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External Accident Costs of Motor Vehicles Revisited

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Lyn Martin[1]

1 Introduction

Road accidents impose a huge burden on the Australian community, estimated to be over $40 million per day, representing a major cause of death and disability (BTE 200 p. xi). It is widely argued road users do not face a sufficient share of this cost burden to ensure that they will act in the community interest. This paper explores the source of the possible disparities between the interests of individuals and those of society—disparities that would generate external accident costs.

This paper does not estimate the external costs of accidents. Rather, it reviews the range of definitions of external accident costs—from the popular to the theoretical—and examines the policy implications of each. The paper is aimed at promoting more critical discussion of this potentially significant component of road-user charges.

2 External accident costs and the optimal level of accidents

Establishing the external cost of accidents is a necessary step towards achieving an 'optimal level of accidents'— the point where the marginal cost of accident-reduction activity equals the marginal benefit.[2] If external costs were not included in the calculation then road use would be higher than desirable from society's point of view. Conversely, if too high a value were assigned to external accident costs then road use would be lower than the socially desirable level.

Accident cost is a function of accident rate and accident severity. Severity is influenced by speed and rate by the number of 'vehicle passings'. The impact of these two factors tend to work in opposite directs, as increased traffic levels are often associated with a reduction in average speed. This will be explored more fully later as it has implications for determining the external component of accident costs.

An 'economically correct' approach to road safety would involve some mix of safer roads, safer cars and safer driving with the level of expenditure on each option stopping at the point where the marginal returns were equalised across the options. As the system currently stands, jurisdictional boundaries limit the scope for achieving an appropriate balance.

The focus of this paper, the external accident costs of road use, starts from this position.

3 Wide variation in estimates of total external accident costs e

There appears to be no discernable pattern in the estimates of external accident costs. Nor surprisingly, the definition adopted for the external accident costs has a major impact on the magnitude of those costs. At the higher end of the scale is an ECMT study whose estimates of the external cost of accidents *exceeded* the official estimates of the *total* social cost of accidents (English *et al* 2000 p. vii). Edlin and Karaca-Mandic (2003)

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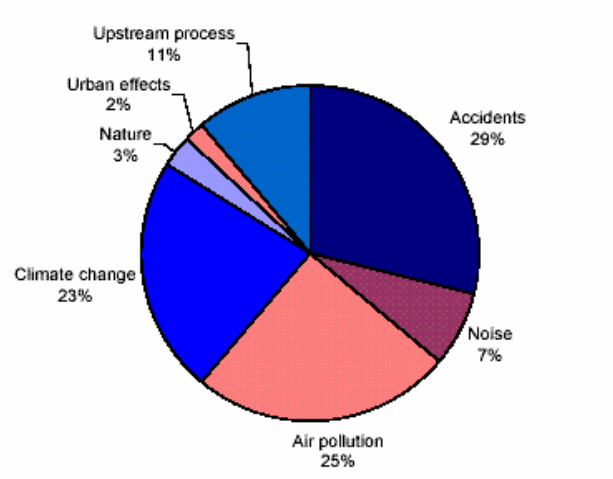
[1] Bureau of Transport and Regional Economics (BTRE). Views expressed in this paper do not necessarily reflect those of the BTRE.

[2] Given current technology, it is unlikely to be in the community interest to completely eliminate road accidents.

concluded that the external costs of accidents in California, if 'internalised' through insurance payments, could result in a trebling of insurance premiums—an increase of US$2231 per year'. At the other end of the spectrum, the Canadian Royal Commission of National Passenger Transportation estimated external accident costs to be around 2 per cent of total social cost of accidents (ibid. p. vii).

High-end estimates for Australia seem to be around $5 billion (Stanley 2002) and $7 billion per annum (Laird 2003), while the Australian Automobile Association put forward a figure of $2.5 billion per annum (AAA 1998).

The higher the external accident costs and the greater the share of transport externalities accounted for, the more significant accident externalities become as policy issue. Much of the European analysis tends to conclude the external accident costs and a major cost category of transport. The European INFRAS/IWW (2000 p. 9) study[3] estimated that transport external accident costs accounted for almost 30 per cent of the (non-congestion) total external costs, see Figure 1 below.[4]



SOURCE: INFRAS/IWW 2000

Figure 1 Composition of external costs of transport in EUR17[5] by cost category

3.1 External costs vary by location, vehicle type and traffic flows

While there are widely disparate approaches to estimating external accident costs, most analysts agree that they vary significantly with location/road type, vehicle type and traffic flows. In one study, the European Commission observed that 'the total accident externality charge is likely to be over ten times higher in a central city area than on interurban roads (EC 1999 p. 11). The estimates from the INFRAS/IWW 2004 study, presented in Table 1 below, illustrate even greater variation. The marginal external accident cost for passenger cars range from €3.9/1000 vehicle km (Sweden, motorways, low estimate) to €161.3 (Netherlands, urban roads, high estimate)—41 times the lower estimate.

