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EXTERNALITIES IN PUBLIC FACILITY USE: THE CASE OF HIGHWAY ACCIDENTS

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That accidents are an important incident to the use of public highways is no secret; how important is often not fully realized, nor has attention been given to the relation of such accidents to the manner in which individuals pay for highway use.

A great deal of work has indeed gone into the measurement of benefits from accident reduction resulting from better highway design or various forms of accident prevention activity. But it remains by and large true that the average user of the highways has relatively little appreciation of the impact of his activity on accidents in general, nor has there as yet been much discussion of appropriate means of bringing this cost home to him. In a sense, this is but another aspect of the externality problem involved in traffic congestion, but an aspect which has unique features worthy of detailed examination.

The National Safety Council estimates the cost of highway accidents in 1966 as follows:[1]

Property damage	$ 3.3 billion
Wage loss	2.6
Medical expense	0.6
Total direct loss	6.5
Insurance administration	3.5
	$10.0 billion

Not included is any allowance for "pain and suffering," whether or not reflected in the award of damage in excess of the direct cost, nor any public agency costs, such as those of police and courts (to the extent not covered by legal fees), nor any indirect costs from inconvenience to employers, etc.; nor is it clear that the claimants' expenses of collection are included. As a general order of magnitude, however,

[1] National Safety Council, *Accident Facts,* 1967.

the minimum figure for costs is substantially in excess of total gasoline tax revenues ($7.4 billion in 1966), and an inclusive figure would rival the total amount of governmental expenditure on highways.[2]

The degree to which this cost is borne by highway users in their capacity as such is difficult to determine with any accuracy from the data available. One obvious mode of payment is through various forms of insurance. Total automobile insurance premiums earned in 1967 came to $8.9 billion and loss claims incurred to $5.4 billion, which would seem to take care of a good deal of the $6.5 billion of loss.[3] However, payments by insurance companies included in many cases a considerable amount for damages in excess of the direct monetary cost, and in other cases must be discounted considerably to allow for costs incurred by claimants in presenting their claims. On balance, there remains a very substantial amount of loss uncompensated for by such insurance. In a sampling study of Michigan personal injury accident cases related to accidents occurring in 1958,[4] it was found that out of an estimated total aggregate loss for the state for the year of $178 million, only $85.2 million in reparations was received by the victims from all sources, of which $17.5 million came from the victims' own automobile insurance, and $46.7 million from tort claims, insured and uninsured. In addition, there was an expectation of future compensation payments amounting to $8.4 million, not broken down as to source, bringing the total received from all outside sources to $93.6 million, leaving $84.5 million of the loss to be borne by the victims individually. In a very rough average sense, then, it can be estimated on the basis of this sample and the various outside figures that, of the losses suffered directly by traffic accident victims, 38 to 40 per cent are compensated from automobile-related sources, i.e., automobile insurance or judgments against tortfeasors; 48 to 50 per cent are borne by the victims themselves (including in this figure an estimate of the cash surrender value of life insurance policies liquidated to provide benefits), and 11 to 13 per cent are provided from sources unrelated to the use of automobiles, such as sick leave provisions, pensions, social security, health insurance, and the like. When to this there is added the uncompensated losses experienced by bicyclists and pedestrians, the cost of providing courts for the adjudication of cases, and the cost of various forms of public assistance, subsidized

[2] An estimate of $12 billion for 1967 is given in *The Economist* (London, 1968, p. xxi); it is not clear how inclusive this figure is intended to be.

[3] Best's Fire and Casualty aggregates and averages, July 13, 1967.

[4] A. F. Conard *et al.*, *Automobile Accident Costs and Payments*, Ann Arbor, Mich., 1964.

hospital care, or other services tendered to victims of motor vehicle accidents and financed from nonmotor vehicle sources, it is apparent that there is a gross subsidy to motor vehicle users of the order of at least $1 billion and quite possibly as high as $2 or $3 billion, financed in ways that have no restraining influence on motor vehicle use.

But this is on the basis of gross averages, and as so often in the case of transportation, gross averages conceal as much as, if not more than, they reveal. If efficient decisions are to be made as to the amount of motor vehicle traffic to make use of, it is the marginal and not the over-all average cost that is of concern, and the object is to bring the decision-maker face-to-face with the differentials between the marginal costs of the alternatives under consideration at the time of decision. While there is very little good statistical information on the relation between increments of traffic and increments of accidents, something can be deduced from considerations of general principles.

According to the National Safety Council, some 22,300 of the 53,000 motor vehicle accident deaths, or 42 per cent, occurred in collisions between two or more cars. It is reasonable to presume that, in most cases where two cars collide, the accident would not have happened if either car had not been there, and that the foregoing of the trip by either vehicle would have eliminated the entire cost of the accident. In effect, then, the entire cost of the accident is a part of the marginal cost, *ex post,* of both trips. Bringing the marginal cost of such accidents home to the potential motorist would involve providing that in the event of an accident, each motorist, lacking insurance, would be required not only to bear the cost of his own damages, but pay a penalty equal to the damages suffered by the other. If the two motorists wish to purchase insurance against the eventuality, they should be required to pay premiums sufficient not only to compensate the two motorists for the damages sustained, but in addition pay into the public treasury a sum equal to the damage claims. That is to say, motorists should be required to buy enough insurance to cover the risk of accident and pay a tax of 100 per cent of the premium (or at least 100 per cent of that portion of the premium used to pay claims).

