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FEDERAL RESERVE BANK OF DALLAS

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CONGESTION TAXES RECONSIDERED

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The theory of congestion costs in traffic networks is firmly entrenched in the economic literature on transportation [2], [3], [8]. In the simplest case, which is sufficient for our purposes, a driver enters a road and willy-nilly increases the travel time of other users, thus imposing costs on them equal to the value of the extra time. The driver does not take these costs into account because he doesn't experience them; he experiences only his private operating and time costs which do not include the additional costs he imposes on others. These additional costs are called congestion costs and are regarded as an externality. The externality is presumed to create an inefficiency-- that is, a condition in which Social Marginal Cost differs from Social Marginal Benefits. Such a condition means that resources are not allocated in the manner that maximizes Social Utility. The recommendation of modern welfare economics (which treats the capitalized terms as names of meaningful concepts) is to impose a tax on drivers sufficient to cover the congestion costs.

Figure 1, adapted from Bertrand [2], illustrates the story. $D(x)$ is the demand curve, $P(x)$ is the private marginal cost, $S(x)$ is the Social Marginal Cost, and triangle abc is the Social Utility gained

*This article represents no official views from any part of the Federal Reserve System. I am indebted to Sydney Hicks for helpful comments on a previous draft.

by imposing tax t , which reduces usage from the private equilibrium x_2 to the Social Optimum x_1 . Bertrand [2] and Boardman and Lave [3] compute t for a number of combinations of basic parameters. This computation has become a standard exercise in applied political economy.

Both the reasoning and the welfare-economic views that motivate it are expressed particularly well by Boardman and Lave [3, p. 341] in the following passage, the notation of which I have changed to conform with my own and the emphasis of which is mine:

If an individual takes to the highway he experiences a (private) cost of $P(x_1)$. Society as a whole experiences the social marginal cost $S(x_1)$, which exceeds the private cost. In order to internalize this cost, the individual must behave as if he faces a cost equal to the marginal social cost, rather than the private cost. One way of making an individual behave in the desired fashion is to levy a "congestion toll," t

These views are widely held, and the quoted passage might well have been selected by a random process from among many such passages in the literature. The passage is unusual only in its clear and rapid movement from the perceived externality to the recommended remedy, almost as if it were impatient to get to the really interesting job of inducing people to behave in the proper manner by taxing them.

Now in practice we do not pay congestion taxes. So it seems that even if the automobile pays its way with respect to road construction

