Benefits and Costs in Primary Markets

Yoshitsugu Kanemoto

BGVW Chapters 3 & 4

Outline

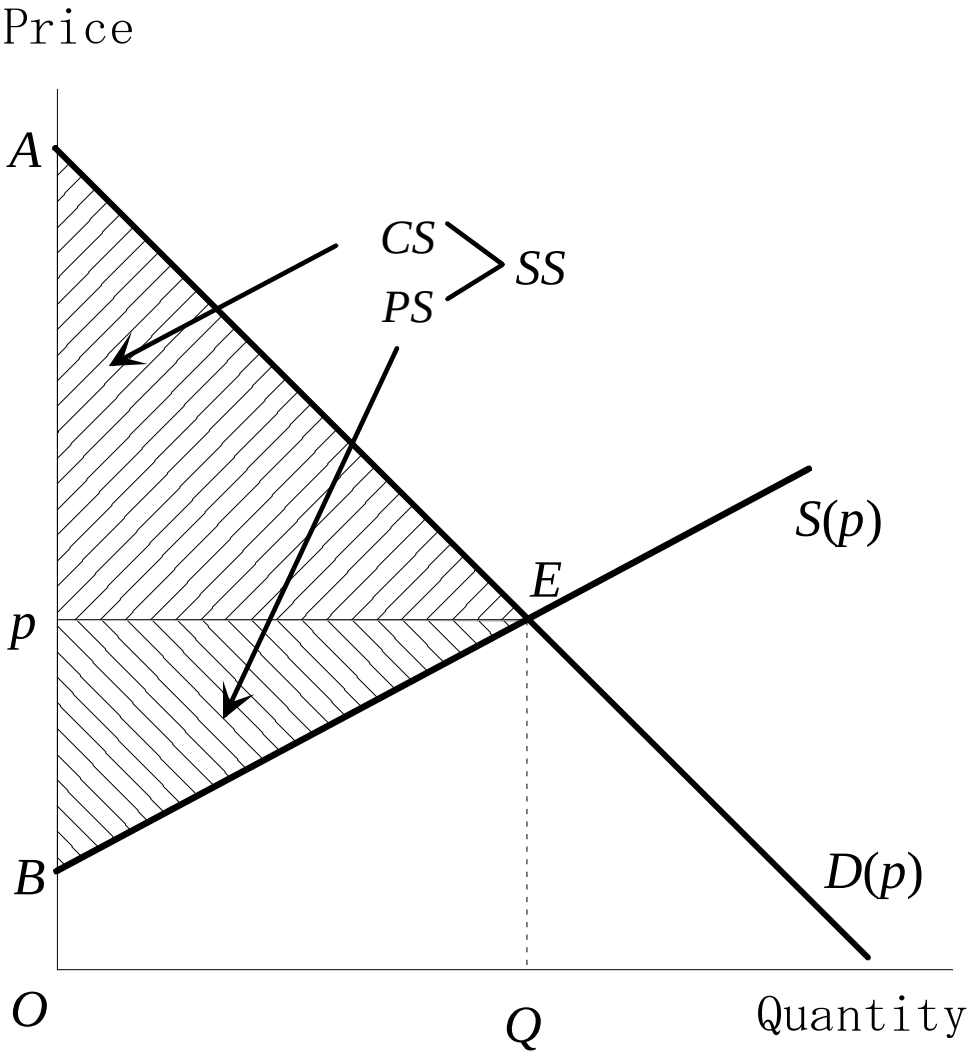
- Questions
- Consumer surplus and producer surplus
- Social benefit (Gross consumer surplus)
- Social surplus
- Costs and producer surplus

Questions

- How to measure the benefits of a public project (for example a transportation investment)?
- How to measure the benefits of a price change?
- Can a money-losing project be justified?
- Should an increase in tax revenues of a local government be included in the benefits?

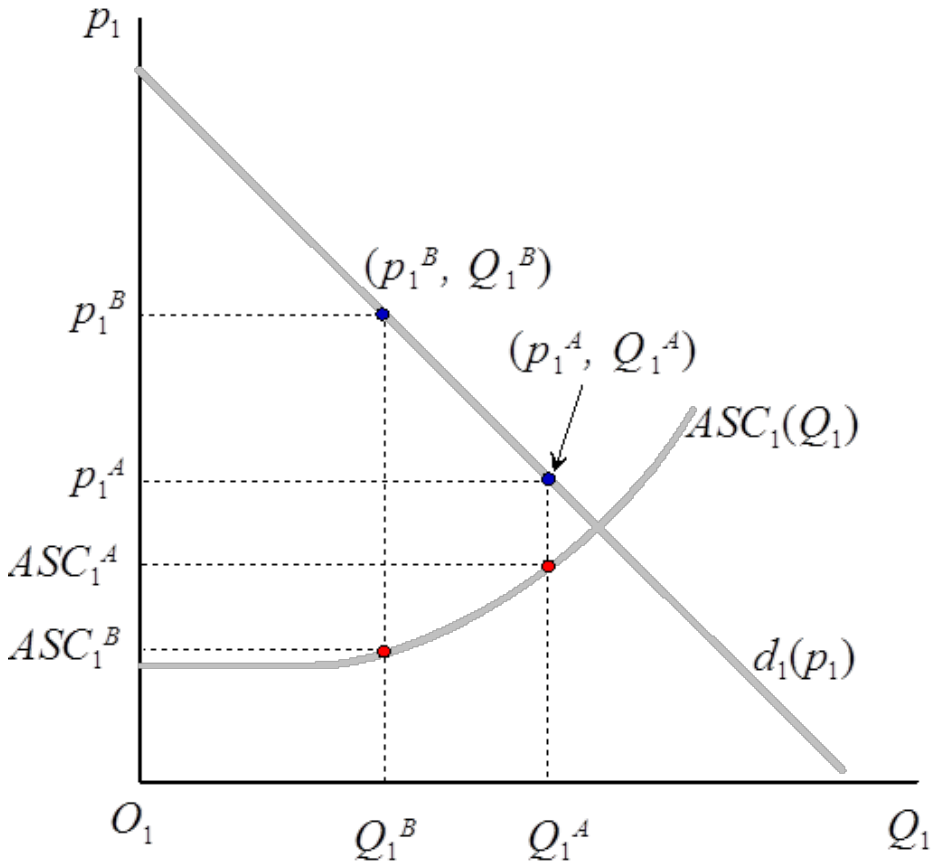
Consumer surplus and producer surplus: Review

- Consumer surplus: The area to the left of a demand curve
  - Height of a demand curve = Willingness to pay (WTP)
  - WTP: Maximum amount an individual is willing to pay to obtain something good
  - Net benefit for a consumer = WTP - Price
- Producer (supplier) surplus: The area to the left of a supply curve
  - Height of a supply curve: Opportunity cost = Marginal cost
  - Opportunity Cost: Value of an input in its best alternative use
- Social Surplus: Consumer surplus + Producer surplus



