ECN 275/375 Environmental and natural resource economics 3: Welfare (ch. 4, Perman *et al.*)

Learning objectives and outline

Chapter 4 (things to emphasize when reading – key aspects will be taken in class)

Part 1: Efficiency and optimality (general equilibrum setting)

- Efficiency and optimality when there are multiple products (private consumer goods) and multiple productions (in the book 2 consumers (*A* and *B*) and 2 products (*X* and *Y* produced with two inputs, labor *L* and capital *K*). This section is quite technical = grasp the essence
  - **Consumption efficiency** $MRUS^A = MRUS^B$, i.e. the **m**arginal **r**ates of **u**tility **s**ubstitution are equal for the two consumers between the consumption of *X* and *Y* (point **b** in figure 4.1 where the indiffence curves tangent each other). Remark: if this was not the case, given quantities of the two goods *X* and *Y* could be reallocated between the individuals and both would be better off (= reach higher levels of utility (absence of arbitrage in consumption)
  - **Production efficiency** $MTRS_X = MTRS_Y$, i.e., the **m**arginal **t**echnical **r**eturns of **s**ubstitution are equal for the two products *X* and *Y* (point **b** in figure 4.2) for the two inputs labor and capital. Remark: if this was not the case, one could reallocate total resource use and produce more of one good, and less of the other good) (absence of arbitrage in production
  - **Product-mix efficiency** $MRT_L = MRT_K = MRUS^A = MRUS^B$, i.e., the **m**arginal **r**ates of **t**ransformation for the two inputs labor and capital are the same, and this corresponds with the **m**arginal **r**ates of **u**tility **s**ubstitution (point **b** in figure 4.3).
- For (private) consumer goods (no distortions or externalities): Market prices provide the "bridge" between consumers and producers (in figure 4.3, the imagine a price line $-P_X/P_Y$ that is a tangent to both the production possibility set (line $X_M - Y_M$) and society's indifference curve *I* through point **b**.. Remark: for *N* goods there is an *N*-1 dimensional (separating hyperplane that captures the relative prices).
  - For a two input – two products economy: $MRT_L = MRT_K = -\frac{p_X}{p_Y} = MRUS^A = MRUS^B$ (equation 4.12, p. 116)
- Maximizing social welfare (**b** in figure 4.6) where the social welfare function $W(W^A, W^B)$ tangents the **utility possibility frontier** (combinations of the maximum attainable utility for individuals A and B)
  - All points on the **utility possibility frontier** are **Pareto-optimal** (= impossible to improve one individual's utility without making at least one other individual worse off)
  - Utility allocations in the interior of the utility possibility set (bounded by the **utility possibility frontier**) are **Pareto-inferior** (= possible to make at least one individual better off without making other individuals worse off)
  - **Pareto-improvement** (= any movement in the northeast directions from a **Pareto-inferior** allocation.

Remark: In general equilibrum (GE) all prices and quantities are endogenous

Part 2: Partial equilibrium (PE)

Relates to single markets (or parts of an economy) where all prices and quantities outside the market(s) that is (are) analyzed are kept constant.

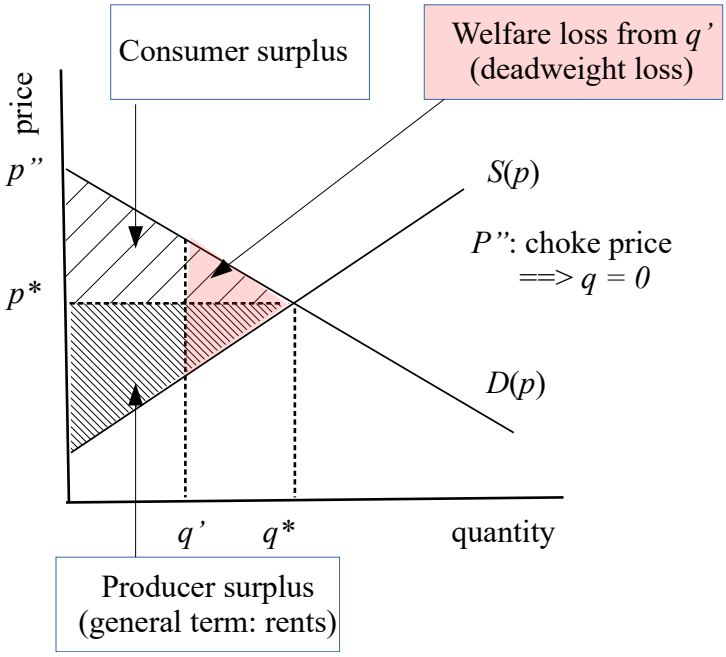
PE is useful for analyzing issues where price and quantity adjustments outside what is analyzed are minor.

If this assumption is violated, one needs to go into general equilibrium (GE) which brings with it far more complicated modeling. GE-models are therefore usually quite coarse (stylized) for all sectors. Trade-off: the error of neglecting that all prices and quantities are endogenous **vs.** loss of detail in the analysis of the sectors (believed to be) important for the analysis.

Figure 4.11 key. In conventional PE analysis, we often relate to panel **d**

Important terms in PE analysis

- market equilibrium $\{p^*, q^*\}$ = the set of prices and quantities that
  - equates supply and demand in the market: $q^* = D(p^*) = S(p^*)$
  - gives zero market welfare loss
  - welfare losses only relevant for goods and services (from which consumers derive utility)
  - welfare loss (from a market dis-equlibrium): pink shaded area
  - consumer surplus: area below demand curve and above price line
  - producer surplus: area above supply curve and below price line
  - welfare loss from the quantity restriction q' = red triangle (remark: the vertical middle triangle point is always at the true optimum, here $\{p^*, q^*\}$).