Perhaps surprisingly, the study suggests that passenger cars have higher external accident costs than trucks ('heavy duty vehicles'). Both the upper and lower estimate of external marginal accident costs for passenger cars is higher than for trucks: €2.5

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3 Study sponsored by the International Union of Railways (UIC)

4 Assumed a value of human life of € 1.5 million and that average costs and marginal costs re equal.

5 EUR17 refers to the Western European countries—the original 15 EU countries plus Norway and Switzerland)

(Sweden, motorways, low estimate) compared with €3.9 at the lower end and €73.3 (Belgium, urban, high estimate) compared with €161.3 at the upper end.[6]

	Motorways						Inter-urban Roads						Urban Roads					
	Cars			HDV			Cars			HDV			Cars			HDV		
	low	mean	high	low	mean	high	low	mean	high	low	mean	high	low	mean	high	low	mean	high
Austria	14.2	27.3	34.1	8.7	16.6	20.7	36.7	41.9	51.6	22.3	25.5	31.4	51.8	53.5	55.1	31.6	32.5	33.5
Belgium	11.3	21.7	27.1	7.5	14.4	18.0	60.3	69.0	84.9	39.1	44.7	55.0	122.6	126.4	130.2	69.0	71.1	73.3
Denmark	6.3	12.1	15.1	4.0	7.6	9.5	35.8	40.9	50.4	23.1	26.4	32.4	89.5	92.3	95.1	52.3	53.9	55.6
Finland	5.0	9.5	11.9	3.4	6.5	8.1	28.7	32.9	40.4	19.5	22.3	27.4	9.5	9.8	10.1	6.5	6.7	6.9
France	7.5	14.5	18.0	5.4	10.5	13.1	46.0	52.6	64.8	32.9	37.6	46.3	62.0	63.9	65.9	38.4	39.6	40.8
Germany	7.1	13.6	17.0	4.5	8.6	10.7	48.9	55.9	68.8	30.6	35.0	43.0	122.2	126.0	129.9	65.4	67.5	69.5
Ireland Rep.	11.2	21.6	26.9	8.8	16.9	21.1	19.5	22.3	27.5	15.3	17.5	21.5	60.2	62.1	64.0	47.2	48.7	50.1
Nether-lands	6.2	12.0	14.9	3.9	7.5	9.4	55.9	63.8	78.6	35.8	41.0	50.4	151.9	156.6	161.3	85.2	87.9	90.5
Sweden	3.9	7.6	9.5	2.5	4.9	6.1	27.4	31.3	38.5	17.5	20.0	24.6	19.5	20.1	20.7	12.5	12.9	13.3
Switzer-land	5.1	9.8	12.2	3.1	6.0	7.5	52.3	59.8	73.6	32.3	36.9	45.5	59.3	61.2	63.0	36.6	37.8	38.9
UK	7.7	14.9	18.6	4.5	8.6	10.7	46.6	53.2	65.5	26.9	30.8	37.9	53.4	55.0	56.7	30.9	31.8	32.8

SOURCE: INFRAS/IWW (2004) P. 92

Table 1 Range of Marginal Accident Costs for Medium Traffic Flows (€ per 1,000 vehicle km)

Wide variations in external accident costs have major policy implications simply because a tax on fuel or on distance traveled is not likely to provide an accurate mechanism for internalising such costs.

Ultimately, it is the definition of external accident costs that is adopted that determines both the total value and the variation. Commonly-used definitions of external accidents range widely and still appear to be in 'the state of flux' that Cox identified more than a decade ago (Cox 1994 p. 189).The various definitions and their implications are explored in more detail below.

4 Definitions of external accident costs

The following definitions are not mutually exclusive and some can be regarded as separately identifiable components of total external accident costs. The order of presentation roughly reflects popularity of the definition in general usage.

