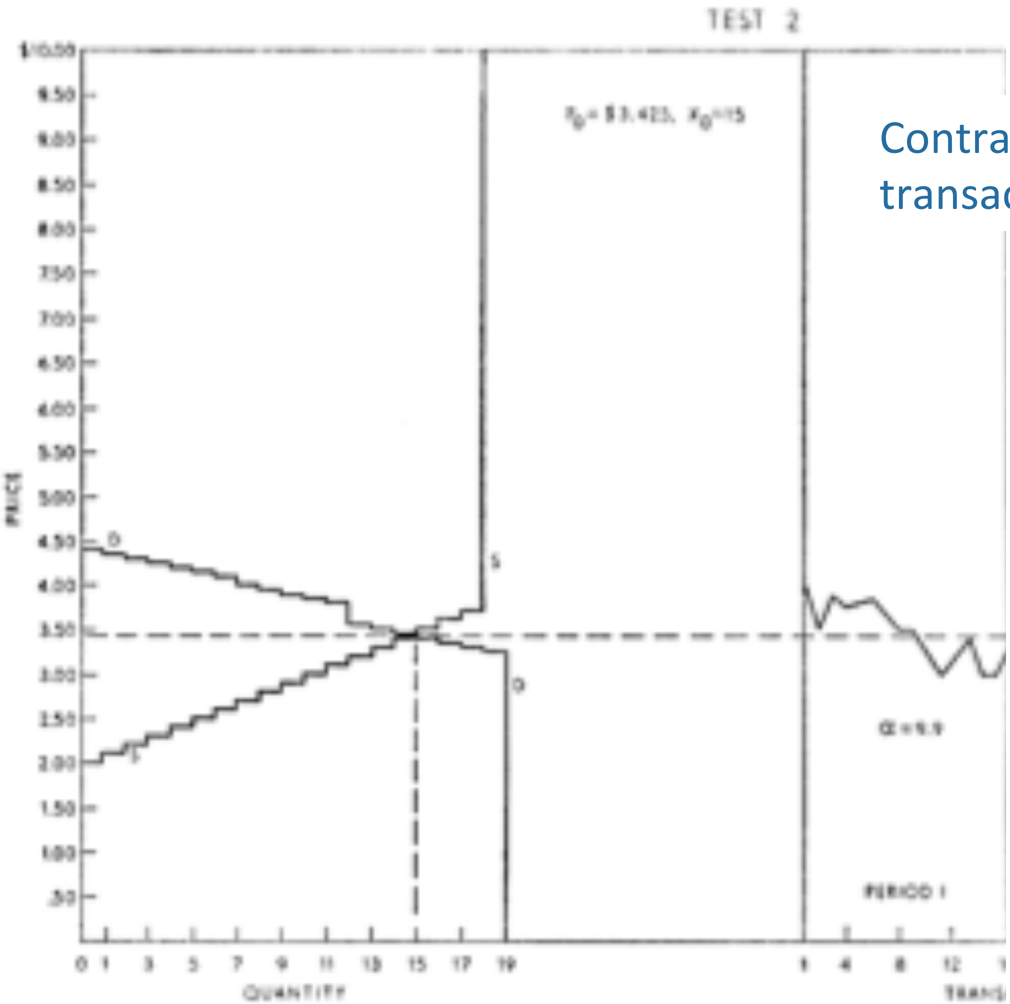
-Supply

-Equilibrium price

Justification for equilibrium?

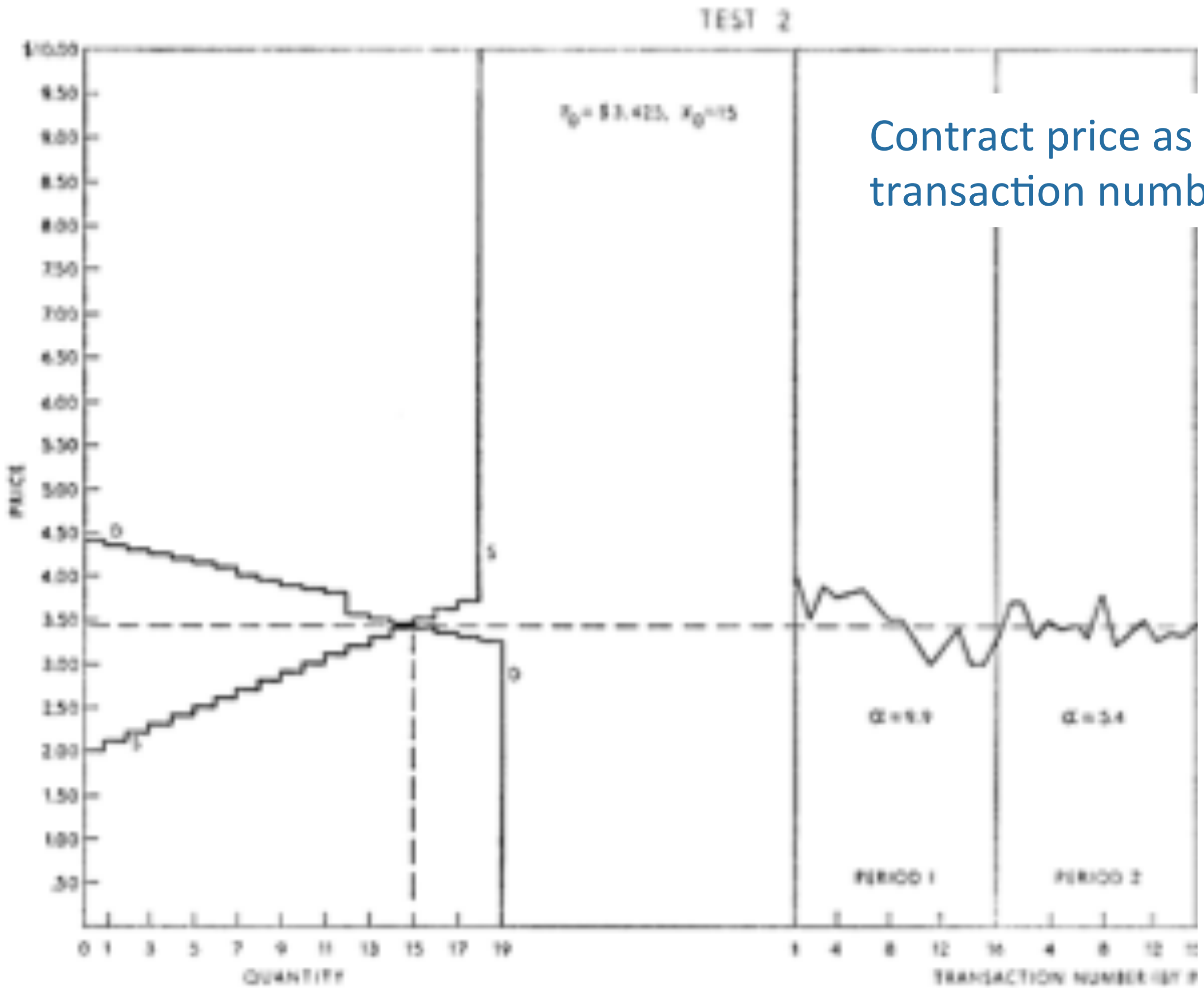
- Trading
  - Every trading period is 5 – 10 minutes
  - Each agent can raise his hand and offer to buy or sell at some price
  - Each other agent can accept
  - The trading period continues until nobody is making additional offers
  - Then new trading period

Justification for equilibrium?



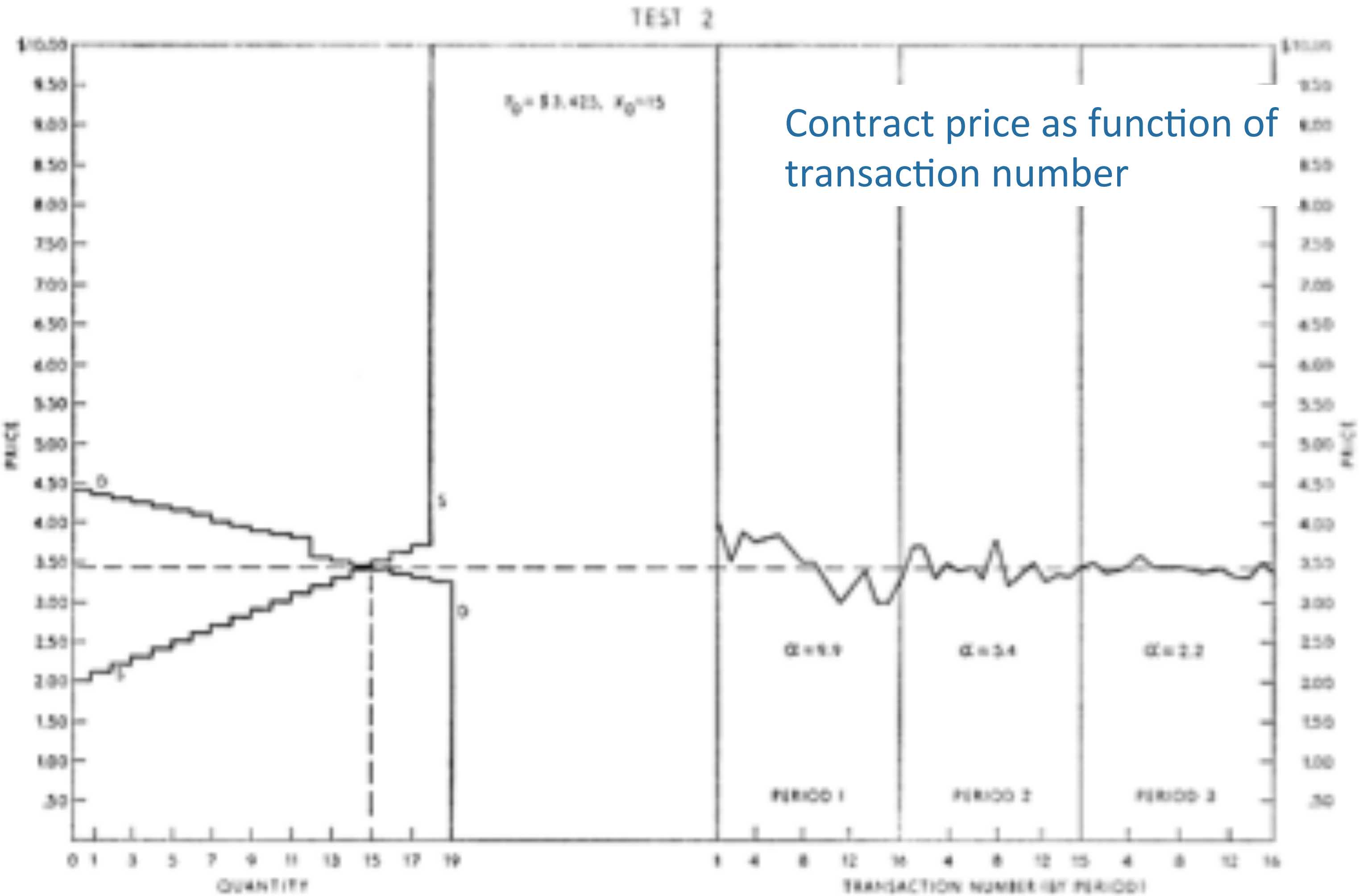
Contract price as function of transaction number

Justification for equilibrium?



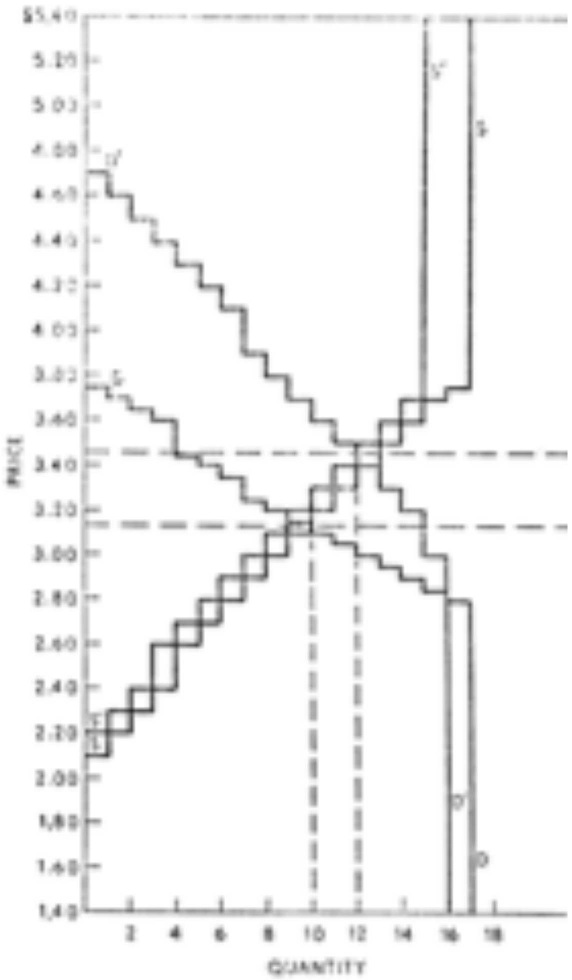
Contract price as function of transaction number

Justification for equilibrium?



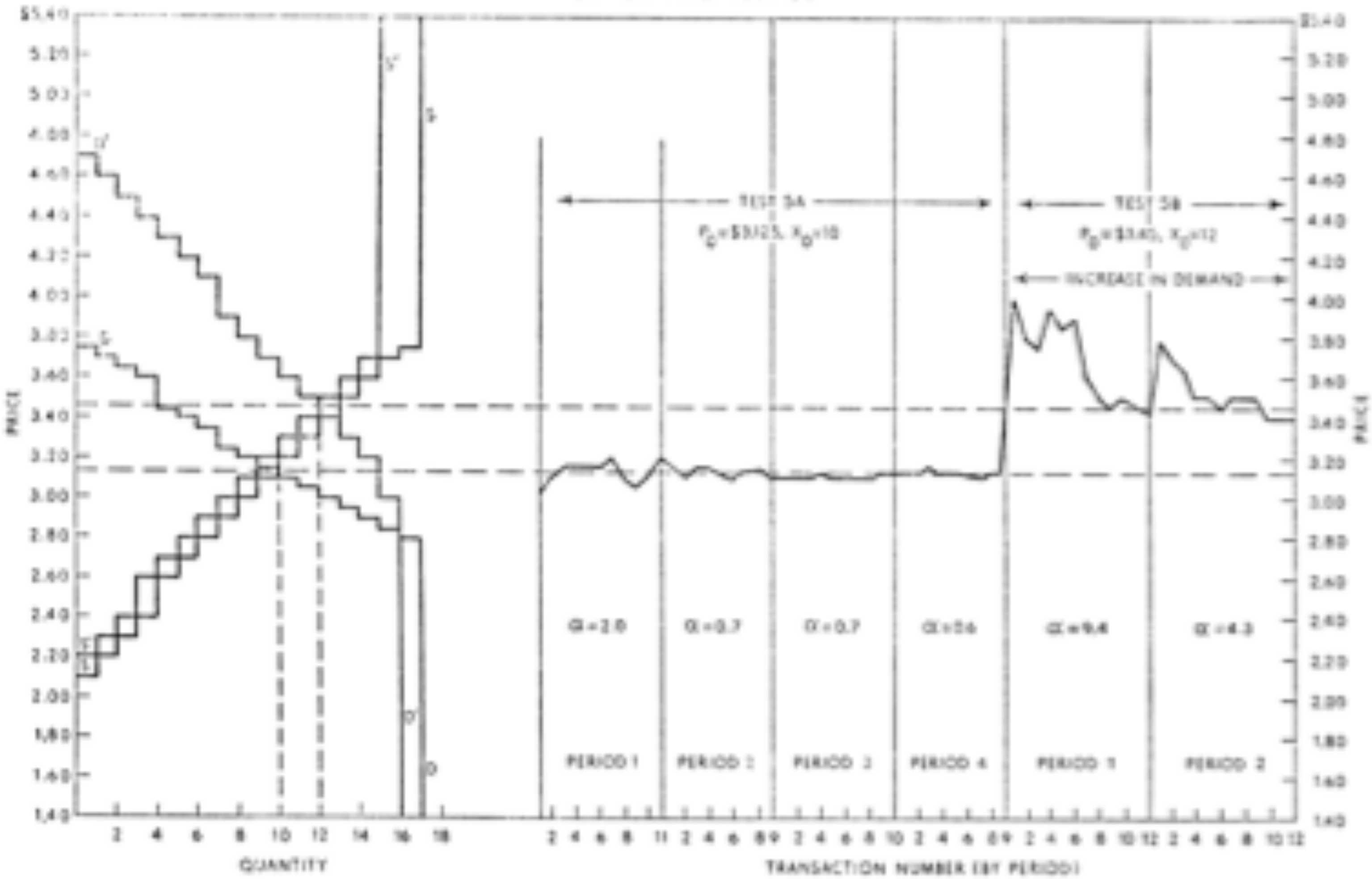
Justification for equilibrium?