$S(p)$: horizontal summation of positively sloped parts of individual producers' marginal cost curves

$D(p)$: (for private goods) horizontal summation of individual consumers' willingness-to-pay for (marginal benefits of) a good or service (Remark: public goods = the vertical summation, fig. 4.12)

Implications:

- $MC_i(q_i^*) = MC_j(q_j^*) = p^*$ (marginal costs for all producers evaluated at their chosen production (optimum) levels, q_i^* , are equal, and equal to the optimal market price. Remark: does not hold for producers producing zero of that particular product)
- $MB_m(q_m^*) = MC_n(q_n^*) = p^*$ (marginal benefits for all consumers evaluated at their chosen consumption (optimum) levels, q_m^* , are equal, and equal to the optimal market price. Remark: does not hold for consumers consuming nothing of that particular product)

Public goods: non-rival and non-excluding in consumption (graph in class)

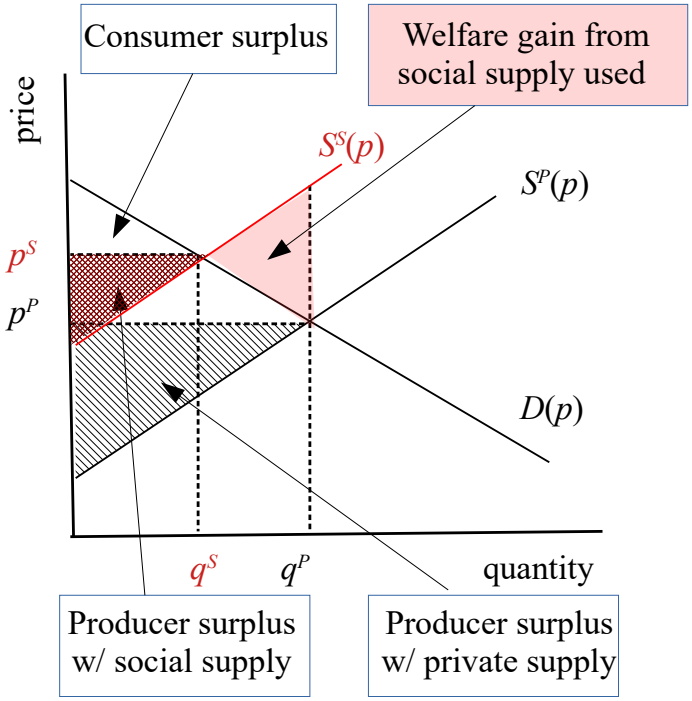
Part 3: Externalities

Externality: unintended impact on a producer's production possibility set (or a consumer's utility) from a producer's production activity or a consumer's consumption (table 4.6, p. 122 gives an overview of various classifications, full discussion section 4.10)

Externalities therefore have to be **internalized** through bargaining (the Coasian solution) or through a tax (the Pigouvian solution). Remark: A subsidy is a negative tax, and can in some cases be optimal, like when correcting for a positive externality (under a positive externality too little of the consumption or production causing the positive side effect takes place: example bees pollinating an orchard)

Market failure: market prices do not reflect consumers' marginal values (or producers' marginal costs) which cause the optimality conditions (part 1) to break apart (MRSU not equal to market price, MRT not equal to market price, or both)

Suppose that private supply, S^P, does not reflect the social costs. This gives the private equilibrium solution $\{p^P, q^P\}$, while the externality adjusted supply, S^S, does, with the socially optimal equilibrium $\{p^S, q^S\}$. The welfare gains shown by the red triangle. Note that the vertical center of the triangle (again) is at the optimal equilibrium (as in the graph on the previous page, but that the trinagle now faces left).



Suppliers or consumers will not change their behavior until some incentives are provided (like in this graph a tax on supply, changing supply from S^P to S^S). These incentives can come in various forms (like a binding non-tradeable quota (permit) on production, a tradeable permit or a tax on production or consumption.

Pigouvian taxes (subsidies) – after English economist Arthur Pigou (1920s)

- basic idea: a tax (subsidy) corrects the market price / introduces a market price if there was none, so that the externality is internalized (figure 4.14)
- negative externality → tax: makes the activity less desirable for the agent (producers or consumers) causing the externality → exit (= fewer agents undertake the undesirable activity)
- positive externality → subsidy: makes the activity more desirable for the agent causing the externality → entry (= more agents undertake the desirable activity)

Coase theorem: In the absence of transaction costs (= agents have costs identifying other affected agents or bargaining is costly), agents will negotiate away the externality provided they have the property right (figure 4.13)

Coase – implications

- Whether to assign the property rights to victims or polluters depend on what lowers transaction costs the most.
- Important for the idea of tradable emission permits or tradable catch quotas (for example in fisheries)

- Tradable permits/quotas: reduces the transaction costs as the market price for permits (quotas) becomes observable, and agents do not have to look for affected agents with whom to negotiate. Remark: requires the introduction of property rights onto areas where such rights are missing or incomplete.

Read and be aware of (for now)

Second Best (section 4.11), imperfect information (section 4.12), public choice theory – government failure (section 4.13)

Exercises

Go to the exercises section on the course web page.

Discussion topics

1. Conditions where we would expect the Coasian bargaining solution: (i) To work well. Examples. (ii) Not to work well. Examples.
2. Conditions where we would expect the Pigouvian tax (subsidy): (i) To work well. Examples. (ii) Not to work well. Examples.
3. Coase vs. Pigou: Implications for use
4. Entry-exit issues related to (environmental) regulation.