BASIC MICROECONOMIC FOUNDATIONS OF COST-BENEFIT ANALYSIS

EE465/EE463 Project Evaluation

Semester 2/2014

Topics

- Demand Curves
- Supply Curves
- Social Surplus and Allocative Efficiency
- Government Surplus and Allocative Efficiency
- Measuring Changes in Welfare

Assumption: Perfectly Competitive Market

- There are many buyers and sellers in the market.
- Buyers and sellers can easily enter and exit the market.
- The goods sold are homogenous.
- There is no transaction costs.
- Information is perfect.
- Private costs and benefits are identical to social costs and benefits.

DEMAND CURVES

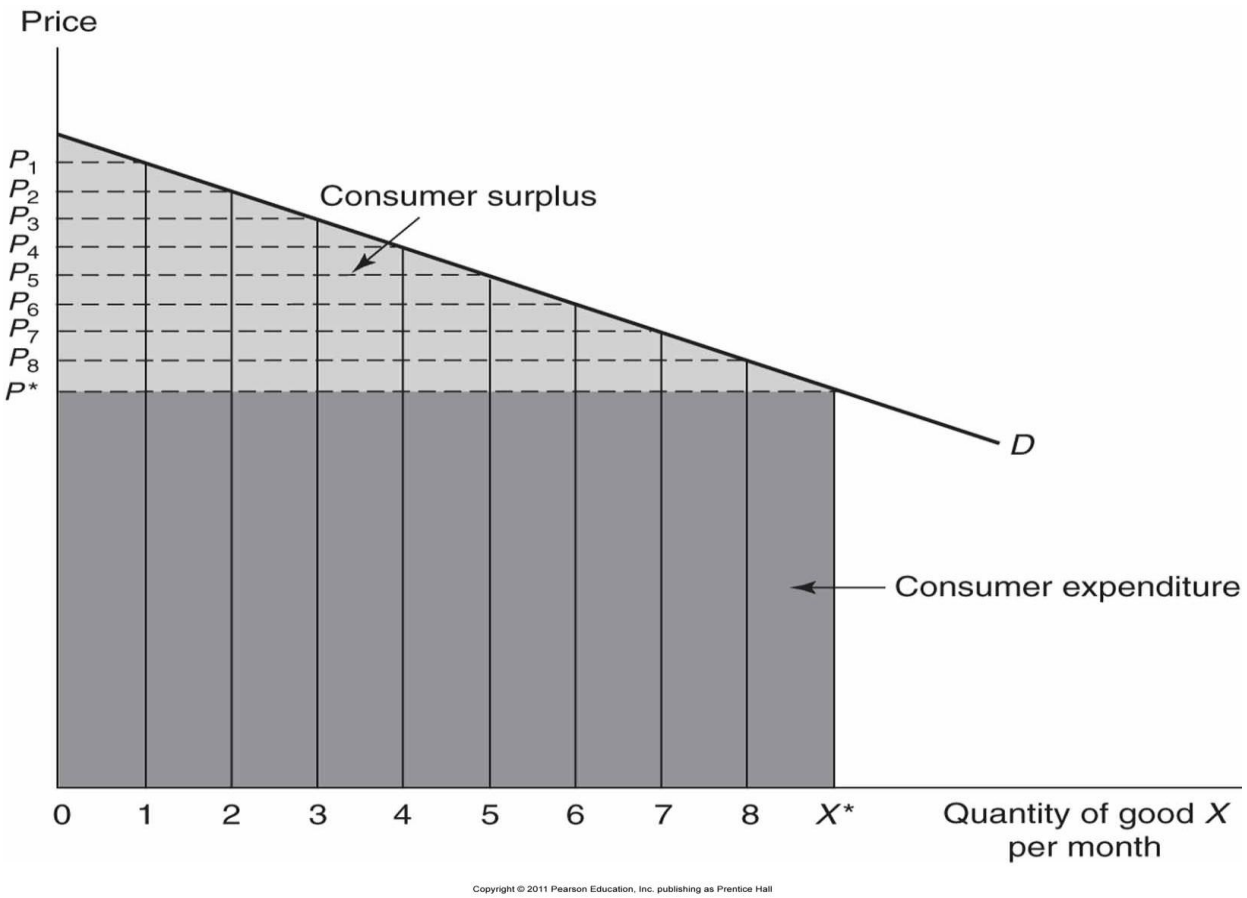
Demand Curves

- Ordinary demand curve vs. Inverse demand curve**
- Individual demand curves slope downward. Why?

  ➔ Diminishing marginal utility.

- The *inverse market demand curve* can be interpreted as a *societal marginal benefits (MB)* curve.
  - It indicates the *maximum* amount someone is willing to pay for an additional unit of a good.
  - The sum of all the willingness to pay amounts equals the total WTP for the good by all the members of society.
- Thus, WTP is an appropriate measure of the benefit of a good or service.