Matters are, of course, not quite as clear-cut and simple as this example suggests. There is, for example, the phenomenon of the accident looking for a place to happen, as with the maniac who persists in passing on blind curves, until such time as a fatal encounter removes his genes from the driving population by Darwinian selection. Keeping the potential victim of one fatal collision from the scene would then merely shift the accident to another later occasion. A

similar consideration applies in somewhat modified form to the driver of a car with a suddenly developing defect: if a tire blows out and causes a collision with another car, keeping the other car out of the way might only substitute a fixed object for the car, though in this case the probable damages would be considerably reduced. On the other hand, not all accidents recorded as noncollision, or collision with a fixed object, are free from interaction effects: in many cases the car that hits a fixed object (or a pedestrian!), or rolls over in the ditch, has swerved to avoid a more serious collision with another car that has got off scot free.

On a larger level, one can consider, in the abstract, the relation between increments in traffic density and increments in the number of encounters that give rise to the possibility of a collision. On an unseparated highway, for example, the number of times a car making a given trip will pass cars coming in the opposite direction will obviously be proportional to the density of the opposing traffic flow, so that the total number of such encounters will vary as the square of the traffic density. With very low density of traffic, these encounters will constitute the main occasions at which collisions between two cars are possible. (Even where density is somewhat higher, so that the accident potential involved in following or overtaking cars going in the same direction becomes significant, such occasions also tend to increase in frequency according to the square of the traffic flow.) But as density increases to still higher levels, opportunities to overtake drop off; on the one hand, this reduces the number of occasions for accidents to take place during overtaking, and average speeds are reduced. On the other hand, the temptation to overtake under hazardous circumstances increases, and possibilities for accidents due to multiple interaction increase, as when the slowing down of the first car in a sequence of closely following cars forces each subsequent car to brake somewhat more sharply than the preceding car until finally a car finds itself unable to brake in time and collides with the car in front. There is also the increased possibility that one collision will involve still other cars. As traffic flow increases still further, however, movement is likely to be slowed to the point where accidents, when they occur, cause relatively little damage.

Unfortunately, the available statistics are not entirely appropriate for the derivation of the marginal cost of accidents per trip. Indeed, a superficial look at some of the data might tend to cast doubt on the entire analysis. For example, data by states on deaths per vehicle-mile show a strongly inverse relation to density of traffic: the highest death rates are found in the Southern and mountain states, where traffic

densities are generally low, and the lowest in the Northeast and in California, where densities are relatively high. With respect to two other measures, the number of bodily injury claims per 100 vehicles and the number of property damage claims per 100 vehicles, the reverse relation exists: the highest rates are found in the high-density states. And if one looks separately at the death rates in one-car and multiple-car accidents, according to some figures at least, the one-car death rate shows a strong negative association with traffic density while the two-car death rate shows an equally strong positive association.[5]

It is clear, indeed, that there are not only a number of types of accidents, differing in their economic implications and etiology, but there are a number of traffic situations that present substantially different relationships between the volume of traffic and the cost of accidents. For analytical purposes we may distinguish (a) the solo accident, involving only the motorist himself and having substantially no externality effects, except insofar as the victim may then draw on community services or obtain nonautomobile insurance compensation; (b) the auto-nonauto accident, in which injury is done to pedestrians, cyclists or wayside property; and (c) the auto-auto collision. The following types of ambients may similarly be distinguished: (i) the low-density road, usually of at most two lanes where interactions are almost entirely of the crossing or meeting variety, with overtaking relatively unimportant, with the number of occasions for auto-auto accidents varying very nearly as the square of the traffic flow; (ii) the moderate density, nondivided highway, with some constraint imposed on drivers by the presence of preceding cars; (iii) the high-density, nondivided highway, characterized by extensive queuing conditions, substantial amounts of close following, passing maneuvers executed in the face of oncoming traffic, and the like; (iv) heavy urban traffic, with frequent signalized intersections; (v) divided lane highways under free flowing conditions, with interactions largely in overtaking, or with cars stopped by emergency or entering or leaving; (vi) heavy traffic in divided lane highways, with interactions involving chiefly following, lane-changing, entering and leaving.

Unfortunately, the data that might show precisely how accident rates vary with traffic volume for different conditions are not easy to come by. One indication is given by data in Table 1 showing data for

[5] J. L. Recht, *Multiple Regressions Study of the Effects of Safety Activities on the Traffic Accident Problem*, Chicago, National Safety Council, December 1965. See especially equations 5, 6; but *per contra* see also equations 41, 42!