Increase in demand and supply



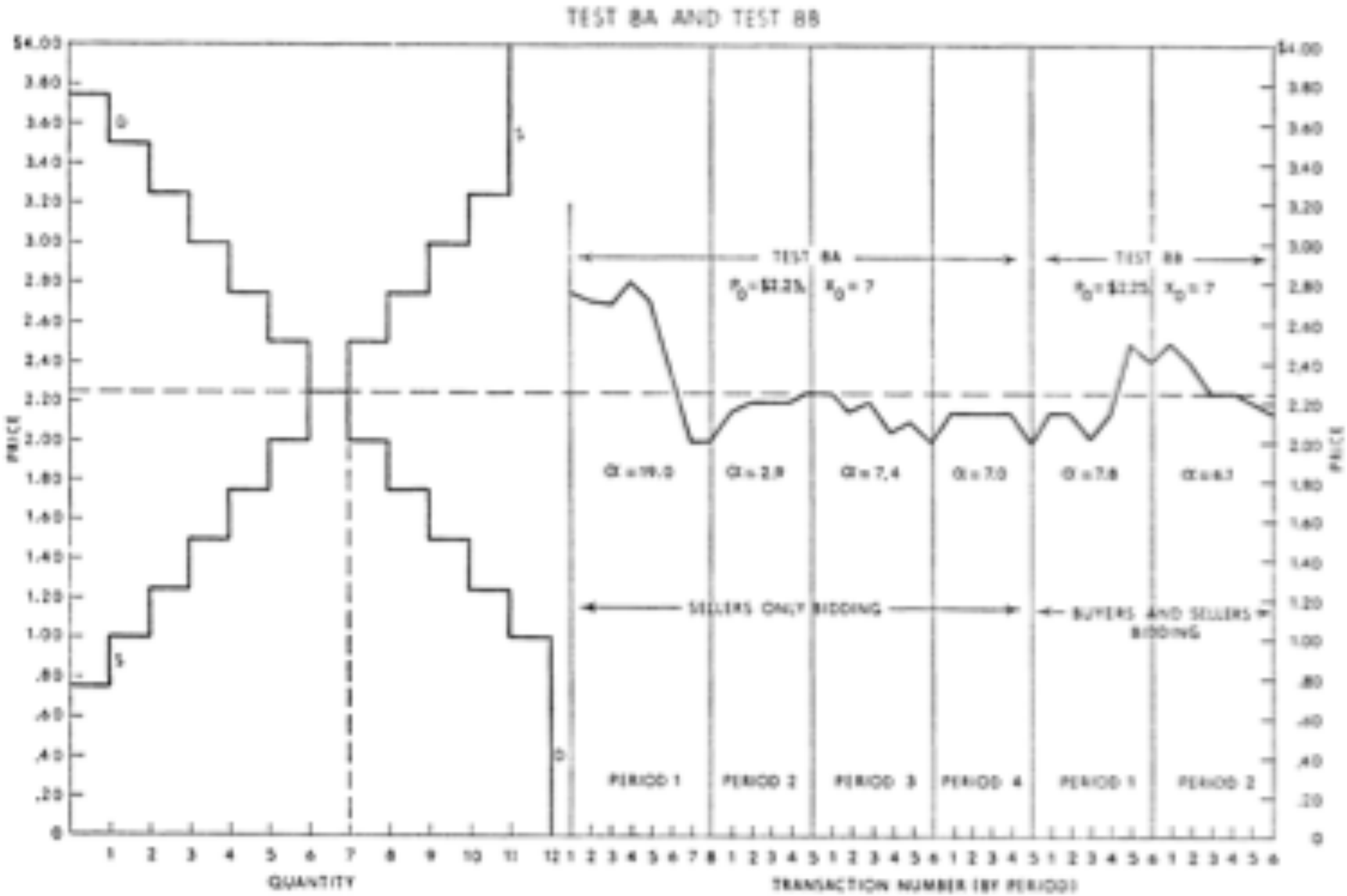
Justification for equilibrium?

Increase in demand and supply



Justification for equilibrium?

"Retail market": Only sellers propose prices



Justification for equilibrium?

- Results
  - Exchange prices approach equilibrium price
  - Finds new equilibrium price following shock (after some initial “confusion”)
  - Both in “commodity exchange” and “retail market”

Justification for equilibrium?

- Note
  - Small number of participants (12 on each side)
  - Process is quick. Only a small number of trades.

Justification for equ

- Most important result:
  - Market aggregates information
    - Every person only knew his own value
    - Nobody knew the demand and supply curves
    - Nobody knew the equilibrium price, but still that's the price they decided to trade at

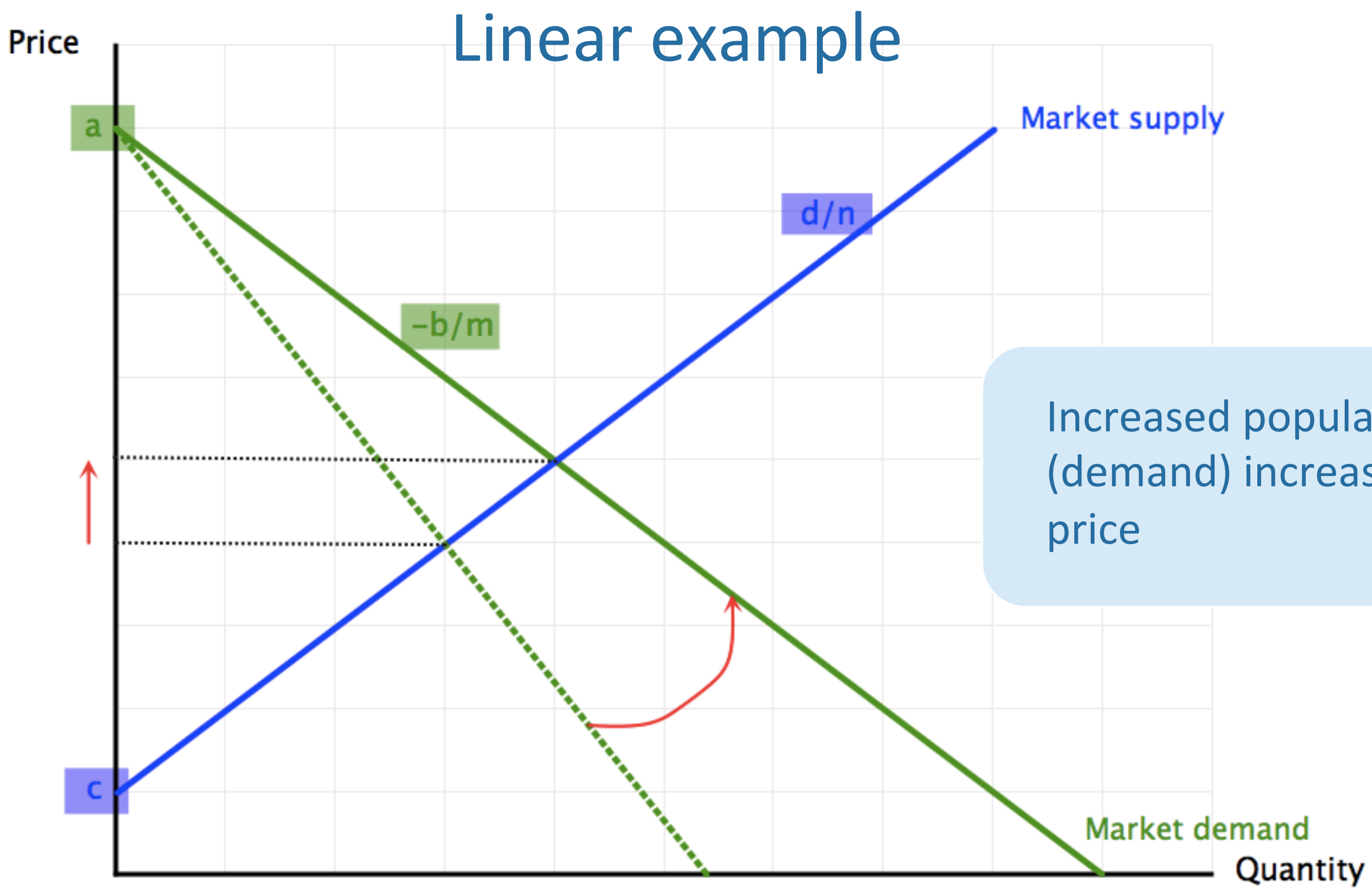
Applications

Comparative statics

Population increase

- What happens to equilibrium price if population is increased?
  - Consumers
    - There are M identical consumers
    - Individual inverse demand: q = d(P)
  - Firms
    - There are N identical firms
    - Marginal cost: q = s(P)

Population increase

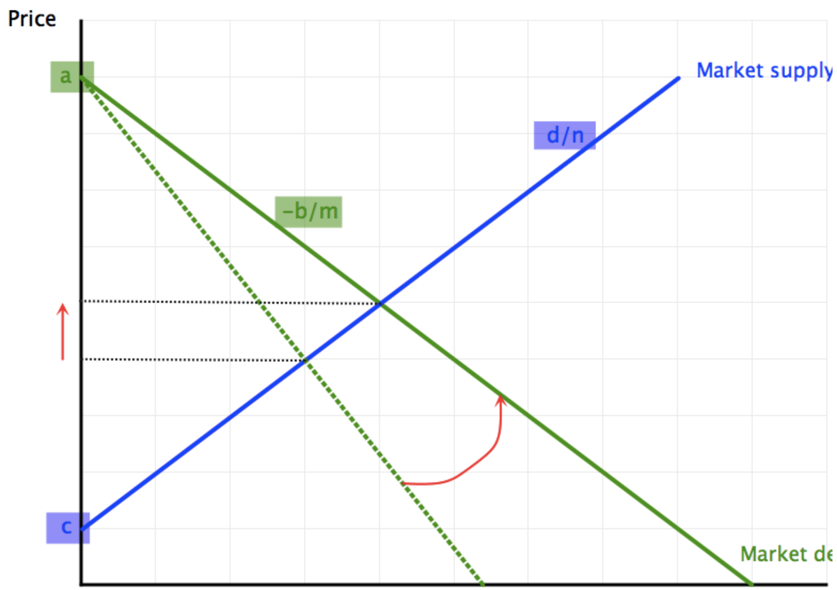


Increased population (demand) increases price

Population increase

Linear example

Price increase is smaller if supply is more elastic



Population increase

- Now: Show this formally

Equilibrium:

$$D(P) = S(P)$$

Population increase

- Now: Show this formally

Equilibrium:

$$D(P) = S(P)$$

Rewrite:

$$M \cdot d(P) = N \cdot s(P)$$

Population increase

- Now: Show this formally

Equilibrium:

$$D(P) = S(P)$$

Rewrite:

$$M \cdot d(P) = N \cdot s(P)$$

One equation in one unknown

Defines P as function of M and N

Q: What is next step to investigate how P depends on M?

Population increase

- Now: Show this formally

Equilibrium:

$D(P) = S(P)$

Rewrite:

$M \cdot d(P) = N \cdot s(P)$

Differentiate fo find effect of an increase in population (ΔM) on price (ΔP):

$d(P) \cdot \Delta M + M \cdot d'(P) \cdot \Delta P = N \cdot s'(P) \cdot \Delta P$

Population increase

Collect terms:

$$\left(N \cdot s'\left(P\right) - M \cdot d'\left(P\right)\right) \cdot \Delta P = d\left(P\right) \cdot \Delta M$$

Population increase

Collect terms:

$$\left(N\cdot s'(P)-M\cdot d'(P)\right)\cdot\Delta P=d(P)\cdot\Delta M$$

Divide by $M\cdot d(P)=N\cdot s(P)$

$$\left(\frac{N\cdot s'(P)}{N\cdot s(P)}-\frac{M\cdot d'(P)}{M\cdot d(P)}\right)\cdot\Delta P=\frac{d(P)}{d(P)}\cdot\frac{\Delta M}{M}$$

Population increase

Collect terms:

$$\left(N\cdot s'(P)-M\cdot d'(P)\right)\cdot\Delta P=d(P)\cdot\Delta M$$

Divide by $M\cdot d(P)=N\cdot s(P)$

$$\left(\frac{N\cdot s'(P)}{N\cdot s(P)}-\frac{M\cdot d'(P)}{M\cdot d(P)}\right)\cdot\Delta P=\frac{d(P)}{d(P)}\cdot\frac{\Delta M}{M}$$

Simplify

$$\left(\frac{s'(P)}{s(P)}-\frac{d'(P)}{d(P)}\right)\cdot\Delta P=\frac{\Delta M}{M}$$

Population increase

Divide and multiply left hand side by P

$$\left(\frac{s'(P)\cdot P}{s(P)}-\frac{d'(P)\cdot P}{d(P)}\right)\cdot\frac{\Delta P}{P}=\frac{\Delta M}{M}$$

Population increase

Divide and multiply left hand side by P

$$\left(\frac{s'(P)\cdot P}{s(P)}-\frac{d'(P)\cdot P}{d(P)}\right)\cdot\frac{\Delta P}{P}=\frac{\Delta M}{M}$$

Q: Interpretation?

Population increase

Divide and multiply left hand side by P

$$\left(\frac{s'(P)\cdot P}{s(P)}-\frac{d'(P)\cdot P}{d(P)}\right)\cdot\frac{\Delta P}{P}=\frac{\Delta M}{M}$$

Q: Interpretation?

