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Notes on Market Failure and the Paretian (Kaldor-Hicks)
Relevance and Irrelevance of Unfavourable Externalities

1. Preamble

The following are notes that have been distributed by me over the last few years to students in Environmental Economics at The University of Queensland. They give particular attention to whether externalities are Pareto or Kaldor-Hicks relevant from a policy point of view.

Externalities are Kaldor-Hicks or Pareto irrelevant if no change is possible for which gainers could compensate losers. Both absolute and marginal externalities may be Kaldor-Hicks relevant. Infra-marginal negative externalities are often, but not always, Kaldor-Hicks irrelevant. There are at least two cases where such externalities can be relevant. First, the absolute impact of the negative externality may be so great that the source of the externality should be eliminated. Secondly, if the externality arises from production, its nature may depend on the type of production technique adopted. Although for the technique adopted, an infra-marginal negative externality occurs. That is Paretian irrelevant given that choice of this technique is the only available possibility, alternative techniques may actually be available in practice. Some of these may generate even smaller total external effects and be socially preferable. Both cases are outlined and illustrated in these notes.

The analysis reveals the dangers of relying on marginalism for deciding on environmental policy. Total (external) effects are often of great social and economic importance and appropriate social choices cannot be made on the basis of marginalism alone.

Notes on Market Failure and the Paretian (Kaldor-Hicks)
Relevance and Irrelevance of Unfavourable Externalities

2. Introduction

- Under ideal purely competitive conditions, markets result in a Paretian optimum or economic efficiency in satisfying wants. The simplest way to illustrate this is by market demand and supply analysis.

- In the absence of externalities, traditional economic analysis indicates that a social 'optimum' does not occur unless the industry operates at its equilibrium level, which is assumed to be the normal situation under purely competitive conditions. The supply curve represents the additional cost of extra supply whereas the demand curve represents the extra value placed on production. At the equilibrium the extra value (marginal value) of additional production equals the extra cost (marginal value) of extra production and a social optimum occurs.

- This is, however, based upon the assumption that no externalities occur. In the present context, this assumes that no environmental spillovers or externalities occur. If they do, the private marginal cost of production may diverge from social marginal cost and lead to a deadweight social loss. (Similarly, it is possible for the social value of consumption to demand to diverge from the private value). In such a case, a purely competitive market will not achieve a social optimum.

- The above can be illustrated by Figure 1. In Figure 1, curve AB represents the demand for a product X and CEF is the supply curve based on *private* marginal cost. Market equilibrium will be established at E. If production of X results in an unfavourable environmental externality, this equilibrium does not represent a social optimum. To illustrate, let curve HJL represent the *social* marginal cost of production, that is private marginal cost of production of X plus marginal externality costs. Marginal externality costs in this case are assumed to be equivalent to HC per unit of output of X. Under these circumstances, many economists would argue that the socially optimal level of production of X would be X_1 rather than X_2 and that the market solution leads to a social deadweight loss equivalent to the area of triangle JKE.