TABLE 1

AVERAGE AND MARGINAL ACCIDENT RATES, CALIFORNIA FREEWAYS, 1960–62

Average Daily Traffic Class (000's) (x)	Number of Segments (n)	Accidents per Million Vehicle Miles (q)	Average Daily Traffic per Lane (000's) (h)	Accidents per Million Lane Mile Days (Q)	Increments in Total Accident Rate (ΔQ)	Increments in Traffic Density (Δh)	Marginal Accident Rate per Million Vehicle Miles (m)	Ratio of Marginal to Average Accident Rate (r)	Million Vehicle Miles (V)
				FOUR-LANE FREEWAYS					
0–7.0	1	1.04	1550	1612	1612	1550	1.040	1.000	55
7.0–10.0	3	1.51	2225	3360	1748	675	2.590	2.031	97
10.0–15.0	18	0.86	3400	2924	−436	1175	−.371	−.313	1269
15.0–21.5	18	0.95	4725	4489	1565	1325	1.181	1.300	970
21.5–31.6	32	1.18	6350	7493	3004	1625	1.848	1.735	2306
31.6–46.5	20	1.45	9600	13920	6427	3250	1.977	1.503	2051
46.5–68.0	8	2.03	13525	27456	13536	3925	3.449	1.982	491
68.0–100.0	1	2.46	17100	42066	14610	3625	4.030	1.795	107
Over 100.0	0	—	—						
Total or average	101	1.25	6675					1.455	7346

SIX-LANE FREEWAYS

16.0–15.0	0	—	—						
15.0–21.5	1	1.02	3467	3536	3536	3467	1.020	1.000	44
21.5–31.6	8	1.00	4417	4417	880	950	.927	.917	338
31.6–46.5	18	1.00	6617	6617	2200	2200	1.00	1.00	1292
46.5–68.0	19	1.20	9133	10960	4343	2517	1.725	1.568	2341
68.0–100.0	23	1.41	13917	19623	8663	4783	1.811	1.387	4424
100.0–120.0	12	1.70	18267	31054	11431	4350	2.628	1.690	2509
Over 120.0	4	1.89	21683	40981	9927	3417	2.905	1.618	578
Total or average	85	1.40	11200					1.455	11526

EIGHT-LANE FREEWAYS

0.0–31.6	0	—	—						
31.6–46.5	3	1.04	5262	5472	5472	5262	1.040	1.000	196
46.5–68	11	.86	7225	6213	741	1962	.378	.399	879
68–100	12	1.30	10738	13959	7746	3512	2.205	2.041	1155
100–120	8	1.31	13538	17735	3775	2800	1.348	1.033	1865
Over 120	14	1.73	18612	32199	14464	5075	2.850	1.875	3185
Total or average	48	1.43	12225					1.596	7280

$$Q = hq;\ m = \Delta Q/\Delta h;\ r_i = 2m_i/(q_{i-1} + q_i);\ \bar{r} = \left[\sum_{i-1}^{n-1} \tfrac{1}{2}(r_i + r_{i+1})V_i + r_n V_n\right] / \sum_{i=1}^{n} V_i$$

California Freeway segments[6] classified by traffic density and number of lanes: marginal accident costs seem to exceed average accident costs by about 50 per cent over-all, though there is considerable variation in the relationship. There seems to be some tendency for the average rate to decline with increased traffic for very low levels of traffic, leading to a marginal accident rate below the average. This may simply be an artifact resulting from the prevalence among the low-volume segments of segments recently opened to traffic, where temporary exits and entrances and the lesser familiarity of the traffic with the road would influence the accident rate, or it may represent a beneficial effect of a low level of traffic in keeping drivers alert, warning of curves at night, and minimizing the chances of going in the improper direction. In any case this range of traffic flows accounts for only 3 per cent of the total freeway traffic. Freeways in turn accounted for 15.6 per cent of fatal accidents and 17.3 per cent of all accidents.

Other indications that there may be a positive relation between traffic density on a given roadway and the accident rate per vehicle-mile are found in the higher insurance premiums charged in high-density areas and in data showing that limited access freeways have lower accident rates than do older facilities.[7] It is at least possible that a good deal of this accident reduction can be related to the reduction in the traffic/capacity ratio that comes about with the construction of extremely high-capacity facilities.

In a sense, the excess revenues generated by charges for marginal accident propensities in excess of the average cost of all accidents would constitute a contribution towards the rental value of the highways. In this respect accidents are simply a form of congestion cost. In a world of constant returns to scale, these excess accident premiums would contribute to a fund which, when combined with other congestion charges, would just suffice to finance the optimum roadway system. This may perhaps be clarified by imagining that highways are sufficiently divisible so that a number of parallel highways can be operated serving each corridor, each highway operated by an entrepreneur in perfect competition with the others, on the basis of a toll which with free entry will tend to be set at a level just covering the costs of the entrepreneur. If c is the cost of roadway per unit of width

[6] Richard A. Lundy, *Effect of Traffic Volumes and Number of Lanes on Freeway Accident Rates,* California Division of Highways, Traffic Department, July 1964, Table 4, p. 9.

[7] See Table 2.