Population increase

Divide and multiply left hand side by P

$$\left(\frac{s'(P) \cdot P}{s(P)} - \frac{d'(P) \cdot P}{d(P)} \right) \cdot \frac{\Delta P}{P} = \frac{\Delta M}{M}$$

Recall definitions of demand and supply elasticities

$$\varepsilon_s = \frac{s'(P) \cdot P}{s(P)} > 0 \qquad \varepsilon_d = \frac{d'(P) \cdot P}{d(P)} < 0$$

Population increase

Divide and multiply left hand side by P

$$\left(\frac{s'(P) \cdot P}{s(P)} - \frac{d'(P) \cdot P}{d(P)} \right) \cdot \frac{\Delta P}{P} = \frac{\Delta M}{M}$$

Recall definitions of demand and supply elasticities

$$\varepsilon_s = \frac{s'(P) \cdot P}{s(P)} > 0 \qquad \varepsilon_d = \frac{d'(P) \cdot P}{d(P)} < 0$$

Substitute

$$(\varepsilon_s - \varepsilon_d) \cdot \frac{\Delta P}{P} = \frac{\Delta M}{M}$$

Population increase

Effect of population increase (in %) on equilibrium price (in %)

$$\frac{\Delta P / P}{\Delta M / M} = \frac{1}{\varepsilon_s - \varepsilon_d} > 0$$

An increase in population increases price.

If supply is inelastic ($\varepsilon_s \cong 0$) price increase is large.

If supply is elastic ($\varepsilon_s \cong \infty$) price increase is small.

If demand is inelastic ($\varepsilon_s \cong 0$) price increase is large.

If demand is elastic ($\varepsilon_s \cong -\infty$) price increase is small.

Who pays a tax?

- How are sellers affected by a tax?
  - You work at ministry of finance
  - Minister wants to increase a per-unit tax on the selling of hot-dogs in streets
  - Lawyers at the ministry are worried that the already poor salesmen will be hurt
  - Minister asks you: What will the effects be?

Who pays a tax?

- Q: What happens to equilibrium price if tax is increased? (7 minutes)
  - Consumers price: P
  - Producer price: $P^* = P - T$
  - Compute $\Delta P/\Delta T$ [not elasticity $(\Delta P/P)/(\Delta T/T)$]
  - It is well-known that supply of hot-dogs is very elastic $\varepsilon_S = +\infty$

Who pays a tax?

Equilibrium:

$$D(P) = S(P - T)$$

Who pays a tax?

Equilibrium:

$$D(P) = S(P - T)$$

One equation in one unknown

Defines P as function of M and N

Who pays a tax?

Equilibrium:

$$D(P) = S(P - T)$$

One equation in one unknown

Defines P as function of M and N

Differentiate to find effect of an increase in tax (ΔT) on price (ΔP):

$$D'(P) \cdot \Delta P = S'(P - T) \cdot \Delta P - S'(P - T) \cdot \Delta T$$

Who pays a tax?

Equilibrium:

$$D(P) = S(P - T)$$

Differentiate to find effect of an increase in tax (ΔT) on price (ΔP):

$$D'(P) \cdot \Delta P = S'(P - T) \cdot \Delta P - S'(P - T) \cdot \Delta T$$

Collect terms:

$$\left[S'(1 - T) - D'(P) \right] \cdot \Delta P = S'(P - T) \cdot \Delta T$$

Who pays a tax?

Divide by S = D:

$$\left[\frac{S'(P-T)}{S(P-T)}-\frac{D'(P)}{D(P)}\right]\cdot \Delta P=\frac{S'(P-T)}{S(P-T)}\cdot \Delta T$$

Who pays a tax?

Divide by S = D:

$$\left[\frac{S'(P-T)}{S(P-T)}-\frac{D'(P)}{D(P)}\right]\cdot\Delta P=\frac{S'(P-T)}{S(P-T)}\cdot\Delta T$$

Multiply by P

$$\left[\frac{S'(P-T)\cdot P}{S(P-T)}-\frac{D'(P)\cdot P}{D(P)}\right]\cdot\Delta P=\frac{S'(P-T)\cdot P}{S(P-T)}\cdot\Delta T$$

Who pays a tax?

Divide by S = D:

$$\left[\frac{S'(P-T)}{S(P-T)}-\frac{D'(P)}{D(P)}\right]\cdot\Delta P=\frac{S'(P-T)}{S(P-T)}\cdot\Delta T$$

Multiply by P

$$\left[\frac{S'(P-T)\cdot P}{S(P-T)}-\frac{D'(P)\cdot P}{D(P)}\right]\cdot\Delta P=\frac{S'(P-T)\cdot P}{S(P-T)}\cdot\Delta T$$

Recall $\mathrm{P}^{*}=P-T$

$$\left[\frac{S'(P-T)\cdot(P-T)}{S(P-T)}\cdot\frac{P}{P-T}-\frac{D'(P)\cdot P}{D(P)}\right]\cdot\Delta P=\frac{S'(P-T)\cdot(P-T)}{S(P-T)}\cdot\frac{P}{P-T}\cdot\Delta T$$

Who pays a tax?

Use definition of demand and supply elasticities

$$\left[\varepsilon_S \cdot \frac{P}{P-T} - \varepsilon_D\right] \cdot \Delta P = \varepsilon_S \cdot \frac{P}{P-T} \cdot \Delta T$$

Who pays a tax?

Use definition of demand and supply elasticities

$$\left[\varepsilon_S \cdot \frac{P}{P-T} - \varepsilon_D\right] \cdot \Delta P = \varepsilon_S \cdot \frac{P}{P-T} \cdot \Delta T$$

Rearrange:

$$\frac{\Delta P}{\Delta T} = \frac{\varepsilon_S}{\varepsilon_S - \varepsilon_D \cdot \frac{P-T}{P}}$$

Who pays a tax?

Use definition of demand and supply elasticities

$$\left[\varepsilon_S \cdot \frac{P}{P-T} - \varepsilon_D\right] \cdot \Delta P = \varepsilon_S \cdot \frac{P}{P-T} \cdot \Delta T$$

Rearrange:

$$\frac{\Delta P}{\Delta T} = \frac{\varepsilon_S}{\varepsilon_S - \varepsilon_D \cdot \frac{P-T}{P}}$$

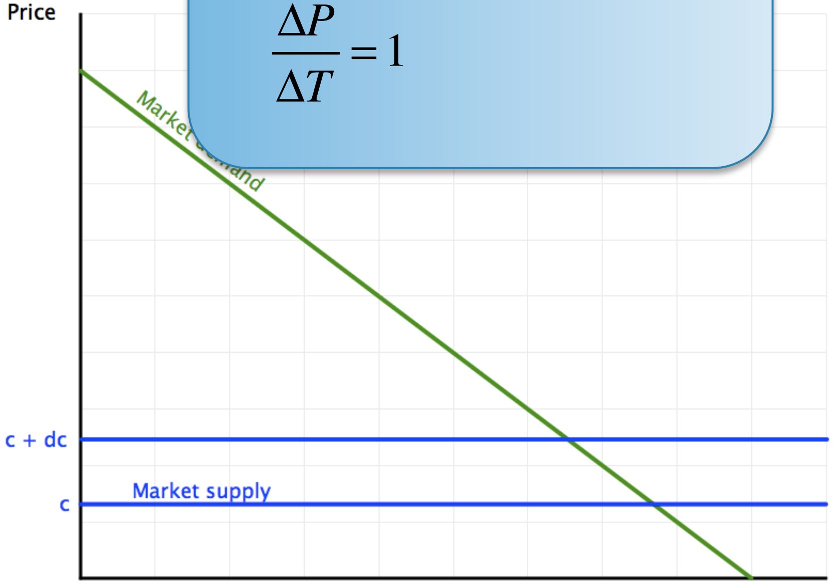
Note:

$$\lim_{\varepsilon_S \to \infty} \frac{dP}{dT} = \frac{\varepsilon_S}{\varepsilon_S - \varepsilon_D \cdot \frac{P-T}{P}} = 1$$

$$\frac{\Delta P}{\Delta T} = \frac{\varepsilon_S}{\varepsilon_S - \varepsilon_D \cdot \frac{P-T}{P}} \in [0,1]$$

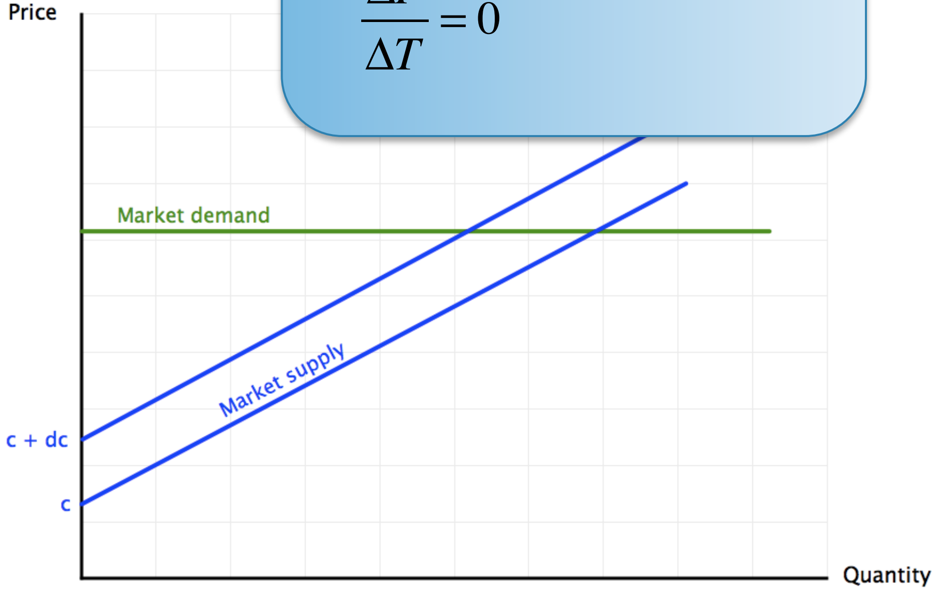
Elastic supply

$$\frac{\Delta P}{\Delta T} = 1$$



Elastic demand

$$\frac{\Delta P}{\Delta T} = 0$$



Who pays a tax?

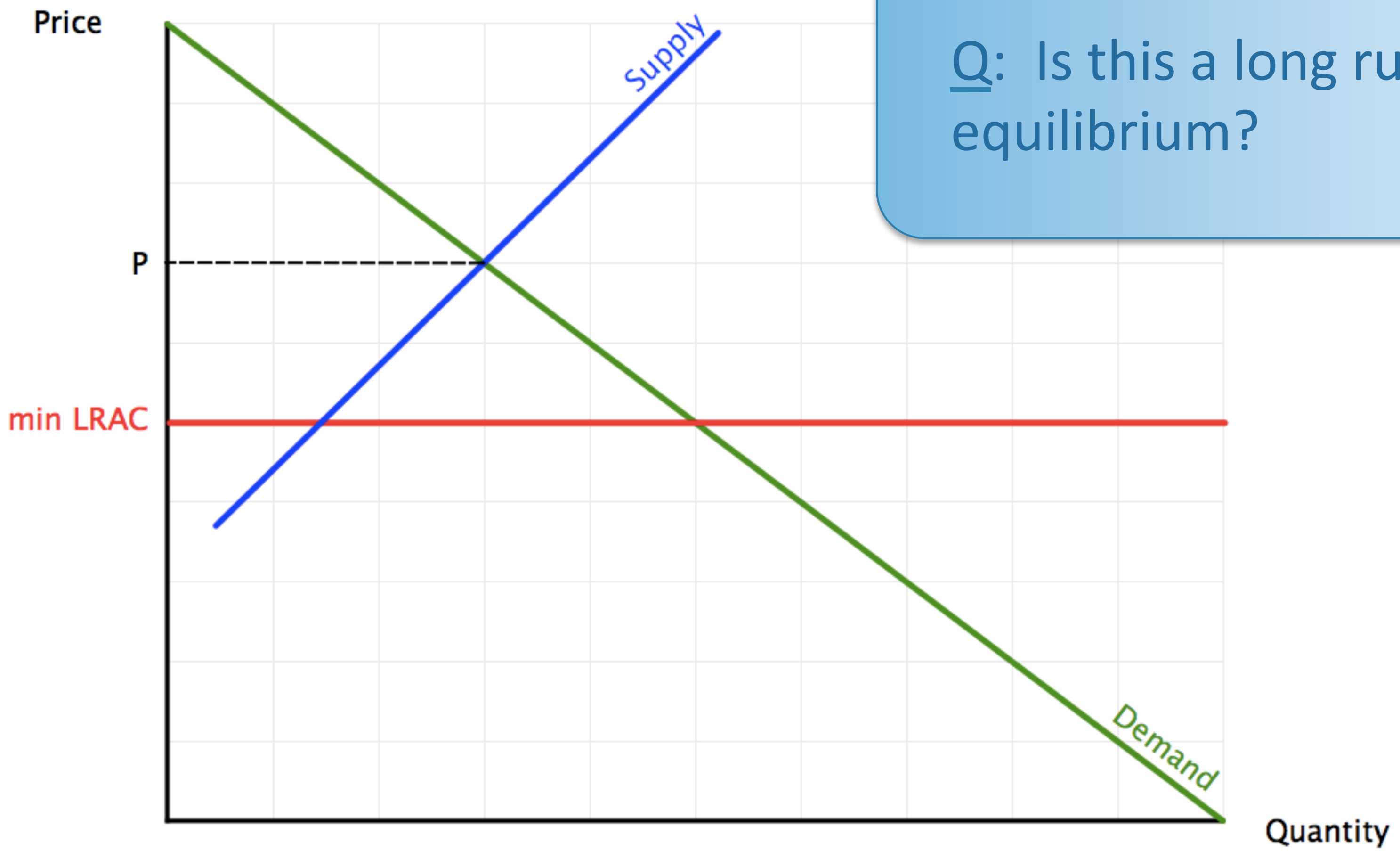
- Conclusion: Legal vs. economic incidence of a tax
  - Even if it is the sellers that formally pay the tax (legal incidence)
  - Part of the tax is passed on to buyers in the form of a higher price
    (economic incidence)
  - In the extreme, only the buyers pay the cost of the tax