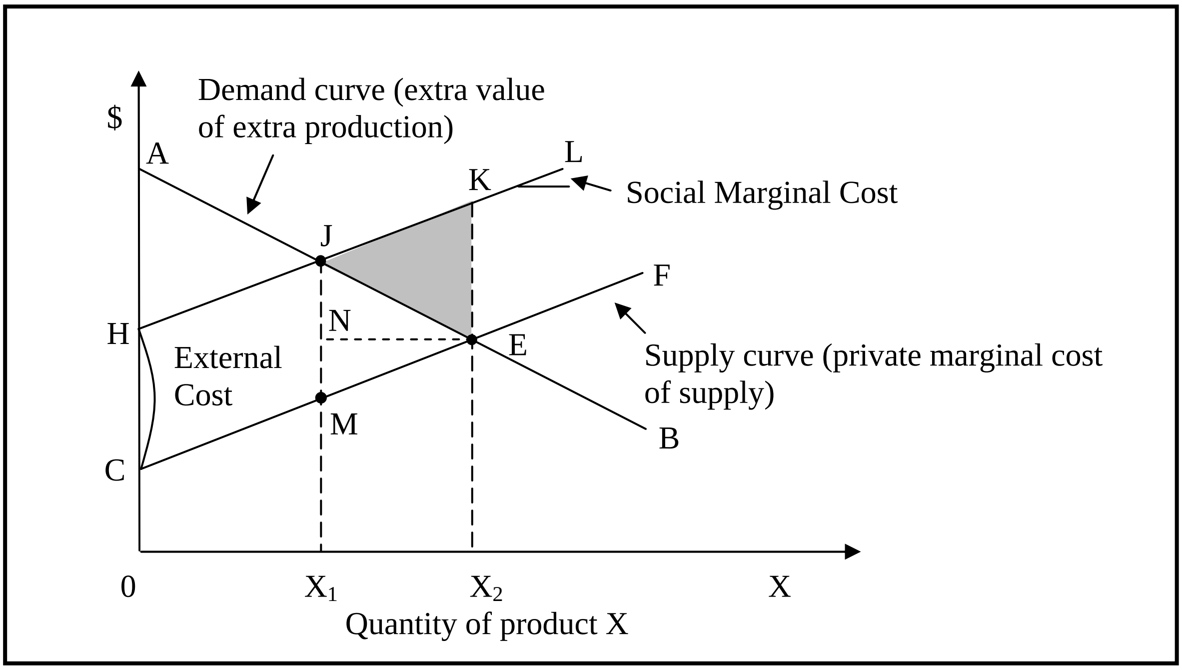

Figure 1: Unfavourable externality and market failure

- The private marginal net value of extra production of X as far as consumers and producers of X are concerned, is equal to the difference between curves AB and CF. At output X_1, this marginal net value just equals the marginal external costs imposed on others. Consequently, if those involved in industry X were required to compensate those damaged by the externality, they would in principle find it worth while to do so up to an output of X_1. Below X_1, the marginal net benefit obtained by those with an interest in the industry (consumers and producers) exceeds the external costs imposed by its extra production. Beyond X_1, the situation is reversed. Thus, the Kaldor-Hicks principle suggests that production at X_1 is socially optimal.

- Note that if production was already occurring at X_2, the Paretian criterion would not sanction the shift to X_1 unless the 'victims' of the externality compensated those gaining from industry X for their lost benefits. In principle the 'victims' would be willing to pay more for reduced output from X_2 to X_1 than the benefits obtained from the marginal output by those with an interest in industry X. Victims of the externality would, for example, be willing to pay an amount equivalent to the area of quadrilateral MEKJ, but would only have to pay an amount equal to the area of triangle MEJ to beneficiaries from the externality[1] (so paying adequate compensation). Therefore, victims are left with a surplus equivalent to the area of triangle JEK after paying compensation. Who gets the surplus (or what proportion of it) depends on negotiating leverage of the parties.

- Who should pay is a question of rights, justice[2] or morality. The Kaldor-Hicks principle is only based upon the *possibility* of compensation. It does not require actual payment of compensation.

- Consider how the size of the deadweight loss is likely to be affected by the size of the marginal externality costs and the slopes of the supply and demand curves.

- Favourable externalities can be considered in the opposite way to the above. In this case, the social *marginal* cost of production is less than the private marginal cost of production.

3. Externalities – May Not Always be Policy Relevant

The use of the above model may give the impression that externalities are always Kaldor-Hicks relevant from a policy point of view. However, it is easy to construct cases where externalities exist, but they are not relevant for policy intervention purposes.

This can occur for example if an unfavourable externality occurs but it is infra-marginal relative to the market equilibrium. Such a case is illustrated in Figure 2.

In Figure 2, line CEF represents the supply curve for the industry producing product X and line AB represents its market demand curve, as before. Producers plus consumers surplus in the industry is equivalent to the area of triangle CEA when equilibrium is established with quantity traded being X_2.

