Part One

The Internalization of Externalities as a Central Theme of Environmental Policy

A. Foundations

I. Object and Methods of Microeconomic Theory

Microeconomics is the science of *scarcity* and coping with the consequences of scarcity. Scarcity arises because the *resources* available to meet human *needs* are not enough to meet all existing desires. The concept of scarcity thus does not (only) refer here to the lack of essentials, but to any divergence between desire and reality. The central concepts of "needs" and "resources" are couched very broadly in modern economics.

The concept of need goes far beyond the area commonly termed "economic" in ordinary speech – namely, food, accommodation, clothing, and transport – to embrace needs often seen as "extraeconomic," such as those for a clean environment, internal and external security, and indeed even the longing for peace and harmony in a relationship.[1]

Similarly, the concept of resources is no longer confined in modern economics literature to the traditional factors of production – (paid) labor, capital, and land. Instead, natural (exhaustible or renewable) resources, as well as such elements as human knowledge and the work ethic in a society, are now taken into account.

A world of scarcity is necessarily one of conflicts over precious (because they are needed to reduce the scarcity) resources. No society is conceivable without mechanisms and institutions to settle these conflicts. The rules whereby scarce resources can be distributed among the all-too-numerous bearers of the all-too-numerous needs are varied. One might think of applying the law of the jungle, basic democratic deciding procedures, the market mechanism, or patriarchal (or matriarchal) allocations. Most societies practice a mixture of these allocation mechanisms, with

1 Cf. Becker (1993), as well as, e.g., Coyle (2007). Gary Becker won the Economics Nobel Prize in 1992 for his contributions to the further development of economics into a general theory of human behavior.

differing strengths of components. Modern economic theory has not only concerned itself overwhelmingly with the market as an allocation mechanism, but has also dealt with the other mechanisms mentioned previously (and still others).

For the (undoubtedly small) portion of the readership who doubt the relevance of the prior observations to environmental policy, let us clarify:

> Consider the airspace above a particular region as a scarce resource with various competing claims to it: firms would like to use the air as a medium to absorb their pollutants, whereas inhabitants would like to breathe it. The allocation mechanisms mentioned previously can also be used as institutions for settling this conflict.

Under the *law of the jungle* the emitters' "aggressive" mode of utilization would win out unrestrictedly against the "defensive" use intentions of the inhabitants.[2]

In the example case, the allocation mechanism of *authoritarian allocation* would mean that emission caps would be allotted to the firms. This would implicitly set a distribution of the scarce resource between firms and inhabitants.

Solutions oriented more or less to *market allocation mechanisms* would consist of such things as negotiations among potential polluters and potential pollutees[3] or the issuing of emission permits.[4]

A *basic democracy variant* might be a plebiscite on the emission level (or establishment or closure) of the relevant firms.

In connection with the analysis of mechanisms to decide the use of scarce resources and the benefits from their use, two questions are of particular interest for economic theory:

a) Which use of the scarce resources is arrived at in an economy as a whole as the outcome of the numerous decisions by individual decision makers?

   Here the point is to find out how the framework conditions under which the individuals take their decisions (e.g., technology or the legal system) affect the allocational outcomes. We call this part of microeconomics theory "positive analysis."

b) How is the allocational outcome established (or predicted) in the previous item assessed from the viewpoint of economic theory?

   This further-reaching program of microeconomics theory is termed "normative analysis."

2 The utilization of the air as a medium for absorbing pollutants limits the possibilities of using air at a quality favorable for breathing. In contrast, breathing does not limit emission possibilities. These statements must not, of course, be confused with the claim that a right conferred on inhabitants to breathe clean air does not limit emitters' possibilities of action. However, allowing such a right would go beyond the framework of the "law of the jungle" as an allocation mechanism. Where it is claimed in the text that under this law the utilization plans of the producers of the externalities would prevail, we are ignoring the possibility that those damaged prevent the emissions by force.