Benefits in the primary market

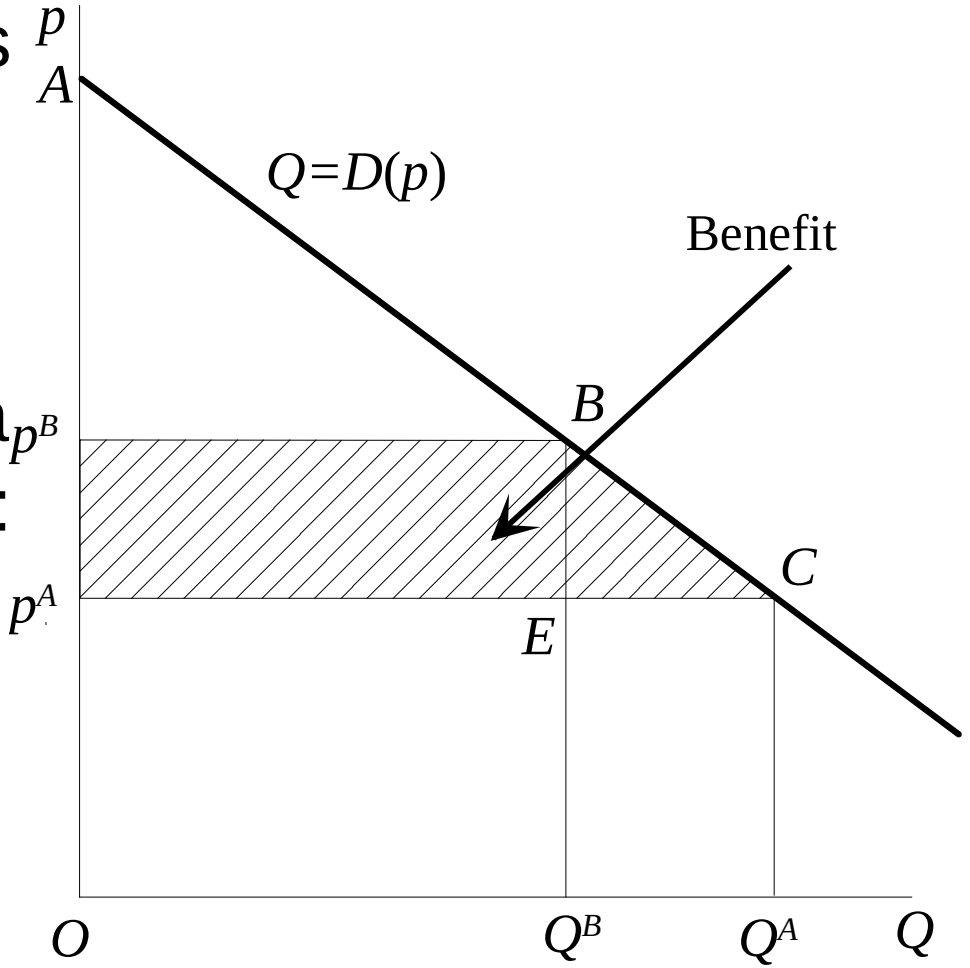
- Forecast quantities demanded, prices, and costs for Without and With cases (four points in a market).
- Estimate net benefits using the rule of a half if demand curves are linear.



Consumer surplus: The rule of a half (Trapezoid rule)

- The demand curve is often assumed to be a straight line.
- Rule of a half (Trapezoid rule) for a linear demand curve: Example: $p^B \rightarrow p^A$
  - B : Without
  - A: With

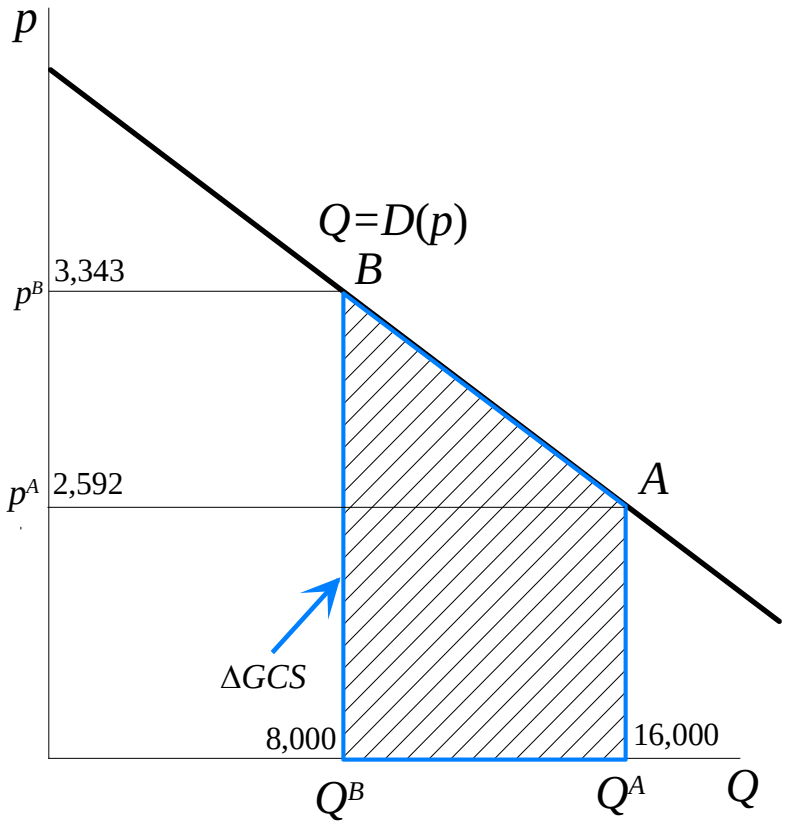
$$B = \frac{1}{2}\left(p^B - p^A\right)\left(Q^A + Q^B\right)$$



Gross Consumer Surplus (Social Benefit) & Consumer Surplus

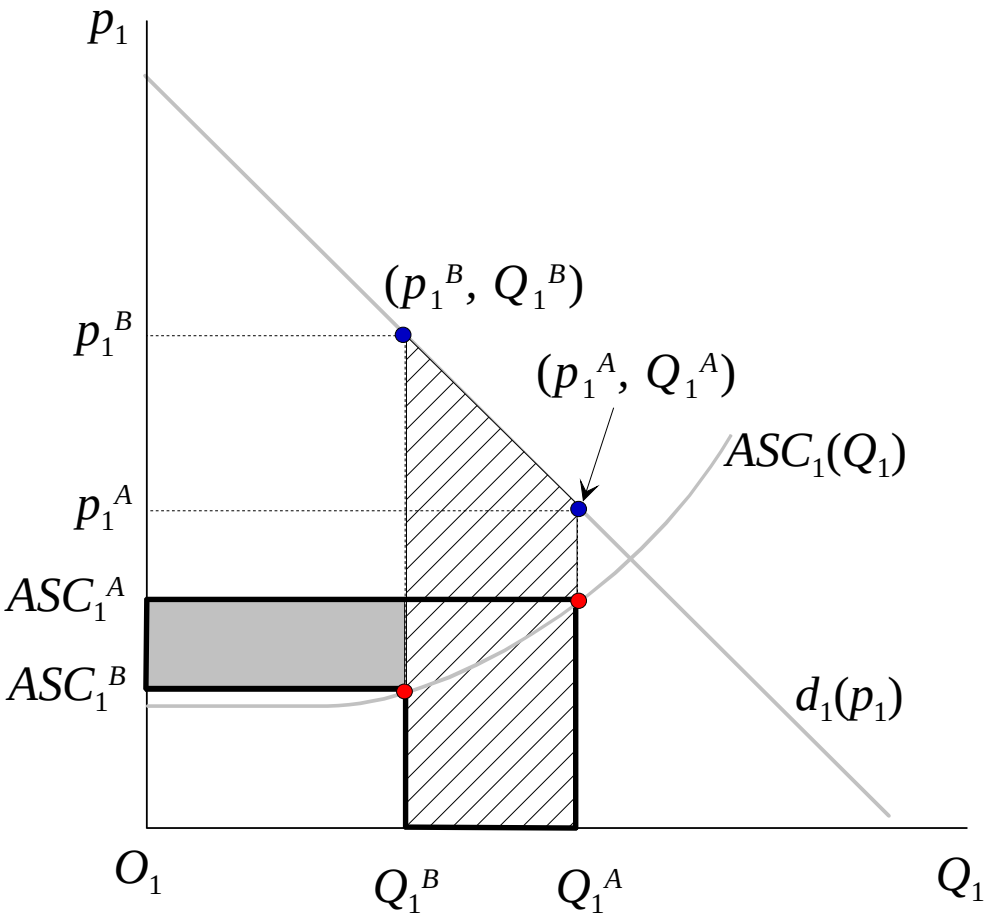
- Gross Consumer Surplus (Social Benefit) = Consumer Surplus + Expenditure
  - GCS is often called Social Benefit in Public Economics textbooks.
  - GCS is the total amount of WTP
  - GCS includes the price that consumers pay.
- Expressway case:
  - Δ GCS (SB) = (3342 + 2592)x(16 – 8)/2 = 23,736 (thousand yen)