Suppose that an unfavourable externality occurs that results in the social marginal cost curve for the industry being HJF. This implies that the *marginal* externality costs fall to zero at an industry output of X_1 and remains at zero for additional output. Nevertheless, the externality continues to exist and results in a total externality cost equal to the area of triangle CJH. Environmental damages occur, but they do not increase once industry output exceeds X_1.

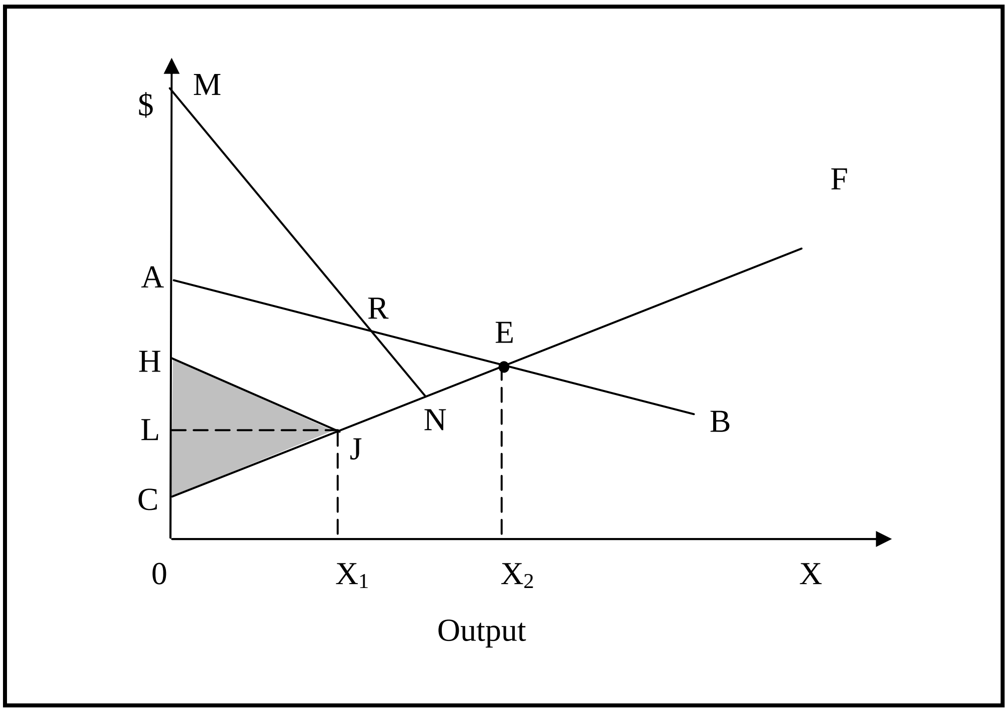

Figure 2: Relevant and irrelevant infra-marginal unfavourable externalities

In this particular case, the externality is Pareto irrelevant and is also Kaldor-Hicks irrelevant. The equilibrium represents a social optimum. Furthermore, the benefits to those gaining from the industry as represented by the area of triangle CAE are greater than the total externality costs generated as represented by the area of triangle CJH. No policy intervention seems justified.

However, this supposes either that there is no choice between techniques or that the one chosen generates the least unfavourable externality costs of those available. If a second technique were available that generated less externality costs, but involved the same private cost, then it should be adopted from a social viewpoint. Suppose, for example, the social marginal costs for this second available technique is CJL. The adoption of this technique would increase social economic welfare by the equivalent of triangle LJH. Therefore, even though the externality is infra-marginal for the first mentioned technique, government intervention may be required to ensure that the environmentally least damaging technique is adopted.

Apart from this problem of choice of techniques, there is another case where public intervention may be justified, even when an unfavourable externality is infra-marginal. It may well be that the industry should be closed down. This case can be illustrated in Figure 2 by supposing that the social marginal cost curve is MNF. In this case, the area of triangle CNM represents total social externality costs and exceeds the net benefit of the industry which is equivalent to the area of triangle CEA. If no other technique is available that gives a lower social cost, the industry should be closed down. The equilibrium point at E is not a global social optimum. It is only a local one.