3 Cf. chapter A in part two.

4 Cf. section B.III in part three.

Many economists are particularly fascinated by comparing the actual result reached by a particular allocation mechanism with a "socially optimal" result. Of course, it is necessary for this undertaking to develop a criterion of social optimality. If an analysis of the market mechanism finds that the market outcome ("equilibrium") departs from the optimum, this gives the economist occasion to ponder possible correction mechanisms.[5]

We show in detail that the existence of environmental problems (in economic terminology, "externalities") establishes a divergence between market equilibrium and optimum. The "internalization of externalities" treated in part two of this book is nothing but an attempt to make economic policy corrections to the market mechanism with the aim of bringing equilibrium and optimum together.

Of course, the demand that politics should bring about an optimum position is – in the sphere of environmental policy as in any other sphere – for various reasons too ambitious. Nonetheless, it is worthwhile to operationalize the concept of optimality and discover structural causes of market mechanism failures by comparing the market equilibrium with the optimum. Even if, in reality, the optimum will perhaps never be reached, we might still provide guidance to environmental policy, which all too often has its view of what direction to take confused (comprehensible as this may be) by the undergrowth of everyday problems.

However, we are not going to recommend uncritically the optimality concept, or that of internalization of externalities used in economics, as an ideal instrument for creating the optimum situation. Instead, we also point out the catches with these concepts. To be sure, this critical presentation should not be misinterpreted as a negative attitude by the author toward internalization strategies. The suitability of the internalization of externalities as guidance for practical environmental policy has to be measured by comparing it with the alternatives actually available. As is established in more detail, the author takes the view that the internalization strategies (and other instruments developed on the basis of economic theory) are, for all their defects, to be placed fairly low on the inadequacy scale of rival environmental policy strategies.

Perhaps one *preliminary methodological observation* might be useful for representatives of other disciplines (than economics) among readers:

> A typical feature of economists' approach to the questions discussed here (and others) is analysis by theoretical modeling. The point in economic theory is not to describe all individual cases of allocation problems occurring in the world in all their historically produced details. That would certainly be a tiresome and fruitless endeavor.[6] Instead, the point is to work out the common structure underlying various classes of individual cases (particularly regarding

5 The wording "occasion . . . mechanisms" has been deliberately couched cautiously: the fact that the market cannot bring about an optimum position does not at all mean that some other allocation mechanism would be capable of it.

6 Although, admittedly some people also find economic modeling theory tiresome and fruitless.

the incentive effects of framework conditions on decision makers). Here it is indispensable to abstract from many sorts of details of specific cases of application.[7] For example, the market for disposal work in the garbage sector certainly differs considerably from the market for bananas, and this, in turn, from the market for computer software. Nonetheless, all three areas come together under the category "market." Economic theory attempts to work out the common structure of the various markets (i.e., the "essence" of the market). For this, it develops such categories as specialization and exchange, supply and demand, efficiency and technical progress, and competition (or its absence). These play a role in all markets and can thus be used for a common understanding of the many and varied types of individual markets.

The outcome of the abstraction process discussed here is described in economic theory by "models." These are abstract cause-and-effect systems. They portray the interaction of the elements of reality considered important to the investigative object of the model in stylized form. Let us, for instance, consider as an example a model for explaining a firm's behavior. It consists of the following components:

a) Definitions (e.g., profit = revenue − costs)
b) Assumptions about the decision makers' objective (e.g., the firm aims at maximizing its profits)
c) Assumptions about the framework conditions under which the decision maker can come closer to its goal (e.g., the firm has a monopoly position)
d) Conclusions (e.g., the firm produces a quantity at which the marginal revenues are equal to the marginal costs)

The design of assumptions on which to base a model is a particularly important and difficult undertaking. On the one hand, the assumptions should be suitable for presenting the problem to be analyzed simply. After all, one of the most important tasks of the model is to reduce the high complexity of reality, which is often enough to drive the observer to despair. On the other hand, the assumptions must not be so simply conceived as to conceal "essential" aspects of the problem to be analyzed from the model's view. The construction of optimization models thus itself constitutes an optimization problem.

