Microeconomic Theory: Lecture 1
Prices, Markets and Efficiency

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Schelling's Seating Puzzle

- In a crowded auditorium, why are the first few rows empty?

Many Theories

- **Hypothesis 1:** Everyone prefers to sit as far back as possible.
- Blocking off the end rows will make everyone unhappy

- **Hypothesis 2:** Everyone wants to sit as much in front as possible as long as they are behind others.
- Blocking off the end rows will make everyone happier.

- **Hypothesis 3:** Everyone wants to sit near others. Provided they don't stand out, they prefer being closer to the stage.
- Blocking off the end rows will make everyone happier.
- Things could have turned out better.

- **Hypothesis 4:** They were afraid to sit in front in school and are unthinkingly carrying the habit.

Questions for a Social Scientist

- What do people want (motives/preferences)?
- How do motives affect individual behaviour (choice)?
- How does the interaction of individual choices affect group behaviour (aggregation)?
- How do we decide which theory is true (empirical testing)?
- Is the outcome good (welfare evaluation)?
- How do we decide what is good (ethics)?
- Can the outome be improved by some suitable intervention (policy)?

Quasilinear Utility

- n consumers, $i = 1, 2, ..., n$.
- Utility functions: $v_i(q_i, m_i) = u_i(q_i) + m_i$ where
  - q_i = quantity of the good consumed
  - m_i = money spent on all other goods
- $u_i(q_i)$ is the utility of consuming units of the good, expressed in money equivalent.
- **Diminishing marginal utility**: $u_i'(q_i) > 0$, $u_i''(q_i) < 0$.
- **Inada condition**: $u_i'(0) = \infty$, $u_i'(\infty) = 0$.
- Consumer's budget constraint: $pq_i + m_i = y_i$ where
  - y_i = consumer i's income.
  - p = price of the good.

Utility Maximization

- Max utility within budget:

$$\max_{q_i, m_i} u_i(q_i) + m_i \quad \text{sub to } pq_i + m_i \leq y_i$$

- Substitution gives unconstrained problem:

$$\max_{q_i, m_i} u_i(q_i) + y_i - pq_i$$

- First-order necessary condition (FOC):

$$\underbrace{u_i'(q_i)}_{\text{marginal utility}} = \underbrace{p}_{\text{price}}$$

- Second-order sufficient condition ($u_i''(q_i) < 0$) due to DMU.
- Interior solution guaranteed by Inada conditions.

Individual Demand Functions

- FOC of consumer's problem gives i's **demand function** $q_i(p)$ as an **implict function**. E.g., if $u_i(q_i) = \alpha_i \log q_i$, then

$$q_i(p) = \frac{\alpha_i}{p}$$

- The FOC can be written as an identity:

$$u_i'(q_i(p)) \equiv p$$

- Equating derivatives of both sides:

$$u_i''(.).q_i'(p) = 1 \Rightarrow q_i'(p) = \frac{1}{u_i''(.)} < 0$$

- **Implicit function theorem** gives **Law of Demand**.

Consumer's Surplus

- How much does the consumer gain from having the opportunity to buy any amount of the good he wants at p?
- Utility from optimally purchasing the good

$$u_i(q_i(p)) + y_i - pq_i(p)$$

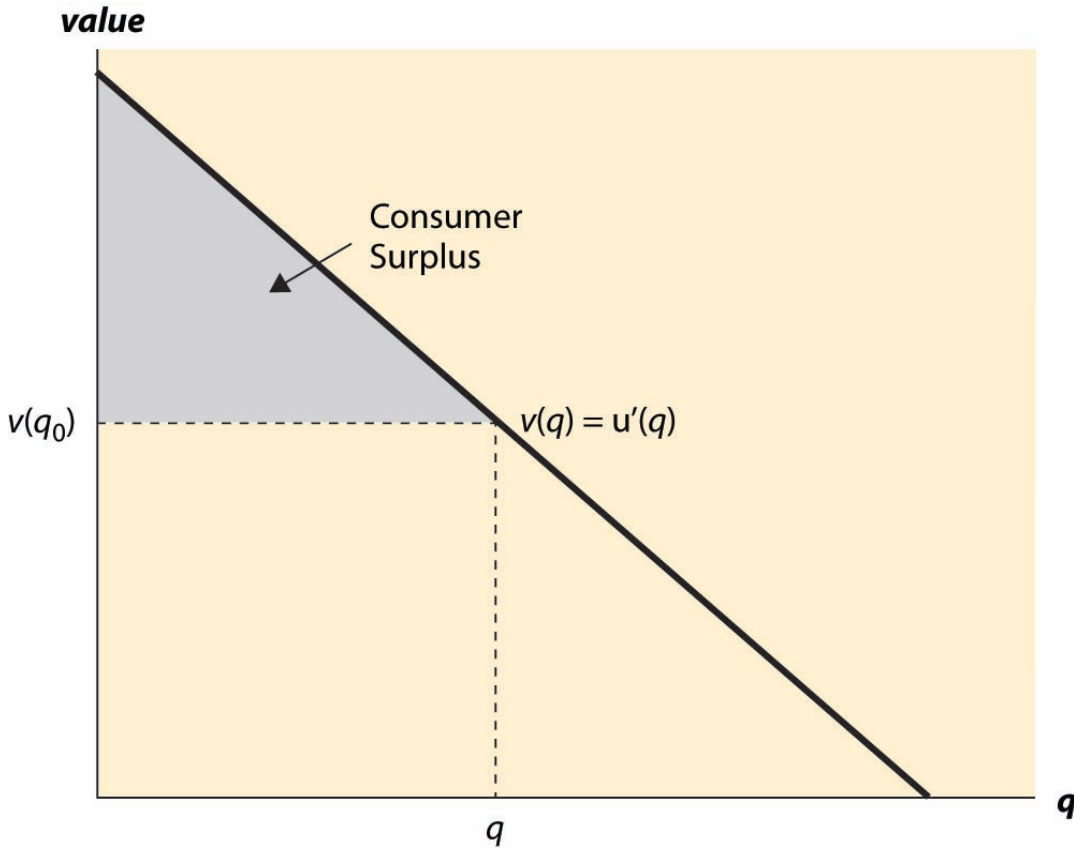
- Utility from not buying the good at all: y_i. Difference is:

$$u_i(q_i(p)) - pq_i(p)$$

$$= \int_0^{q_i(p)} \left[u_i'(q_i) - p\right] dq_i$$

Consumer's Surplus in Pictures

- CS is the area under demand curve and above the price line.



Market Demand Function

- Market demand is the sum of individual demands:

$$Q(p) = \sum_{i=1}^{n} q_i(p)$$

- If each individual demand function is downward sloping, so is the market demand function:

$$Q'(p) = \sum_{i=1}^{n} q_i'(p)$$

- **Price elasticity** of demand: how responsive to price change?

$$\eta = -\frac{dQ}{dp}.\frac{p}{Q}$$

- Petrol likely to have low price elasticity; apples high. Why?

The Cost Function

- m firms, $j = 1, 2, ..., m$.
- **Sunk cost** S_j (cannot be recovered even if firm shuts down).
- **Fixed cost** F_j (avoidable, but independent of quantity).
- **Variable cost** $\phi_j(x_j)$ (increases as production increases).
- Typical assumption: $\phi_j'(x_j) > 0$, $\phi_j''(x_j) > 0$ (increasing marginal cost).
- Total cost function: $c_j(x_j) = F_i + \phi_j(x_j)$.
- Average cost function: $a_j(x_j) = \frac{F_j}{x_j} + \phi_j(x_j)$.
- The average cost function is U-shaped.

Profit Maximization

- Assumption: firms do not face budget constraints as long as they are profitable.
- The firm's problem:

$$\max_{x_j} \pi_j(x_j) \equiv p x_j - c(x_j)$$

- First-order (necessary) condition:

$$\begin{array}{rcl} \underbrace{c'(x_j)} & = & \underbrace{p} \\ \text{marginal cost} & = & \text{price} \end{array}$$

- Second-order (sufficient) condition satisfied if $\phi''(x_j) > 0$.

Supply Function

- The FOC gives the firm's supply function $x_j(p)$ in implicit function form. Written as identity:

$$c'(x_j(p)) = p$$

- Equating the derivatives:

$$c''(.)x_j'(p) = 1 \Rightarrow x_j'(p) = \frac{1}{c''(.)} > 0$$

- The supply function of the firm has a positive slope.
- Market supply function is sum of firms' supply functions:

$$X(p) = \sum_{j=1}^{m} x_j(p)$$

Supply Function

- Price elasticity of supply defined the same way:

$$\mu = \frac{dX}{dp} \cdot \frac{p}{X}$$

- **Producer's surplus** is nothing but the firms profits:

