EXTERNALITIES IN THE TRANSPORT SECTOR

bureau of transport and communications economics

KEY ISSUES

information sheet 10.1

Externalities or 'spillovers' are difficult to define in a non-technical way. But the concept is a familiar one.

In essence, a negative externality occurs when one individual engages in an activity that imposes costs on another, and the victim cannot normally be compensated for them through the market mechanism. The classic example of such a 'bad' is a smoky factory that harms a laundry next door to it. Positive externalities, on the other hand, provide benefits to those affected by them.

GOODS AND BADS IN TRANSPORT

Transport services themselves are a 'good'. They are an essential input into the production process and personal consumption. In recent years they have contributed about 6 per cent to Australian GDP annually. By convention, however, national-income accounts do not include non-traded items. The cost to the community of externalities associated with productive activities such as transport is therefore not deducted from GDP figures.

Exhaust emissions, the additional delay imposed on other road users by an extra vehicle entering a busy street, noise, and accidents are commonly cited examples of 'bads' generated by the transport sector. But traffic congestion or noise can also occur on railway lines, on cycle paths, or at airports. And roads and railway lines may create negative externalities if they cut through a town and restrict movement within the community. A positive externality could include the pleasure gained by car lovers who see a vintage car being driven along a road. Because of the limited number of positive externalities in the transport sector, only negative externalities are discussed below.

PRIVATE, PUBLIC, AND SOCIAL COSTS

Social costs of an activity are those borne by society as a whole. They are the sum of the costs of resources used by individuals in that activity (private costs), and the value of any loss in the community's welfare due to costs imposed by the activity on other individuals (public costs) who are not directly involved. If the opportunity costs of resources are correctly reflected in their market prices, then social costs differ from private costs by the value of the damage caused by any externalities.

In figure 1, for any given level of activity OD, the vertical distance DB represents private costs (eg fuel, travel time, wear and tear on vehicle) and BA represents public costs (the value of an externality such as congestion). Total private costs for all individuals engaged in the activity are given by area LODB, and the total public cost is represented as area ABE.

DEALING WITH EXTERNALITIES

Negative externalities impose costs on the community. But eliminating them altogether (for example, by banning

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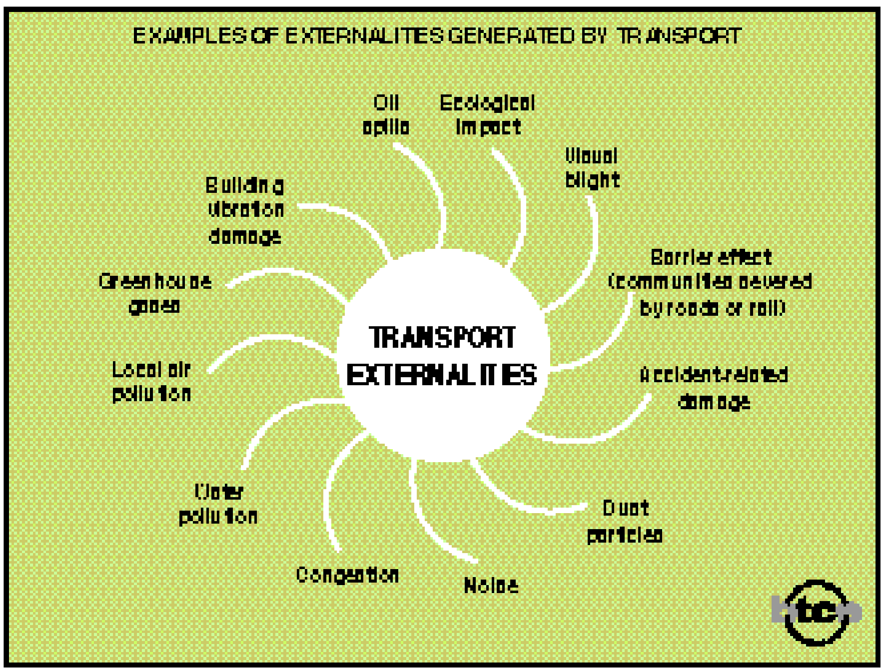
cars totally) would also impose significant costs. A socially optimal level lies somewhere in between, with some amount of 'bad' tolerated in exchange for the benefits of economic activity. However, the social benefits of reducing an externality must outweigh the social costs of doing so, if the community is to benefit overall.

