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Externalities

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EXTERNALITIES

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Abstract:

This paper discusses the concept of 'externalities'. It starts with a brief discussion of market failures in the neoclassical economic framework. It then proceeds to a definition of externalities, thereby distinguishing external effects from other sorts of 'unpriced effects'. Finally, some attention is paid to the relation, and tension, between efficiency and equity impacts of externalities.

Externalities

Erik T. Verhoef

1. Introduction

External effects have been studied by economists ever since the days of Marshall and Pigou. Along with the development of the field of environmental economics, the theory of externalities has remained of great and growing importance in economic science. Indeed, it is fair to say that, starting from the traditional neoclassical economic framework, the most logical way to look at problems of environmental pollution is from the perspective of external costs (see, for instance, Baumol and Oates, 1988; Pearce and Turner, 1990; Cropper and Oates, 1992; and Tietenberg, 1994). However, although economists have been investigating the concept of externalities for a long time, both theoretically and empirically, they still prove to be an area of slippery ice. Frequently one finds fuzzy discussions on the policy implications of external costs. This may often be caused by, for instance, a mixing up of equity and allocative efficiency arguments, from mistaking pecuniary externalities for 'true' or technological externalities, or from some sense of compassion with the victims of externalities on equity grounds, leading to pleas for 'compensation' which may often be unwarranted from the perspective of allocative efficiency.

This paper aims at shedding some light on the concept of 'externalities'. It starts with a brief discussion of market failures in the neoclassical economic framework. It then proceeds to a definition of externalities, thereby distinguishing external effects from other sorts of 'unpriced effects'. Finally, some attention is paid to the relation, and tension, between efficiency and equity impacts of externalities.

2. Paretian welfare criteria and market failures

Mainstream neo-classical micro and welfare economic theories suggest that governments should in principle be reserved in directly intervening in the economic process. It is broadly accepted that economic science should aim at providing 'value free' descriptions and analyses of human choice, and the associated social processes, under conditions of scarcity. As it is not possible to construct a value free social welfare function according to some ethically objective criterion (see, for instance, Boadway and Bruce, 1984, p. 2), welfare economics has an inherent tendency to rely on quite humble welfare criteria for the evaluation of different possible outcomes of

the economic process; for instance, under different possible forms of government intervention (including, of course, non-intervention). Among these, the strict and potential Pareto criteria are without doubt the ones most often employed.' The *strict Pareto criterion* classifies a policy (change) to be socially desirable if, as a result, everyone is made better off (in its weak version), or at least if one person is better off, while no one else is made worse off (in its strong version). For most policy choices however, both losers and gainers will be involved, and the strict Pareto criterion becomes of limited use because does not provide any basis for choice between the feasible alternatives. In such cases, one usually relies on well-known *potential Pareto criteria*, or compensation criteria, as suggested by Kaldor (1939) and Hicks (1939). According to these, a change is classified desirable if the winners are able to compensate the losers such that everyone could be made better off after the change has occurred (Kaldor), or if the losers are in the initial situation unable to compensate the winners such that both groups would prefer to stay in the initial situation (Hicks). Actual compensation, however, is not required according to these principles.

The related concept of *Pareto efficiency* is defined as a feasible situation, usually in terms of the allocation of goods and production factors, for which there exists no other feasible situation that is weakly preferred to it by all agents. Therefore, if an economy attains a Pareto efficient allocation, there remain no mutually beneficial exchanges to be exploited. Unlike the strict Pareto criterion, the potential Pareto criterion will always rank any Pareto efficient allocation above any Pareto inefficient allocation (for a careful discussion, see Boadway and Bruce, 1984, p. 96-102). However, neither the strict nor the potential Pareto criterion can say anything about the relative desirability of different Pareto efficient allocations (see Atkinson and Stiglitz, 1980; and Johansson, 1991).

The economists' reservation in advocating government intervention then, is closely related to a number of basic welfare economic theorems (see Varian, 1992, ch. 17). The first of these is known as the First Theorem of Welfare Economics, stating that under certain conditions (see below), a competitive equilibrium, if it exists, is Pareto efficient. In addition, the Second Theorem of Welfare Economics asserts that essentially all Pareto efficient allocations can be supported by competitive equilibria for appropriate distributions of endowments. Next, a welfare maximum for any social welfare function that satisfies welfarism (social welfare depends only on the utility of the households) and is Paretian (it satisfies the strict Pareto criterion) is necessarily Pareto efficient. Finally, Pareto efficient allocations are welfare maxima under

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'For a comparison of these Pareto criteria with other social welfare criteria such as the mininial state, the egalitarian criterion, the Benthamite criterion and the Rawlsian criterion, see Atkinson and Stiglitz (1980, pp. 336-343).

concavity assumptions for some choice of welfare weights in a welfaristic Paretian social welfare function, Varian (1992, ch. 17) presents formal derivations of these theorems.