Consumer's Total Benefits & Consumer Surplus



Total benefits (B) = consumer surplus + consumer expenditure
(i.e. the area under the demand curve)

Consumer Surplus & Changes in Consumers' Surplus

- Consumer surplus is the net benefit to consumers, which is equal to the total benefits less consumers' actual expenditures:

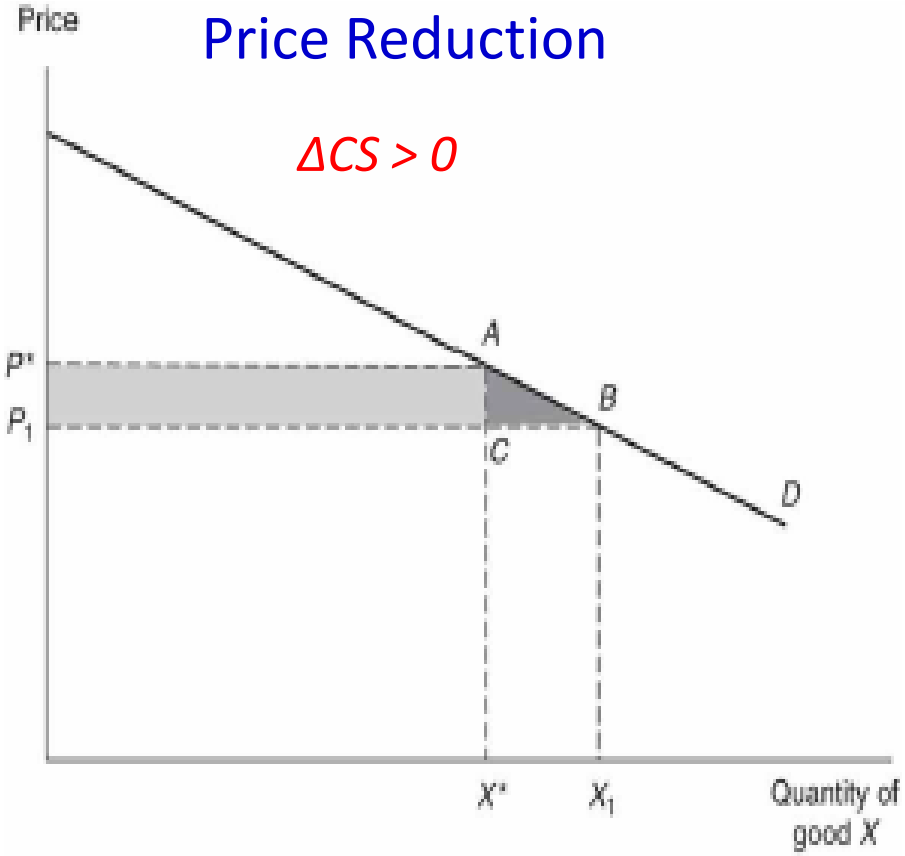
$$CS = B - P^*X^*$$

- In CBA, changes in CS can be viewed as close approximations of the WTP for (the benefits of) a policy change.
  - A policy that *reduces* the price of the good would result in a *benefit* to consumers (an *increase in consumer surplus*).
  - A policy that increases the price of the good would impose a "cost" on consumers (an *loss in consumer surplus*).

Changes in Consumers' Surplus

Price Reduction

$\Delta CS > 0$



Price Increase

$\Delta CS < 0$

For linear demand curves, $\Delta CS = -(\Delta P)(X^*) - \frac{1}{2}(\Delta X)(\Delta P)$

Changes in CS for Unknown Demand Curve

- Suppose the demand curve is unknown, but we know the price elasticity of demand (E_d):

$$E_d = \frac{P}{X}\frac{dX}{dP}$$

- Given the initial prices (P*) and quantity (Q*):

$$E_d = \frac{P^*}{X^*}\frac{dX}{dP}$$

- Hence, one can derive the change in consumer surplus as:

