Models for Applied Environmental Economics

EDCE course ENV-723

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Partial equilibrium models: basics

- market equilibrium: supply = demand (flexible prices)
  - partial = not general
    - one market or selection of markets
    - represents only part of the economic cycle
  - supply and demand functions
    - based on (usually neoclassical) microeconomics
      - theory of production (profit maximization)
      - consumer theory (preferences, utility maximization)
        -> subjective value -> willingness to pay
        -> diminishing marginal utility
      - marginalism: status quo -> one unit more or less?
      - horizontal summation over consumers/firms

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Deriving demand functions (Cobb-Douglas CRTS case)

$$U = C_1^{\beta} C_2^{1-\beta}$$ -> max s.t. $$p_1 C_1 + p_2 C_2 = \bar{I}$$

$$L = C_1^{\beta} C_2^{1-\beta} - \lambda (p_1 C_1 + p_2 C_2 - \bar{I})$$

$$\left[\frac{\partial L}{\partial C_1} = \right] \beta C_1^{\beta-1} C_2^{1-\beta} - \lambda p_1 = 0$$

$$\left[\frac{\partial L}{\partial C_2} = \right] (1-\beta) C_1^{\beta} C_2^{-\beta} - \lambda p_2 = 0$$

$$\Rightarrow -\frac{\frac{\partial U}{\partial C_1}}{\frac{\partial U}{\partial C_2}} = -\frac{p_1}{p_2}$$

$$\left[\frac{\partial L}{\partial \lambda} = \right] p_1 C_1 + p_2 C_2 - \bar{I} = 0$$

first order optimality condition:
marginal rate of substitution
= relative prices

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Deriving demand functions (Cobb-Douglas CRTS case)

Marshallian demands:

$$c_1 = \frac{\beta \, \bar{I}}{p_1} \quad ; \qquad c_2 = \frac{(1-\beta) \, \bar{I}}{p_2}$$

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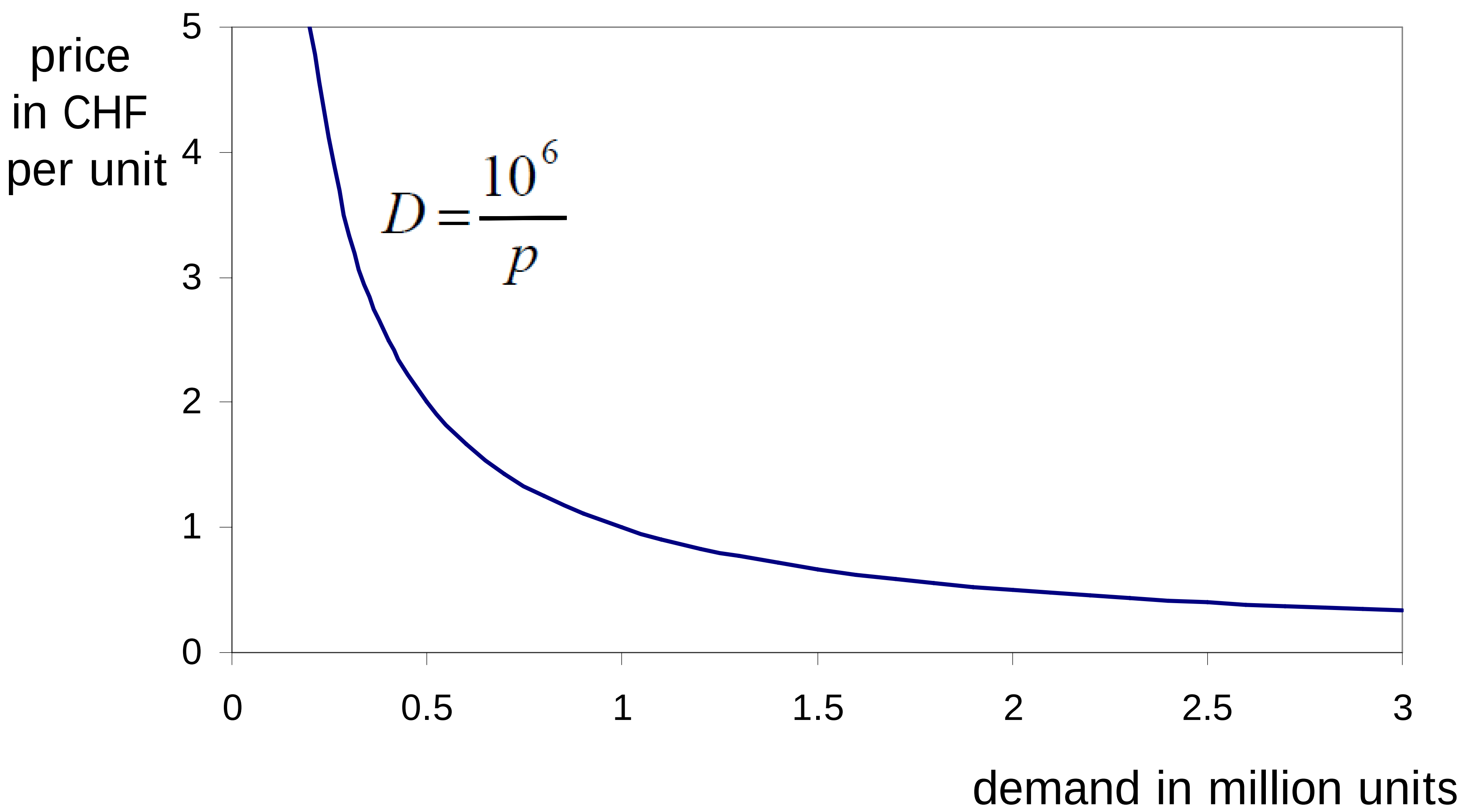
Demand functions: example