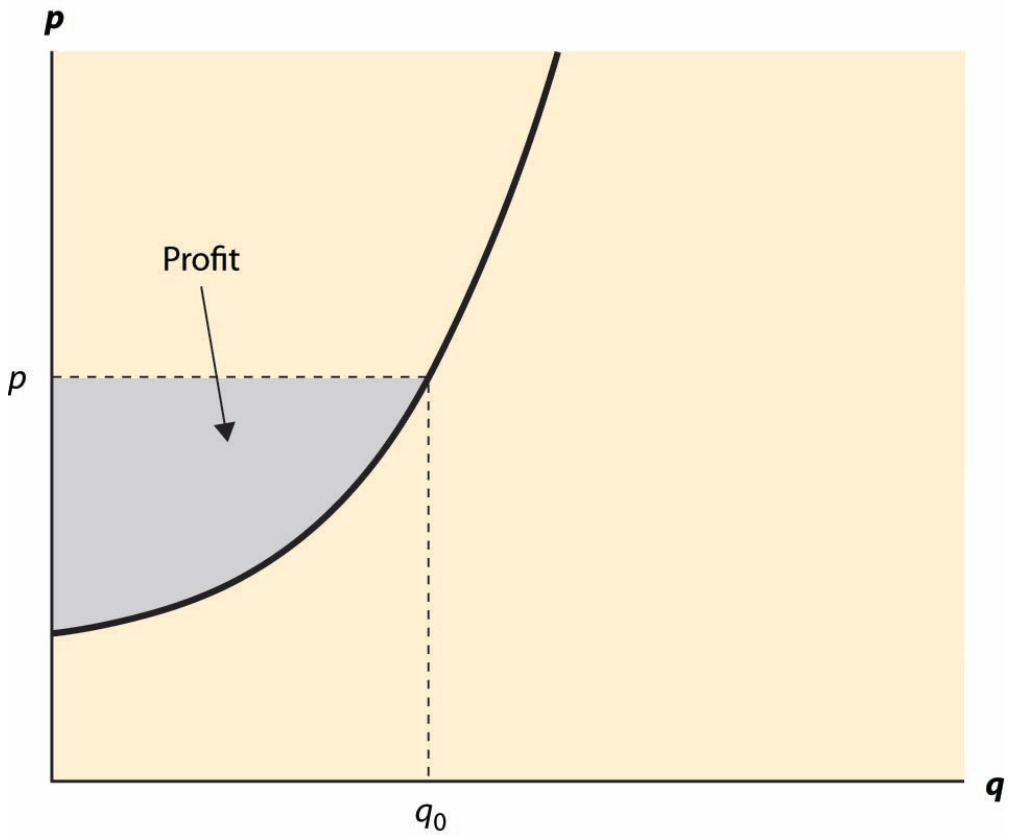
$$px_j(p) - c\left(x_j(p)\right)$$

$$= \int_0^{x_j(p)} \left[p - c'(x_j)\right] dx_j$$

- Area between the price line and the marginal cost curve.
- **Social surplus** is producers' plus consumers' surplus.

Supply Function

- Producer's surplus (profit) is the area above the supply curve and below the price line.



Equilibrium: Definition

- A market quilibrium is a set of prices and quantities, $(p^*, \mathbf{q}^*, \mathbf{x}^*)$, such that the market clears:

$$q_i(p^*) = q_i^*; \quad x_i(p^*) = x_i^*$$

$$\sum_{i=1}^{n} q_i^* = \sum_{j=1}^{m} x_j^* \text{ or, } Q(p^*) = X(p^*)$$

- **Existence:** a market equilibrium exists if $Q(0) > X(0)$.
- **Uniqueness:** given the slopes of demand and supply curves, there is no more than one equilibrium.
- How does the equilibrium price emerge? Imaginary auctioneer.
- **Stability:** depends on the price adjustment process.

Comparative Statics

- What happens when there is a demand or supply shock?
- Introduce shift parameters into demand and supply functions:

$$Q(p^*; \alpha) = X(p^*; \beta)$$

- α could respresent consumer tastes; β input prices.
- When tastes change:

$$Q_\alpha(p^*; \alpha) + Q_p(p^*; \alpha).\frac{dp^*}{d\alpha} = X_p(p^*, \beta).\frac{dp^*}{d\alpha}$$

$$\text{or, } \frac{dp^*}{d\alpha} = \frac{Q_\alpha}{X_p - Q_p}$$

- The denominator is positive. If $Q_\alpha > 0$, then $\frac{dp^*}{d\alpha} > 0$. If consumer tastes shift in favour, market price will increase.

Comparative Statics

- What happens to equilibrium quantity?
- Using the chain rule:

$$\frac{dX^*}{d\alpha} = X_p . \frac{dp^*}{d\alpha} = \frac{Q_\alpha X_p}{X_p - Q_p}$$

  which is positive if $Q_\alpha > 0$.
- Similarly, for a shift in costs, β,

$$Q_p . \frac{dp^*}{d\beta} = X_p . \frac{dp^*}{d\beta} + X_\beta$$

$$\text{or,} \quad \frac{dp^*}{d\beta} = \frac{X_\beta}{Q_p - X_p}$$

- If $X_\beta > 0$ (rising costs), this is negative in sign.

Blood Ivory

Seized Stockpiles

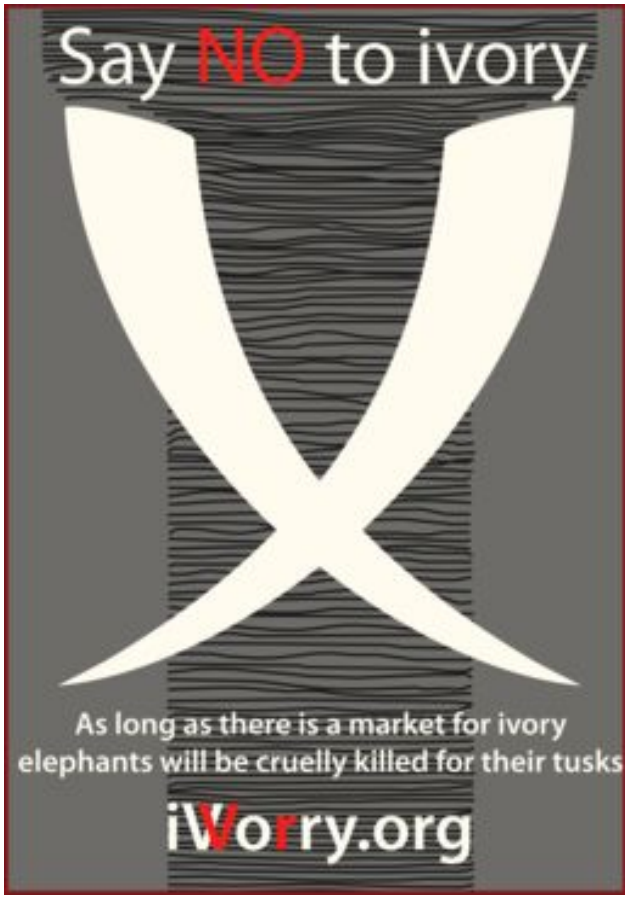
What to do with Stockpiles? Option 1

What to do with Stockpiles? Option 2

Ivory Trade

- African elephant population fell from 1.3 million in 1979 to 600 thousand in 1989.
- Annual ivory trade worth $1 billion in the 1980s, 80% coming from poached elephants.
- In 1989, the international ivory trade was banned by CITES (Convention on International Trade in Endangered Species).
- In 1997, CITES allowed the sale of 49 tons of ivory from Zimbabwe, Namibia and Botswana to Japan.
- In 2010, CITES turned down Zambia and Tanzania's petition to offload their stockpile of 110 tons worth $20 million.
- In 1986, Kenya, and in 2010, Phillipines publicly destroyed their stockpiles.

Poster Against Selling Stockpiles



Ivory Trade

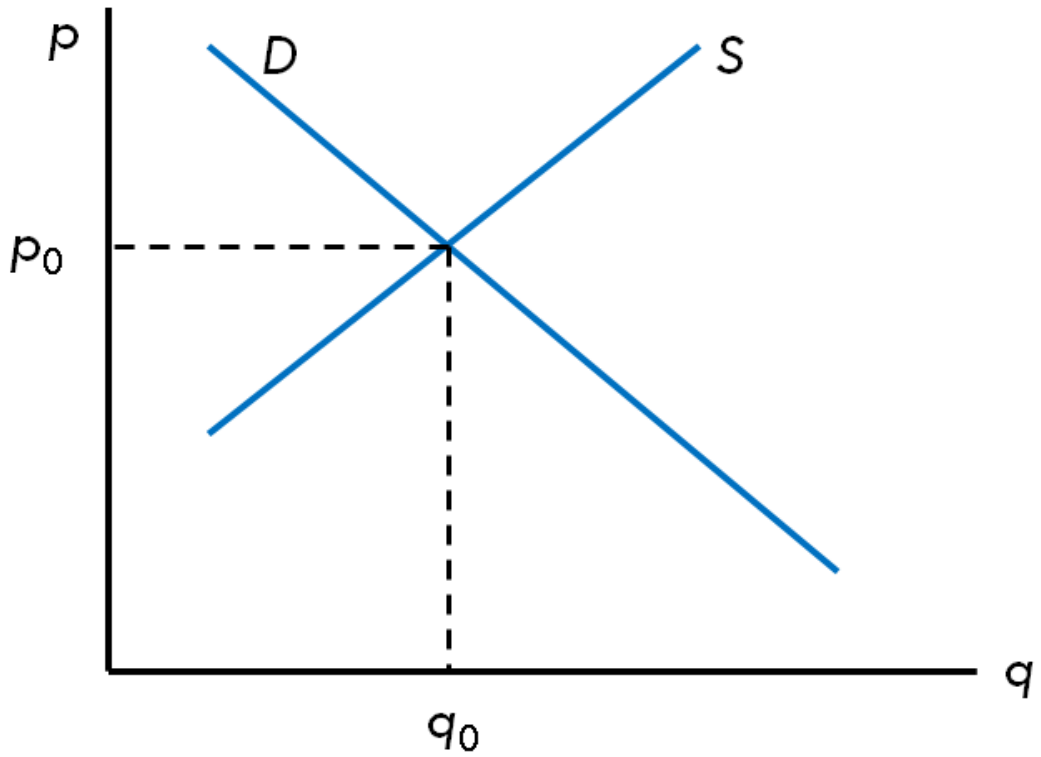
Arguments for allowing sale of stockpiles:

- Sunk cost: the elephants are already dead.
- Governments need the money for development.
- Sales proceeds can fund conservation efforts.
- Investment in local communities can reduce incentives for poaching.

Arguments against allowing sale of stockpiles:

- It is inherently immoral.
- May boost demand and open up new trading.
- Sends the wrong message?