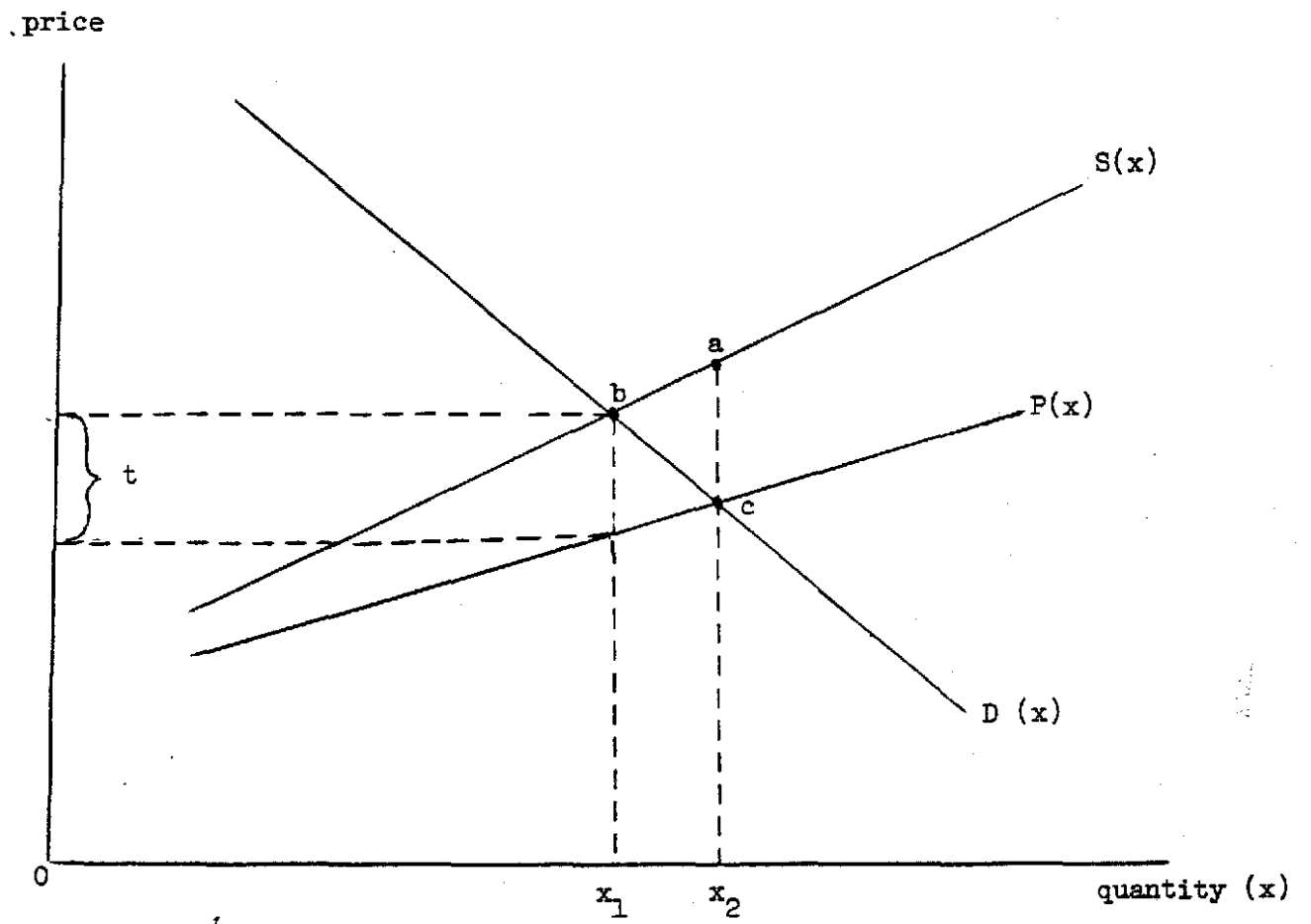


FIGURE 1

and maintenance, traffic management, and air pollution, it does not pay its way with respect to congestion costs. Hence it seems to be subsidized by Society As A Whole. This appears to be an additional argument against the private automobile and is often used as such by advocates of public transportation. We are not concerned here with the relative merits of public and private transportation but merely wish to reconsider the subject of congestion costs and taxes.

Walters' [8] original article on the subject established a tradition of concern for the proper tax and unconcern for its proper use. An article by Sharp [7] almost broke this tradition; however, after expressing his misgivings on this score he neglected to pursue the matter. The typical sentiments remain those expressed by Walters:

Problems of the distribution of income—who would and who would not be harmed by the policy advocated—will not be considered here. The general ramifications of such a policy are reasonably clear, but the detailed analysis would be cumbersome and boring. [8, p. 686]

In retrospect, this appears to have been a mistake. Equity demands some consideration, and when we look into it we find a paradox.

Suppose, therefore, that a tax is levied on drivers. Since its purpose is to correct a pricing failure, the proper disposal of its revenues is an essential part of the analysis. For this it is not sufficient to say, with modern welfare economics, that the revenues should go to Society As A Whole. Society As A Whole has no checking account and no pockets, so the revenues will go into the accounts or pockets of particular individuals. Ideally, the beneficiaries will

be those who bear the congestion costs. Only by compensating those who bear the costs can we fully correct the apparent misallocation. And it is clear that travelers, and only travelers, bear congestion costs. We are not here concerned with pollution, noise, or any other undesirable by-product of travel except congestion. Clearly these other costs fall on drivers and non-drivers alike. But congestion cost is the value of excess travel time, and a person can suffer travel delays only while traveling. Though travelers include passengers as well as drivers, for brevity we speak only of drivers. In this sense, drivers bear all congestion costs.

It is frequently alleged in discussions of the subject (though I cannot find it stated in print) that non-drivers also bear congestion costs because congestion keeps them off the roads: They would drive if the roads were clearer, but will not when the roads are congested; hence those who do drive impose costs on those who don't (but otherwise would) by depriving them of an opportunity. This reasoning, however, would establish a proposition that is obviously absurd when applied to more familiar cases. Thus let apples, for instance, be supplied at increasing cost and let Jones be willing to pay a nickel but not a dime for an apple. If other buyers drove the price up to a dime they would, on the present reasoning, impose a cost on Jones by knocking him out of the market. But who would imagine it proper to count this "cost" as part of the Social Cost of apples, and who would want to compensate Jones for "bearing" it? Yet the cases differ only in inessential details.

Since, therefore, drivers bear all congestion costs, they should get the tax revenues. As the tax just covers congestion costs, the revenues (absent administrative costs) are just enough to compensate all drivers.