$$\Delta GCS(=\Delta SB)=\frac{1}{2}\left(p^B+p^A\right)\left(Q^A-Q^B\right)$$



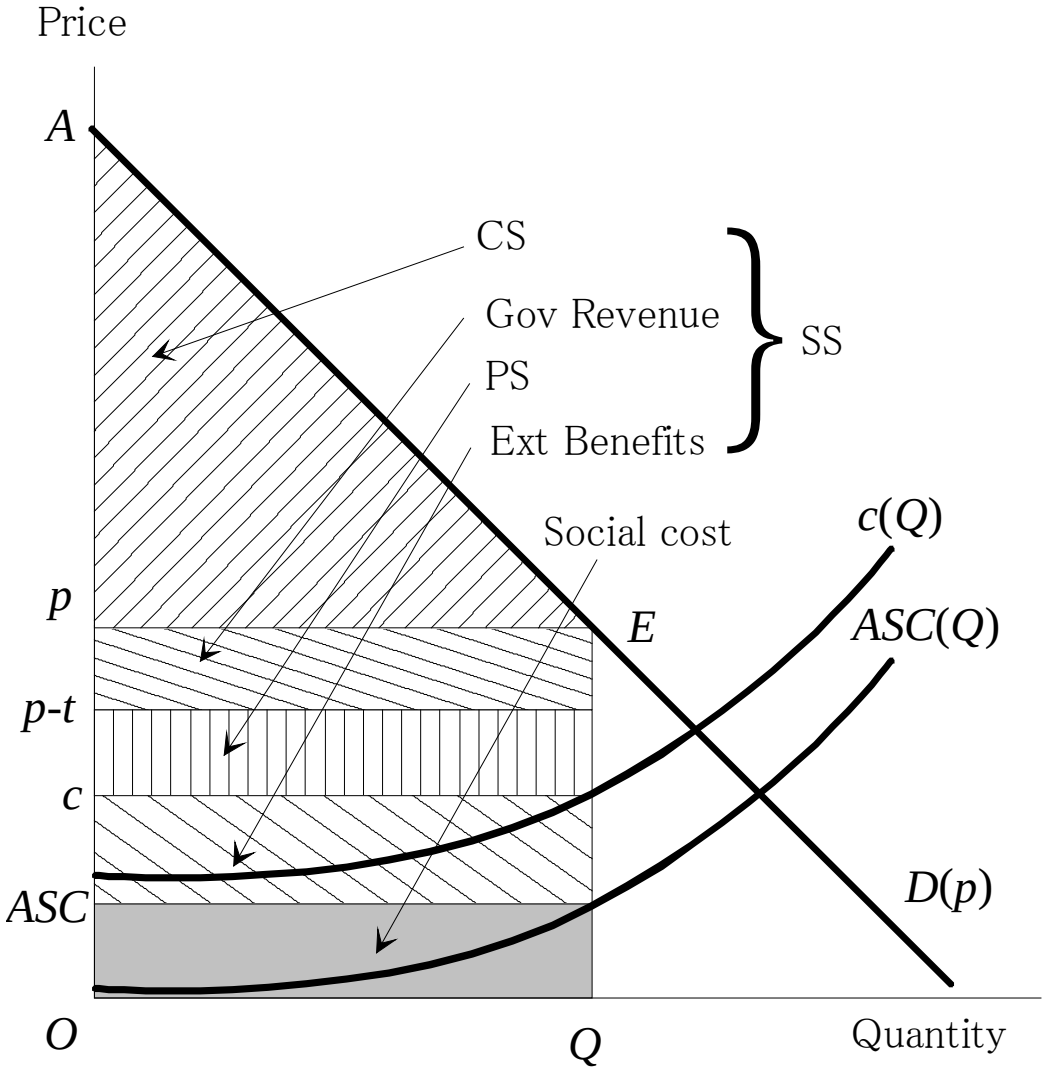
Social Surplus with GCS and ASC

- Social Surplus: GCS – Social Cost (SC)
  - SC = ASC x Q
- ΔGCS = Hatched Area
- ΔSC = Thick Line Area
- ΔSS = ΔGCS – ΔSC



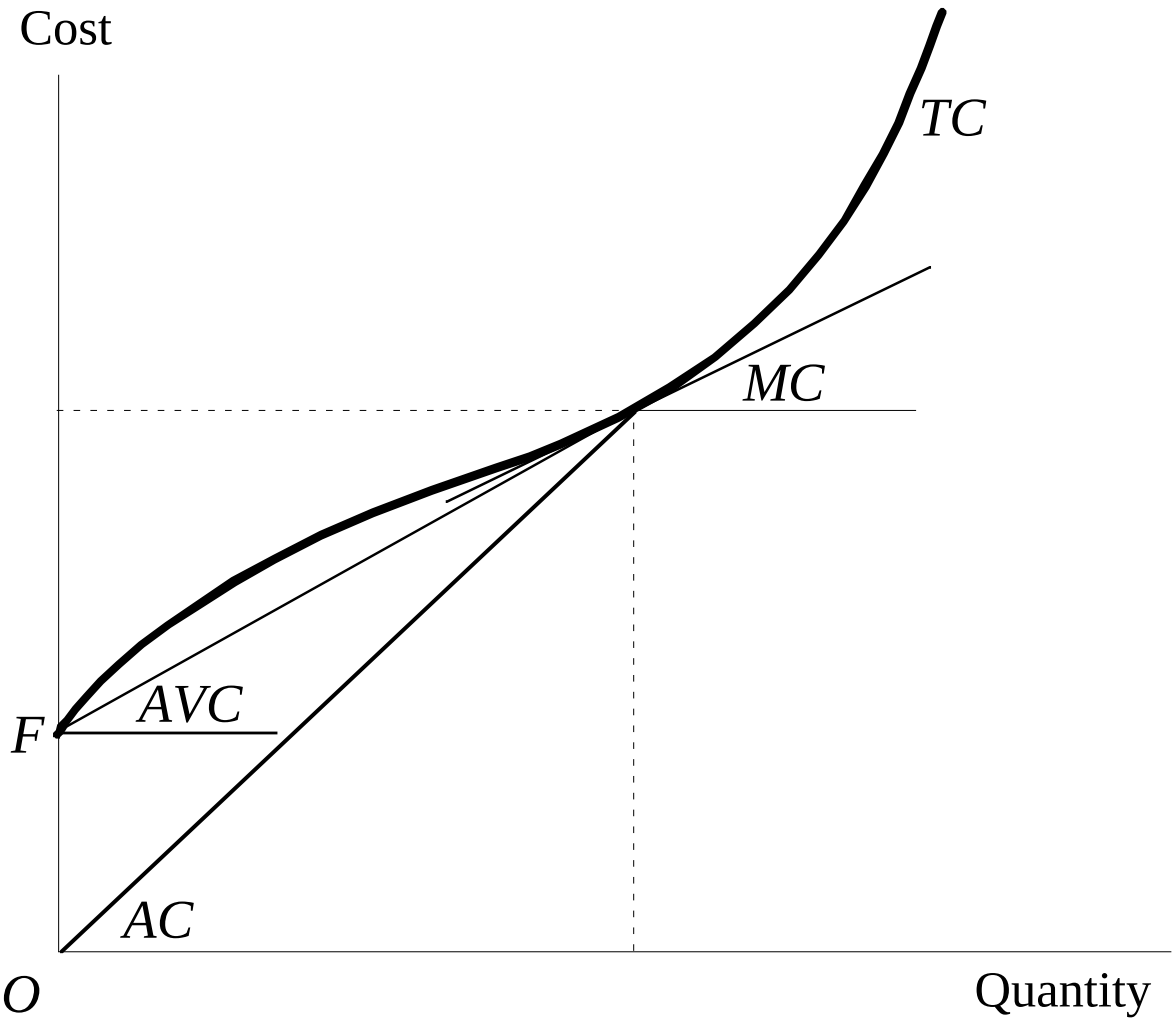
Two ways of measuring the social surplus