Another reason why externalities may not justify policy intervention is that the agency costs involved in intervention might exceed the social benefits. For example, in the case shown in Figure 1, the costs incurred by a government agency and compliance costs imposed on polluters in order to bring about output X_1 rather than X_2 *may* exceed the area of triangle EKJ. The intervention would then not be justifiable on economic grounds. In some cases, government agencies regulating externalities may incur greater costs than benefits. Furthermore, they may feel justified in incurring regulation costs equal or almost equal to the externality costs. Consequently, regulators may be able to obtain ‘rents’ by being in the environmental regulation business.

4. Other Economic Models Can Be Used To Illustrate Similar Points

Other market models and economic models can also be used to illustrate the above points. As in Tisdell (1993), *Environmental Economics* (Chs. 2 & 3), they can be illustrated by a simple model that considers the allocation of resources or inputs. Under perfect competition, resources or inputs should be allocated so as to equate the value of their private marginal products everywhere. If externalities occur, private marginal products and social marginal products are liable to deviate thus leading to market failure. The externalities generated can once again be shown to be either relevant or irrelevant for policy purposes. See, for example, Figures 2.1, 2.2, 3.1 and 3.2 in C. Tisdell (1993) *Environmental Economics*.

The models in Tisdell (1993, Chs. 2 & 3) can be used to illustrate the *possible* irrelevance of marginal externalities if the externalities involved are reciprocal. If they are reciprocal, they tend to balance one another out, and the balance between the parties creating externalities may be socially optimal. However, if the total (aggregate) level of activity can be varied, the total activity will be over-expanded if the activity generates unfavourable externalities and insufficiently expanded if it generates favourable externalities. See Figure 3.2 in Tisdell (1991), *Economics of Environmental Conservation*, Section 3.2.

5. Models Using Marginal Benefit And Marginal External Cost Curves Of An Activity Causing External Damage

Figure 3 illustrates a standard type of pollution control model used in the economic literature. Along the horizontal axis, the levels of emissions of a pollutant (or more generally the level of a controlled variable that adversely effects the environment) are measured. The curve, OAB represents the marginal external costs imposed by this externality and line CAD represents the marginal benefits obtained by those engaging in the activity.

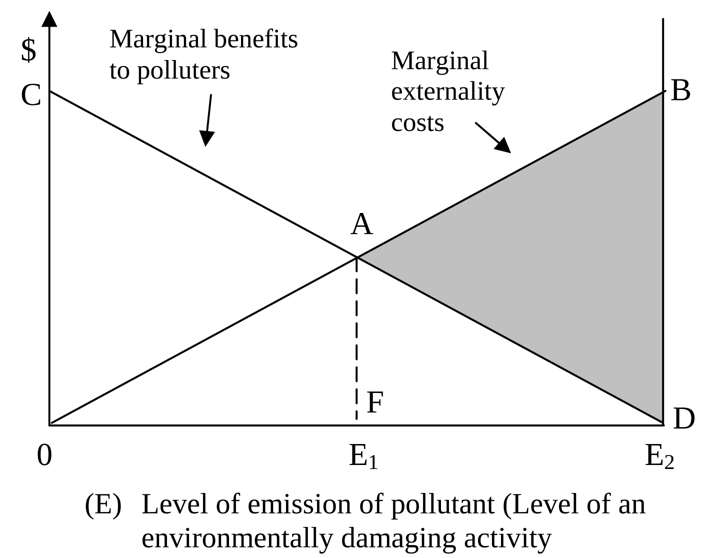

Figure 3: A relevant externality from a Kaldor-Hicks viewpoint

Standard economic theory suggests that a level of emissions of E_1 is optimal. However, in the absence of control, emissions of E_2 will occur leading to a deadweight social loss equivalent to the area of triangle ADB. This is a deadweight social loss because a Kaldor-Hicks improvement is possible. The victims of pollution would be prepared to pay up to the equivalent of the area of quadrilateral FDBA to have pollution reduced from E_2 to E_1. However, the polluters would only need to be paid the equivalent of the area of triangle FAD to be compensated.