One of the standard simplifying assumptions in the theory is that all traffic is homogeneous: "with a given volume of traffic, each vehicle will experience the same costs, speed, etc." [8, p. 677]. This assumption is clearly required for the concept of a single optimum tax rate t to be paid by all drivers. On the further suppositions that (a) the costs both borne and imposed by a driver increase with his usage and (b) no driver enjoys squatter's rights to the road, the situation contains an essential (and apparently overlooked) symmetry: the congestion costs borne by a driver equal the congestion costs imposed by him.

In practice, on any particular trip, drivers in front impose more costs on drivers behind than the latter impose on them. But to take this into account when taxing would confer a kind of squatter's right on the first driver. For taxing--and dispensing the revenues--all drivers must receive equal treatment for equal usage. In any case, things even out over a large number of trips. In that statistical sense, therefore--the only sense appropriate to the proposed taxing scheme and hence to the proper refunding scheme--each driver bears congestion costs equal to those he imposes.

Indeed, on the homogeneity assumption, the congestion cost c_{ij} imposed by driver i on driver j equals the cost c_{ji} imposed by j on i . The assumption is untrue in particular cases but the equality nevertheless remains true in a statistical sense. If driver i follows immediately behind driver j on half the days but immediately precedes him on the other days, then the daily averages of c_{ij} and c_{ji} are equal. Assuming a random distribution of relative positions over all pairs of drivers, it follows that a randomly chosen pair delay each other equally. In practice, the members of a pair will not always value time equally, but both are expected to value it as the average driver does. Hence the expected values of c_{ij} and c_{ji} are equal.

It follows that each driver should receive 100% of his tax payment as compensation for the congestion costs he bears. Since he can only receive this payment by bearing congestion costs and can only bear those costs when engaging in the congesting activity, the payment will not induce him to "substitute away" from the activity; rather, it will lower his private costs by precisely the amount his tax payments raised them, both being the same function of his usage. Both the payment and the receipt are "per unit" and not "lump-sum," so no wealth or substitution effects will change the terms of trade between the congesting activity and others. Each driver, therefore, will behave precisely as he would have done had no tax been imposed (and disbursed) in the first place. Proper dispersal of the revenues precisely restores the pretax position.*

In short, modern welfare economics began by conceiving an externality, proposed a tax to eliminate it in the interest of efficiency, determined the proper use of the tax revenues on the ground of equity, and found itself undoing in the name of equity what it had done in the name of efficiency, restoring the very evil it set out to correct. This is a paradox. It cannot be the fault of nature, which has no paradoxes. The fault must be in the reasoning.

To see that the fault is not in the new reasoning here introduced, suppose drivers were able to obtain cash payments from their fellows for bearing their congestion costs. It is irrelevant how this might be

*Evidently, the argument still holds if taxes are returned in the form of improved roads. In this case congestion will decrease though usage will be the same as before the tax. Both the tax payment and its dispersal remain functions of usage. The average driver regains by the saving of time what he pays as tax; at any given rate of usage he is precisely as well off as before, so his usage will not change.

accomplished; simply suppose it possible. Obviously, the externality would then disappear. However, while each driver would see his private cost rising by the amount he pays his fellows, he would simultaneously see it falling by the amount his fellows pay him. Since the costs he imposes equal those he bears, the amount he pays would equal the amount he is paid (on the average). So even if the drivers paid for their congesting activities in cash, they would drive precisely as much as they would when the payments were impractical. The payments--and their cumbersome substitutes, the congestion taxes--serve no purpose.

The fault lies, therefore, in the traditional reasoning. It enters with the supposition that the externality creates an inefficiency. The externality surely exists, but its effects are not those of the usual externality. Here we have no uncompensated costs falling on innocent parties. The only way a driver can impose congestion costs on others is to bear the costs they impose on him, and the only way he can bear others' costs is to impose costs on them. Though the driver fails to take account of the congestion cost he imposes on others, he does take account of the congestion costs others impose on him. Since the costs he bears equal the costs he imposes, it is as if he were in fact paying his way. He "pays" by bearing the unpaid-for costs of others. This confines the externality to the group that creates it.

The case is precisely the same whenever a good is supplied at increasing cost. Each additional buyer causes the price to rise for all buyers. He does not take this rise into account; on the reasoning of congestion-cost theory, he creates an externality. But he reciprocally bears the "externalities" created by other buyers. He cannot escape these costs except by leaving the market. Like those he imposes, they

increase with his purchases. Clearly, cash or any other material compensation for these costs would be pointless.