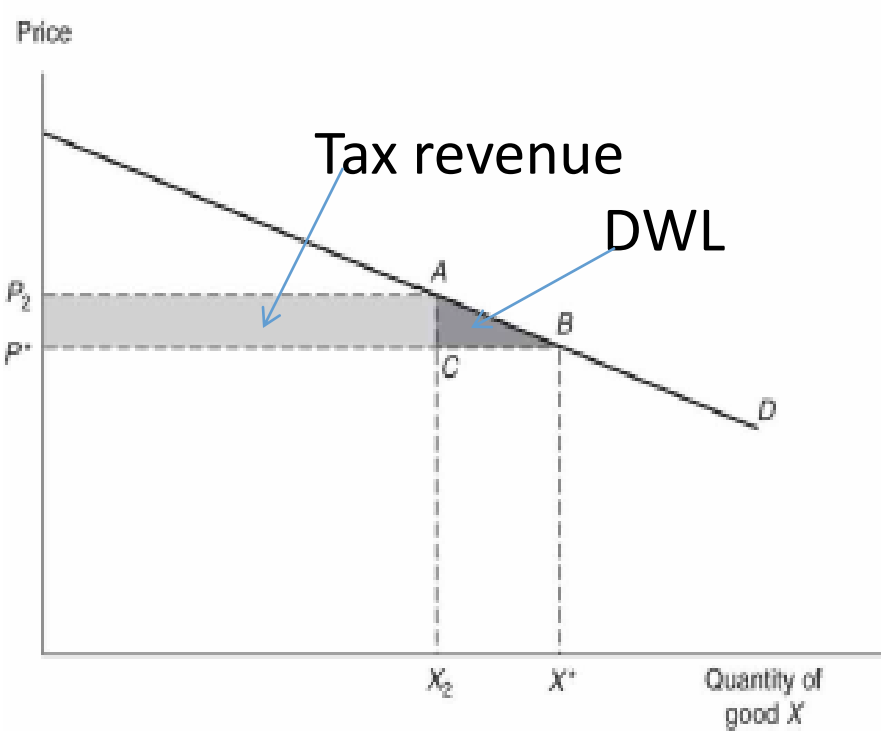
$$\Delta CS = -X^*\Delta P - \frac{1}{2}\Delta X \Delta P$$

➔ $$\Delta CS = -X^*\Delta P - \frac{E_d X^* (\Delta P)^2}{2P^*}$$

Taxes

- Taxes are important in CBA because governments often raise funds for government projects through taxes.
- Suppose the price increase results from a government-imposed excise tax.
- The *tax revenue collected* can be viewed as a *transfer f*rom consumers of X to the government.
- The tax incurs a cost – lost consumer surplus for which there is no offsetting benefit accruing to some other part of society.
  - This is deadweight loss of taxation.
  - It results from a distortion in economic behaviour from the competitive equilibrium.

Illustration of DWL from Taxation



$$\Delta DWL = -\frac{E_d X^* (\Delta P)^2}{2P^*}$$

If $\Delta P = t$, then $\Delta DWL = -\frac{E_d X^* t^2}{2P^*}$

DWL and Leakage

- *Leakage* is the ratio of the deadweight loss to the total tax revenue raised:

$$Leakage = \frac{DWL}{Tax\ Revenue}$$

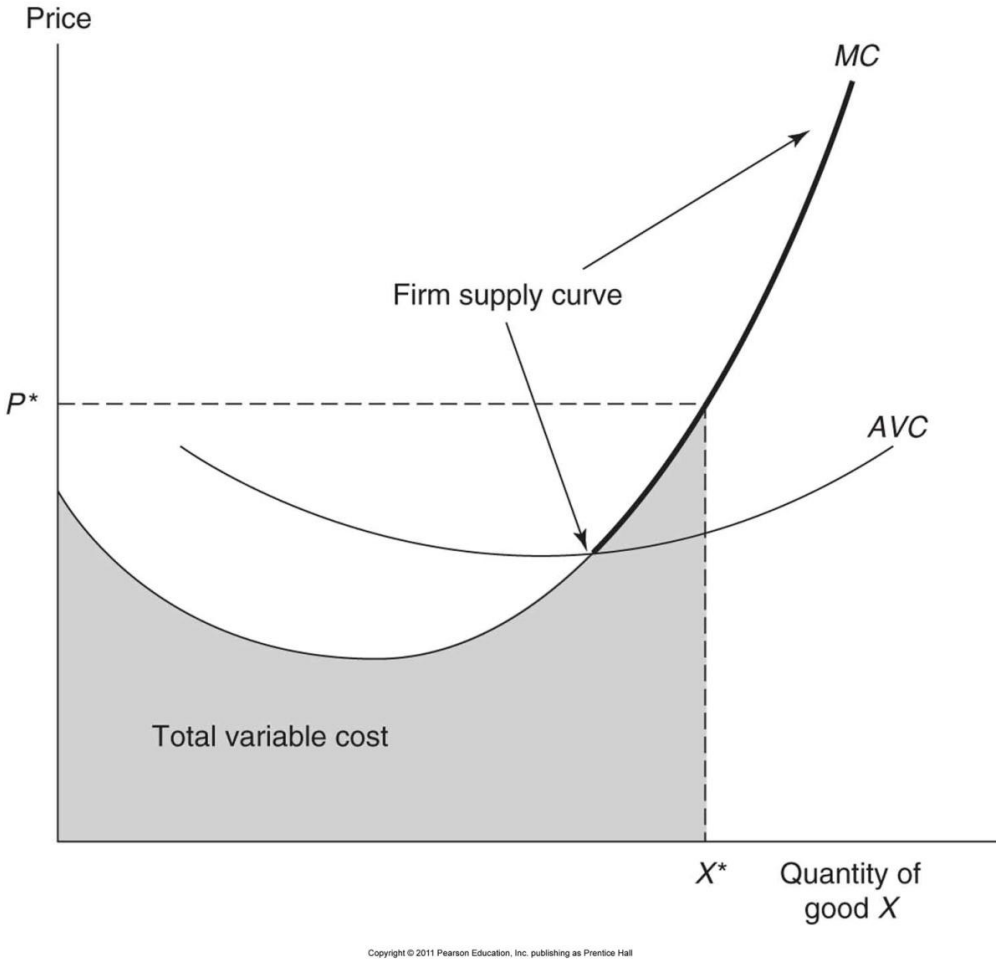
➔ $$Leakage = -\frac{E_d t}{2P^*(1+\frac{\Delta X}{X^*})}$$