Where action is taken, it is important that all externalities, in all modes of transport (including public transport), are addressed. Otherwise, patterns of production and consumption will continue to be distorted, and there can be no guarantee that social welfare will be increased.

A **regulatory**, 'command and control' approach is one means of reducing externalities. Regulation may be justified when 'economic' instruments are not feasible, as was the case until recently with electronic charging for road use. However, regulations can be highly arbitrary, may involve significant costs of administration or enforcement, do not encourage reductions below official limits, and fall with equal force on all. Compulsory vehicle inspections to reduce emissions, for example, are costly even to those who tune their engines regularly. Costs of administration and enforcement are usually also not trivial.

A 'polluter' can be required to 'internalise' a pollution externality by paying a tax or charge to reflect the additional costs to society from the externality. Imposition of such '**Pigovian'taxes**, named in recognition of their first proponent, A.C. Pigou (1920), results in a socially optimal level of pollution. Apart from any administrative costs involved, a major drawback of Pigovian taxes is the difficulty of estimating the value, and hence the cost, of an externality at the socially optimal level. This problem is currently almost intractable in the case of 'carbon' taxes to reduce greenhouse emissions because there is no scientific consensus on the effect or the likely damage in local areas.



Pigovian or 'green' taxes have attracted considerable attention in Europe in recent years because they offer a 'double-dividend'. Not only do they correct market failure by reducing externalities to optimal levels, but the revenue raised offers governments scope to reduce income, payroll and other taxes. All taxes reduce the community's welfare (the so-called 'deadweight loss') because they discourage the economic activity being taxed. (The congestion charge in figure 1, for example, involves a deadweight loss of area BEF because some travellers no longer use the road due to the increased cost to them, even though its overall effect is positive because the item being taxed is a 'bad' rather than a 'good'.) By reducing taxes on income, payrolls, retail goods, etc, deadweight losses can be reduced, thus increasing community welfare through increased economic activity.

Recycling tax revenues may be a problem, particularly in the transport sector. In principle, once a 'polluter' has been taxed, a social optimum is achieved, and less of the externality is produced. To subsequently also compensate the victims of the polluter would involve an over-correction of the situation. Because a carbon tax on fuel, for example, would affect virtually the whole community (as 'polluters'), it would be difficult for a government to recycle the revenue without compensating the victims (again, most of the community). A further problem is that the polluters would also receive some of the benefits from the revenue, thus partially offsetting any initial reduction in their incomes.

Subsidies offer a theoretical but probably inferior alternative to taxes. Subsidising public transport to make it cheaper or of higher quality, for example, could reduce car usage. However, it would be necessary to ensure that the social benefit of any reduction in externalities exceeds the social cost of the deadweight loss from taxing the whole community. Subsidising 'polluters' directly is another possibility: free train tickets could be made available to all car owners. Again, overall social benefits would need to outweigh costs. But a 'moral hazard' problem might also arise if some commuters bought cars as a means of obtaining free train tickets for themselves or their families.

Partly in response to Pigou, Coase (1960) proposed through a set of examples an alternative that does not require direct government intervention. The so-called Coase theorem requires only that there be a legal allocation of **property rights** affected by the externality in question. (Either the factory should have a right to pollute, or the victim should have a right to enjoy clean air.) Bargaining between the polluter and the victim will then result in a socially optimal level of pollution. But this approach is unlikely to ensure optimality when there is a large number of polluters or victims, because of the high (transactions) cost of coordinating common negotiating positions.