Consequently, as it is not possible to make a value free comparison between different Pareto efficient market outcomes, the logical step for economists is to advocate regulation only if the 'certain conditions' necessary for the free market to attain Pareto efficiency, and hence a welfare maximum given the distribution of endowments, happen not to fulfilled. The question of the desirability of the resulting distribution is then often left aside as an ethical one, beyond the domain of economists. Alternatively, the issue of equity is dealt with either in the light of the initial distribution of endowments, however artificial the bench-mark concept of lump-sum[2] distributions may be in practice, or in terms of the 'efficiency price' that has to be paid for attaining a desirable or satisfactory distribution through distortionary taxes and subsidies.

The non-fulfilment of the above mentioned 'certain conditions' for the First Theorem of Welfare Economics to apply is often referred to as 'market failure': markets fail to accomplish Pareto efficiency. The following forms of market failure are usually distinguished: (a) increasing returns to scale over the relevant range (falling marginal and average variable cost curves); (b) non price taking behaviour (market power); (c) external effects; (d) public goods; and (e) imperfect information.[3] Apart from these, two other important reasons for government intervention often mentioned are (f) distributional or equity considerations; and (g) (de-)merit good arguments. In this paper, the focus is on external effects. The next section discusses this concept in some more detail.

3. A definition of externalities

Although the concept of external effects is widely used in economics, there seems to be some confusion on its exact definition and interpretation. This justifies a short discussion of the concept itself here. It is commonly recognized that externalities are

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[2] A lump-sum tax or subsidy is defined as one which is independent of the behaviour of the affected agent. It therefore induces no substitution effect. As it usually will have an income effect, it is not correct to claim that it has no effect on behaviour (Atkinson and Stiglitz, 1980, p. 28).

'A somewhat different terminology may be encountered in the literature, where one speaks of 'externalities' to indicate what is called 'market failures' above. Bator (1958), for instance, uses 'technical externalities' to indicate 'scale economies'; 'public good externalities' to indicate 'public goods'; and 'ownership externalities' to indicate 'externalities' as used in this chapter. The latter only refer to 'technological externalities', as opposed to 'pecuniary externalities' (see the discussion in the main text). Conversely, the term 'market failure' is sometimes reserved solely to indicate a market's non-existence (its 'failure to exist'), which is the fundamental reason for technological externalities to occur.

an important form of market failure. Their existence leads to a deviation from the first-best neo-classical world, in which the price mechanism takes care of an efficient resource allocation (Pareto efficiency). In the presence of externalities, market prices do not reflect full social costs (or benefits), and, for instance, regulatory taxes (or subsidies) are called for to restore the efficient workings of the market mechanism. Furthermore, it is generally accepted that the source of externalities is typically to be found in the absence of well-defined property rights (see Baumol and Oates, 1988, p. 26). Consequently, the theory of externalities is often applied in environmental economics: environmental quality is a typical 'good' for which property rights are not defined and hence no market exists.

These commonplaces may clearly indicate the causes and consequences of external effects, but still leave the definition unclear. Such a definition can be as follows: *an external effect exists when an actor's (the receptor's) utility (or production) function contains a real variable whose actual value depends on the behaviour of another actor (the supplier), who does not take this effect of his behaviour into account in his decision making process.* This definition is in line with, for instance, Mishan (1971). In the terminology of Viner (193 1) and Scitovsky (1954), the above definition concerns 'technological' externalities, as opposed to 'pecuniary externalities'. [4] These latter, which are ruled out by considering real variables only (that is, excluding monetary variables), do not lead to shifts of production and utility functions, but merely to movements along these functions (see also the discussion of Figure 1 below). Consequently, externalities as defined above are, in the terminology of Buchanan and Stubblebine (1962), potentially 'Pareto-relevant' (if the costs of correcting for the market failure do not exceed the welfare gains to be obtained), whereas pecuniary externalities are not, because they do not reflect a failing market (see also Mishan, 1971). The final condition in the definition distinguishes externalities from other types of unpriced interactions, such as barter, violence, jealousy, altruism or goodwill-promoting activities (for instance, handing out samples of products as part of a commercial campaign). Such phenomena differ fundamentally from external effects, both in a theoretical and in a policy-relevance sense. According to Mishan (1971), "the essential feature of an external effect [is] that the effect produced is not a deliberate creation but an unintended or incidental by-product of some otherwise legitimate activity" (p. 2).

The unresolved tension between the receptor, who has no direct control over the size of the effect at its source, and the supplier, who has no *a priori* interest in the magnitude of the externality, can only persist provided there is no market on which

[4] Note that Bator's 'technical externalities' (footnote 3) are completely different from Viner's and Scitovsky's 'technological externalities'.

the externality is traded. This stems from a lack of well defined property rights concerning the externality, which is in turn often related to prohibitive high transaction costs. As pointed out by Coase (1960), in the absence of transaction costs, both the supplier and the receptor of the externality can benefit from negotiations on the size of the externality. 'Corrective' Pigouvian taxation would in that case only distort the resulting Pareto efficient outcome, as pointed out by Turvey (1963).