Note that if no pollution was allowed, a deadweight loss equivalent to the area of triangle OAC would occur. Why?

Note that the Pareto relevance or irrelevance of an externality may also be considered by modifying Figure 3. An example of an infra-marginal irrelevant externality is given in Figure 4. The marginal benefit to the polluter curve is shown by line CAD. The marginal externality costs curve is represented by curve OBG, and no *marginal* damages occur beyond a level of emissions of E_1. The emissions in this case are Kaldor-Hicks irrelevant, even though a negative externality exists.

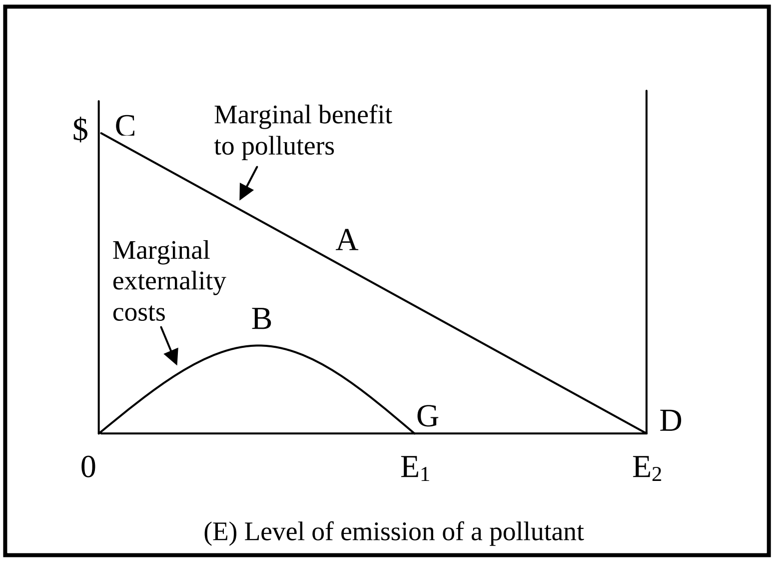

Figure 4: An irrelevant externality from a Kaldor- Hicks viewpoint

We can also modify Figure 4 so the marginal externality cost function intersects the marginal benefit function twice and thereby generate an interesting case. As in the case involving industry supply and demand curves, an infra-marginal externality can become policy relevant. An example is shown in Figure 5. Here the marginal externality cost curve is represented by OBCDFG. In this case, the corresponding total 'social' net benefit curve of allowing pollution is as shown in Figure 6.

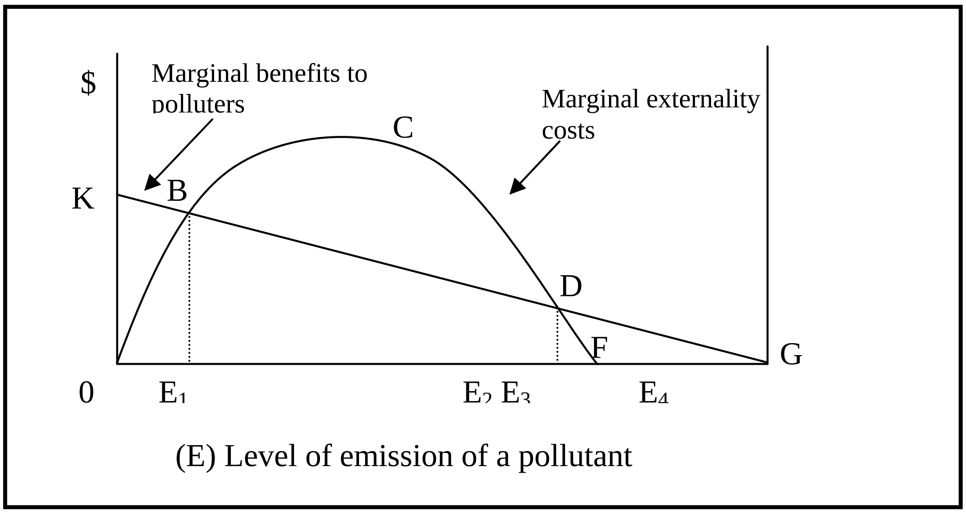

Figure 5: In this case, pollution emissions in excess of E3 generate no marginal externality costs