- SS = GCS – SC
- SS = CS + PS + GR – EC
  - GR: Government Revenue
  - EC: External Costs
- Relationship
  - GCS = CS + Expenditure
  - PS = Revenue for suppliers – Private (variable) cost $c(Q)$
  - SC = Private (variable) cost + EC
  - GR = Expenditure – Revenue for suppliers



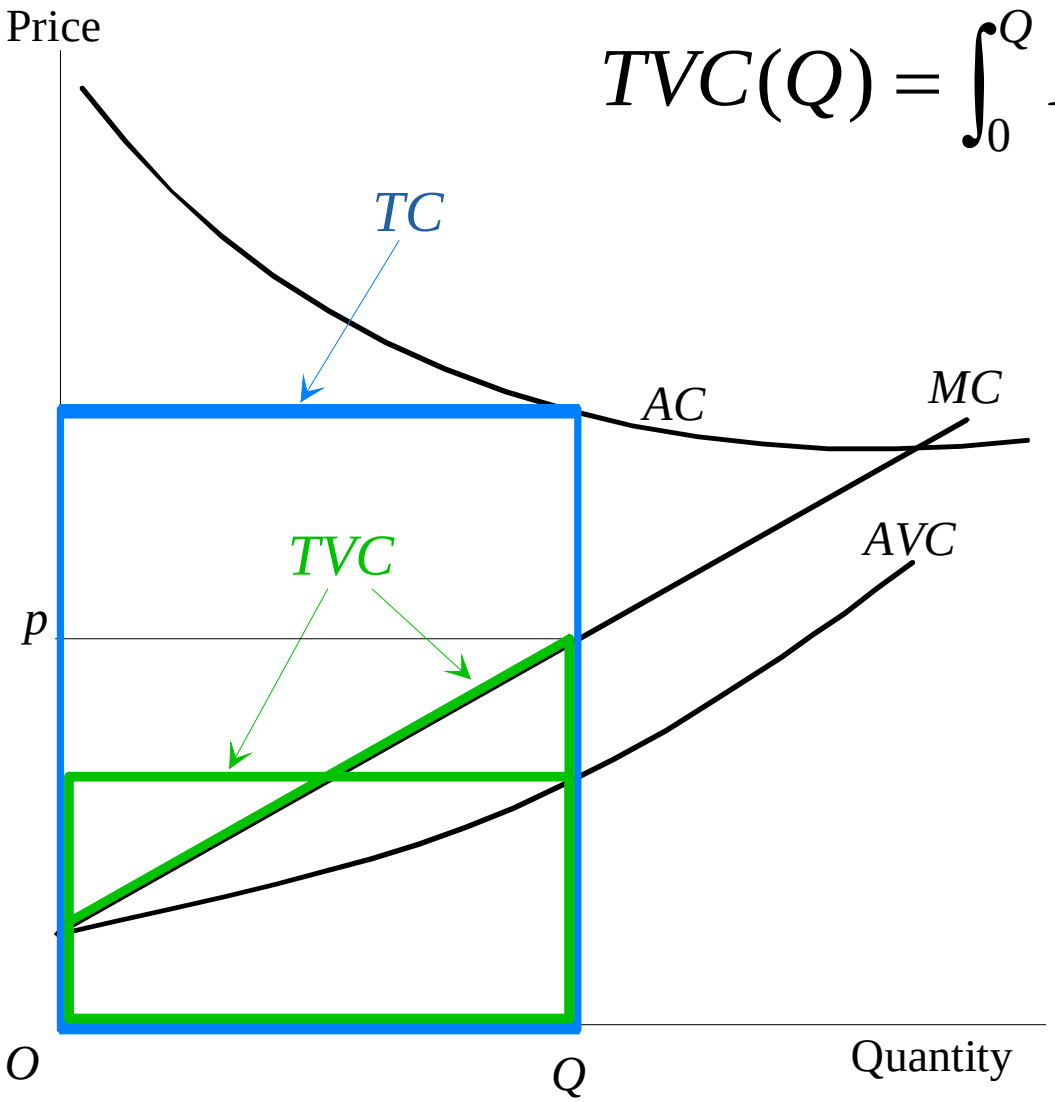
Total Costs, Average Costs, and Marginal Cost

- Cost concepts: Total Cost, Total Variable Cost, Fixed Cost, Average Cost, Marginal Cost
- TC = TVC + F
- AC = TC/Q
- AVC = TVC/Q = (TC – F)/Q
- MC = ΔTC/ΔQ = ΔTVC/ΔQ = MVC