Within the above defined class of technological externalities, various further distinctions can be made. One of these is between *depletable* and *undepletable* externalities, where in the latter case, the consumption of the externality by the one receptor does not affect the consumption by other receptors. Therefore, an undepletable externality in fact exhibits two types of market failure at the same time: the external effect itself, and a public good (or bad) character. After an interesting discussion in the literature, the consensus now is that this distinction does not imply different pricing rules for each type of externality (Freeman, 1984; Bird, 1987; Peskin, 1988; Bird, 1988; Oates, 1988). Nevertheless, it has been shown elsewhere (Verhoef, 1994) that the Coasian solution to externality optimization may easily fail for undepletable externalities due to strategic behaviour and free riding (which is intuitively easy to understand for those who are familiar with the theory of voluntary private provision of public goods; see for instance Bergstrom, Blume and Varian, 1986).[5] Another specific type of technological externality that is sometimes distinguished concerns congestion externalities, where each actor is at the same time both supplier and receptor of the effect. Probably the most important form of this type of externality is road traffic congestion. This topic is studied in great depth by transport economists; for a literature review, see for instance Verhoef (1996). It is in this respect an interesting detail that economists like Pigou (1920, p. 194) and Knight (1924) used the example of a congested highway as an illustration of the points they had to make on externality regulation.

The question of whether unpriced external relations are either external effects or other types of unpriced external relations involves important policy consequences. This is illustrated in a partial equilibrium setting in Figure 1 for a certain activity Q. The standard case in Figure la shows the optimal workings of the market mechanism in absence of external effects. In this case, no government intervention is called for: market forces secure social welfare maximization (the bold triangle) at the market equilibrium Q^0, where marginal private cost (MPC) equals marginal private benefits (MPB). The algebraic sum of total benefits (the area under the MPB curve) minus

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'Another relevant sort of market failure that has been studied in joint occurrence with externalities concerns monopolistic market power (see, for instance, Buchanan, 1969; Bamett, 1980; Oates and Strassmann, 1984; and Carraro (1997).

total (variable) cost (the area under the MPC curve) is therefore maximized. MPB and MPC can be interpreted as the benefits and costs as experienced by one actor. They can also be thought of as demand and supply curves for a marketed good, in which case P^0 is the market clearing (efficient) price.

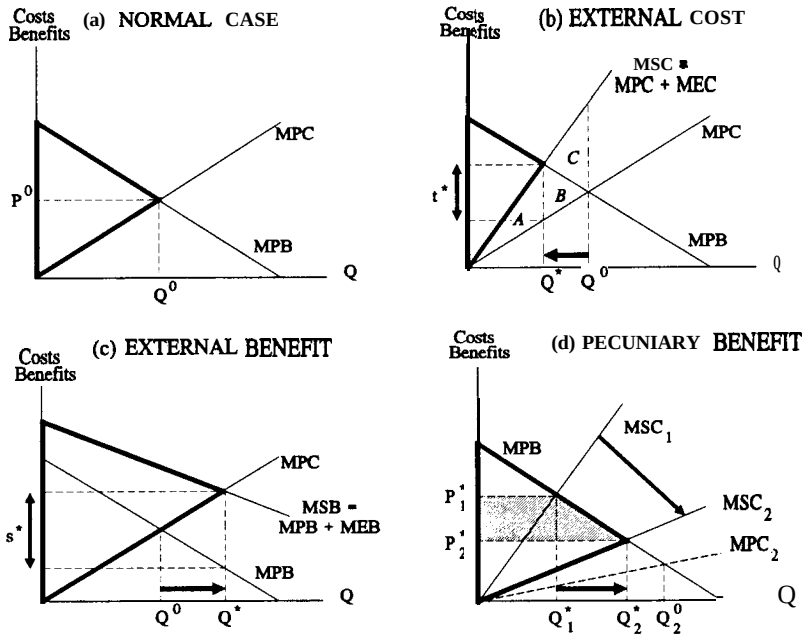

Figure 1. Graphical representation of external costs, external benefits and pecuniary benefits

The existence of (marginal) external costs (MEC) in Figure lb drives a wedge between marginal social cost (MSC) and marginal private cost (the fact that both MPC and MEC are equal to 0 at Q=O and rising afterwards is an arbitrary choice, and does in principle not affect the generality of the discussion)[6]. The market outcome Q^0, where private welfare is maximized, is not optimal from a social point of view. The resulting level of the external cost $(A+B+C)$ is excessively large. Social welfare maximization requires the activity to be restricted to a level of Q', where the marginal social cost is equal to the marginal benefits and the dead-weight welfare loss C is avoided. This optimum can for instance be accomplished by means of a quantitative

[6]Although it is fair to acknowledge that in case of a non-convex external cost function, things may become a lot more complicated; see for instance Burrows (1995).

restriction (Q') or a Pigouvian tax (t^*) on the activity.[7] The triangle A gives the optimal level of the external cost. The bold triangle again represents maximum social welfare.