Long run

Long run

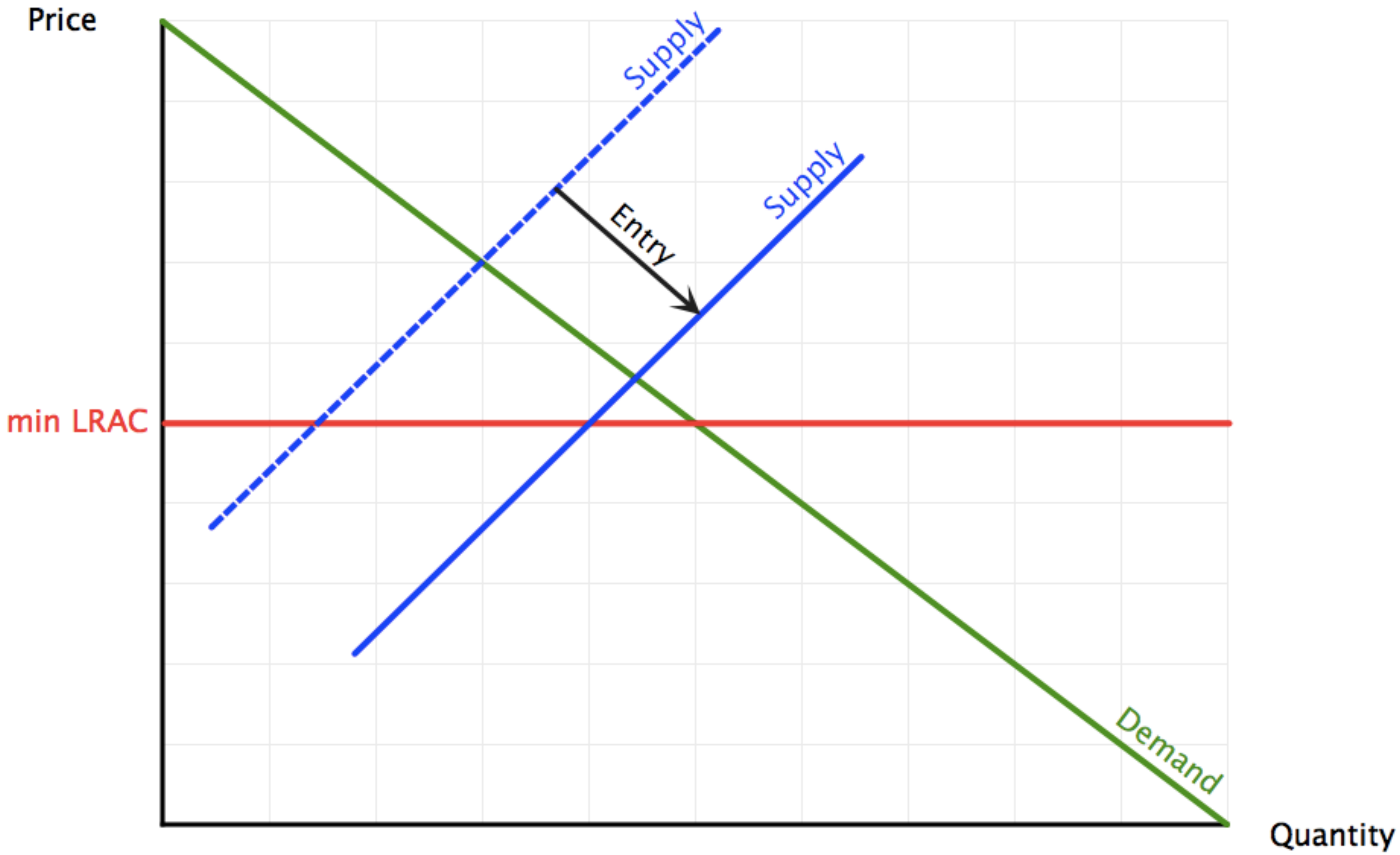
- Q: What do we mean by long run?
  - Individual firms can adjust capital
  - Exit if $P < LRAC$
  - New firms enter if $P > LRAC$

Long run

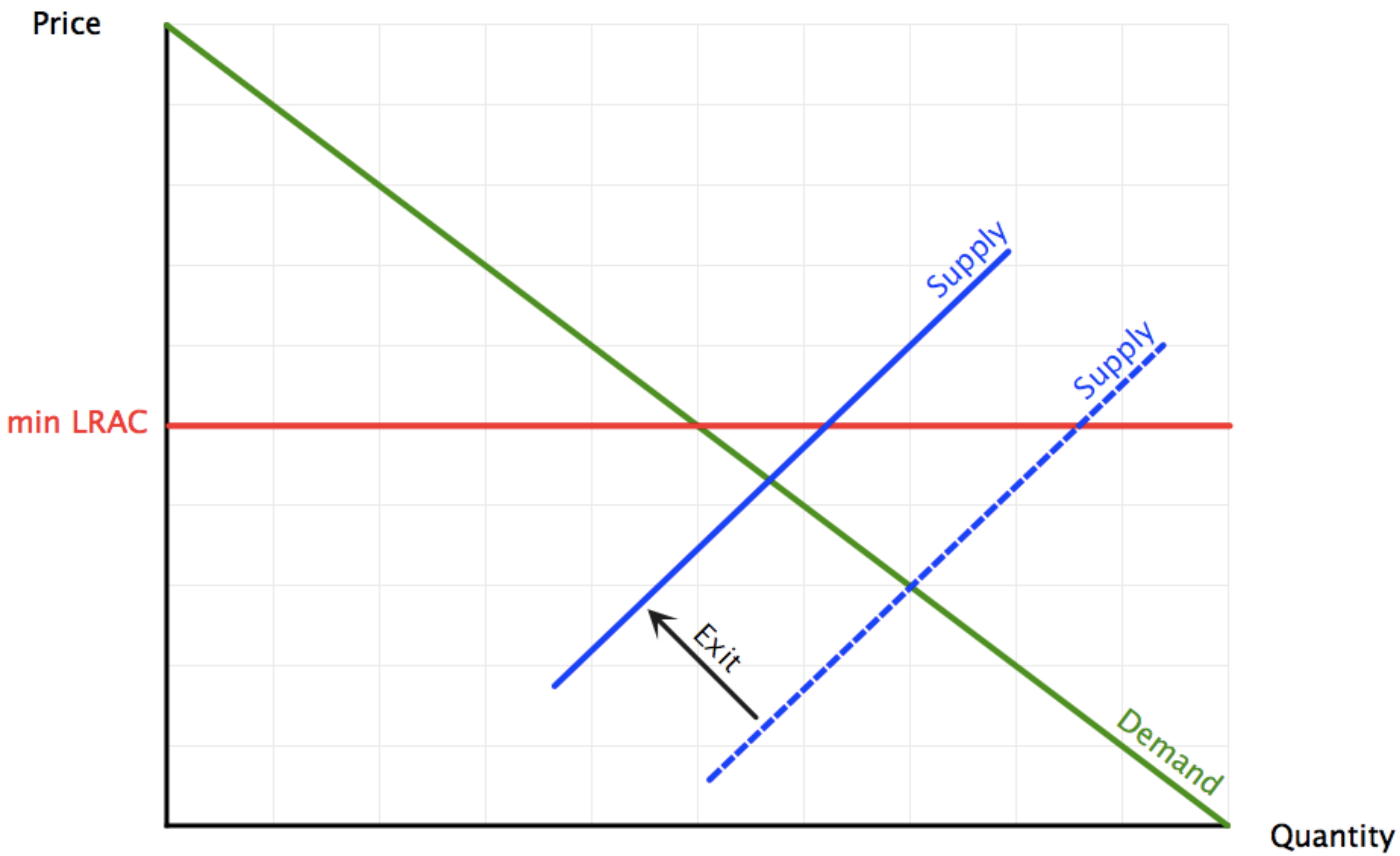


Q: Is this a long run equilibrium?

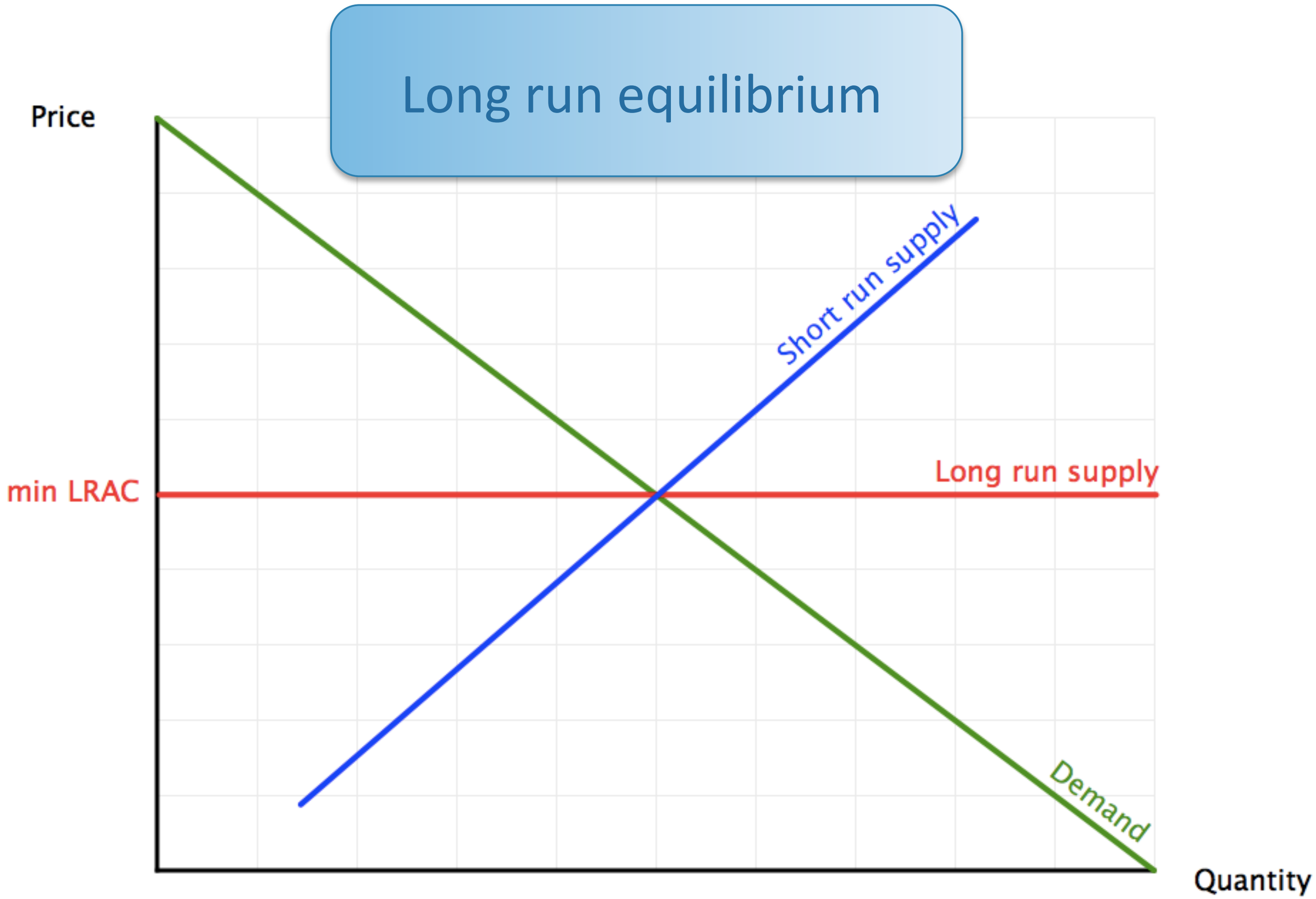
Long run



Long run



Long run

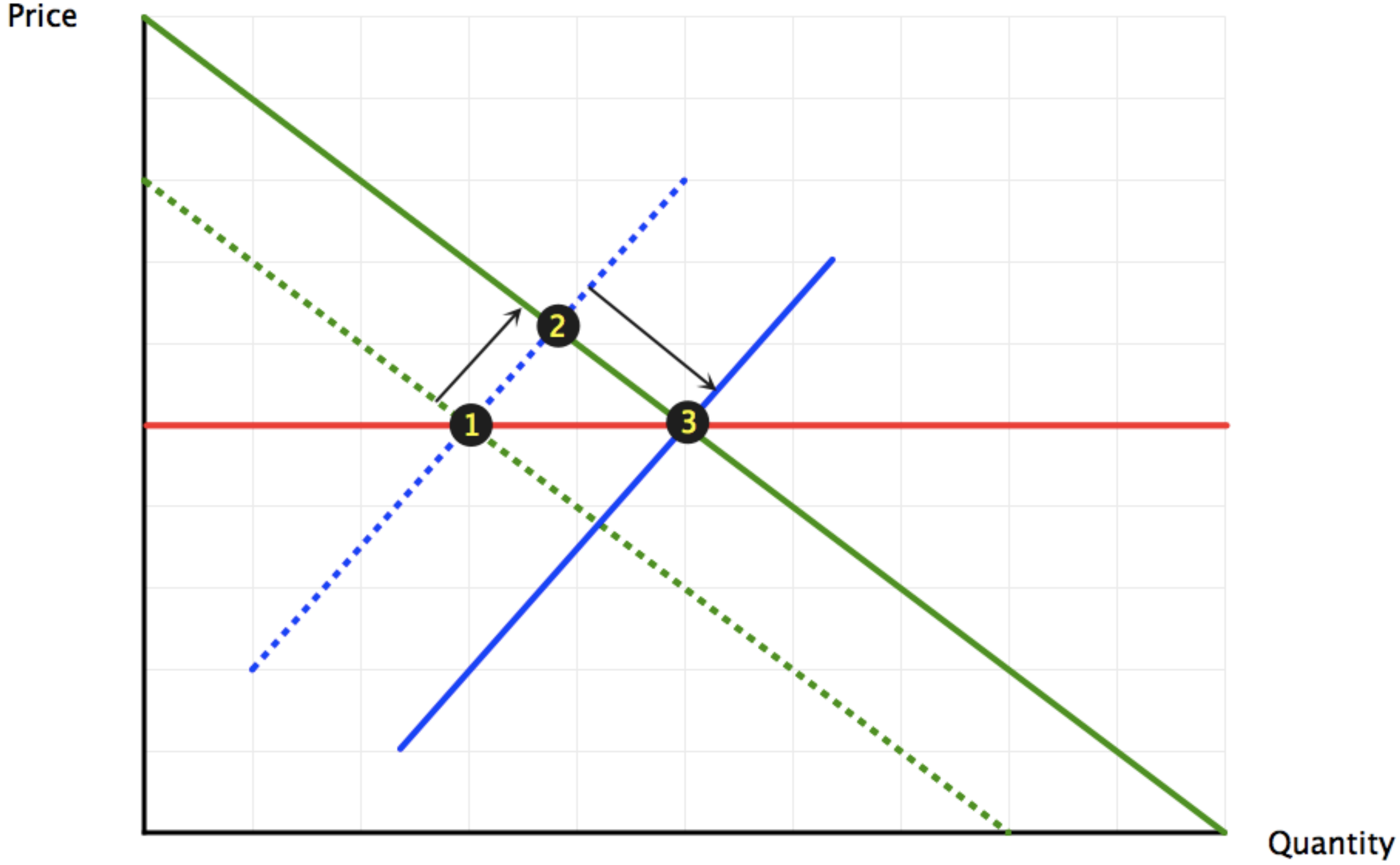


Long run equilibrium
Price
min LRAC
Short run supply
Long run supply
Demand
Quantity