TABLE 2

SUMMARY OF ACCIDENT RATES ON THE CALIFORNIA STATE HIGHWAY SYSTEM, 1964–66

(ACCIDENTS PER MILLION VEHICLE-MILES)

	Total Including Property Damage Only	Fatal and Bodily Injury	Fatal
Rural Areas			
Freeways	1.00	.47	.045
Other	2.48	1.13	.091
Total	2.06	.94	.078
Urban Areas			
Freeways	1.61	.68	.022
Other	5.61	1.91	.042
Total	2.84	1.06	.028
All Areas			
Freeways	1.48	.63	.027
Other	3.70	1.43	.072
Total	2.52	1.01	.048

or capacity w, q the flow of traffic, and p the toll, we then have, for each highway, $pq = cw$. If $h = q/w$ is the density of traffic relative to capacity, $p = cw/q = c/h$, and if we suppose that the various roads are operated under various tolls and various densities to suit the relative preferences of the users as to price versus quality, tolls will vary inversely with the density of traffic; otherwise profits or losses would induce changes in the pattern.

We may suppose that the users, in addition to the toll paid to the firm providing the highway, also pay a premium $r(h)$ for insurance against accident during each use of a highway at density h, the rate generally increasing with h to reflect the higher accident rate on highways operated at higher traffic densities. (It makes no difference, for present purposes, whether the insurance is on a liability basis or on a direct compensation basis.) Put $v_i(h)$ for the value placed by the user on the ith use when that use is at density h, defined as the total price (toll plus premium) that the user would be willing to pay for use under those conditions rather than foregoing the use entirely. Then $(dv_i/dh)dh$ is the change in the value of the ith use resulting from an

increment in traffic density dh produced by an increment of traffic $dq = wdh$ on the roadway in question. If we assume that the variety of roadways available approximate to a continuous spectrum, then for any use i that in equilibrium uses a roadway with a density h, a toll $p(h)$ and an insurance premium $r(h)$, we must have $(dv_i/dh) = (dp/dh) + (dr/dh)$; otherwise the user would find it to his advantage to move either to a less congested road where the toll would be higher and the insurance premium lower, or to a more congested road where the reverse would be true, depending on the sense of the inequality. In the former case he would value the gain in quality plus the reduction in premium more than the increase in toll, and conversely in the latter case.

Thus, although different uses of the same roadway may have different values, the differential between the value of each use at a particular density h, and the value of that use at adjacent densities, given by dv_i/dh, must be the same for all uses i which use the same road (or any other road operating at the same density h). Accordingly, the impairment of the value of service to users of a roadway having a volume of traffic q and a density h caused by an increment of traffic dq resulting in an increase of h by $dh = dq/w$ is given by

$$\begin{aligned} mdq &= q(-dv/dh)dh \\ &= q[-(dp/dh) - (dr/dh)](1/w)dq \\ &= (q/w)[-d(c/h)/dh - dr/dh]dq \\ &= h[ch^{-2} - (dr/dh)]dq \\ &= [p - h(dr/dh)]dq \end{aligned}$$

whence $p = m + h(dr/dh) = m + [d(rh)/dh - r]$.

In other words the toll is equal to the sum of the short-run congestion cost suffered by others, m, plus the excess of the short-run marginal accident cost, $d(rh)/dh$, over the average accident cost, r.

Of course, in practice there are generally substantial economies of scale in rural highways at least; urban streets may be characterized by diseconomies of scale. The extent that the roadway system as a whole shows decreasing or increasing returns to scale would be reflected in the generation of a surplus rent or a deficit condition.

The chief difference between accident externalities and other forms of congestion cost lies in their pattern of variation among roads of different characteristics and the degree of economy or diseconomy of scale encountered. In the case of the usual notion of congestion cost, the importance of this factor at very low levels of traffic is such that it is usual to consider the marginal public cost of travel on such roads

as consisting almost entirely of the wear and tear element, which has been estimated at 0.1¢ per mile for paved roads, as contrasted with 1.8¢ per mile for gravel and 3.3¢ per mile for earth roads (to indicate very rough orders of magnitude).[8] If, however, one gives full weight to the data indicating that high death rates, at least, are associated with low traffic volumes, then it seems likely that a charge approximating 1¢ per mile would be appropriate[9] as representing the accident cost of travel on low-density paved roads, with perhaps a lower figure for the less risky dirt and gravel roads. Since, however, only a relatively small mileage is driven, in the United States at least, on unpaved roads, and most of this is portions of trips involving paved roads as well, the problem of adjusting charges to cover costs on the unpaved roads can probably be neglected. What this means is that while, on the basis of congestion and maintenance costs alone, traffic on low-density paved roads would be considered to have a marginal cost well below the level of the gasoline tax, consideration of the accident element makes it possible to suppose that the marginal cost and the tax rate are much more closely in line in this instance. Moreover, in terms of accident costs, the economies of scale in low-density highway construction appear to be much less drastic than for other costs: if traffic is doubled and road miles are doubled to maintain the same density of traffic per mile of road, intersections are quadrupled, and, to the extent that intersections are an accident hazard, economies of scale are offset.[10]

Where traffic density is higher, it is difficult to say very much about the marginal accident cost of traffic, except that it is likely to vary considerably according to circumstances. If a general system of congestion charges is installed, records enabling the cost of accidents to be included in the congestion charge may either by that time have been developed or may be developed as a byproduct of the congestion-charge system. However, there are no immediate prospects for any such general congestion levy, and it becomes appropriate to ask what

[8] See Allan A. Walters, *The Economics of Road User Charges*, International Bank for Reconstruction and Redevelopment, Washington, D.C., 1968.