Two points are perhaps worth stressing here. First, it is now easy to see that, in order to be able to speak of the optimal level of an externality, it is convenient to adapt the potential Pareto criterion for welfare evaluation. According to the strict Pareto criterion, the move from Q^0 to Q^* is a welfare improvement only if accompanied by an appropriate (lump sum) compensation to the supplier of the externality. Secondly, the optimization of an externality does clearly not mean its minimization (or maximization).

Figure 1c shows the reverse case, where (marginal) external benefits (MEB) exist. Marginal social benefits (MSB) now exceed the marginal private benefits. In this case, social welfare maximization requires encouragement of the activity up to Q^*, for instance by means of Pigouvian subsidization (s^*).

Finally, Figure 1d illustrates the case of pecuniary benefits. Figure 1 b serves as a starting point, assuming that the activity gives rise to external costs. Suppose the private cost curve shifts downwards, perhaps due to another producer leaving the region, causing labour costs to fall. Assuming unaltered external costs, MSC will fall as well. A new social optimum Q_2^*, with a higher social welfare arises: the bold triangle is increased in comparison with Figure lb. Moreover, if Q is a traded good and MPB reflects market demand, the consumer surplus increases by the shaded area. This results from the lower market price P_2^* and the larger quantity sold Q_2^*. This benefit, however, is not external but pecuniary: it results from a movement along – not a shift in – the MPB curve. The pecuniary benefits do not 'compensate' for the external costs: social welfare maximization still requires a restriction from the new unregulated market outcome Q_2^0 to the new social optimum Q_2^*. For the move from the old to the new social optimum (from Q_1^* to Q_2^*) itself, however – given the use of optimal Pigouvian taxes in both the old and the new situation – market forces can be relied upon, and there is no reason for stimulating the activity, unlike in case of external benefits. Consequently, the question of whether unpriced costs and benefits of a certain activity are either external or pecuniary in nature is crucial from a policy point of view.

'The present equivalence between a regulatory tax and a non-economic instrument such as a quantitative restriction is of course due to the extreme simplicity of the current setting. For instance, under uncertainty, this equivalence no longer holds (see Weitzman, 1974; and Adar and Griffin, 1976), nor does it when heterogeneity among the generators of externalities exists. However, in this rather brief contribution, I will not focus too much on the efficiency in the regulation of externalities; Baumol and Oates (1988), Cropper and Oates (1992), and Tietenberg (1994) offer excellent analyses and reviews of this literature (see also Helfand, 1997; and Russell and Powell, 1997).

As already mentioned in footnote 7, this paper will not discuss the efficiency of various forms of the regulation of externalities in great detail. One more general point concerning the policy implications of externalities, however, deserves some attention. This concerns the distinction between the optimization, the compensation, the internalization and the regulation of an externality. These concepts are often used in a rather loose way, whereas a more careful consideration reveals that they are certainly neither identical nor interchangeable. The *optimization* of an external effect can be defined as follows: an externality is optimized when its level is consistent with optimal resource allocation according to the potential Pareto criterion (see above). The *compensation* of an external effect can be defined as follows: an externality is compensated when a (financial) transaction takes place between the supplier and the receptor of the effect, which compensates for the receptor's welfare effects due to the externality. The compensation of an externality does not necessarily imply its optimization, because it may induce inefficient behaviour of the victim(s) of the effect (see also the next section). Next, the *internalization* of an external effect involves the removal of its external character, making it 'internal to the economic process' (Mishan, 197 1, p. 3): an externality is internalized if a market for the effect comes into being.* Internalization typically involves either the creation of a market on which the externality is traded, or a gathering of interest, such as a merger in case of a producer-producer externality, the standard example being water pollution by an upstream firm damaging the product of a downstream firm. The former requires the assignment of property rights, after which 'Coasian negotiations' between the supplier and the receptor of the effect will lead to the social optimum – at least in theory (Coase, 1960). Should such negotiations lead to compensation of the effect, in particular when the receptor of an external cost obtains the property right, then compensation need not be at odds with optimization (this is probably what Pearce and Turner (1990, p. 61) have in mind when stating that a necessary condition for an external cost to prevail is that the loss in welfare be uncompensated). Finally, the term *regulation can* be used for direct government intervention regarding the externality, by means of, for instance, price instruments, command and control measures, tradeable permits, or any other means.

4. Efficiency and equity impacts of externalities

Externalities comprise both efficiency and equity aspects. The first refer to the fact that, in the presence of externalities, the competitive market outcome is not Pareto efficient. The second relate to the fact that the receptors of a negative (positive)

[8] Pigouvian taxation is often referred to as 'intemalization' of an externality. However, such market-conform regulation actually does not satisfy this definition of intemalization.

externality are clearly worse (better) off at any non-zero level of the effect, unless compensation takes place. Unfortunately, there is no straightforward one-to-one mapping between the two goals of efficient allocation and 'equitable distribution', however defined. One can therefore arrive at rather different policy recommendations on the regulation of externalities, depending on the viewpoint taken.