- If the change in output is relatively small, then a very slight over-estimate of the leakage is:

$$Leakage = -\frac{E_d t}{2P^*}$$

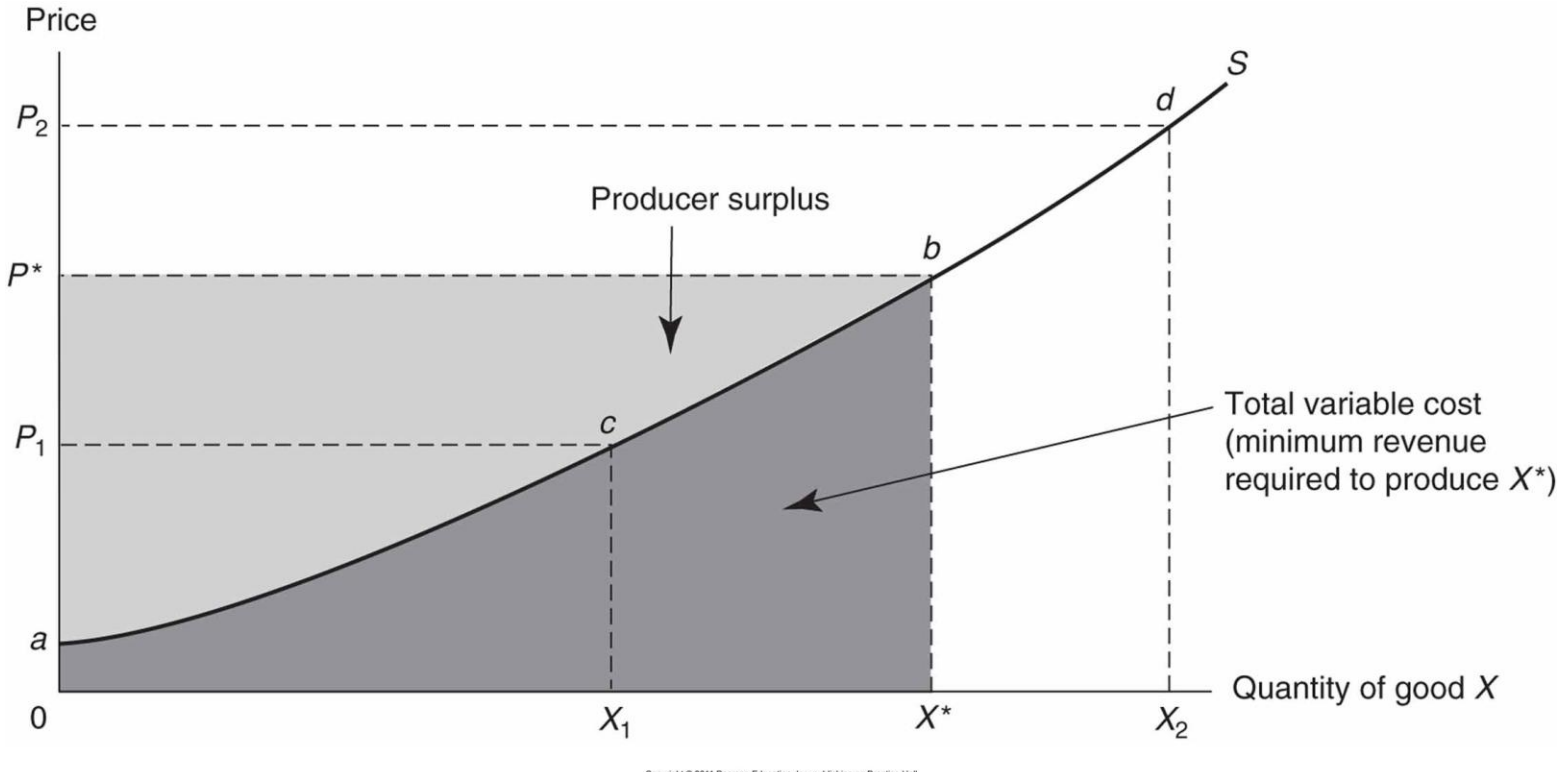
SUPPLY CURVES

Short-Run Individual Firm's Supply Curve



- Supply curve is the upward sloping segment of a firm's marginal cost (MC) curve above its AVC curve.
  - Why does it slope upward?
- Supply curve indicates the MC of each additional unit produced.
  - Area under MC is TVC.
- The cost curve reflects the opportunity costs of the resources used in the production (including a normal return).