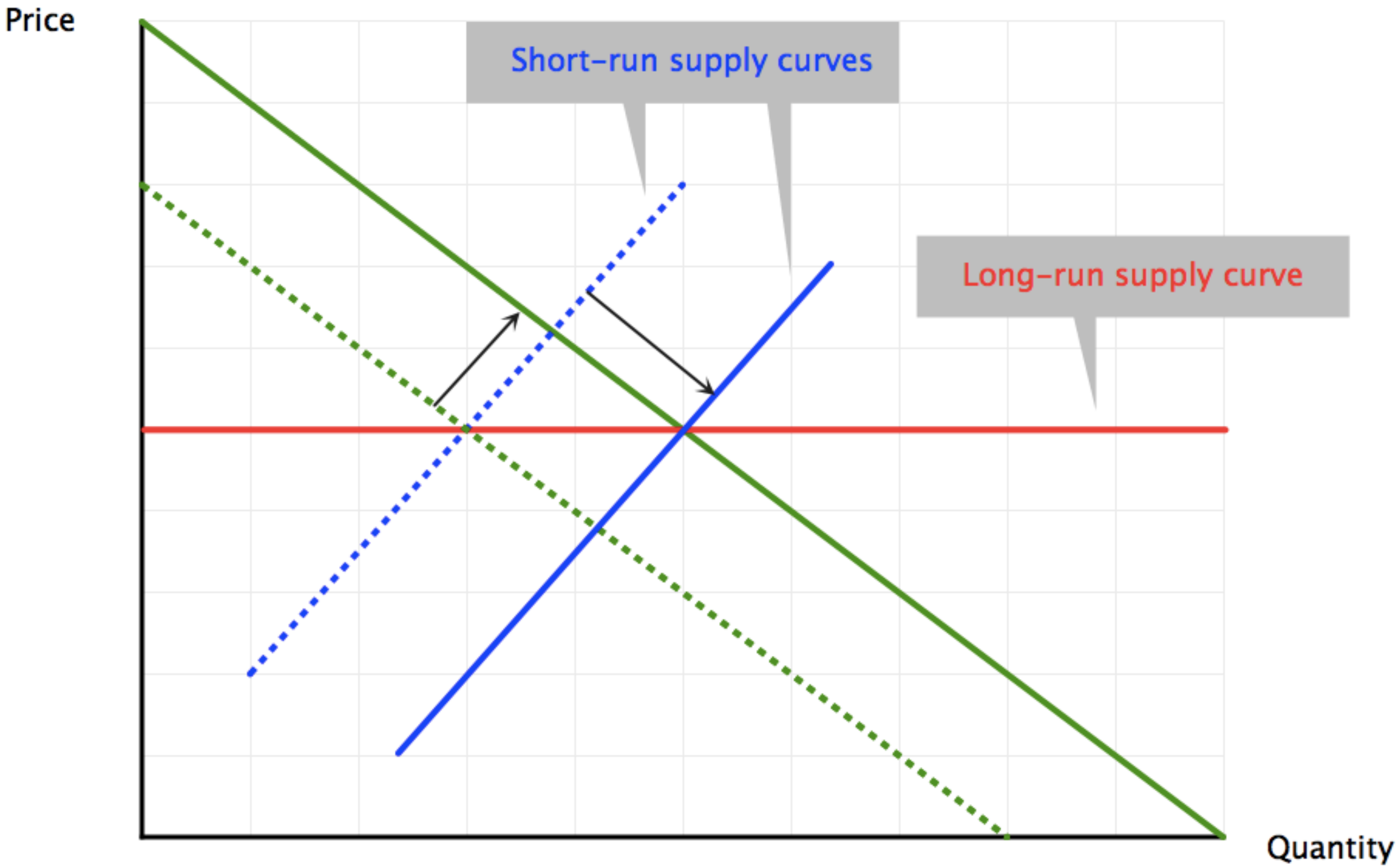
Long run

- Q: Assume that we are in long run equilibrium. Then demand increases. What will happen?
  - Price is increased in the short run
  - Entry
  - Price returns back to min LRAC

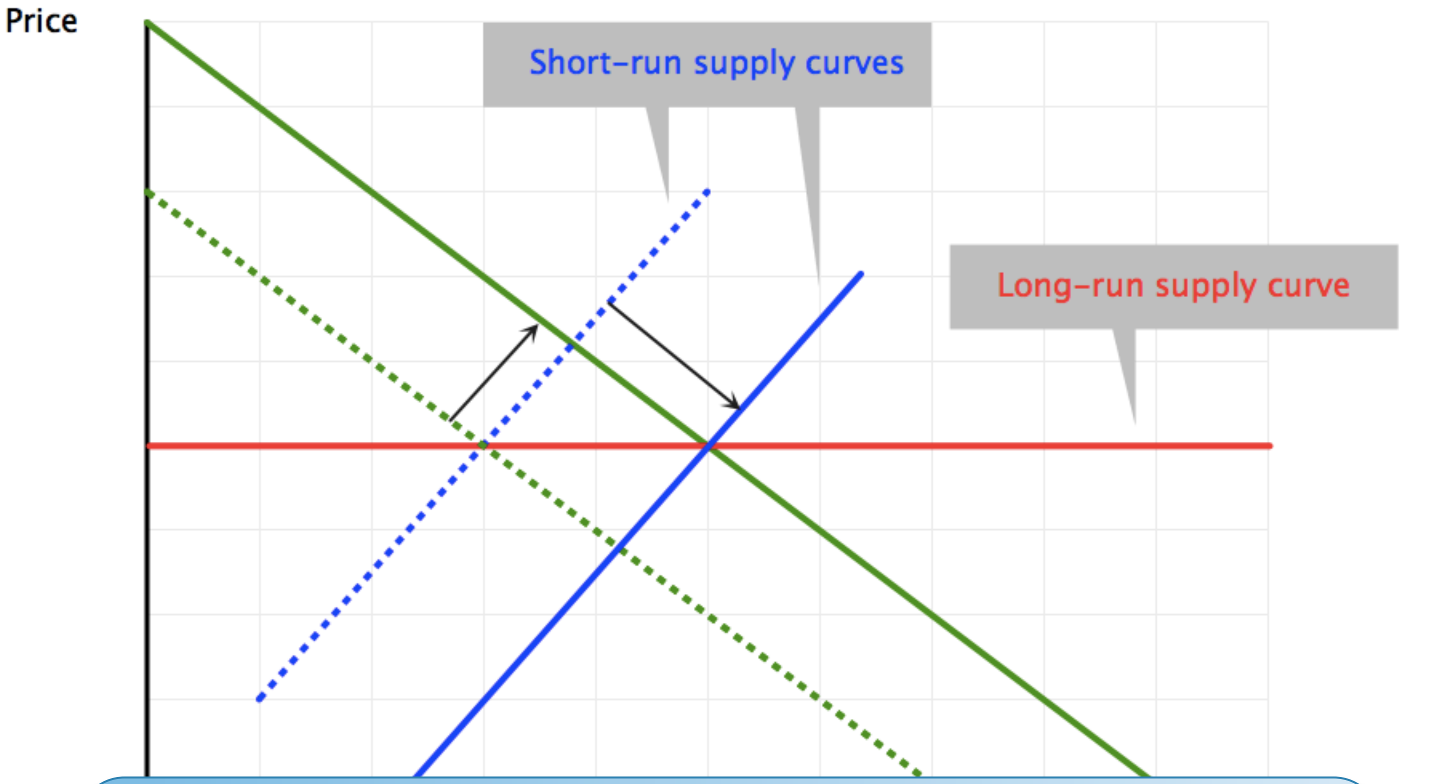
Long run



Long run


Price
Short–run supply curves
Long–run supply curve
Quantity

Long run



Short run supply adjusts so that it cuts demand at the same point as min LRAC

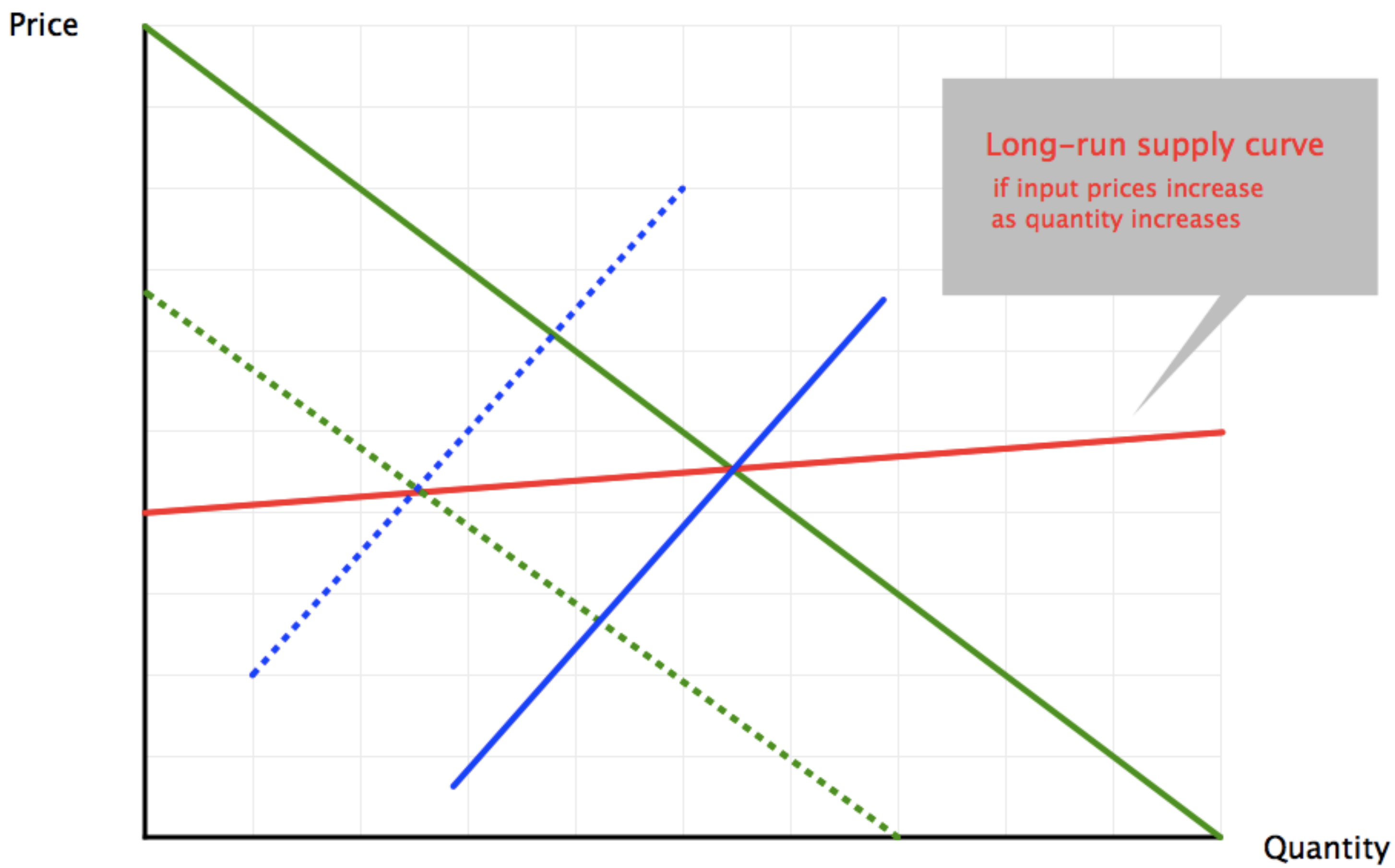
Long run

- Price
  - Determined by cost: P = min LRAC
- Quantity
  - Determined by demand: at P = min LRAC

Long run

- Caveat *min LRAC* may not be constant
  - Assumes that price of inputs remain constant when more and more firms are entering
  - The whole market must be small = Only buy a small proportion of inputs on any input market

Long run



Price
Long-run supply curve
if input prices increase
as quantity increases
Quantity

Welfare

Welfare

- Q: How much does society gain by the transactions in the market?
- A: Let's make a thought experiment
  - Government bans this particular market
  - How are stake-holders affected?
    - Consumers
    - Firm owners
    - Employees and other factor owners

Welfare

- Consumers
  - Consumer surplus = WTP – P   (monetary value)
  - Represents that consumers must buy other goods that they value less

Welfare

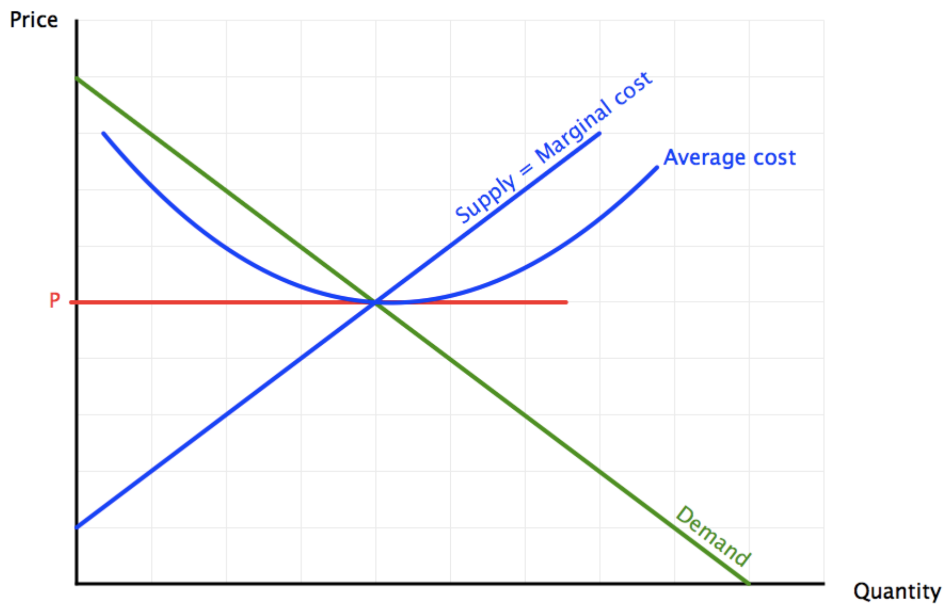
- Employees (and other factor owners)
  - Don't lose
  - Immediately start new job in other market at the *same wage*
  - If our market is small part of the economy, the increased supply of labor for other markets will not change the wage level

Welfare

- Firm owners
  - Two roles
    - Factor owners of *financial* capital
    - Residual claimants
      - They receive difference between revenues and cost (= compensations to all factor owners)