First of all, let us consider the welfare of the receptors of an external cost. It seems reasonable that, from an equity point of view, Pigouvian tax revenues should be used to compensate the receptors of the external cost for the remaining optimal level of the externality. However, this turns out to be problematic as soon as the receptor of an externality is able to protect him- or herself by means of defensive measures (such as double glazing in case of noise annoyance, or relocation in case of localized externalities). In Verhoef (1994), this problem is investigated in several settings, and a main conclusion is that it is in general not in line with overall efficient allocation to compensate receptors for the external cost suffered, nor for any defensive measures undertaken. In some cases, in particular in case of a localized undepletable externality, efficient allocation even requires taxation of receptors in order to secure the optimal number of receptors of an external cost. Compensation would discourage receptors of external costs from undertaking the optimal level of defensive measures. Hence, for the optimal efficient allocation, one might end up in a situation which is not very attractive from the equity point of view, namely where receptors of an external cost not only remain uncompensated for the externality they suffer, but should also be (financially) responsible for their own defensive measures (see also Shibata and Winrich, 1983; and Oates, 1983). A trade-off between efficiency and equity considerations is therefore unavoidable in such cases.

Related to this issue, and unattractive from an equity point of view, is the requirement that the valuation of external costs should be based on the receptors' willingness to pay for their avoidance, or their willingness to accept their existence.[9] It is not difficult to show that this value, apart from being directly related to the marginal disutility of the effect itself, is inversely related to the marginal utility of income (for a formal derivation see Verhoef, 1994). This means that, other things being equal, the same exposure to a negative external effect implies a higher external cost for higher income receptors. The inequitable implications of this property are evident: an externality generating activity should then, from the efficiency point of view, be located near low income rather than near high income receptors. This is closely related to the issue of 'environmental dumping'; see, for instance, Harrison (1994).

[9] In theory, these two measures should be equal at the margin. Empirical research with contingent valuation methods, however, suggests otherwise (see Mitchell and Carson, 1989, pp. 30-38).

Focusing on the generators of externalities there is often a further tension between allocative efficiency, and what seems to be just from the equity point of view. For instance, consider the ***Polluter Pays Principle.*** Taking Figure lb as an example, optimal Pigouvian taxation implies a total tax sum $Q^* \cdot t^*$, which is in the sketched case twice as large as the optimal level of the external cost (area A). Hence, the question of whether the polluter should pay the total external cost, or whether marginal tax rules should be used, may often lead to different outcomes in terms of both allocative efficiency and equity – unless of course marginal external costs are constant and therefore equal to average external costs. This ambiguity in the interpretation of the Polluter Pays Principle, unfortunately, is often overlooked.

Also relevant for the generators of externalities is the fact that people may often be opposed to price measures in the regulation of congestion type of externalities for equity reasons. For road transport, the typical statement is: "Why should we (the road users) pay for something that only harms ourselves (congestion)?". Although it is not difficult to see that the appropriate level of aggregation at which to study optimal Pigouvian taxes is the individual (not the sector), such statements are nevertheless persistent in policy debates due to their intuitively convincing appeal to feelings of 'fairness'. Other important issues related to the public acceptance of congestion charges include its regressive incidence, the fact that most road users will be net losers if the tax revenues are not redistributed, and the allocation of the tax revenues generated (see Verhoef, Nijkamp and Rietveld, 1997).

Given such tensions between efficiency and equity considerations, it is no surprise that the mixing up of equity and allocative efficiency arguments may often lead to rather fuzzy discussions about the policy implications of research findings on external costs. Table 1 gives an overview of the most important characteristics and implications of taking these two perspectives for the case of road transport, demonstrating the absence of a direct mapping between the two, and hence identifying some sources of confusion in the above mentioned discussions (see Verhoef, 1996, for a further discussion of this table).

Also in the practice of policy making, equity considerations are often at least as important as the expected efficiency of various possible instruments. This is narrowly related to the problem of the social and political feasibility of regulation. Figure 2, more or less repeating Figure lb, can be used to illustrate the basic issue. A certain actor, 'the producer', performs an activity Q, from which he enjoys net private benefits (private benefits minus private costs). However, he causes an external cost – say, pollution – to another actor: 'the victim'. The curves represent the marginal net private benefits (MNPB = MPB-MPC) and marginal external cost (MEC) of production. Without government intervention, a production level of Q^0 prevails, whereas the social optimum is again given by Q^*.