4.1 Fixed proportion of total accident costs

External accident costs are commonly defined as a fixed proportion of total costs, generally ranging from 10—50 per cent (e.g. BTRE WP 40 p. 63 and Cox 1994, p. 274). The first comprehensive Australian study on transport externalities—*Victorian Transport Externalities Study 1994,* acknowledged that the 'proportion of accident costs which is borne externally is not known' (EPA 1994, p. 13) but adopted 30 per cent as the external component of accident costs. Parry (2001 p. 11), also acknowledging that it was 'difficult to pin down the split between private and external costs', used a range between 10 per cent and 50 per cent

6 Although a weighted average could produce a different conclusion.

When adopting such a definition of external accident costs the final figure will be heavily dependent on the estimate of total accident costs. There is a great deal of uncertainty surrounding these total cost estimates since costing accidents is not an exact science—estimates can vary widely depending on the two key parameters: the value of life and the discount rate.7 Since human costs generally account for over half the accident costs8, a, say, doubling of the value of life would increase any estimate of accident costs by 60 per cent—and, accordingly, the external component if it were defined as a fixed proportion of total costs.

4.1.1 Determining value of life

There are two major methodological approaches to valuing human life:

- human capital, based on the discounted value of an individual's future stream of earnings; and
- willingness-to-pay, based on an 'observed' individual's willingness to pay to reduce the risk of death or injury.

While initially providing some rationale for developing early valuations, more recently the human capital approach has generally been criticised on a number of grounds, including the unfortunate fact that it means that the life of individuals beyond the working age may be accorded zero value. Small (1999) also argued that the human capital technique is discredited because 'it attempts to value the full transition between life and death rather than the small changes in risk that people actually face'.

Feldman added his criticism of the human capital approach noting that:

> …while it [human capital method] measures earning capacity, it does not measure how much the deceased valued his own life. To measure how much people actually value their own lives, it is said, we should see how much they are willing to pay to avoid fatal risks (Feldman 1997, p. 1).

The perceived shortcomings of the human capital method have caused many policy makers to embrace the willingness-to-pay methodology, with a concomitant increase in the value of life—sometimes by an order of magnitude.

However, the willingness-to-pay approach also attracts its share of criticisms.[9] Feldman (1997 p. 2) noted that 'the studies get wildly differing estimates for the value of life, and many absurd results'. Professor Ross Parish (n.d) argued that, for a number of reasons, the willingness-to-pay estimates have very little credibility. In particular, that they assume that workers and consumers respond rationally to very small variations in the risk of death, despite the fact that 'people concerned have no way of knowing these probabilities'. Parish concluded that 'putting a credible economic value on human life is not possible' (p. 17) and that the main choices facing policy makers are to adopt some political valuation or to restrict analysis to cost-effectiveness studies.

For the sake of the current exercise, it is sufficient to recognise both the almost-arbitrary element in the value-of-life estimates and the influence that the estimates have on the external costs of accidents if, as often happens, the external component is assumed to be a fixed proportion of the total costs of accidents.

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7 For elaboration see BTRE 2000

8 See BTRE 2000, p. xi.

9 BTRE 2000 p. 22 Table 3.1 compares the advantages and disadvantages of both approaches to valuing human life.

4.2 Difference between insurance premiums and total accident costs

This definition of external accident costs as the difference between insurance premiums and total accident costs draws on the logic that if insurance serves as the mechanism to internalise the external costs of accidents and if the total cost of accidents exceeds the total insurance premiums, the difference must, by definition, be external. This definition was adopted by the Inter-State Commission (ISC 1990 vol. 1 p. 163) and is implicit in the work of other researchers.

However, insurance is only one mechanism for internalising costs. Insurance represents the market response to the legal liability that has its basis in Tort law—through which victims of accidents may recover their damage costs from those that cause accidents.

The fact that an individual may not be insured does not automatically mean that such damages cannot be recovered. Road users may opt to carry some risk themselves—to 'coinsure. This is common for many types of insurance reflecting an aversion to catastrophic costs but a willingness to bear moderate costs if insurance premiums are reduced to reflect the share risk. To count only the insurance premiums would completely ignore the residual costs borne by the road users.

4.3 Costs arising from disparate vulnerability of road users

The presence of heavy vehicles on the road (whether trucks or other passenger vehicles) increases the severity of accidents for lighter vehicles and non-motorised road users. Whether or not they are at fault in the accident, a heavy vehicle will cause significantly more damage than a light vehicle in the same collision. This has given rise to a definition of external costs based on the damages suffered by 'less protected users', in particular by pedestrians and cyclists, regardless of fault. Some countries, such as the Netherlands, have enshrined this principle in legislation. In the event of an accident between motorised and non-motorised road users, the legal presumption is that motorised vehicles are at fault. In 2002, the European Commission attempted to introduce similar legislation across the European Union. The Commission argued that motor vehicles cause most accidents and, regardless who is responsible, pedestrians and cyclists usually suffer more.