Market Supply Curve & Producer Surplus



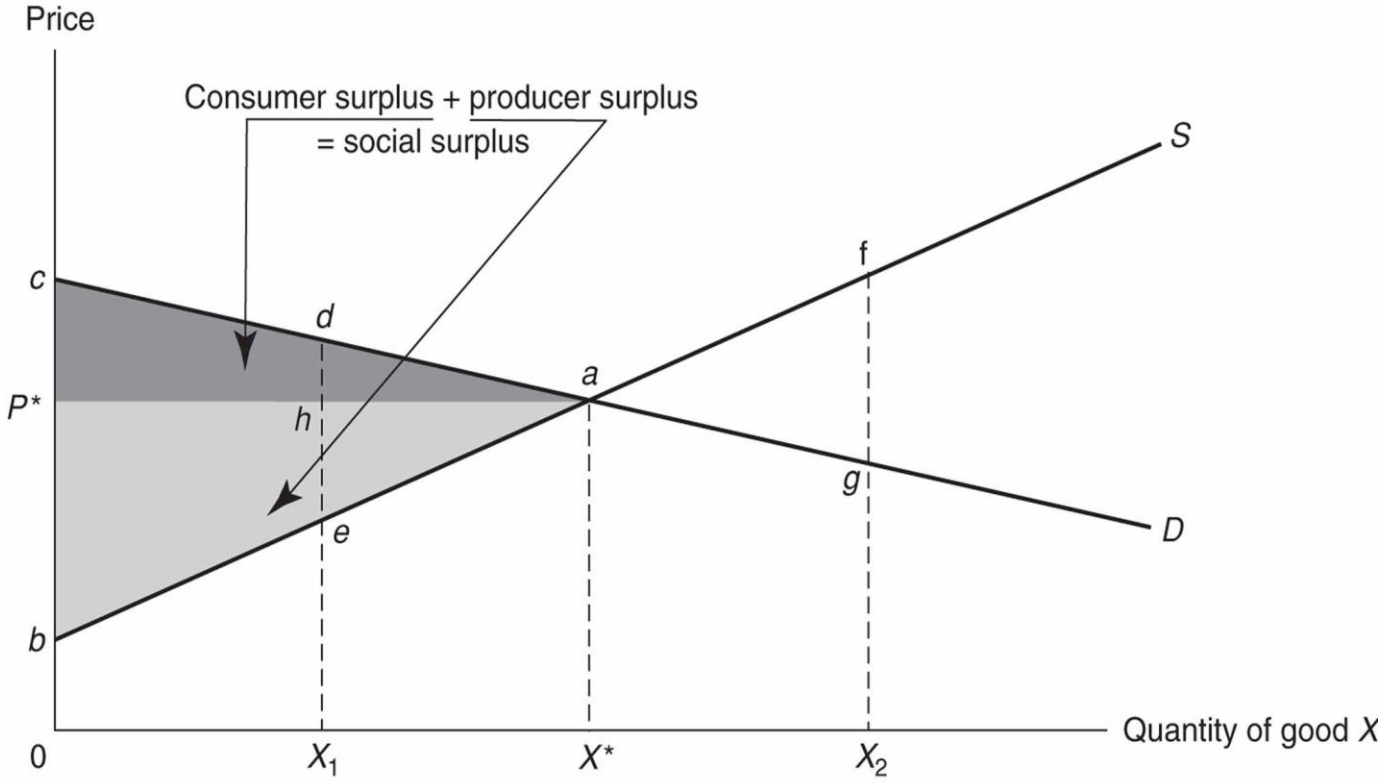
- PS = Total Revenue – TVC = *P*X* - TVC*
- If P decreases from P* to P_1, *ΔPS* = Area P_2dbP^*
- If P increases from P* to P_2, *ΔPS* = Area P^*bcP_1

Social Surplus and Allocative Efficiency (1)

- Social surplus (SS), a.k.a. total surplus, is the sum of consumer surplus and producer surplus: SS = CS + PS.
- Net social benefits (NSB) equals the difference between total consumer benefits (D curve) and total producer costs (S curve).
  - Thus, NSB = SS.
- Since demand reflects MB and supply reflects MC, net social benefits (social surplus) is maximized where the supply and demand curves intersect.
  - In a perfectly competitive market, NSB and SS are maximized.
  - This outcome is *Pareto efficient* and *allocatively efficient* (or economically efficient).