Welfare

- Firm owners
  - As residual claimants: Don't lose
    - Profits are zero



Welfare

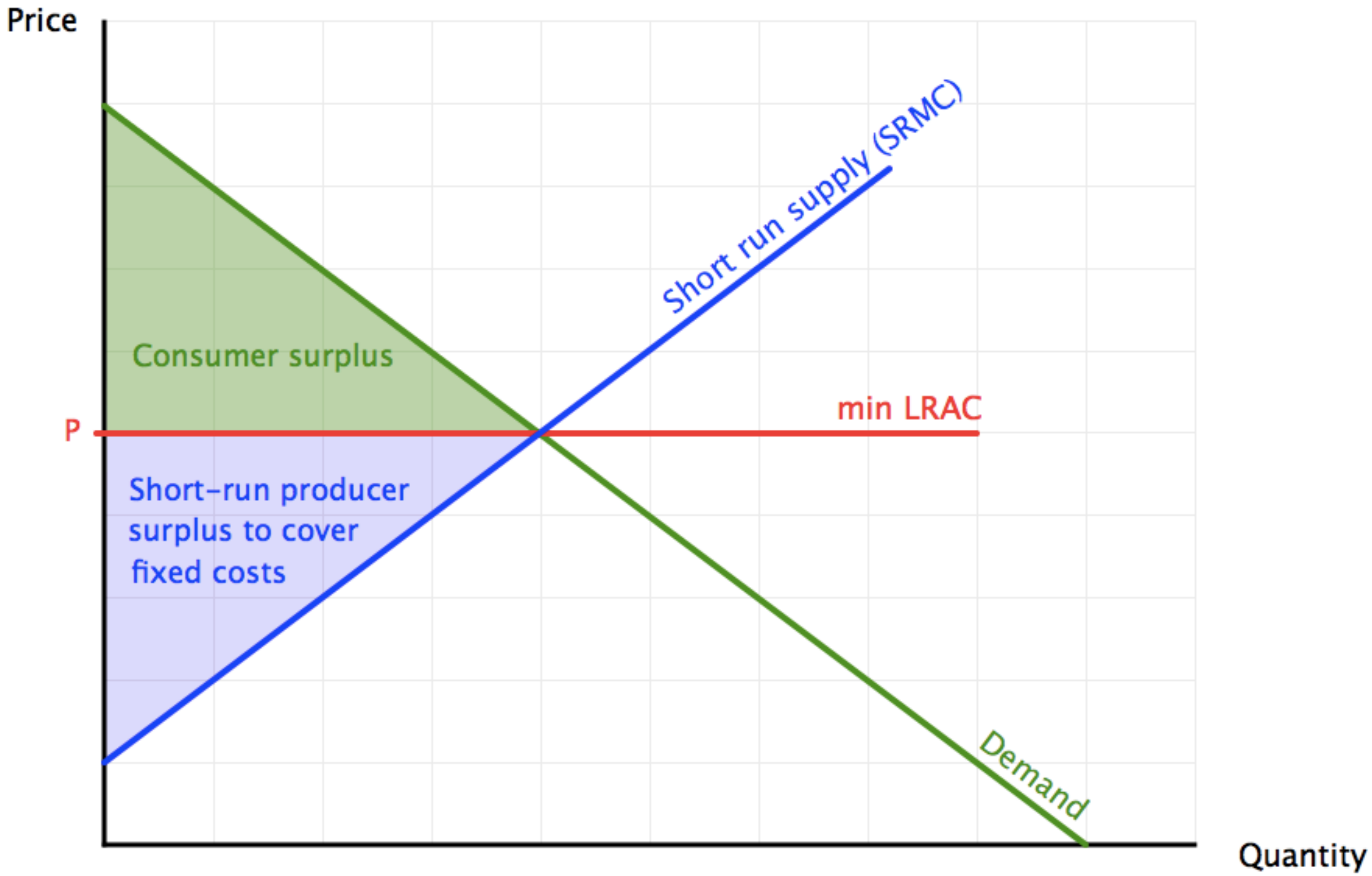
- Firm owners
  - As factor owners: Don't lose
    - Before: Receive "normal" return on *financial capital*
    - Now: Invest in other markets
      - Receive same returns
      - If our market is small part of the economy, the increased supply of financial capital for other markets will not change return on capital

Welfare

- Caveat
  - Employees typically have special training or experience that is less valued in other markets
  - If a market is closed *after* firms have made investments, then they will lose the future profits that where supposed to pay for the investments

Welfare

Summary



Efficiency

Efficiency

- Question
  - Would it be possible to improve the situation somehow (by government intervention)?

Efficiency

- Q: Define Pareto-sanctioned change
  - A re-allocation is Pareto-sanctioned if
    - at least one person gains
    - nobody loses
- Q: Define Pareto efficiency
  - An allocation is Pareto efficient if there are no Pareto-sanctioned changes

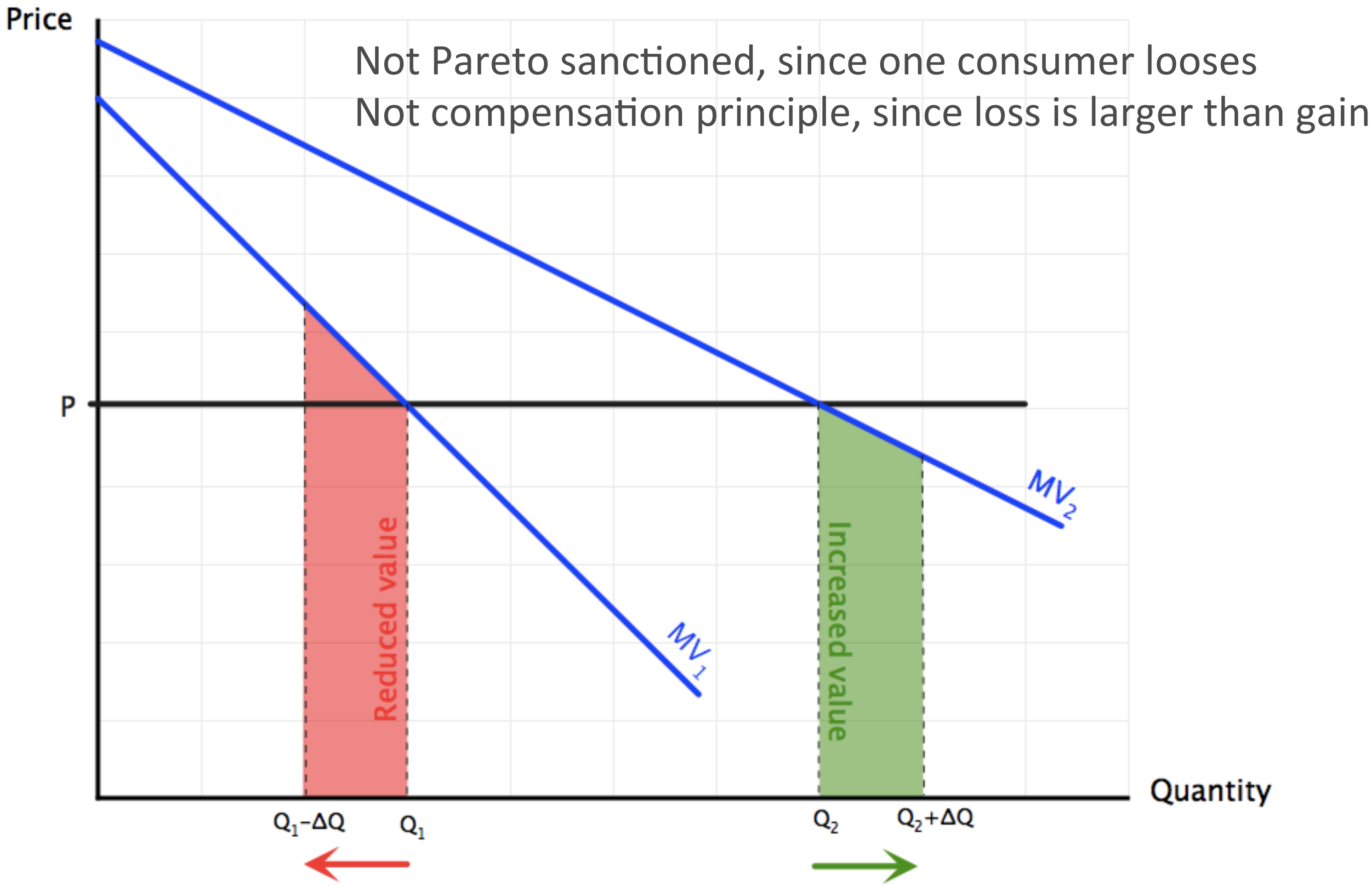
Efficiency

- Q: Define *compensation principle*
  - A re-allocation meets compensation principle if
    - Some people gain
    - Some people might lose
    - Those who gain *could* compensate those who lose

Efficiency

- Q: Consumption efficiency
  - Is it possible to distribute goods between consumers in a better way?

Efficiency



Price
Not Pareto sanctioned, since one consumer looses
Not compensation principle, since loss is larger than gain
P
Reduced value
Increased value
MV1
MV2
Quantity
Q1-ΔQ
Q1
Q2
Q2+ΔQ

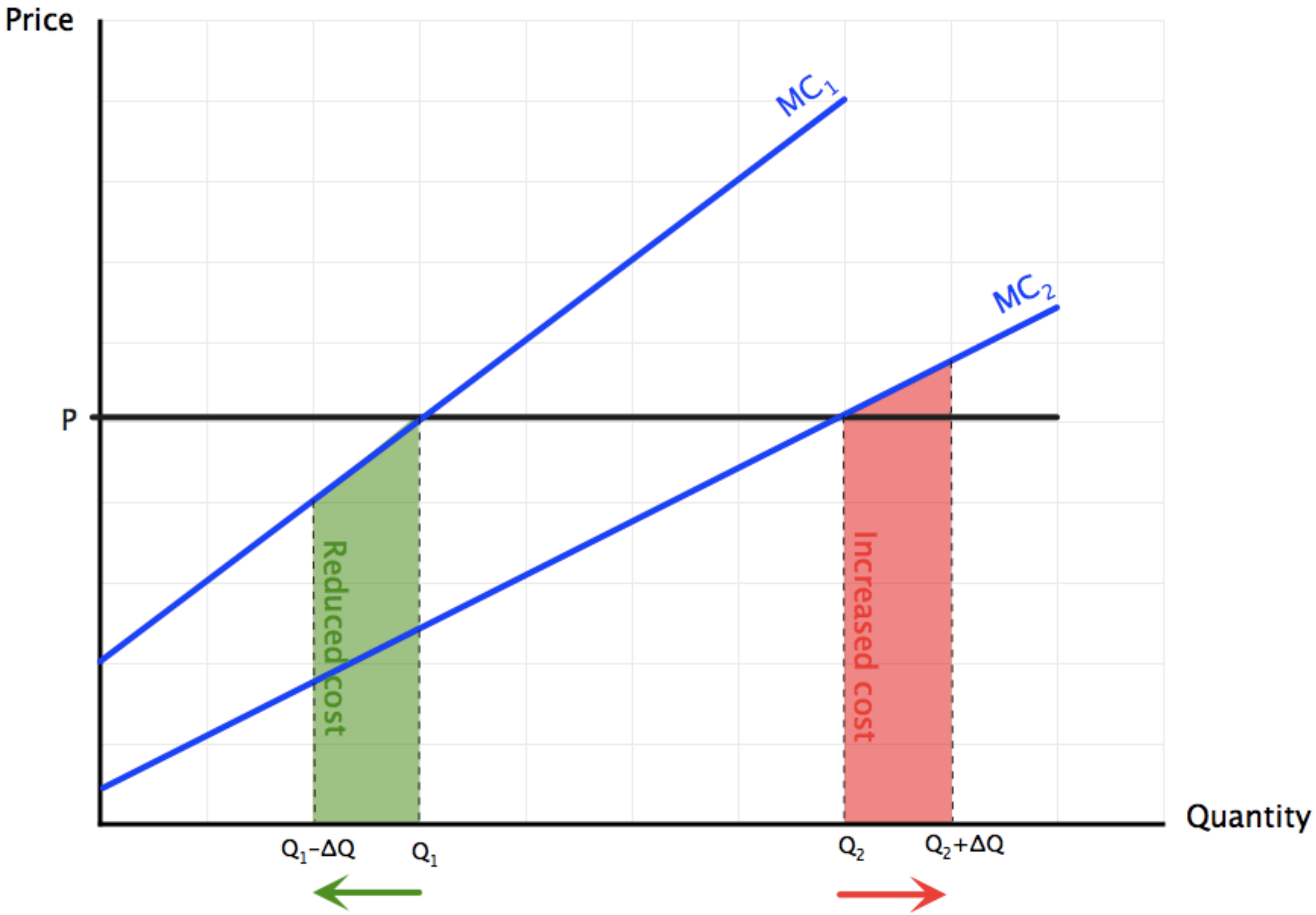
Efficiency

- Q: Consumption efficiency
  - Is it possible to distribute goods between consumers in a better way?
- A: No
  - Consumption allocated efficiently between consumers, since $MV_1 = MV_2 = ... = P$

Efficiency

- Q: Productive efficiency
  - Is it possible to produce the goods in a cheaper way (consuming fewer resources)?

Efficiency



Price
MC_1
MC_2
P
Reduced cost
Increased cost
Quantity
Q_1-ΔQ
Q_1
Q_2
Q_2+ΔQ

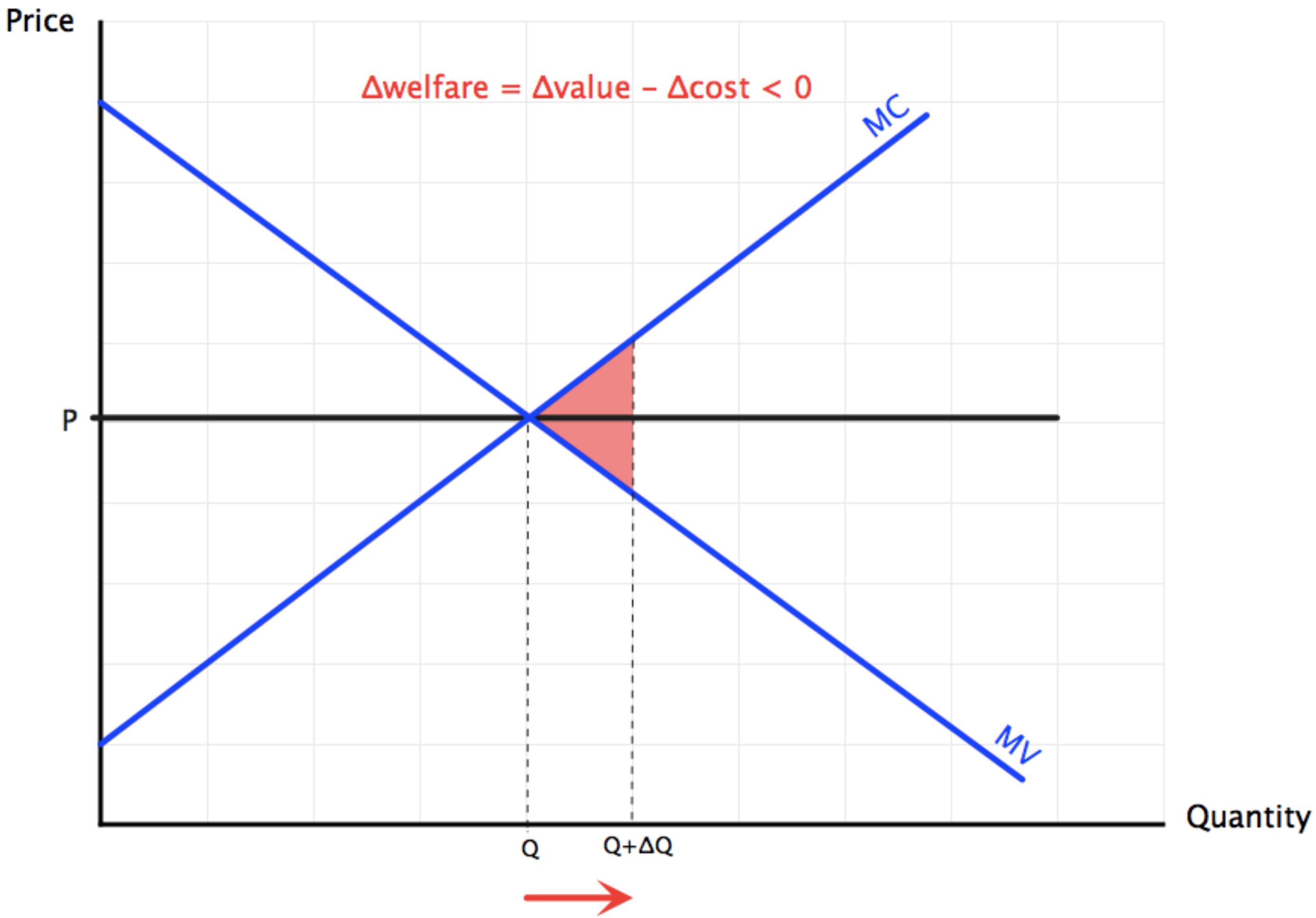
Efficiency

- Q: Productive efficiency
  - Is it possible to produce the goods in a cheaper way (consuming fewer resources)?
- A: No
  - Each firm minimizes cost, given what it produces
  - Production allocated efficiently between firms, since $MC_1 = MC_2 = ... = P$