The Economic Argument for Selling



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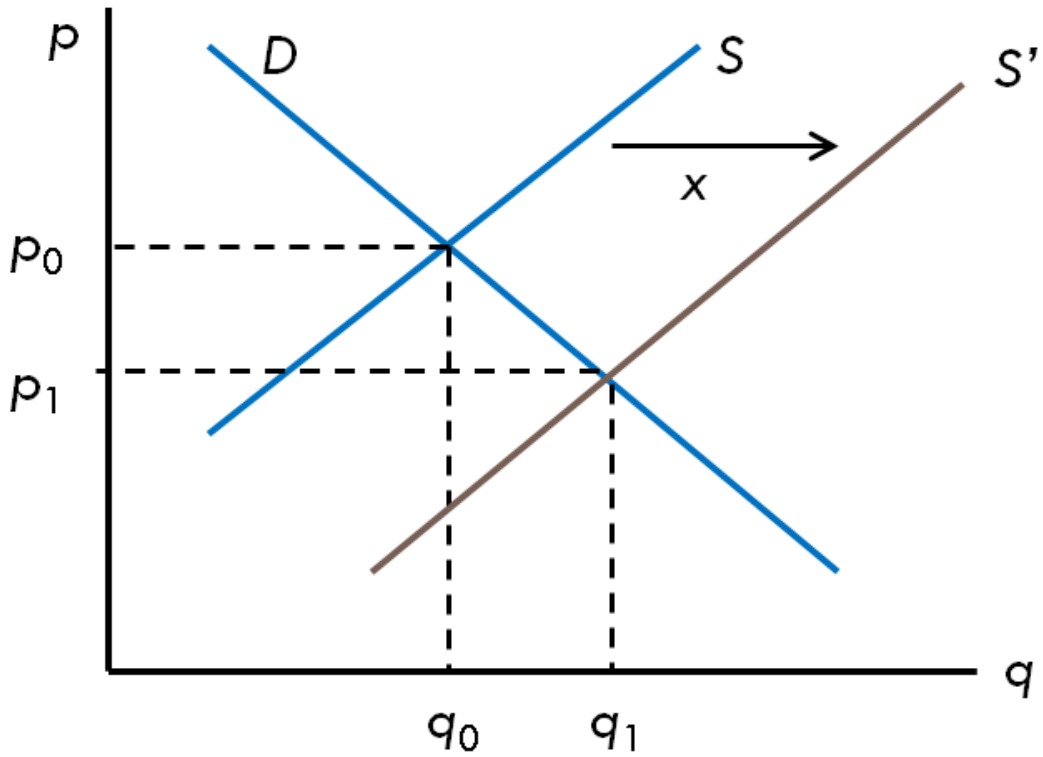

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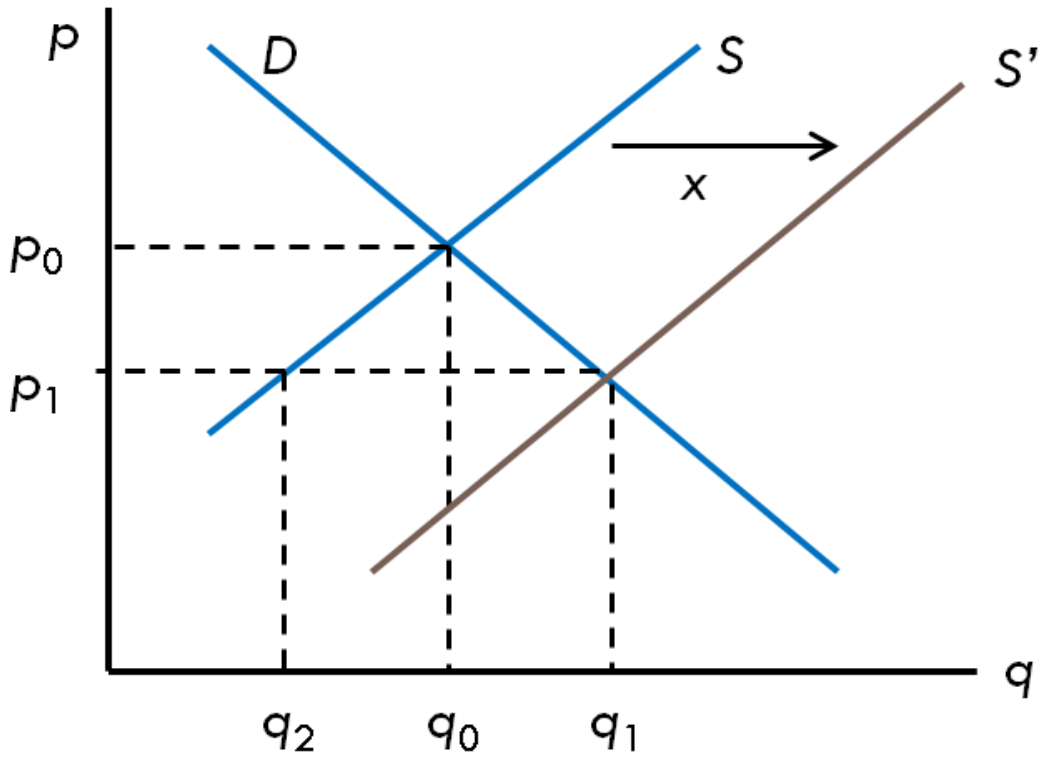


Social Security

- Government pension scheme (USA) started under New Deal.
- Pay-as-you-go system: retirees funded by workers.
- Redistributive and insurance component: benefits do not rise in proportion to contributions.
- Payroll tax of 6.20% on wages up to a ceiling ($113,700 in 2013). Employers have to pay a matching 6.20%.
- As part of the stimulus programme, the Obama administration has cut the workers' contribution to 4.2% since 2011.
- Argument for shifting tax to employers: reducing inequality.
- Argument for shifting tax to workers: creating more jobs.

The Incidence of Taxation

- Assume linear demand and supply:

$$\begin{aligned} Q_d &= a - bP_b \\ Q_s &= c + dP_s \end{aligned}$$

- P_b = net price for buyers, P_s = net price for sellers.
- Suppose government imposes a tax t per unit, with buyers paying λ fraction and sellers paying $1-\lambda$ fraction.
- Let P be the market price. Then

$$\begin{aligned} P_b &= P + \lambda t \\ P_s &= P - (1-\lambda)t \end{aligned}$$

The Incidence of Taxation

- How does the choice of λ affect the welfare of buyers and sellers?
- How does the overall size of the tax (t) affect welfare?
- How is the *economic* burden of the tax (as opposed to the *legal* burden captured by λ) distributed across buyers and sellers?

The Incidence of Taxation

- In equilibrium, $Q_d = Q_s$, i.e.

$$a - b(P + \lambda t) = c + d[P - (1 - \lambda)t]$$

- Solve for equilibrium price and quantity:

$$\begin{aligned} P &= \frac{a - c + [(1 - \lambda)d - \lambda b]t}{b + d} \\ Q &= \frac{ad + bc}{b + d} - \frac{bdt}{b + d} \end{aligned}$$

- The net price for buyers and sellers:

$$\begin{aligned} P_b &= P + \lambda t = \frac{a - c}{b + d} + \frac{dt}{b + d} \\ P_s &= P - (1 - \lambda)t = \frac{a - c}{b + d} - \frac{bt}{b + d} \end{aligned}$$

The Incidence of Taxation

- The net price paid by each side is independent of λ!
- Sellers pass on a part of the tax on them to buyers and vice versa because the market price adjusts.
- The economic burden depends on underlying economic fundamentals, not on the legal burden.
- For every Re 1 of tax, the burden on buyers and sellers is $\frac{d}{b+d}$ and $\frac{b}{b+d}$ respectively.
- Depends on relative slopes (elasticities).

More General Conditions

- Assume general demand and supply functions: $Q_d(P), Q_s(P)$.
- Assume a per unit tax t on sellers. Let $P(t)$ be the equilibrium price.
- By definition

$$Q_d(P(t)) \equiv Q_s\left(P(t) - t\right)$$

- Equating derivatives:

$$Q_d'(.).P'(t) = Q_s'(.)\left[P'(t) - 1\right]$$

- Rearranging terms:

$$P'(t) = \frac{Q_s'}{Q_s' - Q_d'}$$

More General Conditions

- Multiplying numerator and denominator by $\frac{P(t)}{Q(t)}$:

$$P'(t) = \frac{\eta}{\eta + e}$$

where e = elasticity of demand, η = elasticity of supply.

- The tax burden on buyers and sellers:

$$\begin{aligned} P_b'(t) &= P'(t) = \frac{\eta}{\eta + e} \\ P_s'(t) &= 1 - P'(t) = \frac{e}{\eta + e} \end{aligned}$$

- The side of the market with relatively lower elasticity bears a relatively higher tax burden.

Feasible Allocations

- An allocation is a vector of consumptions, productions and transfers:

$$\mathbf{z} = (\mathbf{q}, \mathbf{x}, \mathbf{t}, \mathbf{s})$$

- An allocation is feasible if it meets the resource constraints of the economy:

$$\sum_{i=1}^{n} q_i = \sum_{j=1}^{m} x_j$$

$$\sum_{i=1}^{n} t_i = \sum_{j=1}^{m} s_j$$

Social Welfare Function

- Imagine a social planner who cares about everyone:

$$W(\mathbf{v}, \boldsymbol{\pi}) \equiv W(v_1, v_2, ..., v_n; \pi_1, \pi_2, ..., \pi_m)$$

- A special case: utilitarianism (sum of happiness):

$$W(\mathbf{v}, \boldsymbol{\pi}) = \sum_{i=1}^{n} v_i + \sum_{j=1}^{m} \pi_j$$

- What allocation will a utilitarian social planner choose?
- How does this planner's allocation compare against the market allocation?