Average Costs and Marginal Cost

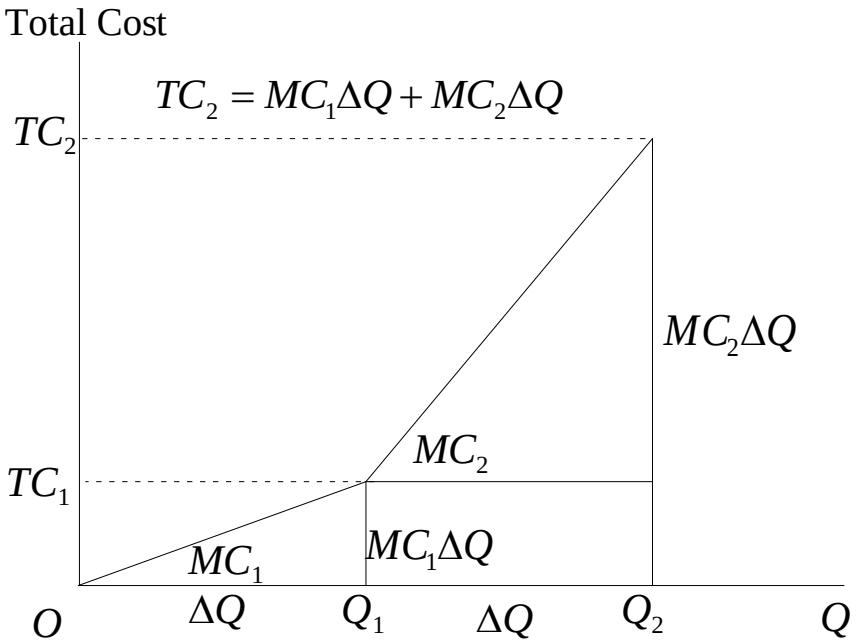
$$TVC(Q) = \int_0^Q MC(q)dq$$

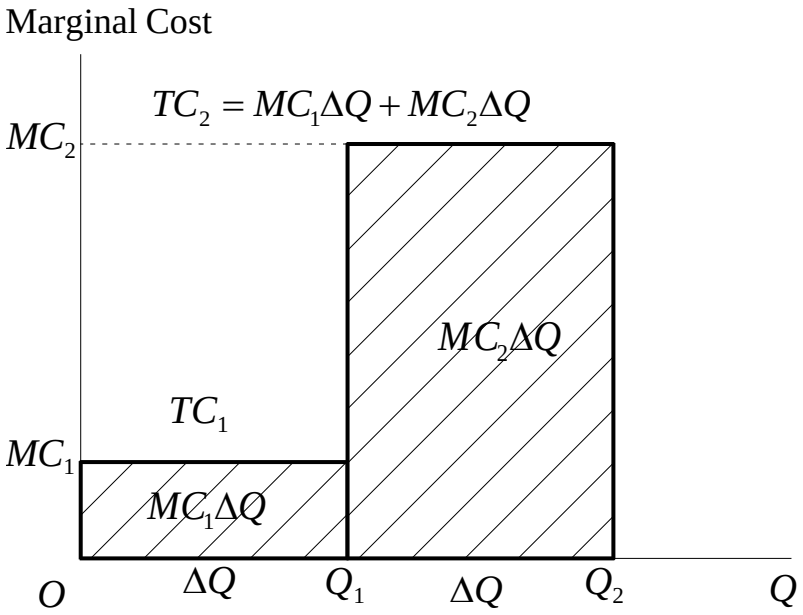


Total and Marginal Costs: Discrete Quantities

$$TVC(Q) = \int_0^Q MC(q)dq \approx \sum_{i=1}^{n} MC(q_i)\Delta q$$

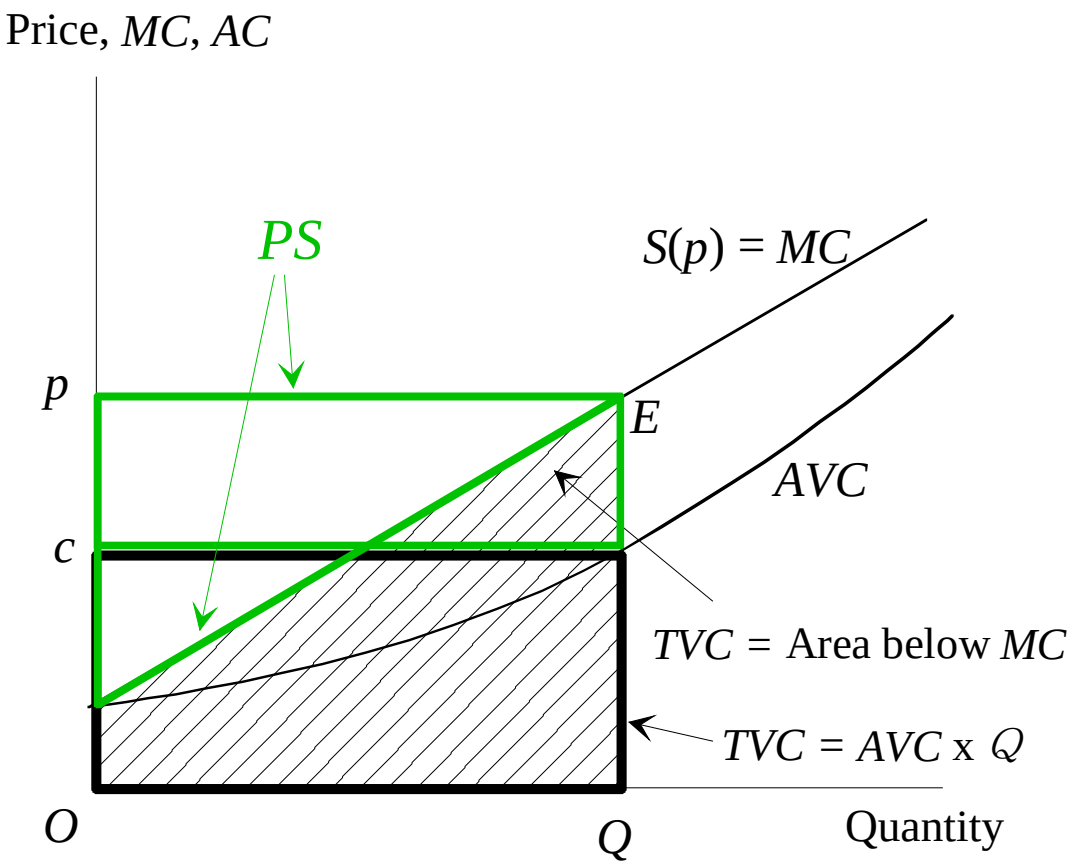
$$q_1 = 0; q_{i+1} = q_i + \Delta q; q_n + \Delta q = Q$$





Producer Surplus

- Producer Surplus: Area to the left of the supply curve
- Supply Curve = MC Curve
  - A supply curve assumes that suppliers are competitive.
- Two equivalent estimation methods: MC or AC(AVC)
- PS (Producer surplus) = Revenue – TVC
  - TVC = Area under MC curve (hatched area)
    = AVC x Q (rectangle)