In figure 1, an alternative to a Pigovian tax GE is for governments to limit administratively the amount of an externality to the socially optimal quota OJ. Individuals can purchase permits to pollute. If permits can be traded freely, a price equal to the Pigovian tax will be established automatically. Such **tradable permits** are not a panacea, because determination of the socially optimal level of an externality poses the obverse problem of estimating its cost. However, limited experience in the USA with tradable permits has been encouraging.

In practice, there is no perfect or unique solution to reducing externalities. The choice between approaches will depend on the specific circumstances, including political, technical, and administrative constraints.

ESTIMATING THE VALUE OF AN EXTERNALITY

If Pigovian taxes are to be levied to reduce externalities to socially optimal levels, the values of the *additional* (marginal) costs imposed by them need to be estimated. This is often difficult because externalities, by their very nature, are not traded, and therefore have no observable market price.

Although there is no market for noxious vehicle emissions or accidents, some of the consequences may involve observable market transactions. If air pollution demonstrably induces asthma or cancer in an individual, any medical expenses can be considered to be a cost of such emissions. Similarly, hospital costs and vehicle repair bills due to accidents can be estimated. This **direct costing** technique does not provide a complete estimate of the costs involved, but it can be used to establish a lower limit.

Differences in prices of similar houses located in noisy and quiet streets can be used to estimate the value of peace and quiet. Similarly, price differentials between cars with and without optional safety features (or differences in insurance premiums) can provide a guide to the value of additional safety (and thus the value of avoiding death or injury). These **hedonic pricing** techniques are useful because they utilise market values. But it may be difficult to attribute differences in house prices solely to differences in noise levels if other factors such as traffic fumes or proximity to shops are also important.

People can also be asked what they would be prepared to pay for an environmental improvement, or what compensation they would want if they had to accept more pollution. Because such **stated preference** techniques involve hypothetical questions, care is required to face interviewees with realistic scenarios, including choices between 'bundles' such as different income levels and amounts of externalities.

Compensation payments awarded by the courts can also be used to identify values placed by the community on damage caused by externalities. Caution is required where such awards represent **control costs** (the costs of eliminating the externality entirely). Imposition of Pigovian taxes at control cost levels would not be socially optimal: for example, by setting such prohibitive charges that all cars are driven off the road.

CONGESTION CHARGES

Congestion is a classic example of an externality. Road users considering whether to join a busy traffic stream would normally only weigh up the private costs of doing so against the expected benefits of the trip. They ignore the additional congestion (and hence delay) that their presence causes for other vehicles. The community's welfare can be increased by charging road users the value of the extra congestion that their presence causes. Similar charges (Pigovian taxes) can be applied to other externalities such as exhaust emissions or noise.

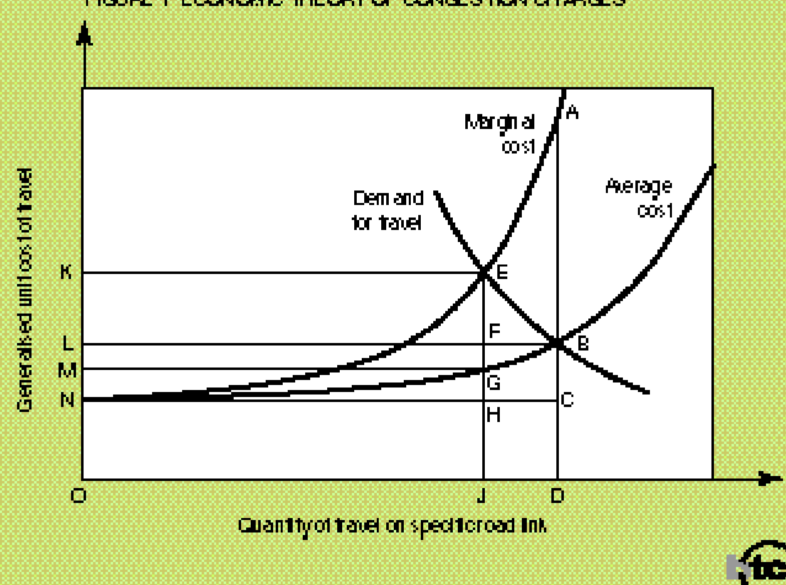
Figure 1 represents the case of congestion for a single road link. The vertical axis represents the generalised unit cost (or price) of travel, including fuel used, vehicle maintenance, and the value of time spent travelling. The quantity of travel, represented by the horizontal axis, is measured in units such as vehicle-kilometres.