Utilitarian Allocation

- The planner solves

$$\max_{\mathbf{q},\mathbf{x},\mathbf{t},\mathbf{s}} \sum_{i=1}^{n} [u_i(q_i) - t_i] + \sum_{j=1}^{m} [s_j - c_j(x_j)]$$

subject to feasibility constraints:

$$\sum_{i=1}^{n} q_i = \sum_{j=1}^{m} x_j$$

$$\sum_{i=1}^{n} t_i = \sum_{j=1}^{m} s_j$$

Utilitarian Allocation

- The problem simplifies to

$$\max_{\mathbf{q},\mathbf{x}} \sum_{i=1}^{n} u_i(q_i) - \sum_{j=1}^{m} c_j(x_j) \quad \text{sub to} \quad \sum_{i=1}^{n} q_i = \sum_{j=1}^{m} x_j$$

- This amounts to

$$\max_{\mathbf{q},\mathbf{x}} \mathcal{L}(\mathbf{q},\mathbf{x}) \equiv \sum_{i=1}^{n} u_i(q_i) - \sum_{j=1}^{m} c_j(x_j) + \lambda \left[\sum_{j=1}^{m} x_j - \sum_{i=1}^{n} q_i \right]$$

- The FOC is the same as that for market allocation:

$$u_i'(q_i) = \lambda = c_j'(x_j) \quad \text{for all } i, j$$

Pareto Optimality: Definition

- Agents' utilities under allocation $\mathbf{z}$:

$$\begin{aligned} v_i(\mathbf{z}) &= u_i(q_i) - t_i \\ \pi_j(\mathbf{z}) &= s_j - c(x_j) \end{aligned}$$

- Set of all feasible allocations $= F$.
- An allocation $\mathbf{z}$ (weakly) Pareto dominates another allocation $\mathbf{z}'$ if

$$\begin{aligned} v_i(\mathbf{z}) &\geq v_i(\mathbf{z}') \text{ for all } i \\ \pi_j(\mathbf{z}) &\geq \pi_j(\mathbf{z}') \text{ for all } j \end{aligned}$$

and the inequality strict for some i or j.

Pareto Optimal Allocations

- Planner maximizes some welfare function $W(\mathbf{v}, \boldsymbol{\pi})$.
- The optimization problem:

$$\max W(\mathbf{v}, \mathbf{z}) + \lambda_1 \left[\sum_{j=1}^{m} x_j - \sum_{i=1}^{n} q_i \right] + \lambda_2 \left[\sum_{i=1}^{n} t_i - \sum_{j=1}^{m} s_j \right]$$

- The FOC is:

$$\begin{aligned} W_{v_i} . u_i'(q_i) &= \lambda_1 = W_{\pi_j} . c_j'(x_j) \\ W_{v_i} &= \lambda_2 = W_{\pi_j} \end{aligned}$$

- Combining, we get same condition as market equilibrium:

$$u_i'(q_i) = c_j'(x_j)$$

The Invisible Hand: Adam Smith

"It is not from the benevolence of the butcher, the brewer or the baker that we expect our dinner, but from their regard to their own self-interest... [Every individual] intends only his own security, only his own gain. And he is in this led by an invisible hand to promote an end which was no part of his intention. By pursuing his own interest, he frequently promotes that of society more effectually than when he really intends to promote it."

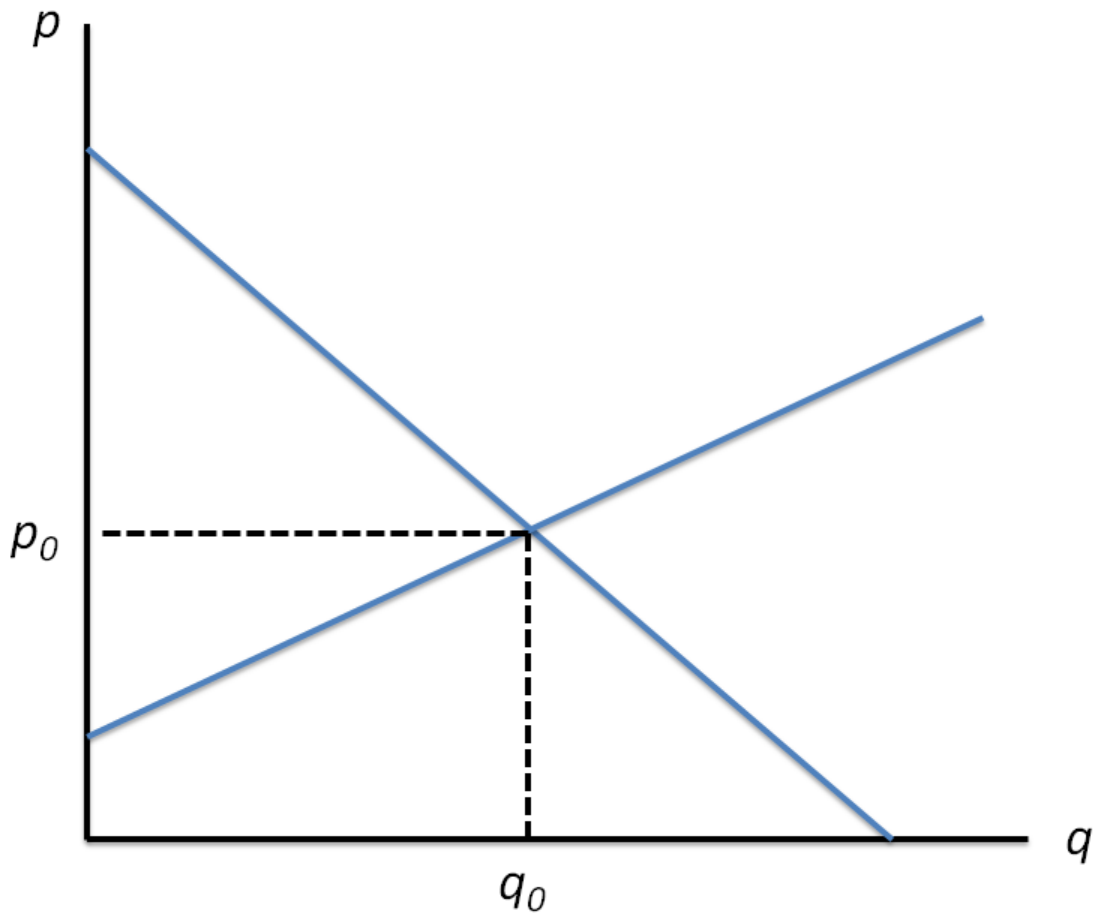
– Adam Smith, *The Wealth of Nations.*

- The **first fundamental theorem of welfare economics**: every market allocation is Pareto efficient.

The Invisible Hand: Adam Smith

- In a **barter economy**, market exchange exhausts all mutual **gains from trade**.
- In a **production economy**, if consumers highly value a good, the high market price incentivizes firms to produce more of it.
- If producing a good is very costly, the high market price incentivizes consumers to reduce its usage.
- The **price system** is like a thermostat that strikes the right balance between utility and cost.
- A planner can in principle replicate market outcomes, but often lacks **information** on consumer tastes and firm costs.
- Warning: don't ascribe too much power to the invisible hand!

Deadweight Loss of Taxation



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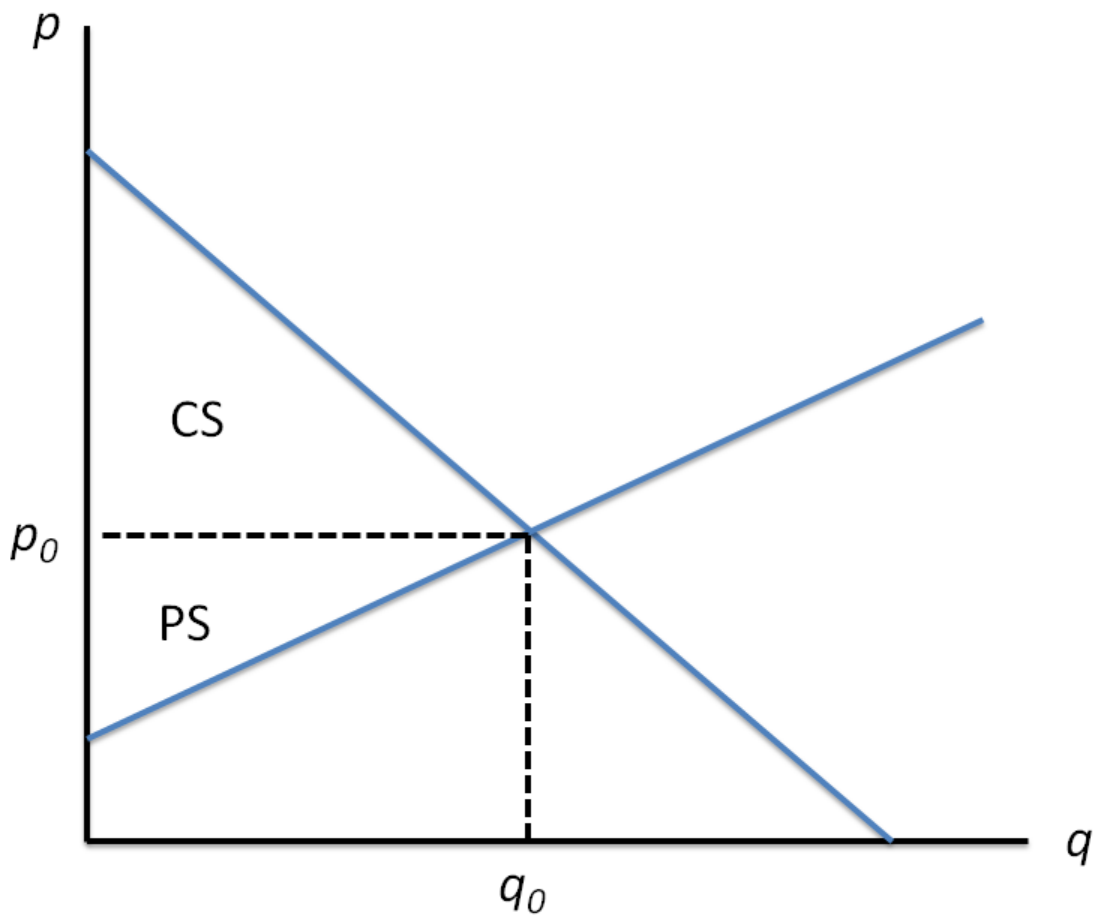