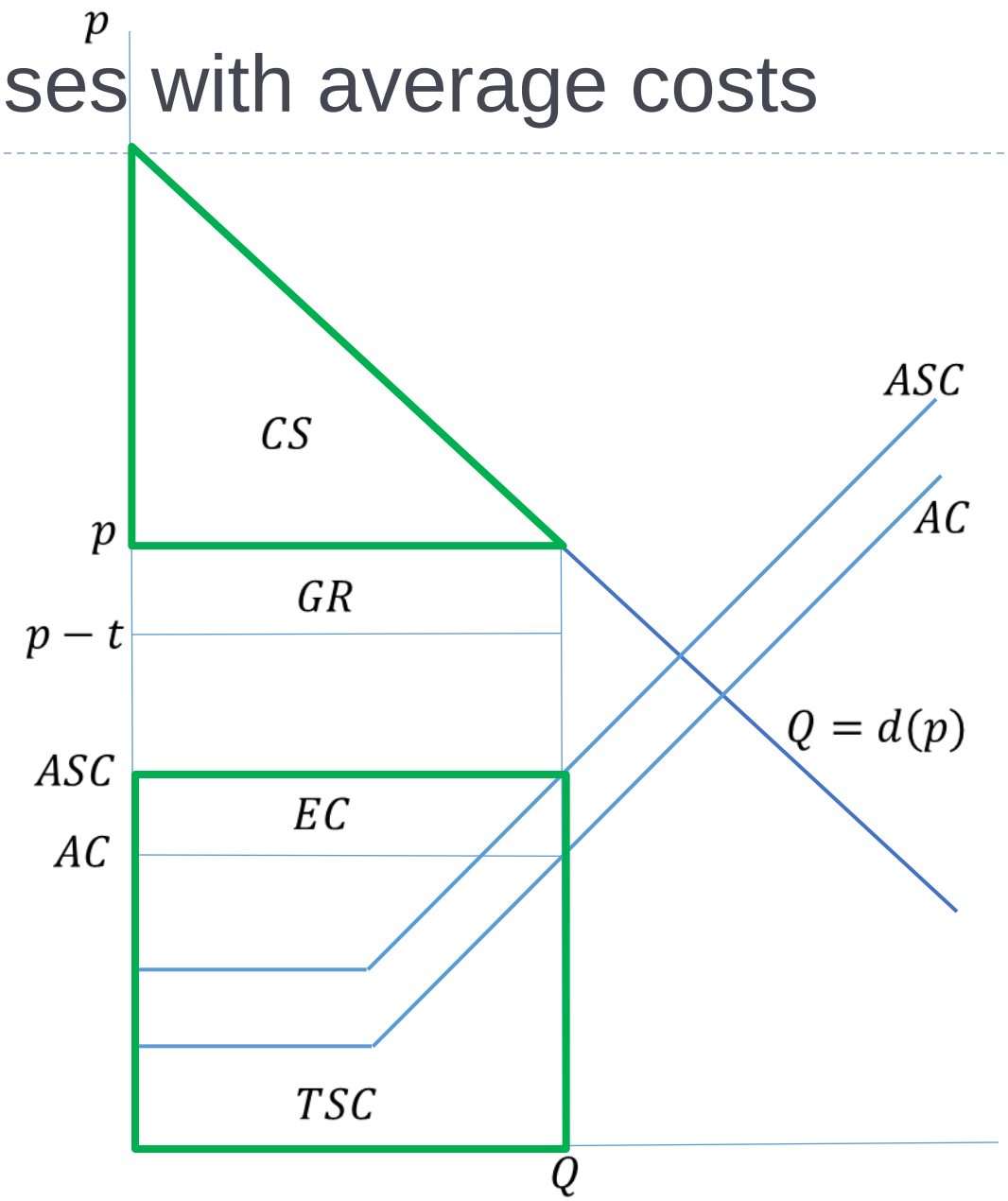
Quick Questions #3_1

- Is it true that when MC > AC, AC is downward sloping?
- Should you add to the benefits an increase in employment caused by constructing a dam? How about in an area with serious unemployment problem?
- Should you add to the benefits an increase in tax revenue generated by a road investment?

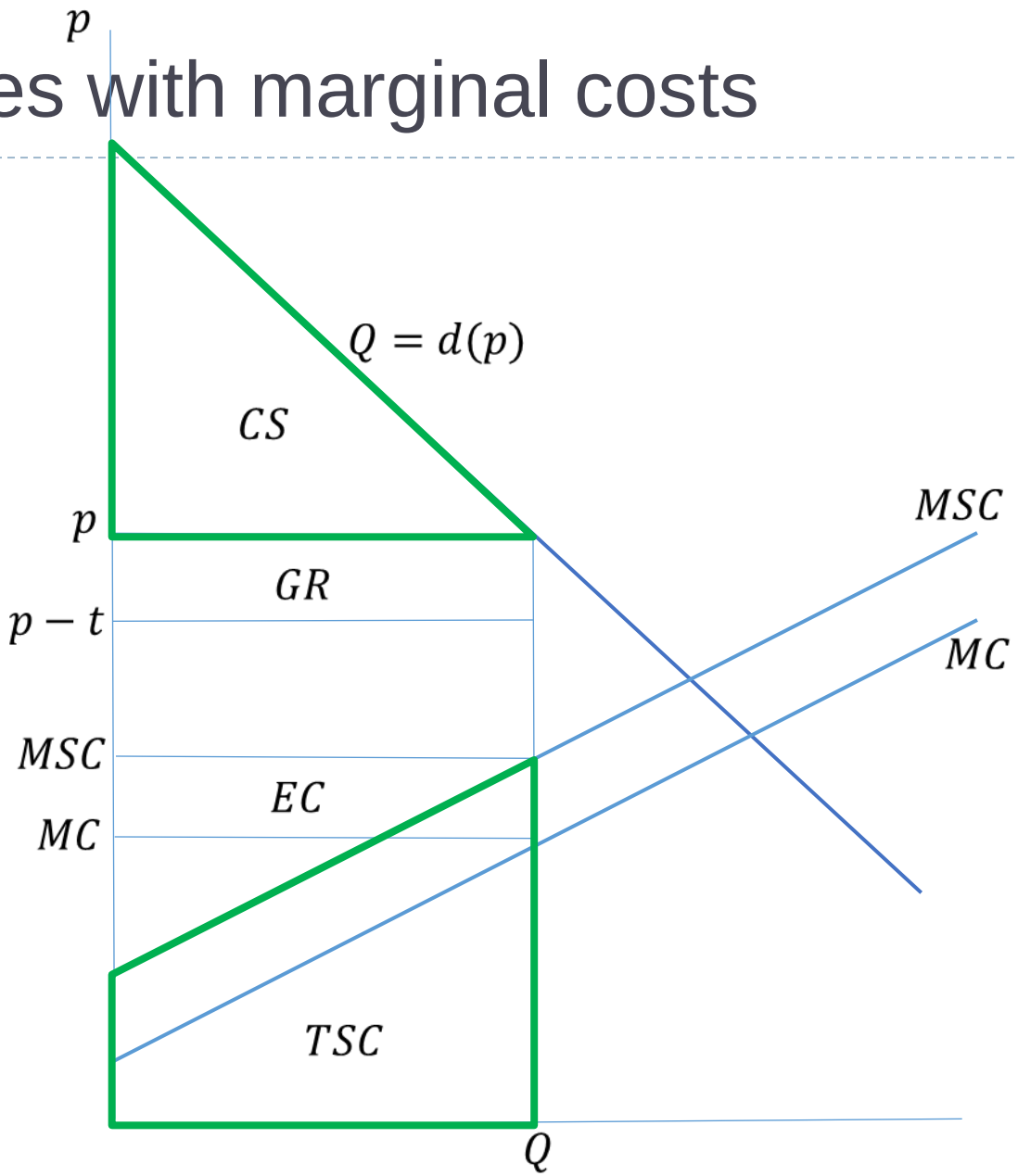
Summary: Measuring the social surplus in the primary market

- SS = GCS - SC
- SS = CS + PS + GR - EC
- Relationships
  - GCS = CS + Expenditure
  - PS = Revenue for suppliers - Private (variable) cost
  - SC = Private (variable) cost + EC
  - GR = Expenditure - Revenue for suppliers
- Total costs, average costs, marginal costs
  - TC = AC x Q
  - TVC = Area below the MC curve