[9] In 1966, total accident costs were $10 billion for 935 billion miles of travel, or 1.07¢ per vehicle mile (National Safety Council, *op. cit.*, p. 59). Although accident rates are lower for lower density roads, this can be offset by the allowing for higher death rates per accident, for the probable excess of marginal cost over average cost, and for pain and suffering and indirect costs not included in the $10 billion figure. On balance 1¢ seems reasonable.

[10] In California in 1966, 32.4 per cent of all accidents and 23.7 per cent of fatal accidents occurred at intersections. (Department of California Highway Patrol, *Report of Fatal Injury Motor Vehicle Traffic Accidents for 1966*, p. 54.)

methods of paying for accidents can be suggested as more conducive to economical allocation of resources, and to more equitable compensation of victims.

The bill of indictment against the present tort liability insurance system is a long one. Many victims obtain inadequate compensation or none at all, as a result of the difficulty of proving fault, the insolvency of the tortfeasor, inability to identify the guilty party, lack of or inadequacy of insurance coverage, or improvident settlement under pressure. A few fortunate victims obtain multiple compensation from two or more sources. Contentious victims of minor accidents often obtain nuisance settlements in excess of their losses, while victims having major losses appear to be substantially undercompensated even where compensation is paid. The costs of the system are exorbitant, the overheads of various kinds amounting to more than the net amounts received by the claimants. The process of pursuing a claim is often demoralizing, and inhibits early rehabilitation efforts. Many insurance companies claim that the business is an unprofitable one in general; much of the underwriting is done on the one hand by shoestring operators who often fail to meet their obligations and on the other by large companies or associated groups wishing to maintain a full-line offering.[11] Unlike most other forms of insurance, claimants are generally not the company's own policyholders, which creates an atmosphere in which adjusters often press hard for inadequate settlements, especially of the larger claims. The contingent fee system, considered unethical in many other countries, is in the United States the dominant arrangement for the prosecution of claims, and is considered by many to be a substantial source of abuse. Still another feature peculiar to the United States is that the claimant is not, at least in legal theory, ordinarily entitled to recover his legal expenses explicitly in addition to his losses, even in cases of demonstrable contumacy on the part of the defendant. There is thus no adequate penalty imposed on insurance companies for going to court with a weak case.

These and other considerations have led to repeated attempts at reform, including the enactment of financial responsibility laws in many states, compulsory liability insurance in a few, the "workmen's compensation-type" plan in effect in Saskatchewan, and the "Keaton-O'Connell" type of plan recently passed by the lower house in Massachusetts but subsequently defeated. The main features of this latter

[11] Cf. "Auto Insurance Pot Boils Over," *Trial Magazine*, Oct./Nov. 1967, pp. 12–13.

plan are that losses between a given lower limit and some defined upper limit are to be compensated on a compulsory hazard-insurance basis without regard to fault, while victims retain the nominal right to prosecute claims for smaller amounts on the basis of fault, on the supposition that few will incur any very substantial expense in doing so, and to prosecute claims on the basis of fault for the excess over the amount awarded on the nonfault basis.

For present purposes, however, what is important is that all of the proposals except the Saskatchewan plan retain the current methods of writing automobile accident insurance. While the settlement costs might go down considerably with the elimination of fault determination as an issue in the bulk of cases, too much should not be expected from this, since the amount of the compensation to be paid would still require adjudication or negotiation. There would still remain in any case the underwriting costs, which tend to be particularly heavy in view of the complexity and inaccuracy of the rating methods adopted by the various companies in attempting to adjust premiums to various circumstances deemed to have a bearing on the individual risk being underwritten. And policies would still be written basically in terms of insuring a car for a given period, a basis that almost inevitably seriously distorts the economics of the situation.

Three types of decisions are, in fact, involved in the generation of automobile accidents: the decision whether to maintain a car (or a second or third one); the decision whether to make a given trip by car and, if to make it, by what route and at what time; and the decision as to what degree of caution to exercise while driving. While one could argue that drivers would exercise more appropriate caution if held strictly accountable, without the possibility of insurance, for accidents in which they were involved (even for accidents in which they were not negligent in the legal sense), it is almost universally agreed that it is better to accept a degree of "moral hazard" in inducing a certain relaxation of caution by insuring, rather than accept the consequences of serious impoverishment of unlucky individuals through lack of insurance. Many writers in the field, particularly those advocating the abandonment of the fault concept, claim with some degree of plausibility that, for most individuals, moral responsibility, the threat of the uninsurable unpleasant effects of accidents, and the threat of penalties for traffic regulation infractions provide enough of an incentive for safe driving that the addition of the threat of uninsured liability for damages caused would have relatively little incremental effect. In some cases, the threat of increased insurance

rates for risks with bad past records may also operate as an additional incentive, though this seems to be more of a deterrent against the presentation of small claims than an incentive for added caution. In any case, for present purposes this aspect of the problem can be considered relatively unimportant. About the most that one could consider doing in this direction would be to require all insurance policies to have a substantial deductible to be borne by the insured in the event of liability.[12] It is one of the many anomalies of auto accident insurance that where the insured is adjudged at fault, the full amount of the settlement is paid by the insurance company, whereas in collision coverage an innocent victim of an accident not involving demonstrable fault on the part of another party is often required to bear the burden of a deductible.