This optimization is not possible without a valuation by the analyst because he has to make a decision as to what aspects of the problem to be studied are in his view "essential" and what aspects can be ignored. The close connection arising here in relation to economic model building between optimization and valuation will come up again in discussing optimum emission or safety levels. Of course, the economist doing the analysis cannot in his valuation get by with "objective science" alone. Instead, he must also (regardless of his awareness of this) bring his own scientific and personal socialization into the process of model building.[8]

7 These are occasionally included in individual "case studies" applying the general theory.

8 These observations are also intended to counter the widespread view that economists are by nature heartless rationalists who (for that very reason!) should on no account be allowed any

Admittedly, the previous explanation of the "model" has come out rather abstractly – just like models themselves, by the way. This is not necessarily an advantage. We now try to make it more plain, availing ourselves of some support from the British novelist David Lodge. In his novel *Thinks* (London: Secker & Warburg, 2001), the protagonist explains what a novel is. Within the relevant passage, we replace the word "novel" with "economic model":[9] "In that sense economic models could be called thought experiments. You invent people, you put them in hypothetical situations, and decide how they will react. The 'proof' of the experiment is if their behaviour seems interesting, plausible, revealing about human nature" (Lodge, 2001, pp. 61–2).

II. The Equilibrium Concept in Microeconomic Theory

The concept of equilibrium is of considerable importance for environmental economics as applied microeconomic theory. However, its description can be kept brief because only the essentials are needed for a discussion of the topic at issue here. Further details can be followed up on in any microeconomics textbook.

Very hurried readers might be inclined to skip the discussion that appears after Figure 1. We take this inclination into account with our "lateral view." Perhaps

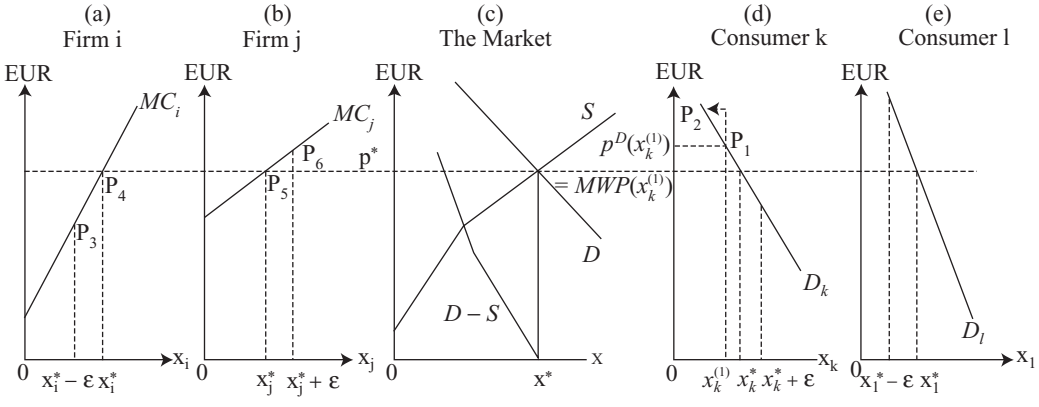

Figure 1

major influence in answering central questions on the life of human society. It is instead true that a good economist is marked by not only a sharp intellect, but also high sensitivity. Anyone regarding this as a contradiction should take heed from the fact that, in Japanese, the very same kanji sign is used for "feeling" and "intellect." (From Todd Shimoda, *The Fourth Treasure* (New York: Doubleday), 2002.)

9 The outcome of the terminological substitution process (economists love polysyllables!) can be seen: I've seen many a poorer definition of models. Here's a proposed topic for an evening fireside discussion: why do novels and economic models have common features? Where does the analogy end? The topic can then be taken up again a few weeks later for another fireside talk, when you have gotten further along in the book. Retrospective comparison of the records of the two discussions might be interesting.

the contemplation of this calligraphy will allow an intuitive (and thus extremely time-efficient) understanding of the equilibrium concept.