Externalities confined to the group that creates them, and falling on a person only so far as he is responsible for imposing them on others, produce no inefficiencies (on the average). The reason is the (statistically) exact reciprocity of the cost burden. Costs are not paid for in cash but in kind through exchange of the externalities themselves. This non-market exchange of externalities has the advantage of avoiding transactions costs and the disadvantage of accomplishing statistical rather than exact compensations. Evidently the advantage exceeds the disadvantage in the case of road congestion, for we don't hear many drivers--apart from transportation planners--agitating for congestion taxes. Probably the advantage exceeds the disadvantage in many other spheres as well; if so, entirely too much is made of externalities.

While the paradox issues directly from a simple misuse of the theory of externalities, it is worth asking how this misuse could have remained hidden so long from so many able thinkers. The answer lies, I believe, in the penumbra of welfare-economic concepts that surround the subject. The unthinking appeal to such notions as the Utility of Society As A Whole, the facile construction of those little triangles purporting to measure it, the readiness to "induce" people to behave in a manner that achieves it, constitute an approach to social questions that is known to be bankrupt. This bankruptcy follows from the conjunction of two facts. On the one hand, except for the rare case of Pareto dominance, modern political economy requires interpersonal comparisons of utility. Any residual doubt about this should have finally been resolved by Chipman's and Moore's recent evaluation [4], which demonstrates that, "judged in relation to its basic

objective of enabling economists to make welfare prescriptions without having to make value judgments and, in particular, interpersonal comparisons of utility, the new Welfare Economics must be considered a failure."* On the other hand, such comparisons are impossible.

Interpersonal comparisons of utility must be distinguished from interpersonal evaluations of merit, which everyone makes on more-or-less equally justified grounds (economists having no advantage). Such interpersonal evaluations do not help modern welfare economics, which claims objective justification for its proposals. The interpersonal comparisons it needs for this purpose must in some sense show whether a proposal would benefit one person more than it would harm another, not whether the gainer is more meritorious than the loser.** I argue at length elsewhere [5] that this need cannot be met.

Road congestion has thus been studied in terms of a framework whose basic presuppositions are inconsistent. Such a framework itself

*Chipman and Moore [4, p. 548]. See also Osborne [6] for an argument that implies the same conclusion with respect to Social Welfare functions.

**I therefore have to dissent from the implication of Chipman's and Moore's quoted remark that an interpersonal comparison of utility is a species of value judgment.

generates paradox.* While more careful work within the framework (and better luck) would have avoided the particular paradox here noticed, it would eventually have met some paradox in any case. It is not simply that the framework lets us down in a few difficult cases, occasionally failing to justify the public policies that we thought we derived from it. It is inherently wrong, and must necessarily lead us astray in every case except where luck saves us.

*The paradoxes of Social Utility are far from being the most repugnant feature of the political economy it spawns. Just as inconsistent axioms imply every conceivable proposition, so do the empty formulas of Social Utility justify every conceivable social policy. "When all is said and done," conclude Chipman and Moore, "the New Welfare Economics has succeeded in replacing the utilitarian smoke-screen by a still thicker and more terrifying smoke-screen of its own." [4, p. 581] This smoke-screen is all the more terrifying by being unintended and unsuspected. It blinds the very people who produce it.

REFERENCES

- [1] Kenneth J. Arrow, Social Choice and Individual Values. New York, 1952.
- [2] Trent J. Bertrand, "Congestion Costs in a Transport System," Journal of Transport Economics and Policy. Vol. XII No. 3 (September 1978) pp. 244-279.
- [3] Anthony E. Boardman and Lester B. Lave, "Highway Congestion and Congestion Tolls," Journal of Urban Economics, Vol. 4 (1977) pp. 340-359.
- [4] John S. Chipman and James C. Moore, "The New Welfare Economics 1939-1974," International Economic Review, Vol. 19 No. 3 (October 1978) pp. 547-584.
- [5] D. K. Osborne, "Interpersonal Comparisons," Research Paper No. 7807, Federal Reserve Bank of Dallas, October 1978.
- [6] _____, "Irrelevant Alternatives and Social Welfare," Econometrica, Vol. 44, No. 5 (September 1976), pp. 1001-1015.
- [7] Clifford Sharp, "Congestion and Welfare--An Examination of the Case for a Congestion Tax," Economic Journal, Vol. 76 (Dec. 1966) pp. 806-817.
- [8] A. A. Walters, "The Theory and Measurement of Private and Social Cost of Highway Congestion," Econometrica, Vol. 29, No. 4 (October 1961), pp. 676-697.