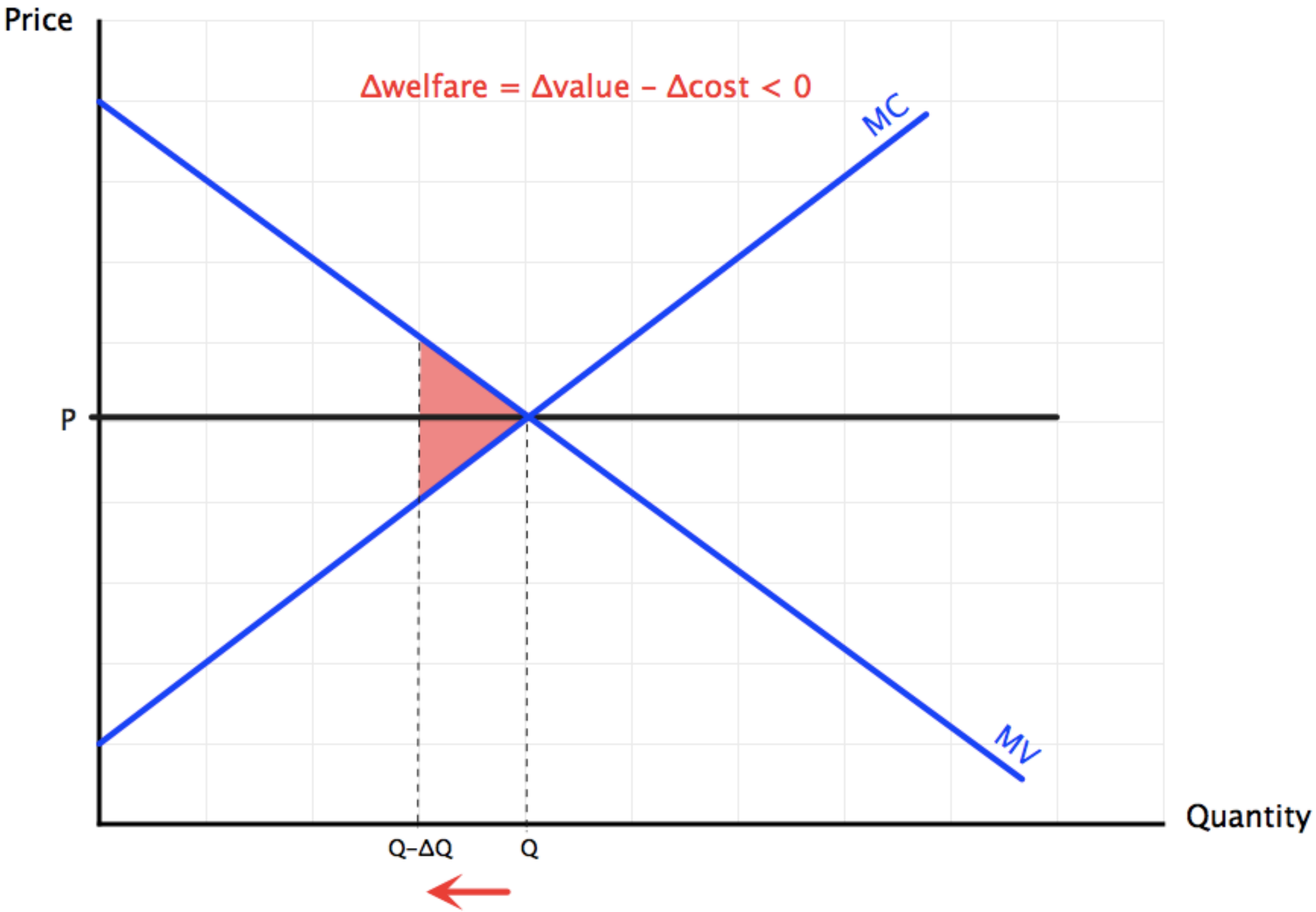
Efficiency

- Q: Level of activity
  - Would it be better to produce more (or less)?

Efficiency



Efficiency



Efficiency

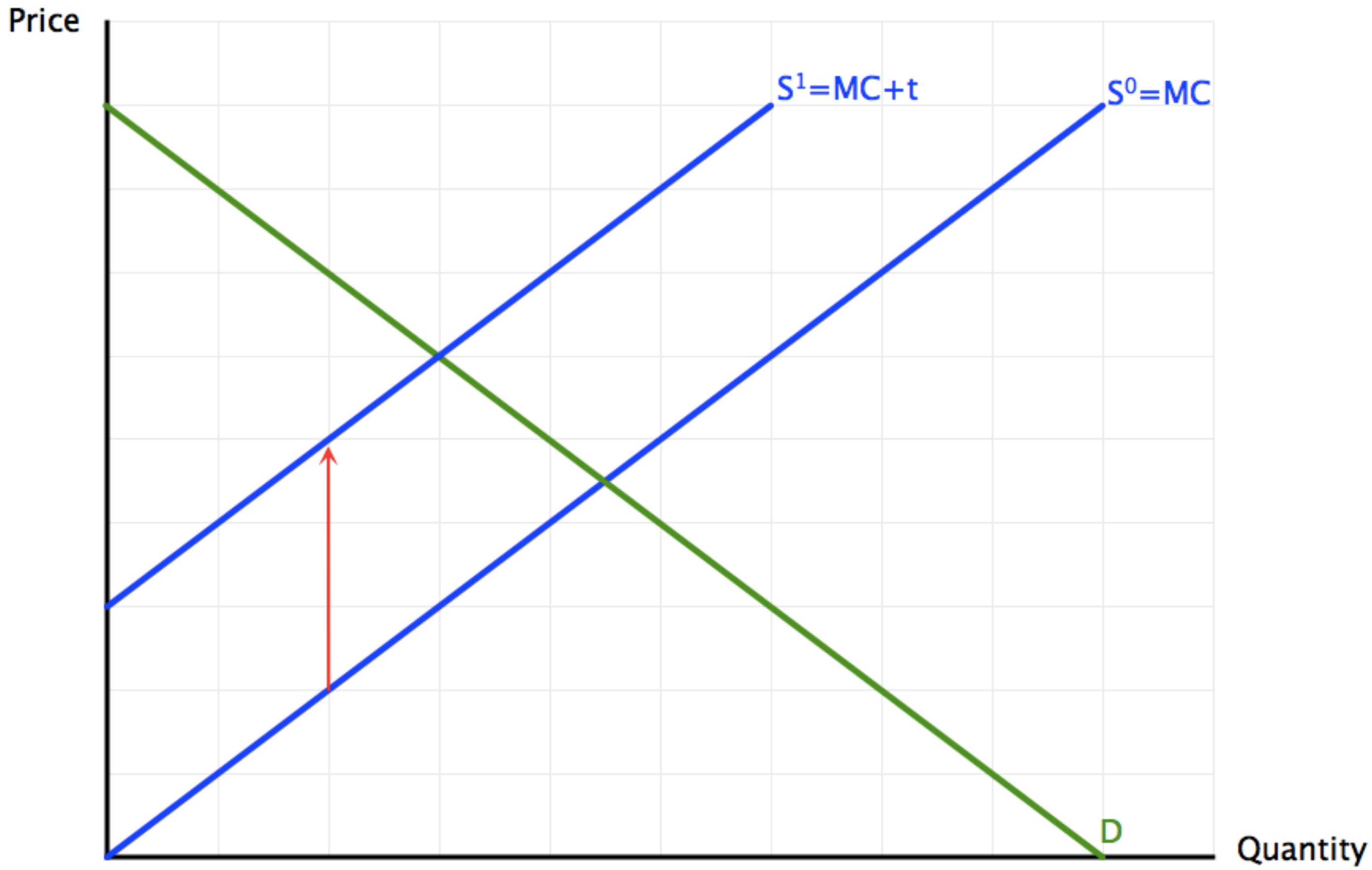
- Q: Level of activity
  - Would it be better to produce more (or less)?
- A: No
  - MV = MC

Efficiency

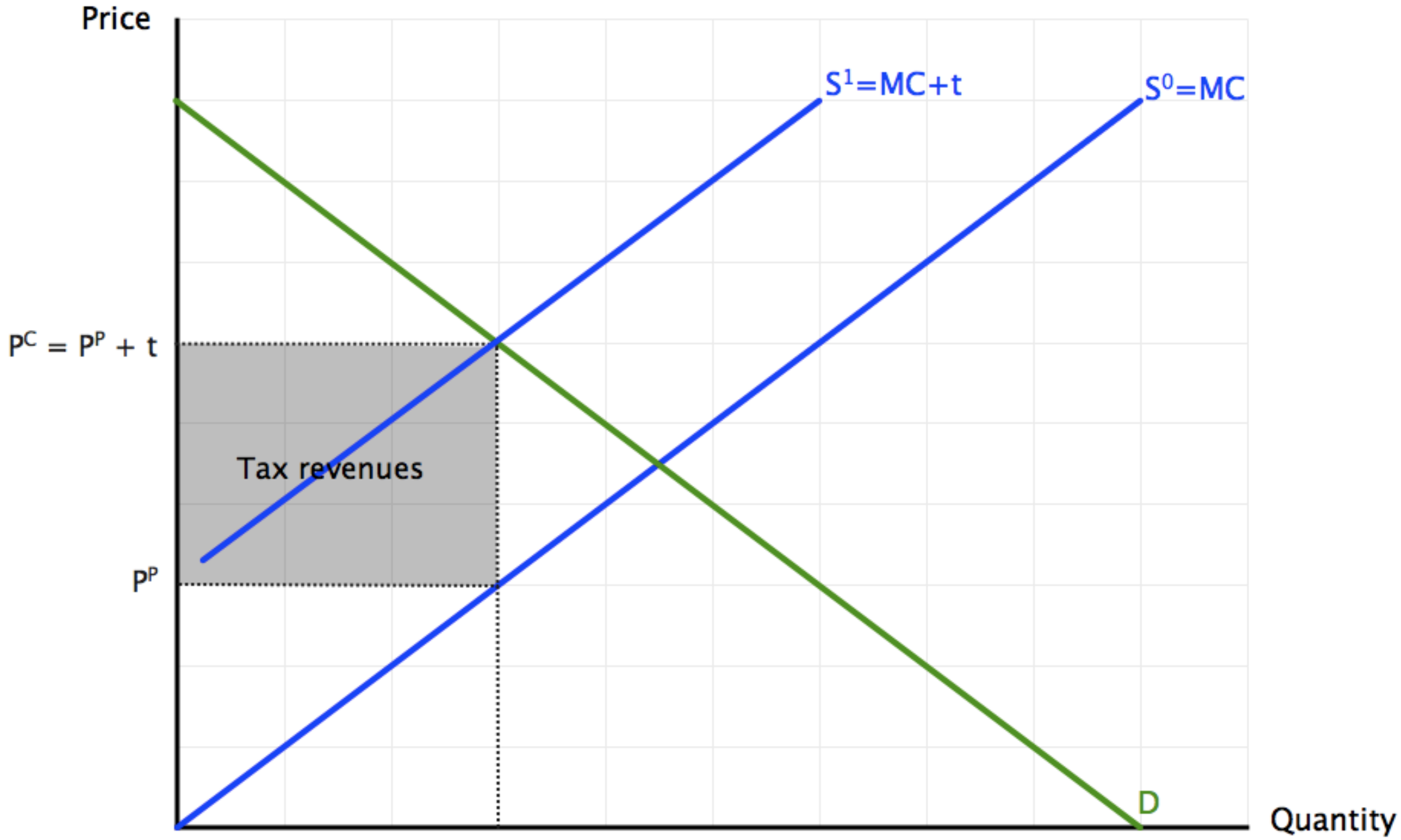
- Conclusion
  - A perfectly competitive market is Pareto efficient
  - No change even meets the compensation principle