In any case the payment of the insurance premium bears primarily on the decision whether to maintain an additional car, and only to a minor extent, if at all, on the decision whether or not to make a particular trip.

To be sure, most underwriters attempt, in determining premiums, to take some account of whatever information is available on the mileage that the insured car is expected to cover during the term of the policy. It is clear, however, that this provides very little deterrent to the use of the car for marginal trips, since this usage is unlikely to induce an increase in the premium rate, and since, in most instances, the policyholder will be unaware of the degree to which information on mileage driven, even if made available to the underwriter, would affect the insurance premium. The most likely place for this kind of influence to operate is in decisions relating to the journey to work, where the character of the usage can be fairly well defined and taken into account. At best, however, this influence is likely to be small, particularly as underwriters cannot, in a competitive market, offer large rate differentials on the basis of largely unverified representations.

Indeed, it is precisely in those cases where the maintaining of an additional car is a close decision that the premium is most likely to overstate the risk substantially: a car that can barely be afforded is likely to be a car that will add much less to total mileage driven and to risk exposure than would be indicated by the added premium that the underwriter will find it necessary to charge. Thus, the manner of

[12] Ideally, one might require the size of this deductible to vary with the resources of the insured.

assessment of insurance premiums is likely to result in a more intensive use of a smaller stock of active cars than would be economically most efficient. It is not clear whether the number of car-miles thus generated would be greater or less than would occur under a more accurate assessment of accident costs: this would depend on the relative elasticities at various points and either result is theoretically possible. But even if the impact of the time-related premium on the active stock of cars were large, the cars added to the total stock as a result of more accurate adjustment of insurance premiums would increase total travel relatively little. It therefore seems likely that this added mileage would be more than offset by reduced intensity of use of the existing stock.

The inefficiency induced by the time-related pattern of insurance premiums might not of itself be sufficient to warrant a change in the practice, but in the light of the widespread dissatisfaction with the present system, for other reasons, it may be an appropriate time at least to explore possibilities for change.

A most appropriate and, as far as collection is concerned, convenient way of assessing the major part of the cost of accidents against motor vehicle users might be a supplement to the gasoline tax. Regional differences in accident cost rates could be reflected in differential tax rates, and while some inequity and inefficiency would be engendered by the opportunity to fill up in the low-tax areas, this problem on the whole seems minor compared to the widespread inequities in the present situation or in any time-based premium approach. It might be best to ignore state and local dividing lines and collect part or all of the tax on the basis of the point of retail sale. This would permit the rate to be graduated more smoothly and would minimize the disturbances to competitive relationships that tend to occur where the tax varies in substantial jumps across a political boundary.

The main difficulty with this approach is that while it takes care of collection, it fails to provide a mechanism for the distribution of compensation to its victims. This is no problem in a place like Saskatchewan, where insurance is already a government monopoly, and it would indeed be an easy means of achieving a substantial improvement in equity and efficiency for Saskatchewan to replace its periodic premium system partially or totally with an increment to its fuel tax. This would have the substantial advantage of extending coverage almost automatically to out-of-state cars driven in Saskatchewan; the

only problem then remaining would be to provide coverage, possibly through conventional private coverage, for Saskatchewan cars being driven elsewhere.

One might, indeed, consider the superiority of the gasoline tax (and possibly also tire taxes) as a means for assessing accident costs, not only in terms of equity and efficiency in allocation, but also in terms of cost of collection (as compared with the cost of selling insurance individually) to be great enough to warrant, if necessary, the establishment of some form of monopoly organization to take care of the awarding of benefits to claimants out of the funds thus provided. It should not be thought, however, that workmen's compensation procedures provide an adequate precedent in themselves for such a scheme: victims of industrial accidents constitute a relatively homogeneous group to which uniform standards can be applied fairly readily, while traffic accident victims cover the entire range of economic status, and it may be that a more flexible, pluralistic approach is needed to deal with the range of cases they present. The Saskatchewan plan has been neither a complete failure nor such an outstanding success as to compel imitation; and what works reasonably well with a relatively homogeneous population might develop difficulties in a more industrialized and heterogenous area. But despite all the difficulties that might develop under such a monopoly or state board, it is hard to imagine a situation more unsatisfactory than the existing one.

Nevertheless, the prospects for developing such a public or quasi-public instrument are not bright, particularly as insurance interests, in spite of their loud wails of anguish at the losses they claim to be suffering from the existing business at regulated rates, are sure to mount vigorous opposition to any such proposal. It may be necessary, therefore, to seek some way by which assessment through the gasoline tax can be combined with private enterprise claim settlement.