	Allocative efficiency perspective	Equity perspective ('unpaid bill')
Goal of the analysis	Assessment of 'optimal road mobility' and optimal regulatory taxes	Assessment of the total costs shifted to society at large
Relevant external cost measure	Marginal external cost	Total external cost *plus* induced defensive outlays
Apt level of aggregation	Individual	Sectoral
Relevant external cost categories	Intra-sectoral and inter-sectoral external costs	Inter-sectoral external costs
Relevance of some existing financial transfers:		
Defensive outlays by receptors	Should not be accounted for in optimal taxes	Should be added to 'unpaid bill'
Insurance premiums	Very limited relevance[a]	Limited relevance[b]
Car ownership taxes	Very limited relevance[a]	Relevant[c]
Indirect taxes on fuel	Potential relevance[d]	Potential relevance[e]

[a] These transfers are usually fixed yearly payments, (largely) independent of total kilometres driven. Hence, they have no direct impact on road usage.

[b] A certain share of accident costs (including fatalities) are intra-sectoral, and hence should not play a role in the 'unpaid bill' analysis. Neither should therefore a certain share of the insurance premiums. Moreover, from the perspective of the 'unpaid bill', the relevant question is whether the payments from the insurance companies to society are enough to cover the costs posed on the rest of the society.

[c] These taxes are a relevant coverage for part of the 'unpaid bill' only if they exceed government outlays on infrastructure (depreciation, maintenance, management, police, etc.).

[d] For Pigouvian taxation using fuel taxes, the tax rate on fuel needs to exceed those of indirect taxes on other goods (forgetting here about the 'optimal taxation' argument for the sake of simplicity; see for instance Sandmo, 1976).

[e] Also here, only any indirect taxes above average rates can be considered as relevant transfers from road users to society, compensating for part of the unpaid bill.

Table 1. Characteristics and implications of the allocative efficiency versus the equity perspective for studying external costs of road transport

In the literature, certain 'standard' schemes can be found which yield this social optimum. Three categories of such schemes are considered below. First, two forms of regulation are distinguished: quantitative restrictions [10] and Pigouvian taxation. The second scheme is direct compensation from the producer to the victim. Finally, two forms of internalization are considered: a gathering of interest through a merger of the victim and the producer, which will often be impossible for very practical reasons; and the assignment of property rights concerning the externality, either to the producer or

[10] Tradeable permits are not considered because the model contains only one producer.

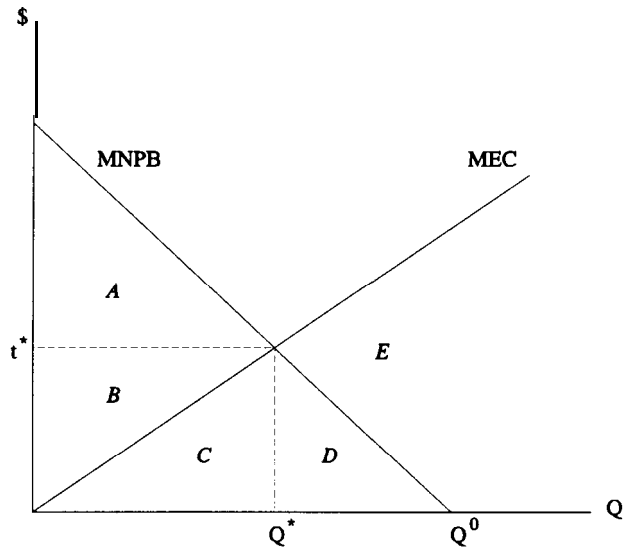

Figure 2. Efficiency and equity implications of an external cost

to the victim, which is assumed to result in Coasian negotiations.

Table 2 shows the distributional impacts of these schemes. Although in this simple setting each of them yields the efficient outcome, that is the maximum social welfare of $A+B$, they have different distributional implications. Most of the values in Table 2 can easily be verified with reference to Figure 2. However, Coasian negotiations deserve some closer attention. Here, the distributional implications depend on the distribution of property rights as well as on individual bargaining skills. The former determines the direction of the financial transfer; the latter determine its size. For both distributions of property rights, transfers between the extremes in Table 2 may occur. These boundary values follow from the fact that the MNPB gives the producer's minimum willingness to accept (maximum willingness to pay) for decreases (increases) in production, whereas MEC represents the victim's minimum willingness to accept (maximum willingness to pay) for increases (decreases) in the production level. [11] Note that, when the property right is assigned to the producer, the associated financial transfer has the direction opposite to compensation of the external cost. Full compensation takes place when the property right is assigned to the victim, while the producer is the extreme best bargainer. As a matter of fact, direct compensation can be seen as a restricted case of Coasian negotiations. The property right is implicitly

"The maximum transfer from the victim to the producer $(D+E)$ mentioned assumes that the producer is truthful. If he pretends considering a production level above Q^0, the victim is willing to pay more than $D+E$ in order to secure Q^*. The victim does not have a comparable possibility of 'cheating'.

assigned to the victim, but he is not allowed to bargain over the size of the compensation.