    → First Welfare Theorem (CE ➔ PE)

Social Surplus



At (X*,P*), D = S and P = MC.

- This point is allocatively efficient because NSB is maximized.
- It is also Pareto efficient because no one can be made better off without hurting anyone else

Profit and Factor Surplus

- In practice, CBA projects often involve changes in fixed costs which should be taken into account.
- Also, regardless of including fixed costs or not, it is easier for most people to think of *profits* than producer surplus.
- One way to deal with these two issues is to recognise that:

$$PS = \pi + FS,$$

where π = economic profits, and FS is *factor surplus*, which are a form of *Ricardian rents*.

  - Example of Ricardian rent: the return going to a particular productive plot of land in a competitive agricultural market.

- Hence,

$$SS = CS + \pi + FS \quad \text{and} \quad \Delta SS = \Delta CS + \Delta\pi + \Delta FS$$

GOVERNMENT SURPLUS AND ALLOCATIVE EFFICIENCY

Government Surplus (1)

- Government surplus (GS) is the net budget impacts on government.
  - Financial inflows: taxes
  - Financial outflows: expenditures
- When GS is non-zero, social surplus and changes in social surplus are given by:

$$SS = CS + PS + GS$$

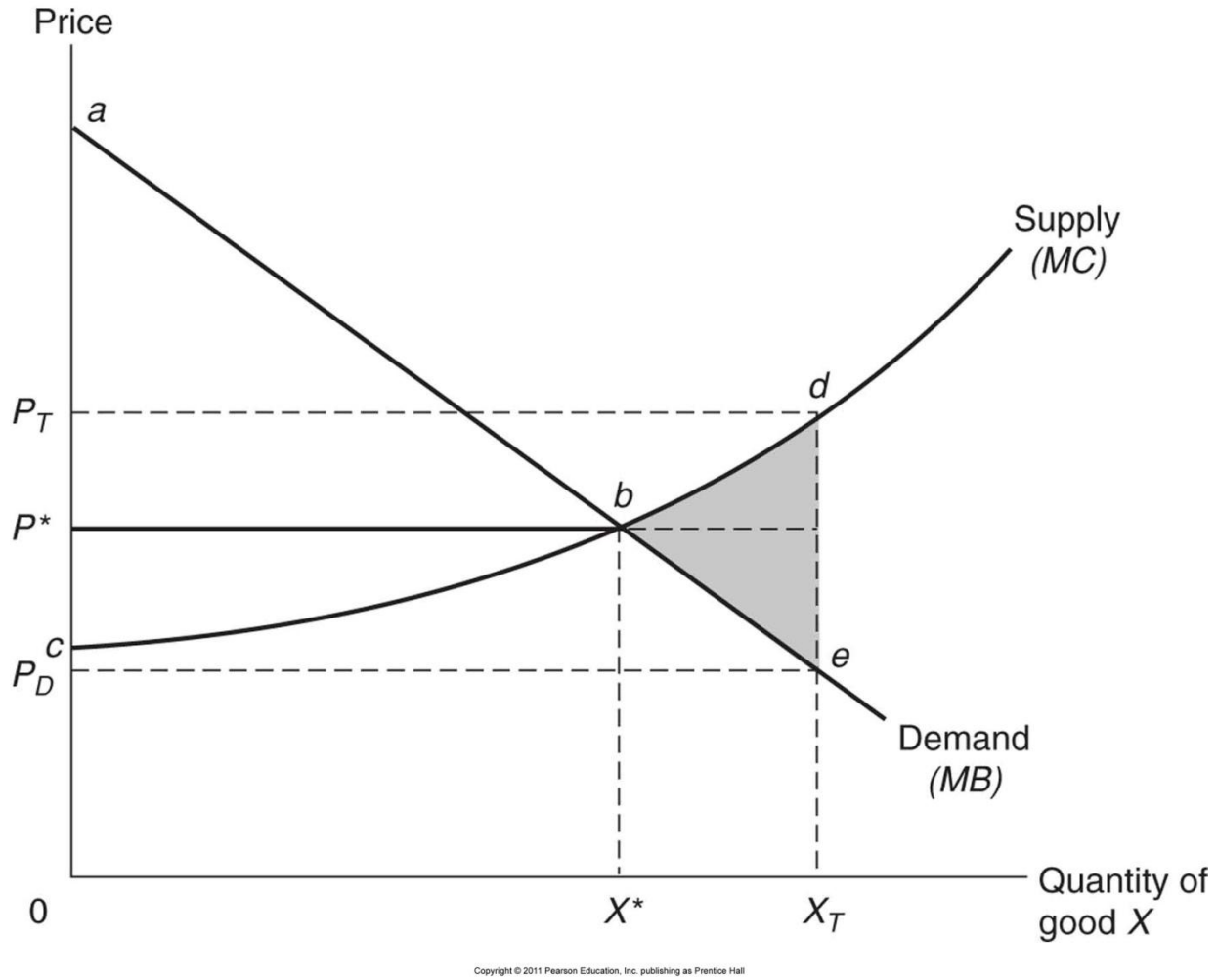
and $$\Delta SS = \Delta CS + \Delta PS + \Delta GS$$