Surpluses with average costs

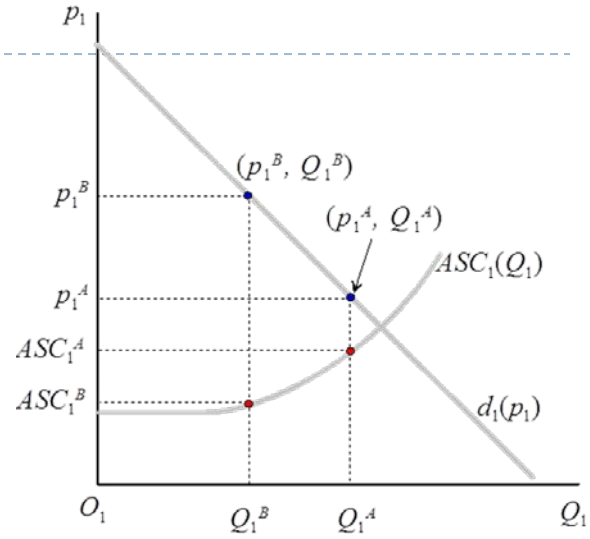


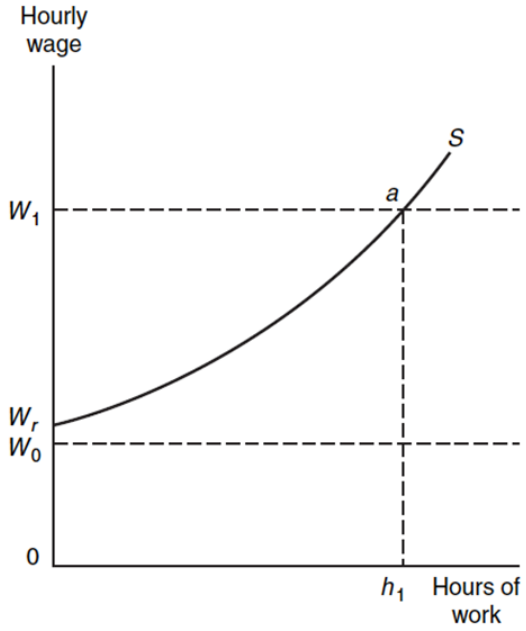
Surpluses with marginal costs



Complexity of applications

- Highway
  - Price: Generalized cost including time costs, operating costs, expressway tolls
  - Social costs: Include external costs, but exclude transfers (taxes and tolls)
- Education and training program: Raises wage rates
  - Price: Wage rate
  - Social costs of labor supply: Can be measured by the supply curve



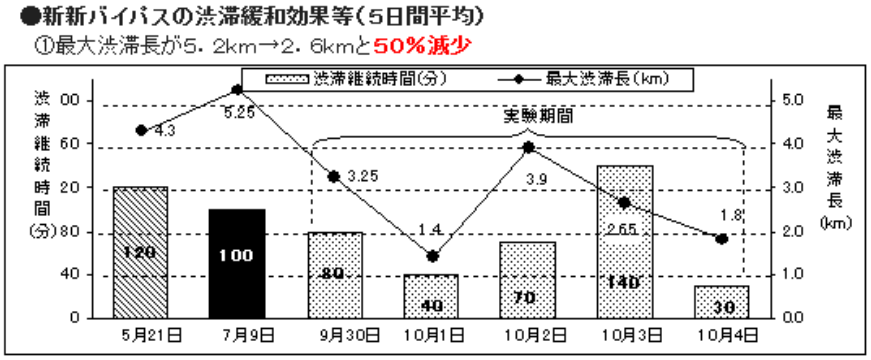


Expressway Case:
NIHONKAI-TOHOKU EXPRESSWAY (Shibata - Niigata)

- Toll reduction experiment

Route	Local Road Route	Expressway Route	
Road Type	Local Road	Expressway	Local Road
Distance (km)	24	26	4
Speed (km/hour)	28	80	30

- Evaluate the benefits of a toll reduction from ¥750 to ¥0



Expressway Case: Cost Structure

- User costs (Generalized cost): Costs paid by each user, corresponds to price in a demand-supply diagram
  - Time costs
  - Expressway tolls: transfer
  - Operating costs
    - Fuel tax: Transfer
    - Fuel costs, Depreciation costs, etc.
- Social costs: costs borne by society as a whole (users + non-users)
  - User costs excluding transfers
    - Time costs
    - Vehicle operating costs (excluding fuel tax)
  - External costs
    - Global warming
    - Air pollution
    - Accidents
    - (Congestion externality: already included in user costs)

References: World Bank Transport Notes No. TRN-5, 14, 15, 16
Many of the materials in the notes will be treated later in the course.

Expressway Case: Estimates of the generalized cost and traffic volume in the Without case

		Expressway Route	Local Road Route
Time (minutes)		27.5	51.43
Time cost (yen/vehicle)	(A)	2,167	4,052
Toll (yen/vehicle)	(B)	750	
Operating costs (yen/vehicle)			
Fuel tax	(C1)	146	153
Operating cost - Fuel tax	(C2)	280	515
Generalized cost (yen/vehicle)	(A+B+C1+C2)	3,343	4,720
Traffic (vehicle/Day)		8,000	24,000

Cost components		Cost per unit
Fuel cost (yen/vehicle,km)	28km/h	6.37 (6.37)
	30km/h	6.16 (6.15)
Expressway	80km/h	4.70 (4.66)
Time cost (yen/vehicle,minute)		78.8
Operating cost (yen/vehicle, km)		27.8
		27.4
Expressay		12.1

Fuel tax in the bracket

Based on MLIT 2003 Manual

- Obtain unit cost estimates (e.g., fuel cost per vehicle kilometer) from a variety of sources such as manuals, guidelines, academic research, past experiences

Expressway Case: Estimates of social costs

Cost components		Expressway Route	Local Road Route
User costs (Exc. taxes & tolls) Subtotal	(A)	2,447	4,567
Time cost	(A1)	2,167	4,052
Operating cost (Excl. taxes & tolls)	(A2)	280	515
Taxes & Tolls Subtotal	(B)	896	153
Expressway toll	(B1)	750	
Fuel tax	(B2)	146	153
Generalized cost	(A+B)	3,343	4,720
External costs Subtotal	(C)	120	232
Global warming	(C1)	50	53
Air pollution	(C2)	26	27
Accident costs	(C3)	44	152
Social cost	(A+C)	2,567	4,800

Cost components	Cost per unit
Accident costs (yen/vehicle,km,day) Local	6.36
	0.74
Global warming (yen/liter)	19.3
Air pollution (yen/liter)	9.9

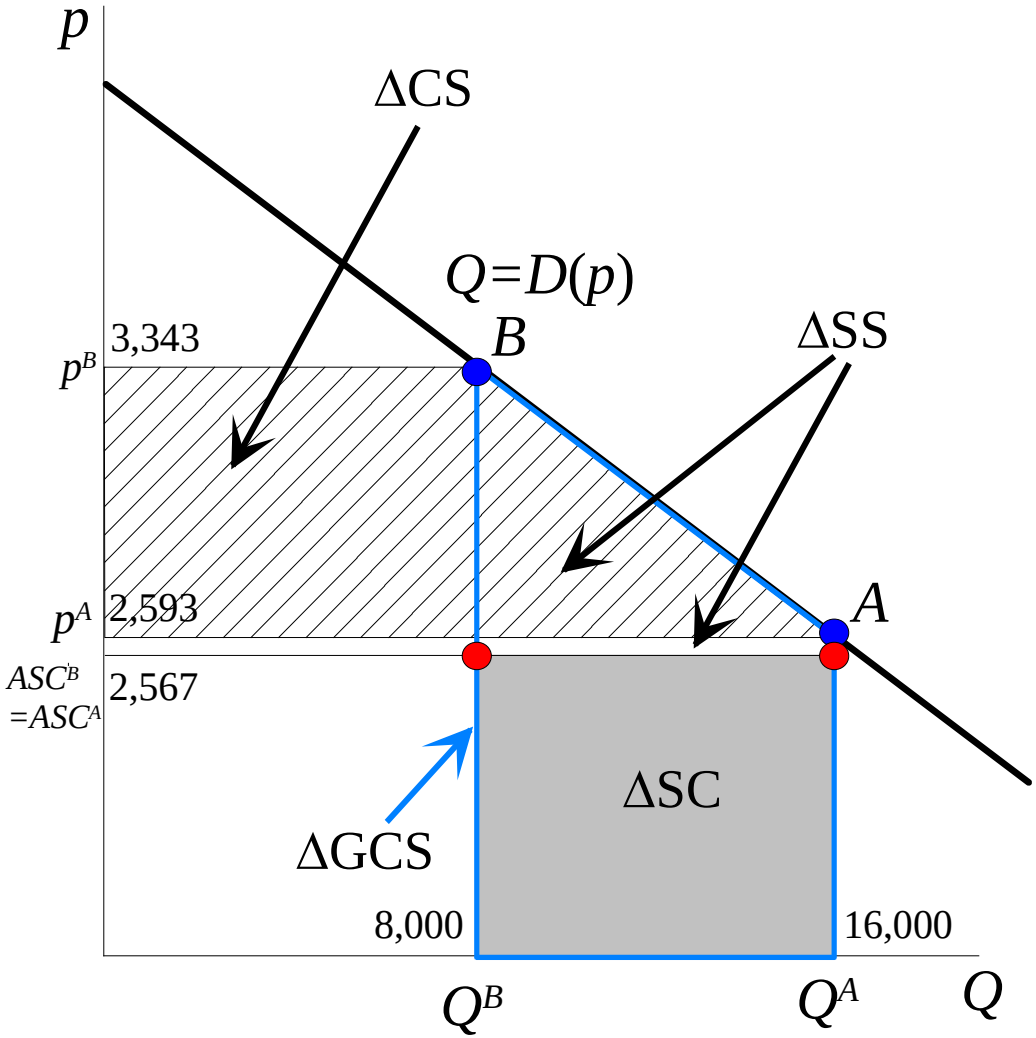
The Benefit of Expressway Toll Reduction