	Producer	Victim	Regu-lator	Social
NON-INTERVENTION	$A+B+C+D$	$-C-D-E$	0	$A+B-E$
REGULATION:				
Quantitative restriction (Q')	$A+B+C$	$-c$	0	$A+B$
Pigouvian tax (t')'	$A+B+C-[B+C]=A$	$-c$	$[B+C]$	$A+B$
DIRECT COMPENSATION	$A+B+C-(C)=A+B$	$-C+(C)=0$	0	$A+B$
INTERNALIZATION:				
Gathering of interest	$A+B$		0	$A+B$
Coasian negotiations [2a]	$A+B+C+(D+E)$	$-C-(D+E)$	0	$A+B$
Coasian negotiations [2b]	$A+B+C+(D)$	$-C-(D)$	0	$A+B$
Coasian negotiations [3a]	$A+B+C-(C)=A+B$	$-C+(C)=0$	0	$A+B$
Coasian negotiations [3b]	$A+B+C-(A+B+C)=0$	$-C+(A+B+C)=A+B$	0	$A+B$

Terms between normal brackets indicate financial transfers between the producer and the victim, and between square brackets between the producer and the regulator.

[1] It is assumed that the producer and the victim do not consider the allocation of Pigouvian tax revenues.
[2a] Property right lies with the producer; the producer is the extreme best bargainer.
[2b] Property right lies with the producer; the victim is the extreme best bargainer.
[3a] Property right lies with the victim; the producer is the extreme best bargainer.
[3b] Property right lies with the victim; the victim is the extreme best bargainer.

Table 2. The individual welfare positions associated with different schemes for optimizing externalities in a basic model

Table 2 indicates that the actors have different rankings of the different schemes. The producer prefers Coasian negotiations with the property rights assigned to himself. He may then realize a welfare level above the level he enjoys with unrestricted production. His second favourite is non-intervention. Next comes a quantitative restriction, followed by direct compensation and finally either Coasian negotiations with the property right assigned to the victim, or Pigouvian taxation, depending on the distribution of bargaining skills (the above ranking of compensation, Coasian negotiations with the property right assigned to the victim and Pigouvian taxation in addition depends on the assumption of rising marginal external cost). The victim prefers receiving the property rights and the associated Coasian negotiations. Next comes direct compensation, followed by any form of regulation. Then comes Coasian negotiations with the property rights assigned to the producer and finally non-

intervention. The 'gathering of interest' possibility can for obvious reasons not be qualified along this criterion.

Of course, the above analysis is rather simplistic because it only considers one single producer of the externality and one single victim (who, in addition, is not able to defend himself). These assumptions are relaxed in Verhoef (1994). Nevertheless, these rankings may to some extent explain why some policies are used more often than others. For example, considering regulation, the producer prefers a quantitative restriction to Pigouvian taxation, whereas the victim is indifferent, assuming he does not consider the possible allocation of the tax revenues. A vote-maximizing government may therefore prefer to use command-and-control measures rather than economic instruments, which seems to be confirmed by practical evidence [12] (see also Pearce and Turner, 1990, pp. 96-8).

5. Conclusion

This paper provided a discussion of externalities, which is a key concept in (neo-classical) environmental economics. However, although externalities have been studied by economists for a long time already, they still prove to be an area of slippery ice. A number of potential sources of confusion and ambiguity were addressed above. These include the definition of externalities, where it is very important to distinguish between externalities and other unpriced effects. Another source of ambiguity lies in the tension between efficiency and equity impacts of externalities and their regulation. In this respect, the role of receptors of an external cost, the ambiguity of the Polluter Pays Principle, and the distributional impacts of regulation in relation to the social feasibility were discussed. Depending on the viewpoint taken (that is, efficiency ***versus*** equity or fairness), one may often arrive at diverging policy recommendations. The aim of the above discussion was not to solve these questions, but merely to identify them, which in itself could be a first step towards a more careful treatment of externalities in scientific and policy debates.

[12] Other possible reasons for preferring either price or quantity measures have been put forward. Weitzman (1974), in his seminal paper, focuses on the relative efficiency of both types of regulation under uncertainty (see also Baumol and Oates, 1988). A bit closer to equity arguments as considered here, Buchanan and Tullock (1975) argue in another classic paper that quantity measures are preferred by producers since these can act as a barrier to entry and may therefore leave them with higher profits.

References

Adar, Z. and J.M. Griffin (1976) "Uncertainty and the choice of pollution control instruments" *Journal of Environmental Economics and Management 3 (3)* 178- 188.

Atkinson, A.B. and J.E. Stiglitz (1980) *Lectures on Public Economics.* McGraw-Hill, London.

Bamett, A.H. (1980) "The Pigovian tax rule under monopoly" *American Economic Review 70* 1037-1041.

Bator, F.M. (1958) "The anatomy of market failure" *Quarterly Journal of Economics 72 35* 1-379.

Baumol, W.J. and W.E. Oates (1988) *The Theory of Environmental Policy* (2nd ed.). Cambridge University Press, Cambridge.