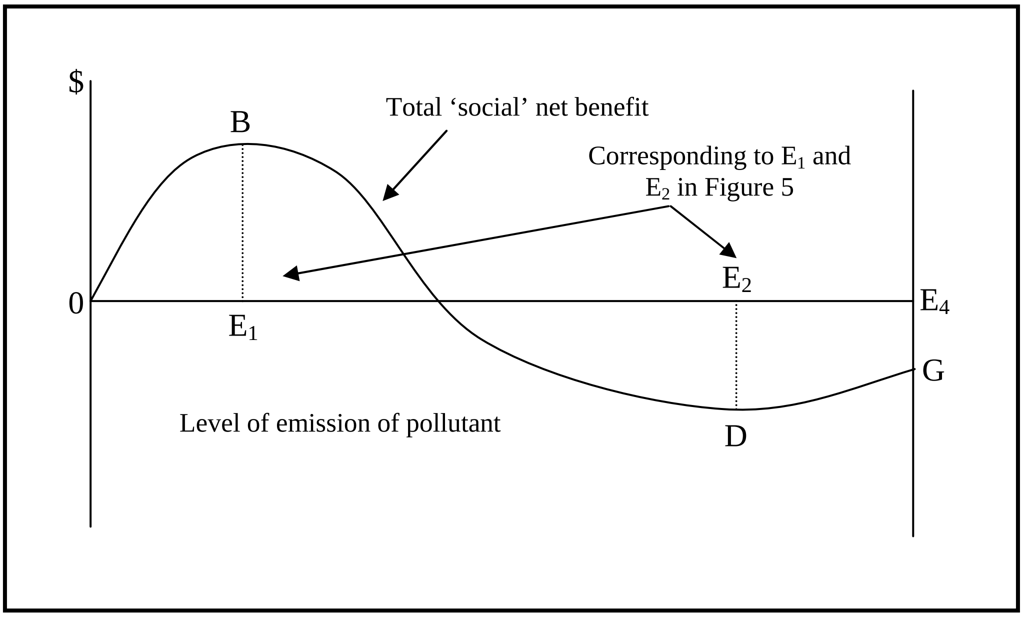

Figure 6: Total benefits corresponding to the case in Figure 5, but not drawn to the same scale as Figure 5. Even though marginal externalities may be zero in this case, they are Kaldor-Hicks relevant.

Furthermore, the point made above about checking on the absolute size of externalities generated by alternative techniques remains relevant. For instance, although the case illustrated in Figure 4 represents a Kaldor-Hicks irrelevant externality and suggests that no government intervention is called for, it is necessary to check on the level of benefits and externality costs generated by alternative possible techniques.

6. Measuring Externality Costs

Accurate measurement of the costs of environmental externalities can be difficult. Some methods that may be used, depending on circumstances, are:

- The contingent valuation method.
- Hedonic pricing.
- Net value of production forgone elsewhere as a result of an environmental spillover.

All such methods have their value as well as limitations. The empirical problems involved in placing economic values on environmental externalities are far from trivial. Estimates are subject both to conceptual difficulties as well as substantial measurement errors. Consequently, environmental policy advice is often subject to conceptual dispute, and frequently involves decision-making under uncertainty. Although this does not imply that environmental economics has no role to play in environmental policy formulation, caution is needed in going from theoretical analysis and empiricism to policy formulation.

Notes

[1] In the case illustrated, the beneficiaries are both suppliers and buyers of product X. The benefit to suppliers is an extra producers' surplus equal to the area of triangle NEM. The benefit to consumers is equivalent to the area of triangle NEJ.

[2] Note in the above example, it was assumed that the victim would pay for a reduction in the adverse externality. However, justice may require the polluter to pay.

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