In the diagram, the average cost curve represents the unit cost of travel as perceived by individual road users. It is made up of vehicle operating costs (maintenance and fuel) and travel time costs. Because it is an average cost, its product with the corresponding quantity of travel gives the total cost incurred by all road users. The marginal cost curve is the derivative of this total cost with respect to the quantity of travel (the contribution to the total cost of an additional unit of travel). The vertical distance between the marginal and average cost curves therefore represents the additional costs imposed on others, but not taken into account by the marginal road user – that is, the external costs. The demand curve represents the benefit of the marginal unit of travel.

The current quantity of travel OD is determined by the intersection of the demand and average cost curves. It results from decisions by road users who take into account only their own private costs. If the quantity of travel is OD, private costs are equal to the average cost DB. Marginal external costs of BA imposed on other road users are not taken into account by individual drivers.

The socially optimal quantity of travel OJ is determined by the intersection of the demand and marginal cost curves. This quantity is optimal because it avoids travel beyond the point where social costs exceed benefits. Imposition of a uniform charge of EG on all road users will reduce travel to the socially optimal level.

FIGURE 1 ECONOMIC THEORY OF CONGESTION CHARGES



Note that congestion is not eliminated if an optimal road user charge is levied; merely reduced in total value from area LBCN to MGHN. Those whose travel is in the range JD will no longer use the road because the price is now too high, and will suffer a loss in welfare. But remaining users gain from reduced delay because fewer vehicles use the road. Overall, the community gains by the area ABE, which equals the cost to society if nothing is done to reduce congestion. BTCE (1996a) estimates optimal road user charges for 3 km grid squares in Australian capital cities, and provides more detailed discussion of figure 1.

Some analyses of congestion have presented results in a manner that is highly misleading in terms of policy formulation.

A common misconception is to calculate the total cost of current congestion LBCN. This cost of congestion is irrelevant, because it is measured relative to a hypothetical situation of zero congestion, a state that is not realistically attainable. It implies that congestion can, and should be reduced to zero. The more correct, policy relevant cost is the 'cost of doing nothing about congestion': area ABE, the opportunity cost of leaving congestion above the socially optimal level. Care is therefore required in accepting estimates of the 'cost' of congestion.