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Elasticities

- direct price elasticity: $$\varepsilon_{C_1,p_1} = \frac{p_1}{C_1}\frac{dC_1}{dp_1}$$
- cross price elasticity: $$\varepsilon_{C_1,p_2} = \frac{p_2}{C_1}\frac{dC_1}{dp_2}$$
- elasticity of substitution: $$\sigma_{1,2} = \frac{\frac{p_1}{p_2}}{\frac{x_1}{x_2}} \frac{d\left(\frac{x_1}{x_2}\right)}{d\left(\frac{p_1}{p_2}\right)}$$

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Supply functions: competitive 1st order condition

$MR = MC$ from $\max \Pi = R(x) - C(x)$

- competitive market (no influence on the price)
  - revenue: $R = px$
  - cost: $C = C(x)$
  - marginal revenue: $MR = p$
  - marginal cost: $MC = \frac{dC}{dx}$

$$\left.\begin{array}{l} MR = p \\ MC = \frac{dC}{dx} \end{array}\right\} \quad \frac{dC}{dx} = p$$

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Deriving cost functions (Cobb-Douglas CRTS case)

- Derivation of the cost function (Cobb-Douglas)

min $C = wL + rK$ s.t. $Y = L^{\alpha} K^{1-\alpha}$

=> $L = Y \cdot \left(\frac{\alpha \cdot r}{(1-\alpha) \cdot w} \right)^{1-\alpha}$ and $K = Y \cdot \left(\frac{(1-\alpha) \cdot w}{\alpha \cdot r} \right)^{\alpha}$

Insert into objective => $C = a \cdot w^{\alpha} \cdot r^{1-\alpha} \cdot Y$

with $a = \alpha^{-\alpha} \cdot (1-\alpha)^{\alpha - 1}$

- marginal cost function: $\frac{\partial C}{\partial Y} = a \cdot w^{\alpha} \cdot r^{1-\alpha}$

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Deriving cost functions (Cobb-Douglas DRTS case)

- Derivation of the cost function (Cobb-Douglas)

min $C = wL + rK$ s.t. $Y = L^{\alpha} K^{\beta}$

=> $C = (\alpha + \beta) a Y^{\frac{1}{\alpha+\beta}} w^{\frac{\alpha}{\alpha+\beta}} r^{\frac{\beta}{\alpha+\beta}}$

with $a = \alpha^{\frac{-\alpha}{\alpha+\beta}} \beta^{\frac{-\beta}{\alpha+\beta}}$

- marginal cost function: $\frac{\partial C}{\partial Y} = aY^{\frac{1-\alpha-\beta}{\alpha+\beta}} w^{\frac{\alpha}{\alpha+\beta}} r^{\frac{\beta}{\alpha+\beta}}$

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Deriving supply functions (Cobb-Douglas DRTS case)

MC=p <=> $$aY^{\frac{1-\alpha-\beta}{\alpha+\beta}} w^{\frac{\alpha}{\alpha+\beta}} r^{\frac{\beta}{\alpha+\beta}} = p$$

=> supply function:

$$Y = \left(\frac{p}{a}\right)^{\frac{\alpha+\beta}{1-\alpha-\beta}} w^{\frac{\alpha}{\alpha+\beta-1}} r^{\frac{\beta}{\alpha+\beta-1}}$$

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Partial equil. models: environmental issues

- calcultating emissions as a function of inputs or outputs
- damage functions
- environmental modules
- modelling environmental policy instruments

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Market power: monopoly

- MR=p(x)
- p(x): inverse demand function
- solving MC(x)=p(x) for x yields the supply function
- x smaller, p higher than with competition

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Partial equilibrium models: pros & cons

- feedback effects with other markets neglected
- no standard framework

- flexibility
- focused analysis
- transparency of mecha-nisms driving the results

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