One way would be simply to establish a state fund derived from suitable surcharges on fuel taxes, registration fees, drivers' license fees, and possibly tolls and congestion charges, where these are in effect, and then allow insurance companies to bid for the job of taking care of accident claims relating to the operation of suitably packaged sets of automobiles registered in the state, possibly including in each package some suitably defined obligation with respect to accidents in the state involving out-of-state vehicles. It would even be possible to include in such a scheme a differential in the surcharge on drivers' licenses to produce much the same effect as that produced by the

higher premium rates now generally enforced against younger drivers. However, it seems unlikely that such a result, accepted with considerable protest even when imposed by private companies impelled by the competitive drive for better underwriting results, would persist in explicit legislative enactment. In any case, there seems to be no reliable way of varying a premium according to the amount of driving done by a particular driver, as distinct from the mileage a particular car is driven.

A major difficulty with such a plan, at least in the Northeastern states, where a large volume of short-haul interstate traffic exists, is that unless a roughly similar plan were adopted simultaneously by a number of contiguous states, avoidance of the insurance surcharge through preferential purchase of fuel out of state would present a fairly serious problem, especially where state lines run through areas with high premium rates.

One procedure that might get around this difficulty, though it would produce others, would be to hold a mass shotgun wedding between oil and insurance companies, by requiring each oil company, as a consequence of the sale of its gasoline for highway use, to assume an appropriate share of the liability for all accidents involving the automobile using its gasoline. The cost of the accidents would then be included in the price of the gasoline, which the oil company could vary with location, and, in the case of credit card sale, with the rating accorded the particular vehicle. Such a scheme would of course require some means of determining whose gasoline a car was using at the time of an accident. One means would be to require the maintenance of a vehicle log, showing the gallons, mileage, outlet, and brand of each fuel purchase, possibly backed up by a similar log maintained by the service station, showing the vehicle license number. Where credit cards are used the record would be relatively automatic. Another method might be the addition of some quantitatively determinable tracer compound to the product of each oil company, so that subsequent analysis of the fuel of a car involved in an accident could establish the company or companies liable for the damages. To facilitate the analysis, a removable sampling cartridge could be installed in the fuel line at relatively slight cost. Still another method might involve the application of a seal to the gas tank cap. Or a combination of methods could be used.

It would even be possible to develop such a form of insurance as a voluntary method, which would involve obligating the vehicle operator to buy his gasoline almost entirely by credit card. There seems to be

no essential reason why the incremental accounting and selling costs involved should be any higher than the costs involved in the commission system; the scheme should be especially attractive to vehicle owners running a low annual mileage. It might be difficult, however, to develop the scheme in a form that would meet the requirements of the compulsory insurance states.

The problem of identifying the underwriting party would be simpler if the liability were attached to the sale of tires, since the brand here is obvious. The main difficulty with this is that tire use can occur at a great distance from the place of sale, so that no substantial geographical discrimination is possible and adoption on less than a nationwide scale would hardly be feasible. Moreover the insurance element in the price would have to be as much as two or three times the present retail price, which would be likely to have serious distorting effects. Unless a substantial rebate were available on the turning in of used carcasses, depending on the weight of tread rubber remaining, the high cost of tires might induce uneconomical and dangerous use of tires worn thin. On the other hand, the liability for accidents would encourage tire manufacturers to promote safer tires. There would be strong and perhaps even excessive incentives to watch tire inflation and wheel alignment very closely, and hard cornering and high speed travel would be appropriately costly. There would be a slight favorable side effect in that travel on gravel and dirt roads would be more costly in terms of tire wear, which is in keeping with the higher maintenance costs of such roads. Use of tire taxes as a vehicle for payments for the marginal costs of accidents and congestion occasioned by highway users seems on the whole more appropriate for underdeveloped countries, particularly where little vehicular traffic across frontiers takes place, than for a federation of fifty states jealous of their independence of action.

But whatever is done with insurance, there will remain substantial elements of gross externality not covered by such insurance, calling for some form of payment by highway users in addition to insurance premiums. One element, resulting from the diseconomies-of-scale element according to which increased density of traffic on a given road increases the average cost of accidents per vehicle-mile, can perhaps best be treated conceptually as a kind of rent to be charged for the use of a limited resource, applicable, where economies of scale in the production of roadway capacity permit, to the improvement of the roadway network, but often, as in the case of core city

streets, considered only as a rent paid in relation to the inherent scarcity of urban land.

A second externality element consisting of contributions from outside the motor vehicle economy for the succor of victims and alleviation of damage inflicted by vehicular traffic, can well be considered as warranting a net additional charge on highway users to be levied apart from any highway trust funds and used as a general revenue. A third, somewhat similar element, would arise from the fact that compensation paid victims is seldom equal to the full cost, inclusive of all elements of pain and suffering endured by the victims. While it may be possible to come up with some not too outrageous estimates of what this added cost should be evaluated at in the aggregate, it may be impossible to come up with the comparable breakdown of this figure for individual cases, and undesirable to pay actual compensation on this scale even if it could be done, in view of the moral hazard that might thereby be generated. But the fact that the full compensation is not, and possibly should not be paid to the individual victim does not affect the desirability of assessing the full loss against the activity responsible for it, if that activity is to be held to an optimal level.