Lateral view 1: Well, everything in balance? *Source:* "Equilibrium," by L.J.C. Shimoda, taken from Todd Shimoda, *The Fourth Treasure* (New York: Doubleday), 2002. Reprinted with the artist's kind permission.

For a more detailed discussion of the equilibrium concept, we advise referring to Figure 1. It depicts in stylized fashion the market for any arbitrary product x of given quality.[10]

In this market, let there be perfect competition.[11] Let the supply side of the market be represented by two firms and the demand side by two households.[12] The supply and demand decisions of the actors in relation to the good x are coordinated as follows through the market.

For firms i and j, respectively, marginal costs of MC_i and MC_j, respectively, arise in producing product x.[13] It can be shown that the marginal cost curve of each firm

10 Of course, the quality is not really given, but to be determined endogenously. For reasons of simplicity, though, we do not bother setting out this aspect here. Cf., e.g., Hirshleifer/Glazer/Hirshleifer (2005).

11 The essential feature of the perfect competition market form is that no individual supplier or demander can influence the market price.

12 The restriction to two on each side is merely in order to keep the graphic portrayal as simple as possible. The generality of the statements remains unaffected thereby. Accordingly, the possible objection that the market form of perfect competition assumed here is incompatible with the assumption of such a small number of market participants is irrelevant in this context.

13 The marginal cost curves need not rise monotonically (still less linearly) with the quantity produced, as shown in Figure 1, but may take a different course (e.g., a U-shaped curve).

corresponds to that firm's individual supply curve.[14] The individual supply curves of the individual firms can be aggregated horizontally to give the supply curve, *S*, for product *x* on the market. For each of the two households, a monotonically falling individual demand curve D_k or D_l has been assumed. (To simplify the portrayal, linearity has also been assumed.) Horizontally aggregating *these* gives the demand curve, *D*, for this market.

The market equilibrium is, as we know, defined by the point of intersection of the supply and demand curves; that is, in Figure 1, an equilibrium situation arises at price p^* and quantity x^*. At the equilibrium price, firm *i* produces quantity x_i^* and firm *j* produces quantity x_j^*. For these quantities, the equilibrium condition for a firm aiming at profit maximization in the perfect competition market form, "price = marginal cost," is met.

At the equilibrium price p^*, household *k* demands quantity x_k^* and household *l* demands quantity x_l^*. The equilibrium position for a household at a given price for a product is defined by the point where the relevant household's marginal willingness to pay for the product equals the price of the product. This condition is rich in consequences for environmental economics based on microeconomics, and we accordingly explain it a little more.

The first thing important to an understanding of the household's equilibrium is that the level of the household's willingness to pay for a (marginal) additional unit of product can be read off for any original endowment of product *x* as an ordinate value on the corresponding demand curve.

We call the ordinate value on the demand curve the "demand price," p^D. Thus, for instance, the willingness of household *k*, if it already possesses quantity $x_k^{(1)}$, to pay for an additional (arbitrarily small) supply of good *x* can be read off as an ordinate value on the demand curve above $x_k^{(1)}$, namely, $p^D(x_k^{(1)})$.[15] We claim that the demand price is equal to the marginal willingness to pay (i.e., that $p^D(x_k^{(1)}) = MWP(x_k^{(1)})$ applies).

To understand this, imagine that things were otherwise, as follows.[16] Let us assume that the willingness to pay of household *k* for a marginal unit above its

Monotonically falling marginal cost curves are, of course, also conceivable, although they would go beyond the perfect competition model taken as the basis here. Cf. the passages on natural monopoly in many intermediate microeconomics textbooks, e.g., Landsburg (2002), Perloff (2007), Varian (2006), and the exhaustive presentations in Berg/Tschirhart (1988), a book still worth reading despite its relative age.