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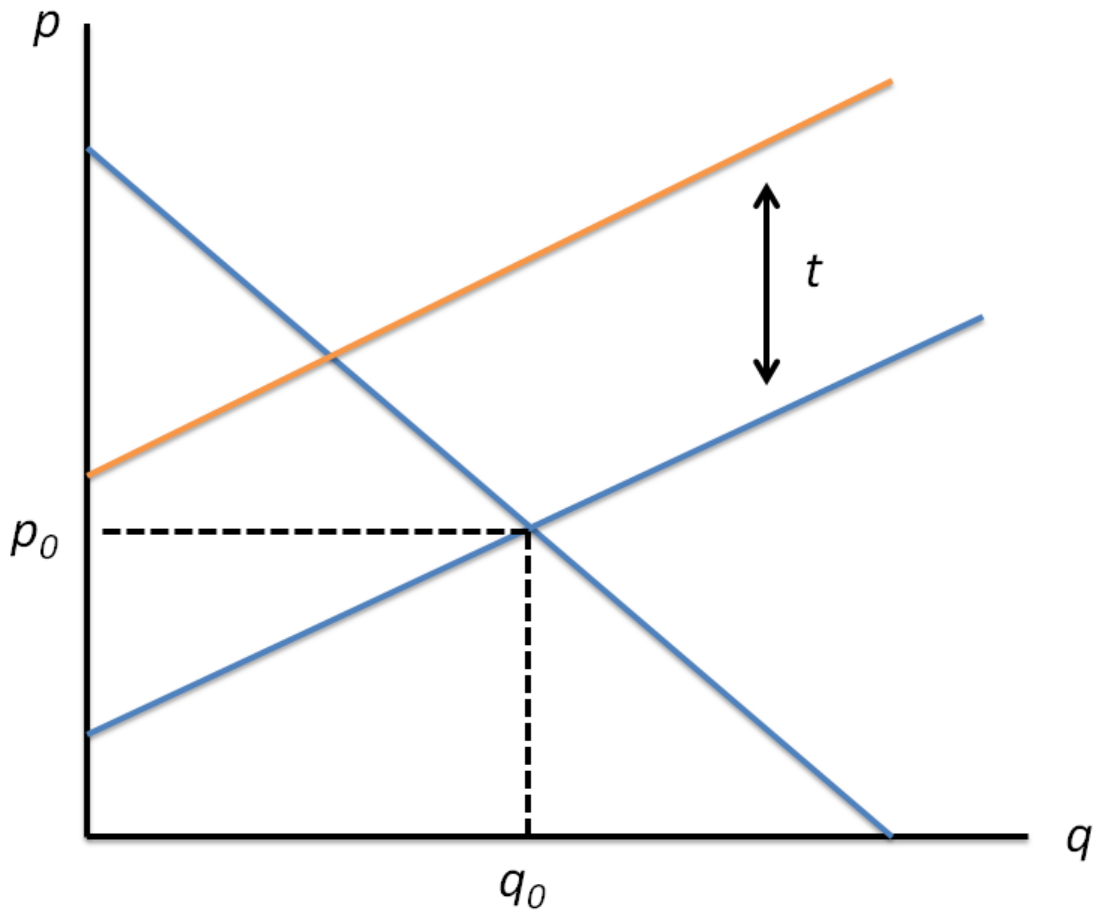

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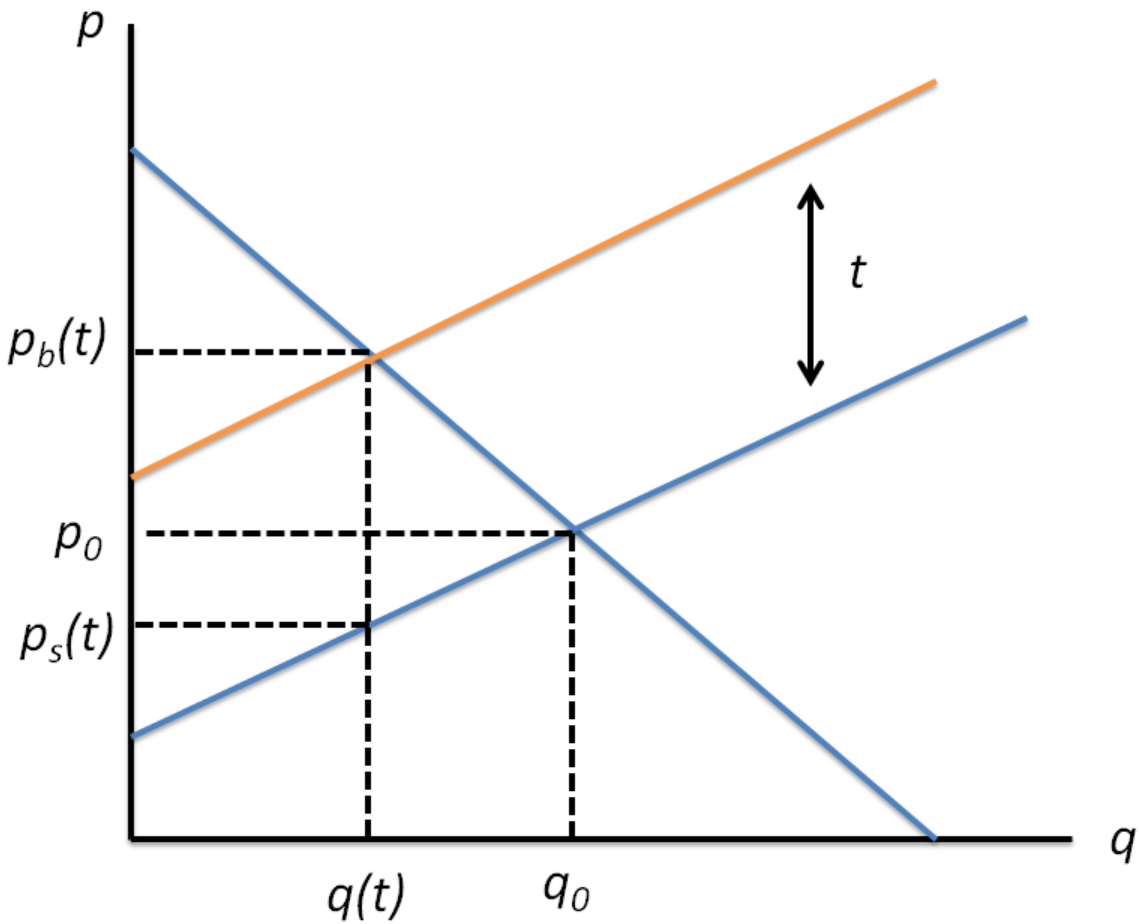

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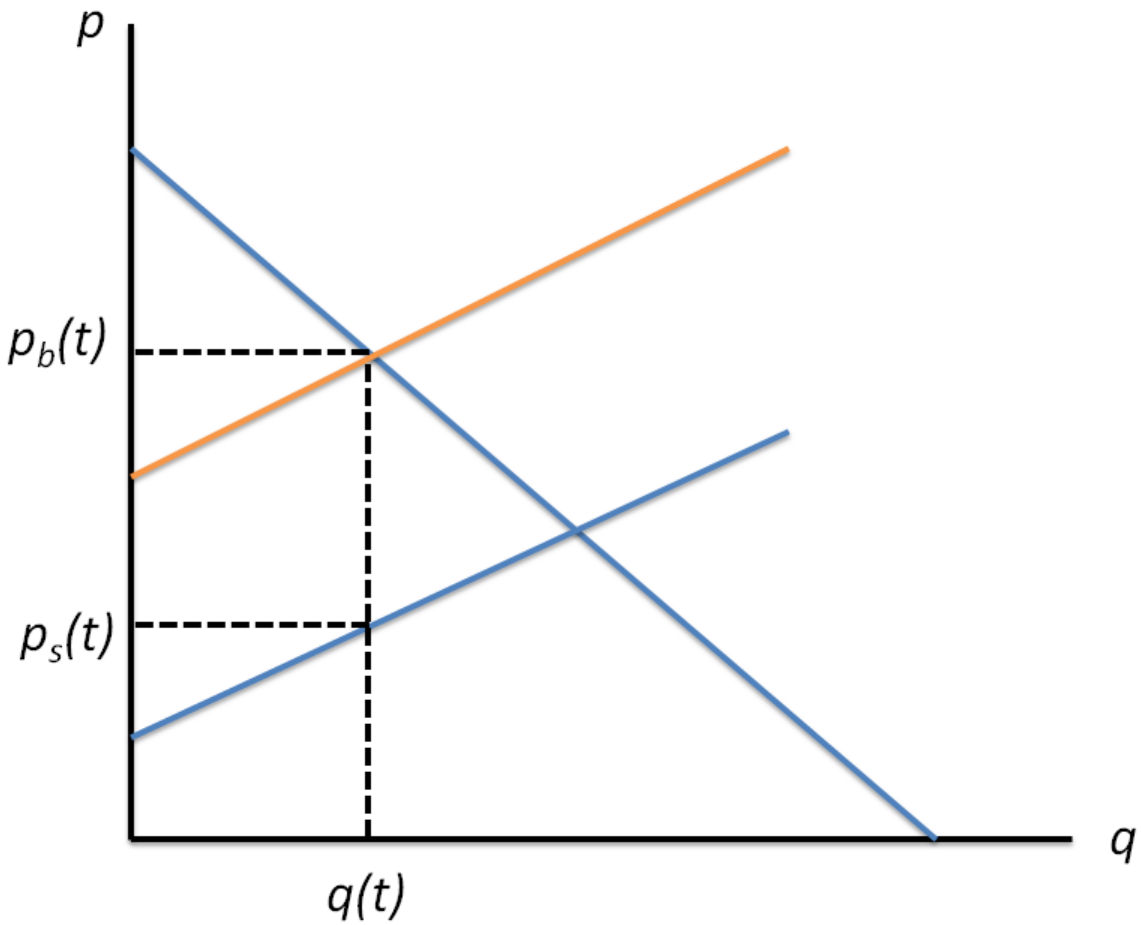