- Estimate the benefit of the Expressway toll reduction: 750 to 0
- Impacts of the toll reduction:
  - Expressway route: From 8,000 to 16,000 vehicles per day
  - Local road route: From 24,000 to 18,000
- Changes in GCS and SC
- Complications
  - External costs and benefits
  - Taxes and toll revenues
  - Secondary markets
    - If no price distortion, benefits and costs measured in monetary unit cancel out each other.
    - With price distortions, net benefits or costs in secondary markets: Congestion reduction in another route

The expressway case: The primary market

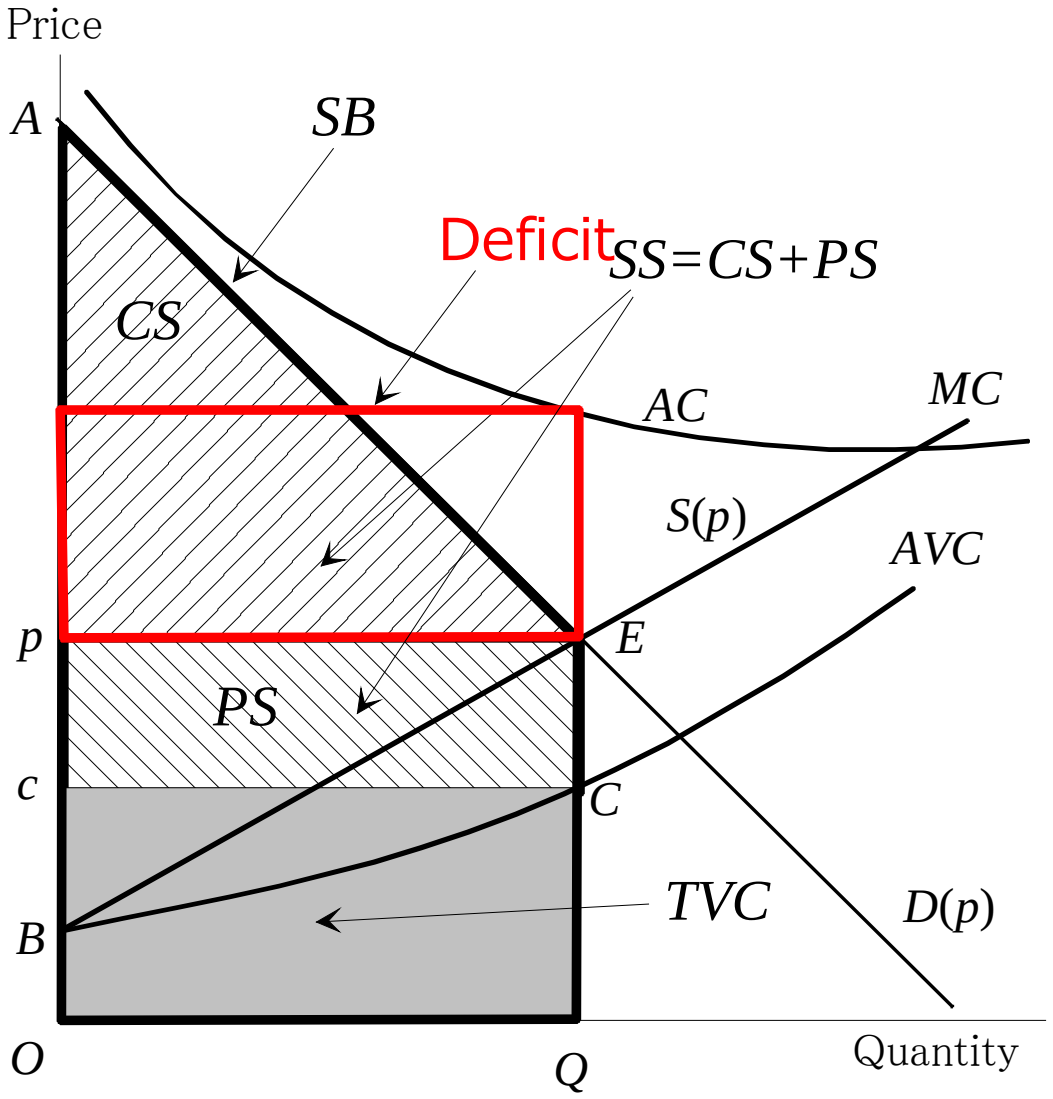
- External costs, taxes and tolls (per vehicle, average costs)
  - Expressway toll = 750yen/vehicle, Fuel tax = 146 yen/Vehicle, External costs: 120 yen/Vehicle
  - Without: Generalized cost = 3,343 yen/vehicle; Social cost = 2,567; Traffic = 8,000 vehicles/day
  - With: Generalized cost = 2,592 yen/vehicle; Social cost = 2,567, Traffic = 16,000 vehicles/day
- SS = GCS (SB) − SC
  - Δ GCS (SB) = (3,343 + 2,593) x(16 − 8) / 2 = 23,744
  - Δ SC= 2,567 x (16 − 8) = 20,536
  - Δ SS= ΔGCS − ΔSC = 3,208
- SS = CS + PS + Gov. Revenue - External Costs
  - Δ CS = (3,343 − 2,593) * (16 + 8) / 2 = 9,000
  - Δ PS = (3,343−(750+146)−2447) * 8 − ((2,593−146)−2447) * 16 = 0
    - Drivers/users are the suppliers of transportation services.
  - Δ Gov. Revenue = 146 * 16 − (750+146) * 8 = − 4,832
    - The highway company is included in the government sector.
  - Δ External Costs = 120 * 8 = 960
  - Δ SS= ΔCS + Δ PS + ΔGov. Revenue − ΔExternal Costs = 3,208

Expressway example: Social Surplus



Applications:
Deficit does not mean a negative net social benefit

- *SS = SB - TVC*
  = CS + PS
- *PS = pQ - TVC*
- Deficits do not mean negative net social benefits
  - Net Social Benefit
    = SS - F
    = CS - Deficit



Applications: Traffic congestion

- *AVC*: Private cost borne by each user = Average cost per person
- Congestion: Upward sloping *AVC*
  - MC > AC ↔ Marginal Social Cost > Private Cost
- Social surplus when congestion tolls are not levied?
  - With AC, the triangle
  - With MC, the hatched area minus the shaded area (called the deadweight loss)