14 More exactly, the supply curve corresponds to the marginal cost curve in its rising part from the minimum of the average cost curve (not shown in Figure 1). This qualification is particularly important in the case of U-shaped marginal cost curves. For a more exact analysis in this context, the distinction between a long-term and a short-term cost curve would become important. For our discussion, however, we can ignore this distinction and content ourselves with referring to the relevant microeconomics textbooks.

15 The willingness addressed here to give money for a small additional amount of a given good is called "marginal willingness to pay."

16 The reader will already be suspecting that a "*reductio ad absurdum*" proof is coming up.

initial endowment $x_k^{(1)}$ is *below* the ordinate value on the demand curve at the abscissal value $x_k^{(1)}$ (i.e., is smaller than $p^D(x_k^{(1)})$). Then the household would not buy the last unit $x_k^{(1)}$ at a price of $p^D(x_k^{(1)})$. Otherwise, it would be paying more for the unit (namely, $p^D(x_k^{(1)})$) than it is willing to (namely, $MWP(x_k^{(1)})$). This result would contradict the assumption of a rational individual aiming at utility maximization – and it is only the behavior of such individuals that is explained by the model being presented here. The marginal willingness to pay can accordingly not be below the demand price.

Let us now assume that the household's marginal willingness to pay is *above* the demand price. If that were so, it would be inexplicable that for only a very slight rise in the price of x above the demand price $p^D(x_k^{(1)})$ associated with quantity $x_k^{(1)}$, the household responds by refraining from buying the last unit. But it *does* do so, as can be seen in Figure 1 from the movement from point P_1 to point P_2. Thus, the marginal willingness to pay cannot be *above* the demand price.

Because we have established that a household's marginal willingness to pay cannot be either below or above the demand price, we must conclude that marginal willingness to pay and demand price are one and the same thing. We can accordingly read off a household's marginal willingness to pay from the demand curve.

This discussion shows one important property of the competitive equilibrium illustrated in Figure 1: in a competitive equilibrium, the *conflict* between the two demanders k and l over good x is resolved by the institution of the market in such a way as to bring about a distribution of the total quantity x^* produced between those interested for which both individuals' marginal willingness to pay is equal to the market price. Because the market price is (in the perfect competition model assumed here) equal for all consumers, the marginal willingness to pay of both demanders is equal at equilibrium.

Much the same argument as we have given in detail for the demand side can be applied to the supply side. Here the two firms i and j are competing for factors of production needed to produce the good x.[17] Each firm has "allotted" to it through the market that quantity of inputs that enables it to produce a quantity of output for which the price is equal to their individual marginal costs. Because in the perfect competition model the price is identical for all suppliers, at equilibrium the suppliers' marginal costs are also equal to each other. At the competitive equilibrium, thus, the "equimarginal condition"[18] is met on both the demand side and the supply side.

17 For an exhaustive presentation of this conflict, an explicit inclusion of factor markets in the consideration would be needed. However, due to the analogy with what has just been said for the conflict between the households on the goods market, we leave out this discussion for space reasons.

18 Term coined by Hartwick and Olewiler (1998, p. 200).

III. The "Social Optimality" of Market Equilibrium in the Ideal-Type Economic Model

We indicated previously that microeconomics (and, thus, also its child environmental economics) is not only confined to describing, explaining, and forecasting human behavior ("positive analysis"), but also makes an attempt at evaluation ("normative analysis"). This is not, though, to be taken to mean that the economist doing the analysis is to make his own preferences as to the relative desirability of goods and social situations the criterion for his assessment. *In this sense*, the economic analysis has to be value free. The normative approach is instead concerned with taking ideas about the determinants of social welfare and the nature of linkages among them that play an important part in society itself and make them operational. A *conditio sine qua non* of this is that the social welfare criterion applied must be made explicit. Then the attempt can be made to measure allocations (and institutions) brought about by society against society's own value conceptions. It may be possible in this way to disclose discrepancies that point to policy errors or provide bases for believing that social actors are actually pursuing different objectives from the ones they claim they are.