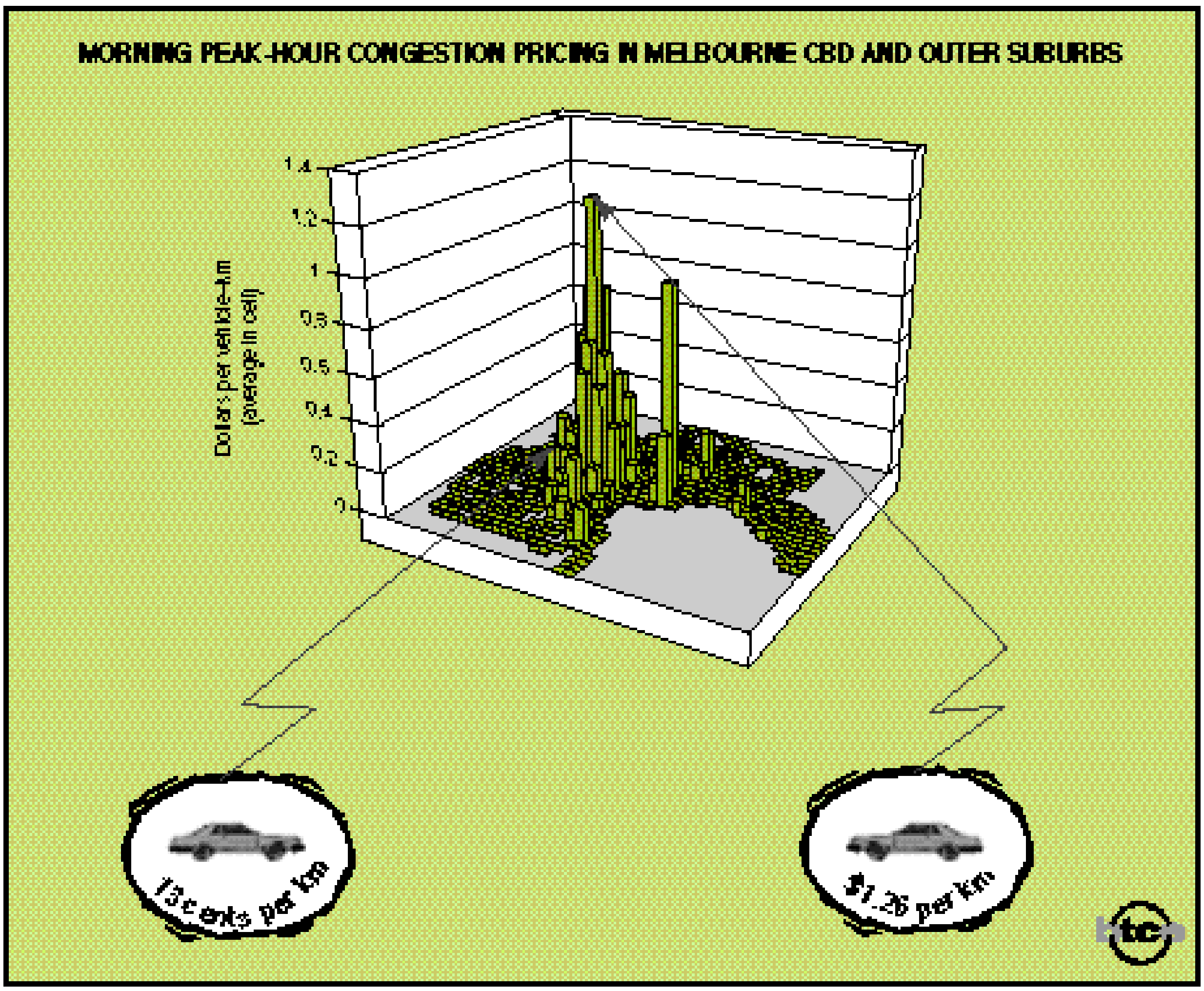
The complexity of applying the theory to urban road networks has led some analysts to estimate 'optimal' road user charges by using average, city-wide figures. Such estimates tend to underestimate the charges required in more congested areas and will overestimate them on relatively uncongested roads. Ideally, estimates should be made on the basis of costs on individual links of all roads in a city. BTCE (1996a) adopts this more complex approach by using 3km grid squares for all major Australian capital cities for the morning peak-hour. Modern technology offers scope to further differentiate road user charges according to congestion levels at different times of the day.

CONGESTION CHARGES IN MELBOURNE AND SYDNEY

Using a disaggregated network model, BTCE (1996a) found that the potential benefit to Australia of controlling congestion would be about $3 billion per year (area ABE in figure 1). More aggregated studies using city-wide data have estimated benefits at only about one third of this level.

In Melbourne, morning peak period congestion is concentrated on a relatively small central area near the CBD. BTCE (1996a) suggests that an economically efficient charge in this area of the city would be about $1.26 per kilometre travelled, whereas the charge would be less than 13 cents per kilometre only 9 kilometres away from the CBD. A peak-hour trip from Frankston to the city would have cost about $5, but only about 30 cents from St. Albans to Werribee.

In Sydney, by contrast, peak congestion charges would have been about 75 cents per kilometre travelled, but would apply over a wider central area than in Melbourne. (Because some drivers would stop using roads in this central area, average traffic speeds would increase by more than 40 per cent.) A peak-hour trip from Casula to Silverwater would have cost in the order of $5 and about $1.60 from Wahroonga to the city.



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