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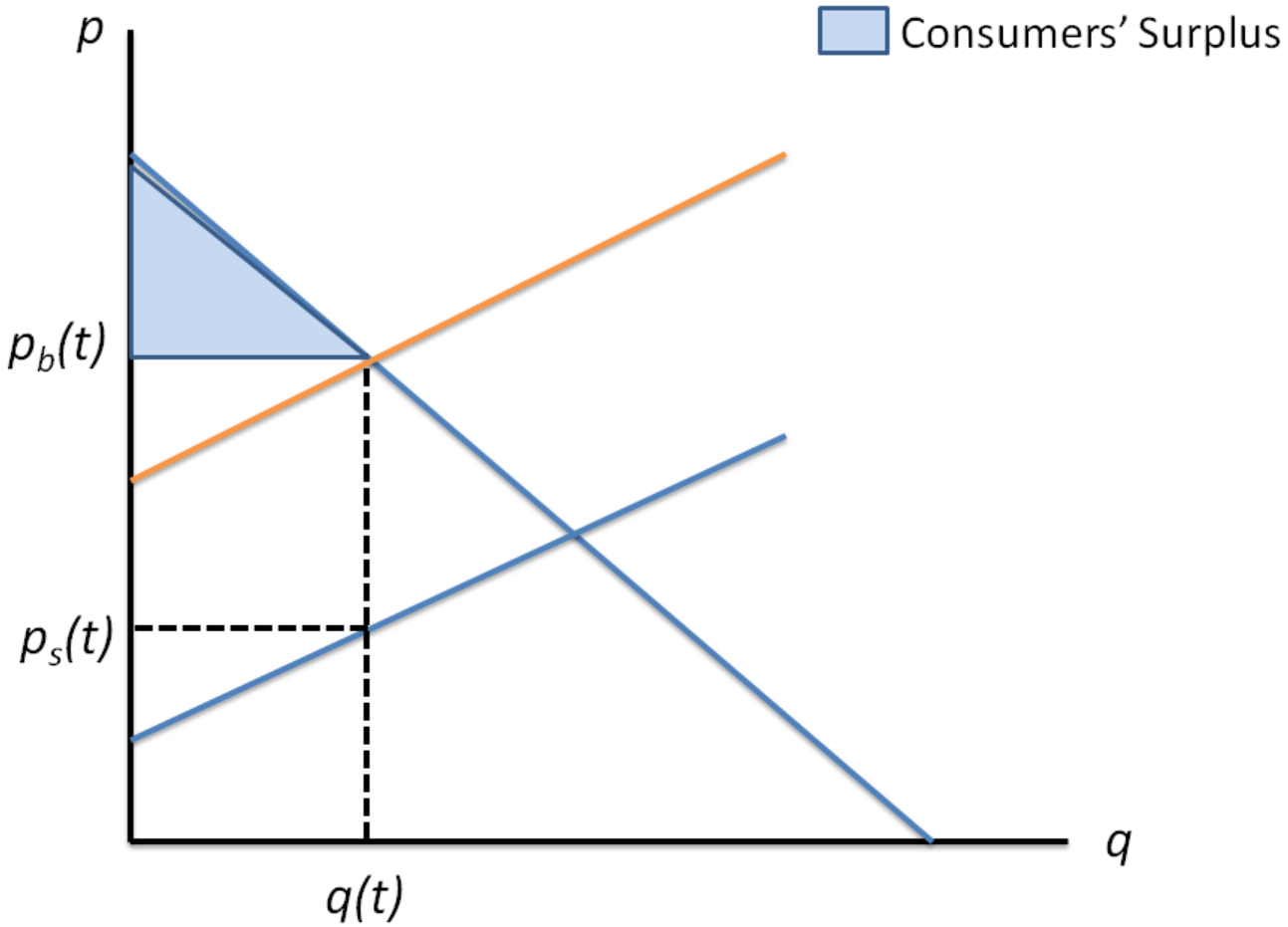

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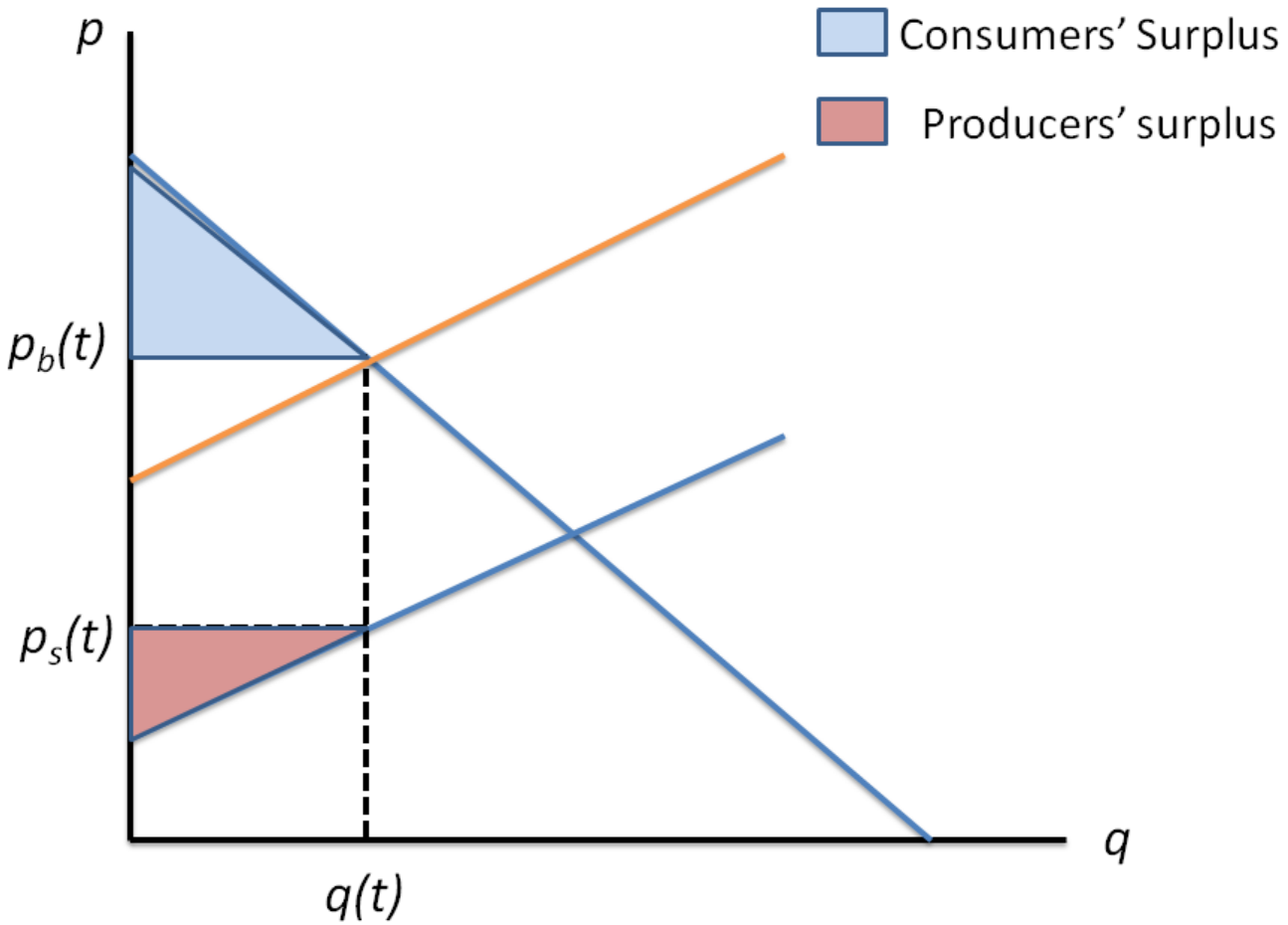