Bergstrom, T., L. Blume and H. Varian (1986) "On the private provision of public goods" *Journal of Public Economics 29 25-49.*

Bird, P.J.W.N. (1987) "The transferability and depletability of externalities" *Journal of Environmental Economics and Management 14 54-57.*

Bird, P.J.W.N. (1988) "One more externality article: reply" *Journal of Environmental Economics and Management* **15 382-383.**

Boadway, R.W. and *N.* Bruce (1984) *Welfare Economics.* Blackwell, Oxford.

Buchanan, J.M. and W.C. Stubblebine (1962) "Externality" *Economica 29* 371-384.

Buchanan, J.M. (1969) "External diseconomies, corrective taxes and market structure" *American Economic Review 59* 174-l 77.

Buchanan, J.M. and G. Tullock (1975) "Polluters' profits and political response: direct controls versus taxes" *American Economic Review 65* 139-147.

Burrows, P. (1995) "Nonconvexities and the theory of external costs". In: D.W. Bromley (ed.) (1995). *The Handbook of Environmental Economics* Blackwell, Oxford, 243-27 1.

Carraro, C. (1997) "Imperfect markets and environmental policy instruments". In: J.C.J.M. van den Bergh (ed.) (1997) *Handbook of Environmental and Resource Economics.* Edward Elgar, Aldershot.

Coase, R.H. (1960) "The problem of social cost" *Journal of Law and Economics 3* (Oct.) l-44.

Cropper, M.L. and W.E. Oates (1992) "Environmental economics: a survey" *Journal of Economic Literature 30 675-740.*

Freeman, A.M. (1984) "Depletable externalities and Pigovian taxation" *Journal of Environmental Economics and Management 8 321-329.*

Harrison, G.W. (1994) "Environmentally sensitive industries and an emerging Mexico" *North American Journal of Economics and Finance 4* (1) 109-126.

Helfand, G.E. (1997) "Standards versus taxes in pollution control". In: J.C.J.M. van den Bergh (ed.) (1997) *Handbook of Environmental and Resource Economics.* Edward Elgar, Aldershot.

Hicks, J.R. (1939) "The foundation of welfare economics" *Economic Journal 49* 696-712.

Johansson, P.-O. (1991) *An Introduction to Modern Welfare Economics.* Cambridge University Press, Cambridge.

Kaldor, N. (1939) "Welfare propositions of economics and interpersonal comparisons of utility" *Economic Journal 49 549-552.*

Knight, F.H. (1924) "Some fallacies in the interpretation of social cost" *Quarterly Journal of Economics 38 582-606.*

Mishan, E.J. (1971) "The postwar literature on externalities: an interpretative essay" *Journal of Economic Literature 9* l-28.

Mitchell, R.C. and R.T. Carson (1989) *Using Surveys to Value Public Goods: The Contingent Valuation Method.* Resources for the Future, Washington.

Oates, W.E. (1983) "The regulation of externalities: efficient behaviour by sources and victims" *Public Finance 38 362-375.*

Oates, W.E. (1988) "And one more reply" *Journal of Environmental Economics and Management* **15** *384-385.*

Oates, W.E. and D.L. Strassmann (1984) "Effluent fees and market structure" *Journal of Public Economics 24 29-46.*

Pearce, D. W. and R.K. Turner (1990) *Economics of Natural Resources and the Environment.* Johns Hopkins University Press, Baltimore.

Peskin, H.M. (1988) "One more externality article" *Journal of Environmental Economics and Management* **15 3 80-3 8** 1.

Pigou, A.C. (1920) *Wealth and Welfare.* Macmillan, London.

Russell, C.S. and P.T. Powell (1997) "Practical considerations and comparison of instruments of environmental policy". In: J.C.J.M. van den Bergh (ed.) (1997) *Handbook of Environmental and Resource Economics.* Edward Elgar, Aldershot.

Sandmo, A. (1976) "Optimal taxation: an introduction to the literature" *Journal of Public Economics 6 37-54.*

Scitovsky, T. (1954) "Two concepts of external economies" *Journal of Political Economy* **17** 143-151.

Shibata, H. and J.S. Winrich (1983) "Control of pollution when the offended defend themselves" *Economica* **50** *425-437.*

Tietenberg, T.H. (1994) *Environmental Economics and Policy.* HarperCollins College Publishers, New York.

Turvey, R. (1963) "On divergences between social cost and private cost" *Economica 30 309-*313.

Varian, H. R. (1992) *Microeconomic Analysis,* third edition. Norton, New York.

Verhoef, E.T. (1994) "Efficiency and equity in externalities: a partial equilibrium analysis" *Environment and Planning* **26A 361-382.**

Verhoef, E.T. *(1996) The Regulation of Road Transport.* Edward Elgar, Aldershot.

Verhoef, E.T., P. Nijkamp and P. Rietveld (1997) "The social feasibility of road pricing: a case study for the Randstad area" *Journal of Transport Economics and Policy* forthcoming.

Viner, J. (193 1) "Cost curves and supply curves" *Zeitschrift für Nationalökonomie 3 23-46.*

Weitzman, M.L. (1974) "Prices vs. quantities" *Review of Economic Studies* **41 477-491.**