- *In a competitive market, the net social benefit of a project equals the change in consumer surplus plus the change in producer surplus, plus the net change in government revenue.*

Government Surplus (2)

- Example 1: Suppose government incurs all the costs of a project and enjoy none of financial benefits (e.g. build a rent-free shelter). Assume that $\Delta PS = 0$.
  - ΔSS = NSB = B – C where $B = \Delta CS$ and $C = \Delta GS$
- Example 2: Suppose now the government charges a market rent. Would the NSB be the same?
  - *Method 1*- Consider the rent paid as a transfer – a cost to consumers but a benefit to government.
    - The net effect of a transfer is zero.
  - *Method 2* - Consider *gross benefits t*o consumers (B) and total cost:
    - B = ΔCS + Rents
    - C = Rents (paid by consumers) + project expenditures (paid by govt)
      - ➔ NSB = B – C = ΔCS – *Construction costs – Operating costs*

Example: Target Pricing



Distributional Implications of Target Pricing: Breakdown of CS Gain, PS Gain, and DWL

Group	*Incremental Benefit*	*Incremental Cost*	*Change in Surplus*
Consumers	P^*beP_D		P^*beP_D
Producers	$P_TdX_TO - P^*bX^*O$	bdX_TX^*	P_TdbP^*
Government			$-P_TdeP_D$
Net (Social)			$-bde$

Leakage is the proportion of each dollar given up by government that, as a result of a deadweight loss, does not accrue as transfers to any other group.

➔ *Leakage* = bde/P_TdeP_D

Marginal Excess Tax Burden & Allocative Efficiency

- The *DWL* that results specifically from a tax is called *excess tax burden*.
- The *change in DWL* resulting from raising an additional dollar of tax revenue is called the *marginal excess tax burden (METB)*.
  - The size of METB depends on the magnitude of the behavioral response to a tax change (e.g. how much consumer purchases change due to an excise tax).
- METB is an *efficiency cost.* Taking this effect into account, social surplus and the change in social surplus becomes:

$$SS = CS + PS + (1+METB)GS$$

$$\Delta SS = \Delta CS + \Delta PS + (1+METB)\Delta GS$$

Measuring Changes in Welfare

- CBA focuses on allocative efficiency. However, *welfare* concerns allocative efficiency and *equity*.
- It is possible to move from measuring social surplus to a measure of welfare by "weighting" each of the different types of surplus:

$$\Delta W = \gamma_c \Delta CS + \gamma_p \Delta \pi + \gamma_f \Delta FS + \gamma_g \Delta GS$$

where $\gamma_c, \gamma_p, \gamma_f, and\ \gamma_g$ are welfare weights for consumers, producers, factors of production and government, respectively.

- If $\gamma_c = \gamma_p = \gamma_f = 1$ and γ_g = 1+METB, then $\Delta W = \Delta SS$.
- In practice, it is not clear what the weights should be. Some studies use the above equation to measure changes in welfare due to privatization.

APPENDIX: CONSUMER SURPLUS & WTP

Compensating Variation

- **Compensating variation (CV)** is the maximum amount of money that consumers would be willing to pay to avoid a price increase.
  - It is the amount required to return the consumers to the same utility level they enjoyed prior to the change in price. (Why?)
- Suppose that if the consumer is willing to pay all the compensation she received, then the price increase will be revoked. Will she accept or reject the offer?
  - She will be indifferent.
    - If she takes the offer, then she returns to her initial equilibrium.
    - If she rejects the offer, she will be move to a new equilibrium but on the same utility level.

Illustration of Compensating Variation

Income and Substitution Effects

- *Compensated Substitution effect* is the change in quantity demanded as a result of price change, holding the utility constant (i.e. the consumer were exactly compensated for any losses of utility she suffers as a result of the price increase).