Looked at all around, forming a normative component is essential if economics is also to be a tool for the critical analysis of social situations and political decisions. The normative approach is not some special feature of economics among the sciences. Instead, an idea of what constitutes social welfare is generally regarded as indispensable to social orientation. It is merely that public debate uses another term, namely, the "common good." There is probably no society that attempts to get by without this concept.

In contrast, anyone who has attempted to make the concept of social welfare (the common good) operational and, if possible, identify the conditions of a *social optimum* (maximum social welfare) has to admit that this project suffers from grave fundamental problems and innumerable difficulties of detail. Here we have to say, undoubtedly, that the way is the goal.[19]

We want to pursue the environmental economics concerns of this book efficiently and therefore avoid the mazes of welfare economic theory. In this pursuit, we may be helped by a simple (and perhaps for this reason very popular in the literature) convention – by social welfare, we understand the sum of the utilities of all members of society. These utilities may be positive or negative. For negative utilities, the term "cost" has become customary.

19 The problems in mind here are treated in welfare economics literature under *social welfare criteria* (Pareto criterion, Kaldor-Hicks criterion, Scitovsky criterion) and *social welfare function* (Arrow's theorem, Black's theorem). Cf. Sohmen (1976). Although this book is now as old as some of the finer malt whiskies, it nonetheless plumbs the depths of welfare economics so thoroughly that for our context it is still worth reading today. Unfortunately, only German-speaking readers will able to savor it. Newer, also fine, and even in English: Feldman/Serrano (2005).

A situation is socially optimal if it maximizes the difference between a (positive) utility and its cost aggregated over all members of society. What we mean may perhaps become (even!) clearer if we narrow the previous extremely general question about the definition of a socially optimum situation to the previous example of producing a good *x*: the socially optimum production quantity is defined by the fact that the difference between aggregate utility and aggregate production costs is a maximum.

This concept immediately raises the next (extremely uncomfortable) question: how then is utility to be measured? With the convention we are considering, as an approximation for the utility deriving for an individual from the good *x*, we take that individual's willingness to pay for a supply of the quantity of the goods considered. If we are considering the provision of an additional (marginal) unit, then correspondingly the marginal willingness to pay will serve as a proxy variable. Not all individuals will derive positive utility from the good concerned. Some are instead burdened with costs, especially (but in the environmental economics context we must add *not only*) the producers. The willingness to pay for bearing costs is negative. Negative willingness to pay corresponds to the demand to be compensated for the loss of utility incurred. If a (marginal) additional unit of the good is concerned, then we talk about the marginal compensation demand, or marginal cost.[20]

Using the conventions briefly explained here, then, the answer to the previous question is that the socially optimal production quantity of good *x* is reached when the difference between the aggregate willingness to pay for *x* and the aggregate cost of producing *x* is a maximum.

Let us now consider the market allocation with perfect competition. We first consider the consumer as "beneficiary" of the production. Because the individual demand curve of each consumer, as explained previously, reflects that consumer's marginal willingness to pay, the aggregate demand curve on the market is a graphic illustration of the "marginal utility" (in the sense of aggregate marginal willingness to pay) that the consumers derive from this product. The marginal utility expressed as the marginal willingness to pay is henceforth called "marginal benefit." The area under the demand curve thus represents the total benefit consumers derive from the good *x*.

Let us now look at the cost side of the market equilibrium and consider the producer as "upholder" of production. In the ideal model that we (initially) consider here, the producer's marginal costs reflect the properly evaluated resource consumption arising from production of an additional unit of good *x*. The supply

20 In applied welfare theory (particularly in the area of *cost–benefit analysis*), *willingness to pay* is set against *willingness to accept* (demand for compensation). The terms *compensating variation* and *equivalent variation* are also frequently used. For more details on the relation between these concepts, cf., e.g., Ebert (2008), Kolstad (2000).The distinction between willingness to accept and willingness to pay will play an important part when it comes to discussing negotiations as an internalization strategy (part two, chapter A, of this book).