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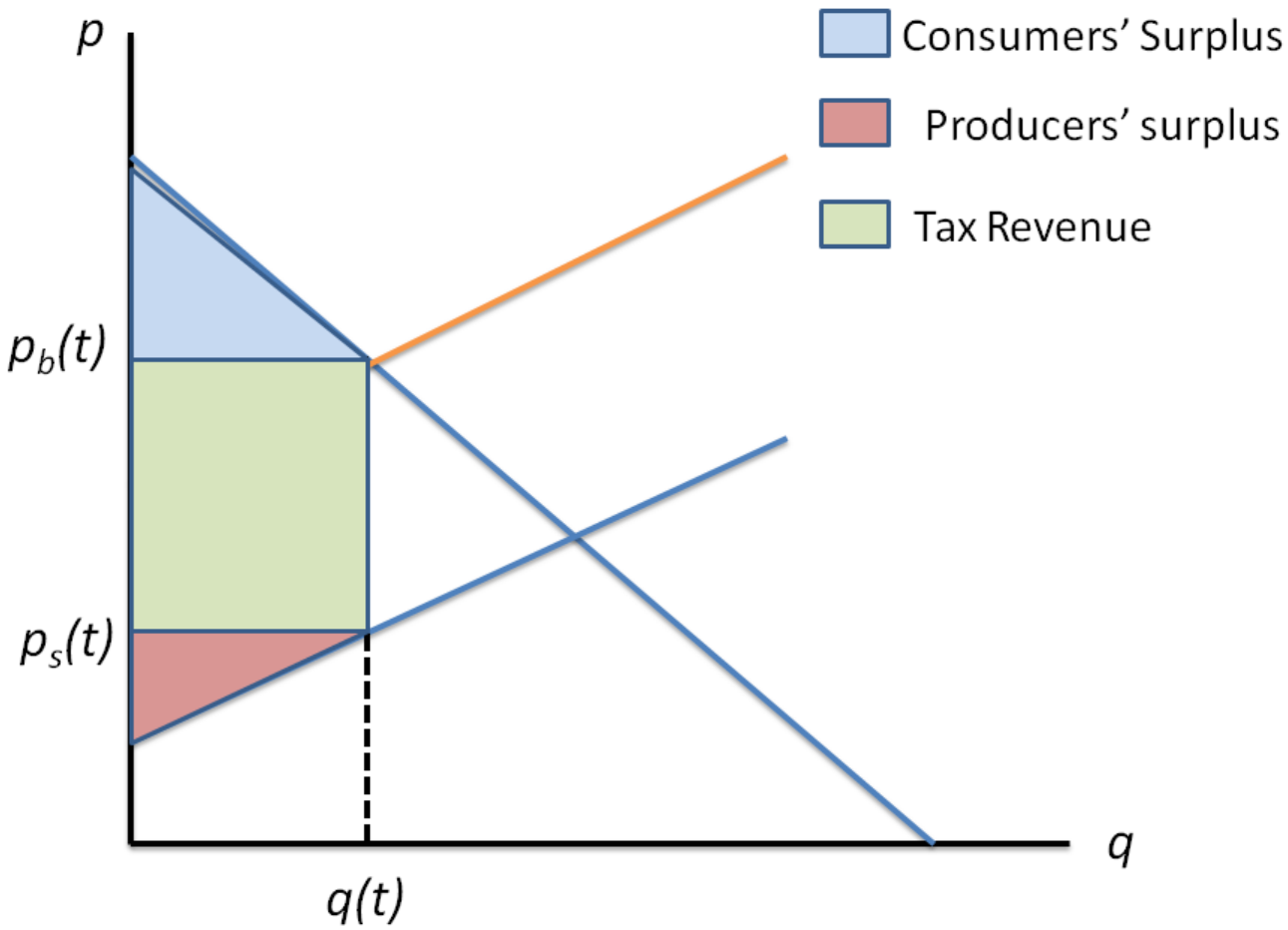

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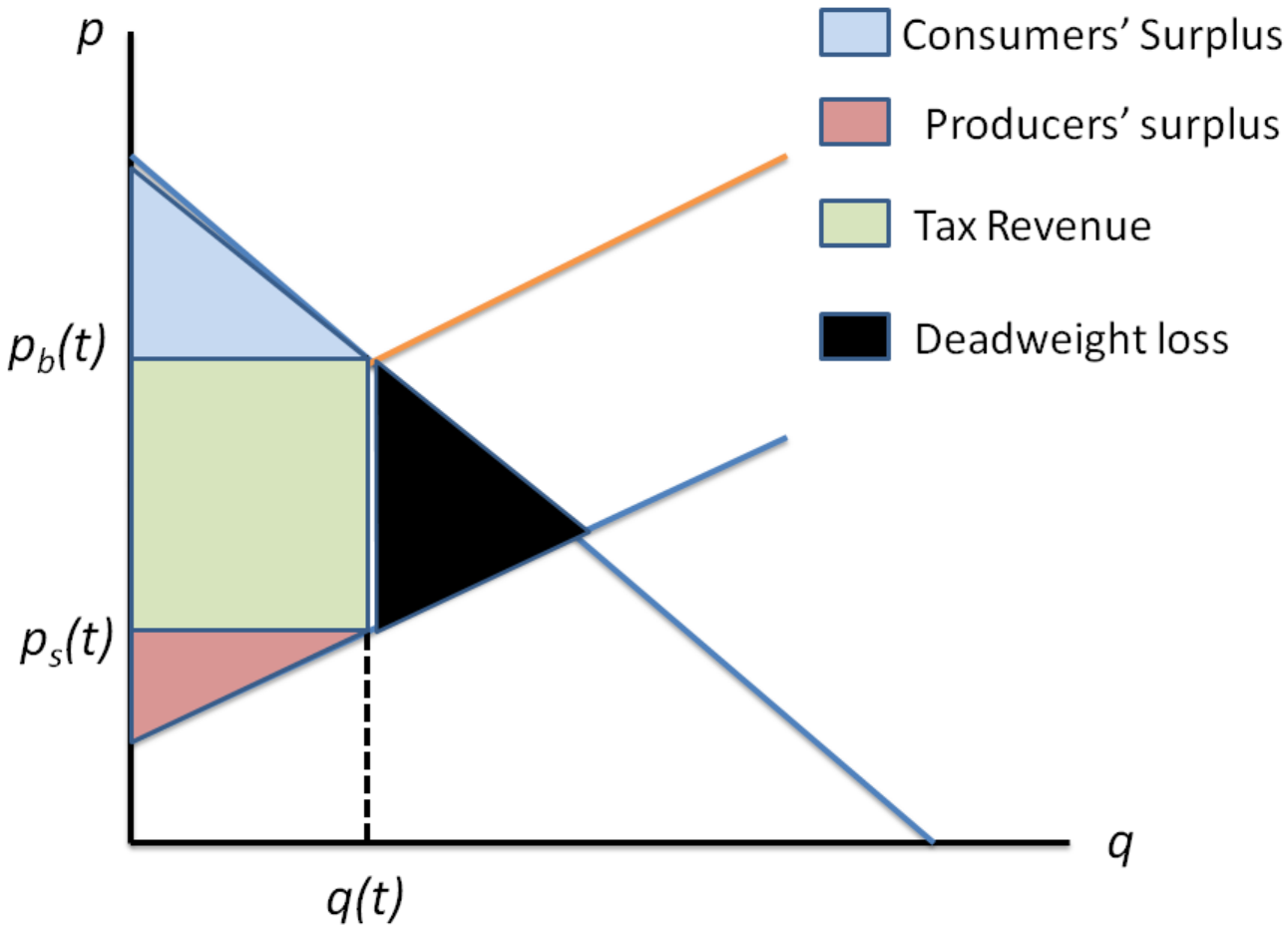
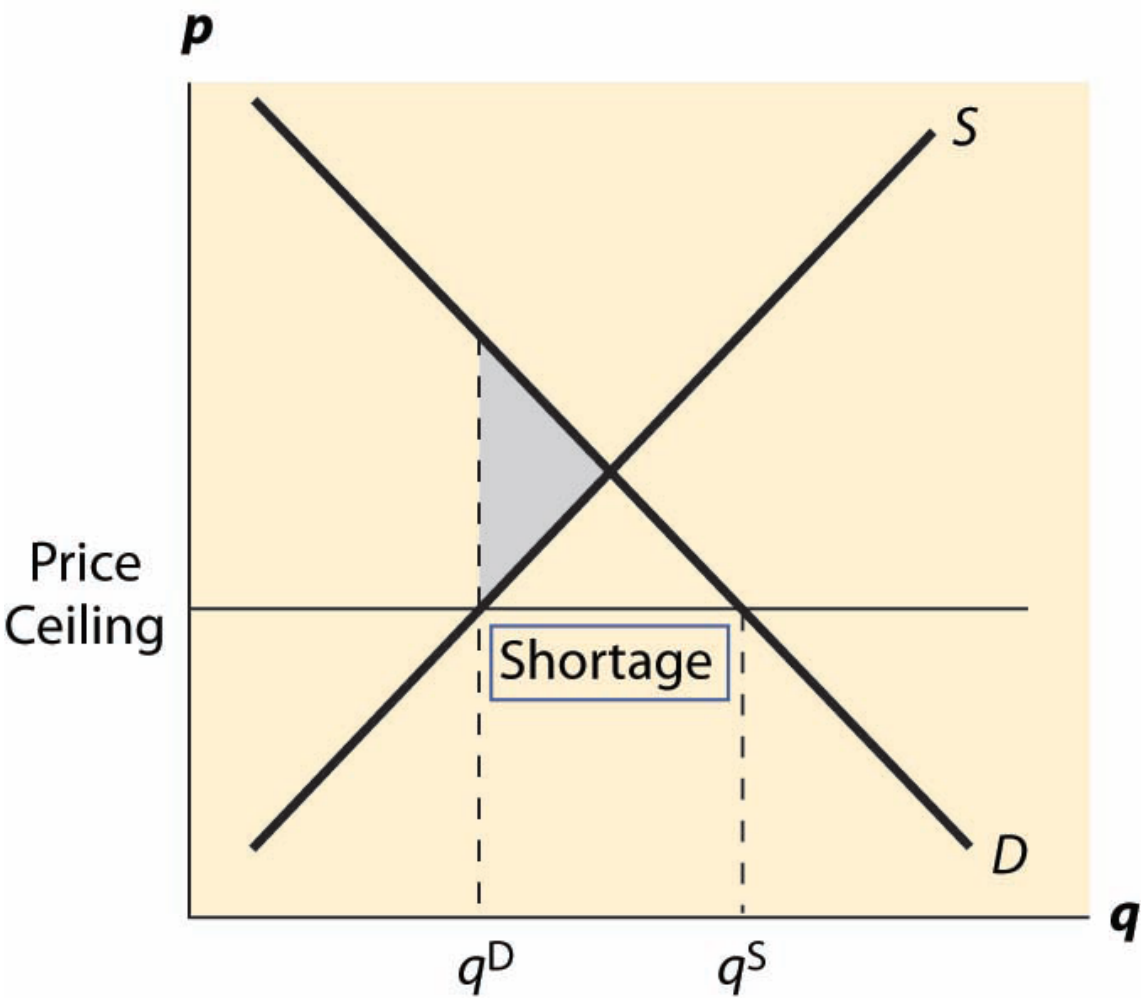


Deadweight Loss of Taxation

- To raise Rs 100 in taxes, the cost imposed on consumers and producers is more than Rs 100.
- The excess cost is the **deadweight loss**: it arises because quantity choices are distorted.
- The tax revenue itself is not a loss; it can be returned.
- Does not mean there should be no taxes. Taxes can
  - fund public goods
  - correct externalities
  - correct the income distribution
- While doing cost-benefit analysis, cost should include not only the taxes but also the deadweight loss.
- Subsidies being negative taxes have opposite distortions: lead to over-consumption.