Welfare effect of a commodity tax

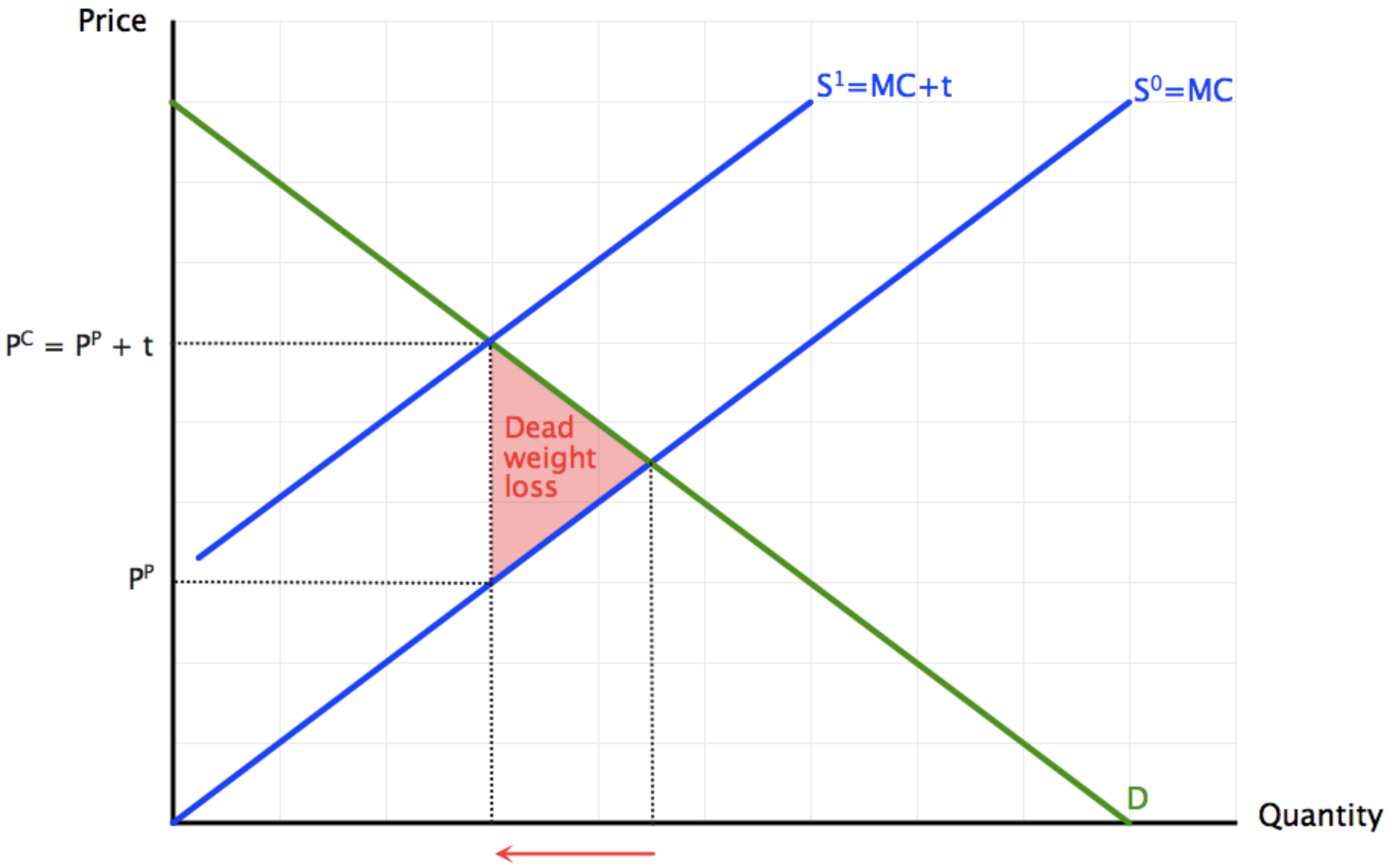
Welfare effect of a commodity tax



Welfare effect of a commodity tax



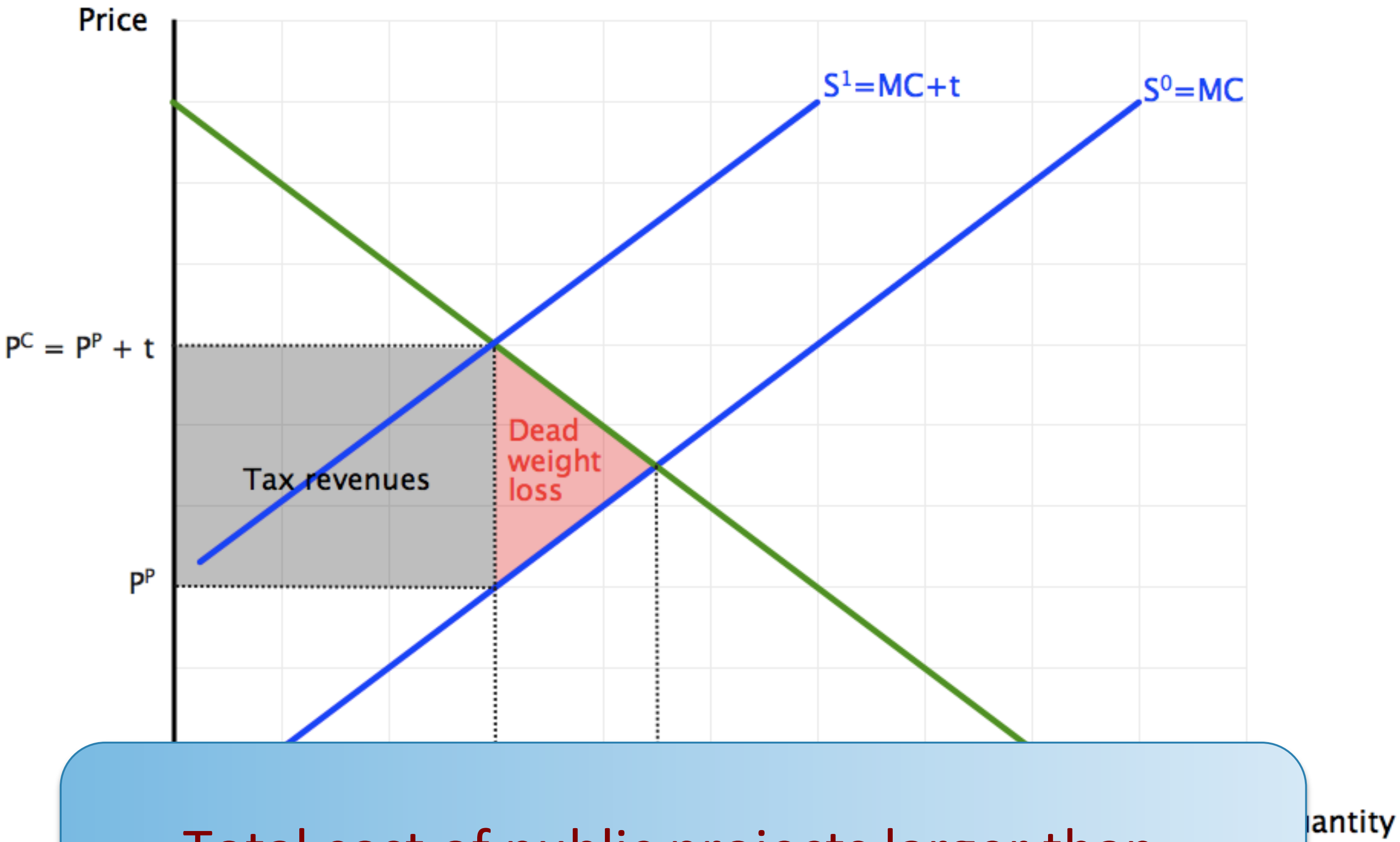
Welfare effect of a commodity tax



Welfare effect of a commodity tax

- Q: What is the cost of a public project financed by the tax?
  - Tax revenues (consumers buy less of other goods)
  - Dead weight loss (consumers buy less of this good)

Welfare effect of a commodity tax



Total cost of public projects larger than expenditures (= tax revenues) suggest.

Partial equilibrium
vs
General equilibrium

Partial vs General

- Partial = okay approximation for predictions if
  - Prices in all other markets are approximately constant, ie
  - Demand and supply in other markets remain approximately constant

Partial vs General

- Q: Is it okay to use partial equilibrium to study the effect of a tax on chocolate on the price and consumption of chocolate?
  - Perhaps need to include other sweets
  - Depends on how close substitutes they are

Partial vs General

- Primary effect
  - Tax on chocolate ↑ =>
  - Price of chocolate ↑ =>

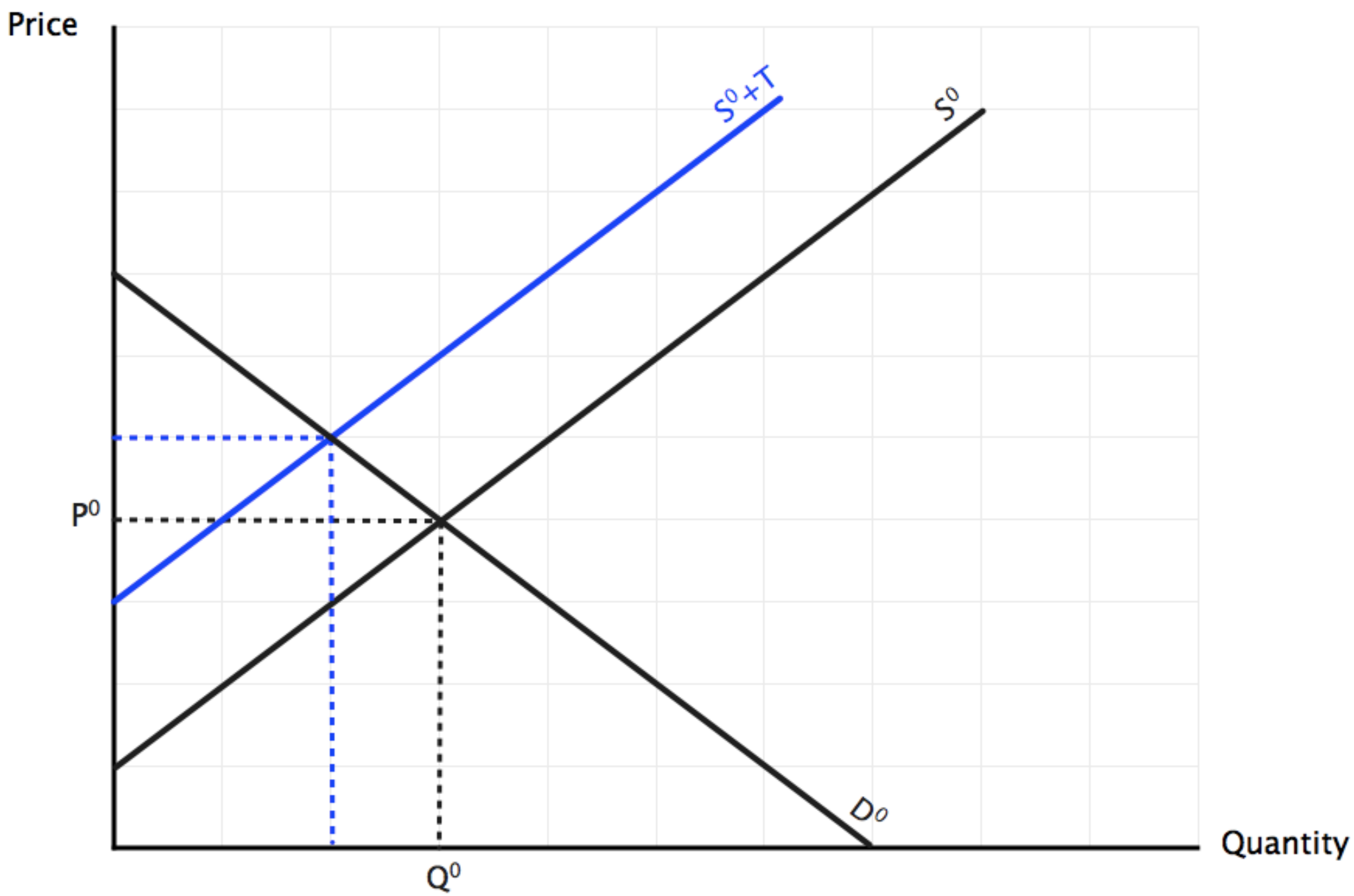
    (partial equilibrium effect)
- Secondary effect (substitutes)
  - Demand for licorice ↑ =>
  - Price of licorice ↑ =>
- Tertiary effect (substitutes)
  - Demand for chocolate ↑

    (repercussions in the primary market)

Even if we don't care about the licorice market, we must take it into account, to understand the chocolate market

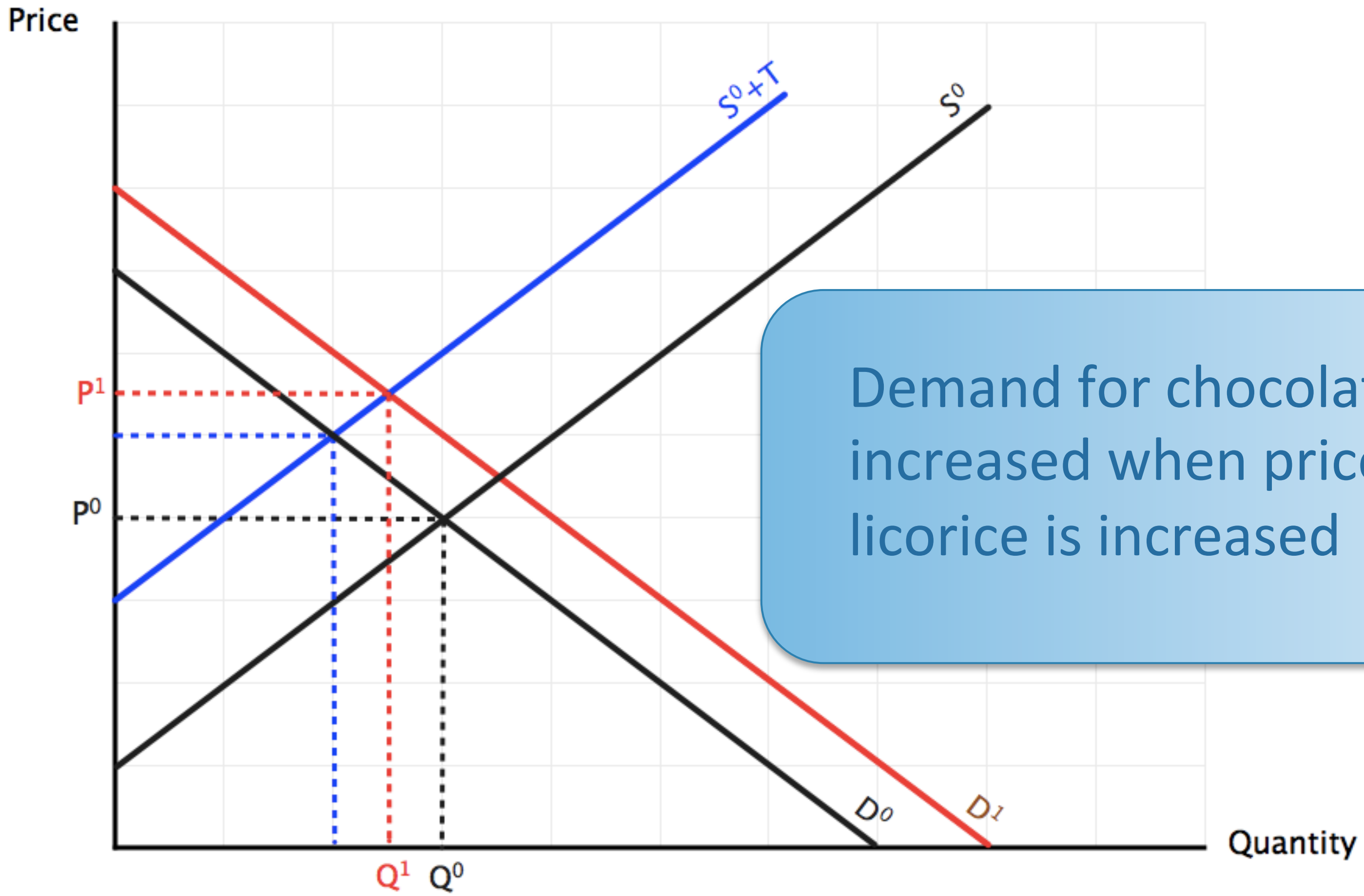
Partial vs General

Partial equilibrium analysis



Partial vs General

General equilibrium analysis



Demand for chocolate is increased when price on licorice is increased

Partial vs General

- Conclusion
  - Partial equilibrium analysis misses several effects when markets are interlinked
- Q: What other links are there between markets?

Partial vs General

- Demand links between markets
  - Substitute goods
    - If price of meat is increased, demand for fish is increased
  - Complementary goods
    - If price of cars is increased, demand for petrol is reduced
  - Income effects
    - If price of housing is increased, demand for most other goods is reduced

Partial vs General

- Technological links between markets
  - Economies of scope
    - If price of mutton is increased, supply of wool is increased
  - Capacity limitations
    - If price of “Sedans” is increased, supply of “Combis” is reduced

Partial vs General

- Resource constraints
  - If price of industrial goods is increased
  - Demand for workers is increased
  - Wages are increased
  - Cost of producing food is increased
  - Supply of food is reduced