COMMENT

by MARTIN J. BAILEY, *University of Rochester*

The first reading of this paper, with its suggestion to let the oil companies pay the costs of all highway accidents, suggested the conclusion, "Vickrey scores again!" As we all know, Vickrey belongs to a small, elite group who have kept the economics of public policy from becoming hopelessly dull. Moreover, he belongs to a still smaller group who are nearly always right. That public authorities have always rejected his proposals merely adds luster to his other accomplishments.

However, a second reading raises questions. Although his proposals this time have most of their usual attributes, it isn't clear that they are right. At best, they fail to follow from his own analysis and evidence. First, he discusses costs borne by third parties: sick leave provisions, pensions, social security, health insurance, unallocated court costs, public assistance, subsidized hospital care, and so on. These classes of external costs apply to all types of accidents, and deserve to be considered as a group, rather than piecemeal. A perfectly discriminating, Pareto-optimizing solution to the announcement effects of these subsidies would be to discontinue them. That may not be the right thing to do, but it highlights the point that these subsidies deserve to be considered as a distinct subject.

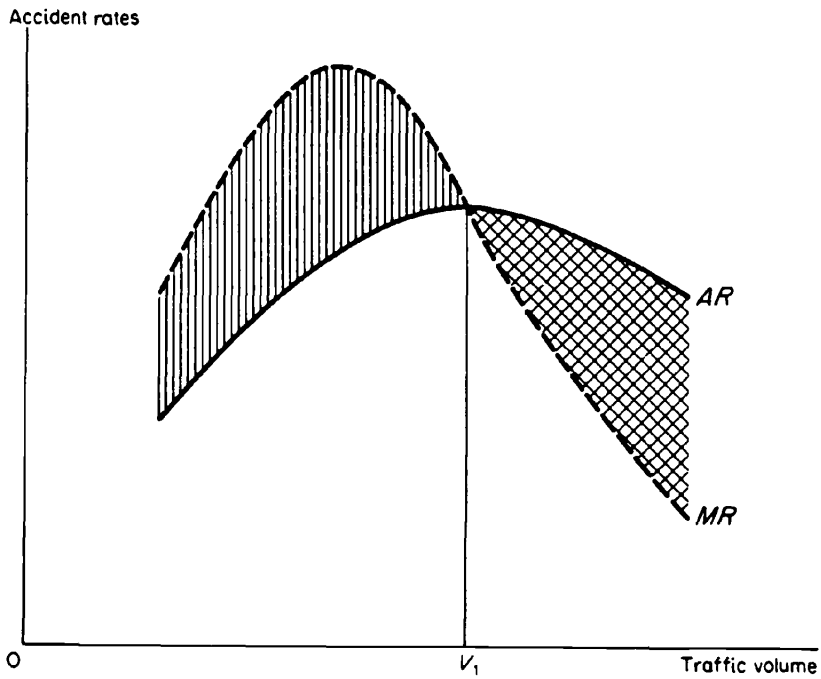
Second, merely having the gasoline companies pay accident costs doesn't meet the problem. In the light of Vickrey's own argument about the excess of marginal cost over average cost, they should in addition pay something, perhaps an equal amount, into the highway fund.

Third, whereas traffic time delays undoubtedly rise monotonically with volume, so that a net excise tax is appropriate for each trip, it is not clear that accidents also rise monotonically. Vickrey's own reasoning and evidence say they do not. He notes that total fatalities decline with volume, because a decline in single-car fatal accidents more than offsets a rise in multiple-car fatal accidents. (Evidently the extra traffic gets in the way and so protects the prospective single-car accident victim.) This decline in fatalities may be enough to offset, or outweigh, the rise in accident property damage and bodily injury with

higher traffic volume. Moreover, Vickrey notes that above a certain degree of congestion serious accidents most likely stop altogether, and accident rates, property damage, and so on, probably decline. If so, the effect of more trips on accident rates points to a tax on trips only up to that volume at which these rates reach a maximum. At higher volumes there should instead be a subsidy.

Figure 1 shows the average traffic accident rate as a function of volume as the curve AR. The curve MR is marginal to AR, and shows the additional accidents per unit of additional traffic. In the left-hand portion of the figure, up to the volume V_1, MR is higher than AR; the difference is the appropriate rate of tax to charge so that a motorist, in contemplation of a trip, bears its full marginal cost. This difference is given by the vertical lines that shade this portion of the figure. However, at volumes higher than V_1 the line MR is below AR; the difference is the appropriate rate of subsidy to induce more trips and push down the accident rate.

FIGURE 1



Unfortunately, we lack hourly data on accident rates, speed, and volume, to measure these effects exactly. With such data it would be possible to work out the right rates of tax for all circumstances to correct for the combination of time delay effects and accident rates effects.