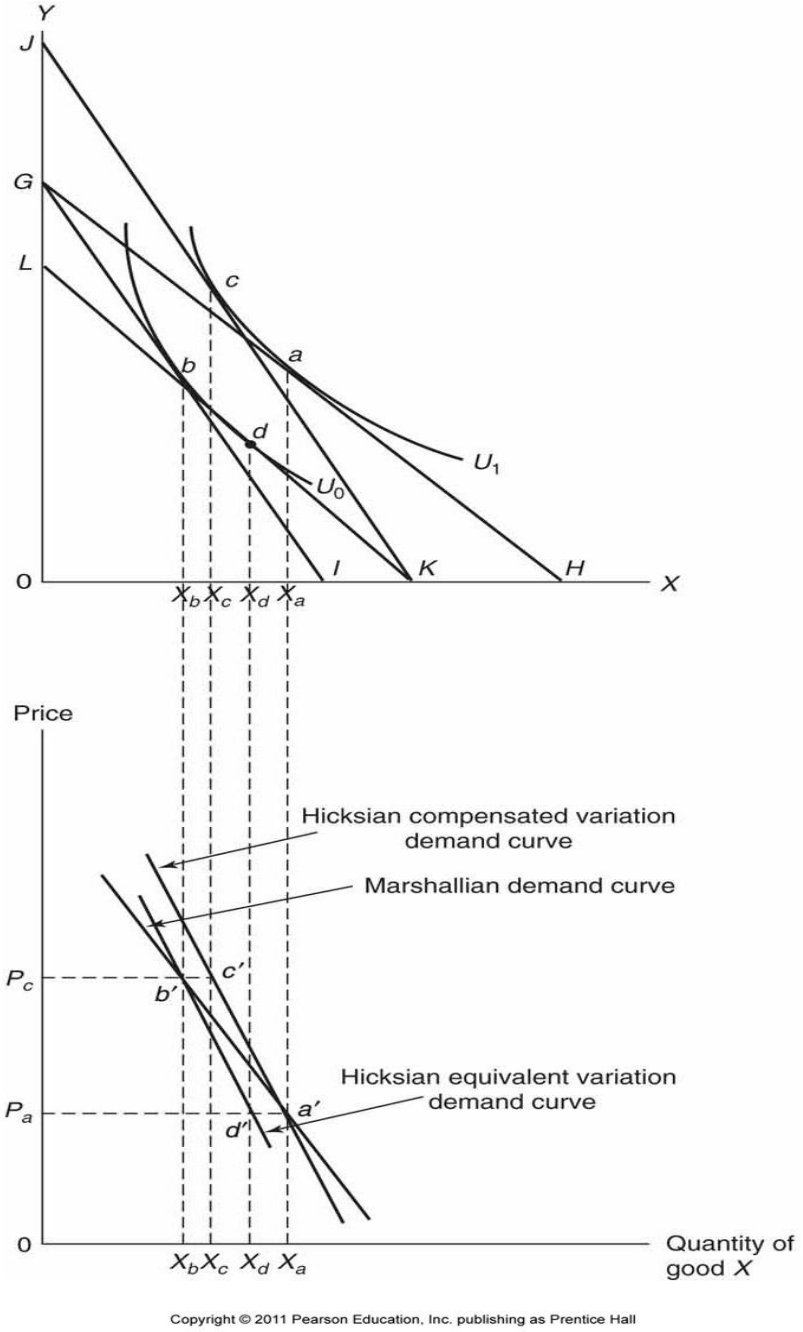
- *Income effect* is the change in quantity demand as a result of the price change.
  - An increase in the price of the good reduces the consumer's disposable income.
  - For normal goods, purchases of the good and disposable income are positively related.

Illustration of Substitution and Income Effects

Demand Curves

- **Marshallian demand curve**
  - Incorporates *both the substitution and income effects* associated with changes in the price of good X.
  - Possible to estimate empirically

- **Hicksian compensated variation demand curve**
  - A.k.a. utility compensated demand curve
  - Incorporates *only the compensated substitution effect* associated with price changes.
  - Cannot be directly estimated using statistical technique



Derivation of Marshallian and Hicksian Cemand Curves

Consumer Surplus (CS) and Compensating Variation (CV)

- Compensating Variation (CV) can be measured graphically as the vertical distance (JG in previous slide) or as the change in consumer surplus indicated by Hicksian compensated variation demand curve (Area $P_a a'c' P_c$).
- Hence, using Marshallian demand curve will result in a *biased estimate of compensating variation* and of WTP.
  - Change in CS (hence WTP) will be *smaller* if measured with Marshallian demand curve.
- The bias from using Marshallian demand depends on the size of *income effect* associated with a price change.
  - Not a big deal for CBAs of policies that affect corn, tobacco, gasoline, etc.
  - But for consumptions goods as housing or automobiles, this bias can matter.

Equivalent Variation as an Alternative to Compensating Variation

- **Equivalent Variation (EV)** is the amount of money (distance GL) paid by the consumer that would cause her to lose just as much utility as the price increases.
- Using equivalent variation approach, the price increase result in:
  - the income effect is the change from X_a to X_d
  - the substitution effect is the change from X_d to X_b.
- The **Hicksian equivalent variation demand** can be derived from the substitution effect by holding the utility constant *after* the price changes.
- EV can be measured by the area $P_a d'b'P_c$.
- Thus, EV is smaller than the change in Marshallian CS.

➔ CV > Δ Marshallian CS > EV