Price Ceilings and Floors



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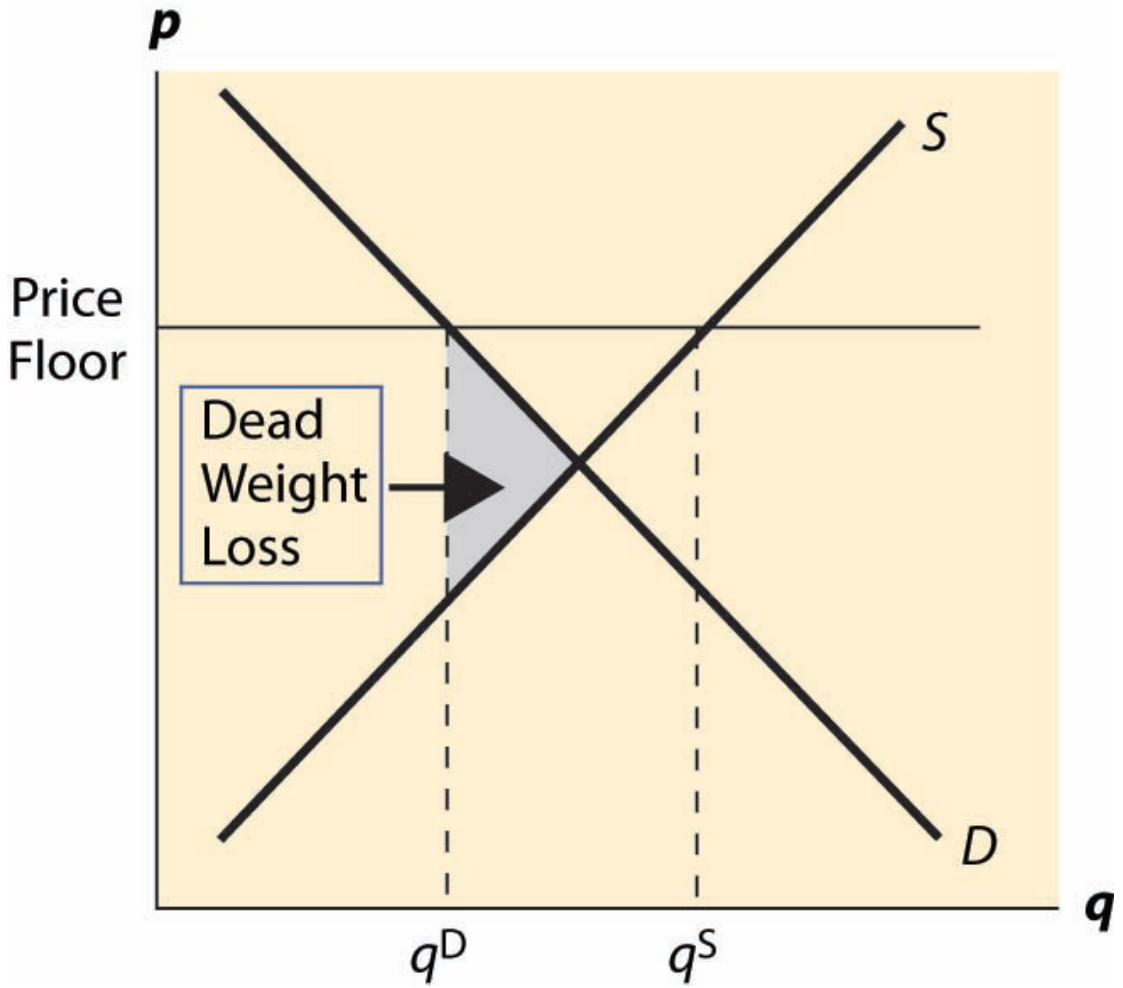
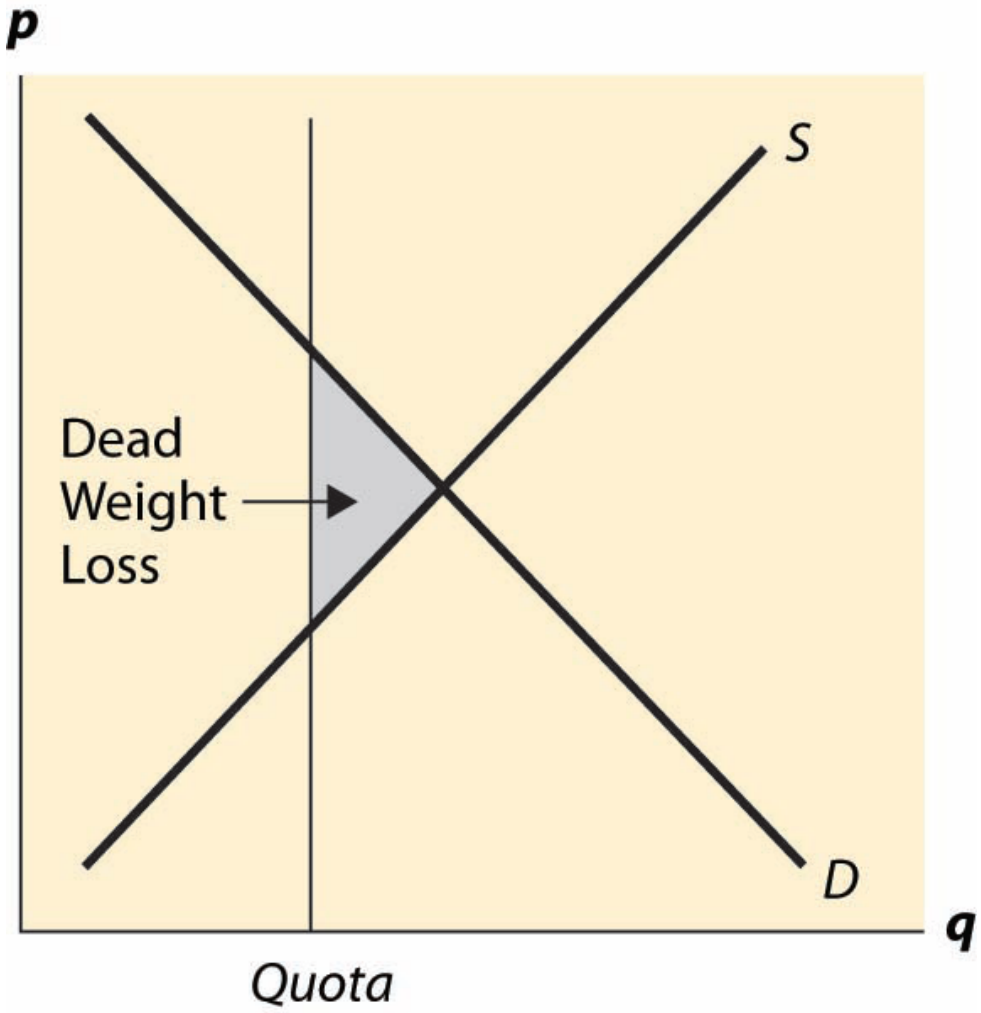


Quotas



Caveat 1: Externalities

"The reason that the invisible hand often seems invisible is that it is often not there. Whenever there are "externalities"—where the actions of an individual have impacts on others for which they do not pay, or for which they are not compensated—markets will not work well... Markets, by themselves, produce too much pollution. Markets, by themselves, also produce too little basic research...The real debate today is about finding the right balance between the market and government... Both are needed. They can each complement each other."

— Joseph Stiglitz.

Caveat 2: Public Goods

- (Pure) public goods, unlike private goods, are:
  - *non-rival*: one person's consumption doesn't reduce another's (e.g., parks, knowledge, music).
  - *non-excludable*: once a good is produced, everyone has access to it (clean air, national defence).
- Voluntary contribution to public goods is subject to a *free-rider problem*.
- Govt. provision has its own problems (corruption, waste)
- A good may be non-rivalrous in consumption but only up to a point (congestion effects)
- Club goods: non-rival but excludable.

Caveat 3: Imperfect Competition

"People of the same trade seldom meet together, even for merriment and diversion, but the conversation ends in a conspiracy against the public, or in some contrivance to raise prices."

– Adam Smith.

- The first welfare theorem only obtains under a perfectly competitive market structure where all agents are price takers.
- A monopolist restricts output below what is socially optimal (creates scarcity) to maximize profits.
- Even with limited competition (oligopoly), efficiency is usually not reached.

Caveat 4: Distributive Justice

- **Efficiency** and **equity** are distinct concepts.
- Typically, the set of Pareto efficient allocations is very large. Pareto efficiency is a weak criterion for judging welfare.
- Some allocations may be efficient but highly unequal or unjust.
- Markets have no inherent tendency to bring about equity.
- Reasons for intervention (efficiency/equity) should be spelt out.