While it is easy to be sympathetic with the argument, some practical obstacles exist. If the attribution of fault is the combination of actual presence in the vicinity of the road and the larger size, then consistency would demand that roadside buildings and other 'street furniture' were also labeled as 'generators of external accident costs'.

There would also appear to be a theoretical inconsistency with this allocation of responsibility. If the aim in ensuring that motorised vehicles face their marginal external accident costs is to encourage more socially responsible behaviour, then it could be argued that non-motorised road users should also face their marginal external cost. If one group of road users were absolved of responsibility for their behaviour because they were less protected than the other party involved in the accident, then the pressure for them to act in a socially responsible way would be diminished.

Also, there are other mechanisms in place that take account of differential vehicle weights—in the tort and the criminal law system. Where an insurance market is working effectively, the fact that a truck can do considerable damage to lighter vehicles (and cars to unprotected road users) should be reflected in the insurance charges facing the driver.[10] While these charges may be paid in a lump sum and hence unrelated to a particular accident, there are still specific penalties that can result from each accident. For

[10] Also, most drivers of heavy vehicles would be loath to have the death of another person on their conscience and reluctant to risk their own lives in an accident. Proponents of this 'differential vehicle weight' argument could still argue that the driver does not face the cost of the life he or she might take. However, consider the case of the pilots of a Boeing 747-300. Is it necessary that they face the real cost of all the 470 deaths if the plane crashes?

instance, criminal charges could apply if the driver had been responsible for a death. A lesser offence could involve fines and penalties that could accumulate to the loss of a licence, putting a driver's livelihood at risk. There will also be insurance penalties through payment of 'excess' and the loss of the no-claim bonus.[11]

In general, the mix of traffic of different weights is a wider problem than the truck and other road-user interface. The disparity of vehicle weights on a particular road reflects the benefits and costs of providing specific roads for different weight classes. Truck-only lanes have been introduced on some high-density routes in the US and Europe. However, due to our lower traffic densities, that is unlikely to be an option for the near future in Australia.

4.4 Cost imposed on non-road users

There are two aspects of the costs imposed on non-road users: the personal and the 'system costs'. The personal costs include grief to victims' loved ones, property damages, lost income, medical costs and reduced quality of life to non-users.

System costs cover subsidised hospital, medical and policing costs associated with road accidents (see INFRAS/IWW 2000 p. 26, the UNITE project[12], and INFRAS/IWW 2004 p.29). One definition adopted by the Interstate Commission[13] was based on system externalities (ISC 1990 p. 89). Elvik (1994) defined system externalities as one of three components of external accident costs estimating that they account for around 30 per cent of the *total* cost of traffic accidents.[14] Accident prevention expenditures can also be included in costs imposed on non-road users.

The logic behind defining costs imposed on non-road users as externalities is straightforward. It is reasoned that participation in the road-use activity implies a full understanding of the risks and related crash costs. Road users are regarded as 'consenting adults' who, as a group, bear the costs of accidents. As a consequence, there are no externalities within this group.[15] Hence, it is the costs borne by the group that has not consented that are external costs. Two of the five studies examined by Gómez-Ibáñez (in Greene *et al* 1997) adopted this interpretation, estimating an external accident costs for automobiles of around one (US) cent per mile.

However, there are some stumbling blocks to this interpretation of external accident costs. First, as with congestion, while road users may bear the costs as a group, it is still important to ensure that the individual road users face incentives that reflect the costs they impose on others, whether the 'others' are motorists or non-road users.

With regard to property damage, there are avenues (although imperfect) to recover these costs through insurance and the legal system. The residual costs are likely to be

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11 Where drivers are not insured at all (such as when vehicles are unregistered or drivers unlicensed) civil action is the only recourse, and this is generally not very satisfactory. However, with modern technology allowing low-cost detection of unregistered vehicles, this should become a declining problem.

12 UNITE is an EU research program aimed at supplying policymakers with the framework and state-of-the-art cost estimates to encourage the development of a sustainable transport policy through the adoption of fair and efficient pricing of transport infrastructure use. For more details see http://www.its.leeds.ac.uk/projects/unite/objectives.html.

13 Another was the difference between insurance premiums and payouts

14 Physical injury externalities and traffic volume externalities (discussion following) were the other components.

15 This is analogous to an argument often made with regard to congestion.

capitalised into the value of roadside property.[16] Similarly, lost income, medical costs and reduced quality of life to non-uses can be accommodated within the legal framework and the resultant insurance system.

Grief to victim's loved ones is a clearly an important issue. Lindberg (2001 p. 41) noted that although only a few studies were aimed at estimating relatives' and friends' valuations, a figure of around 40 per cent of the value of statistical life seemed to be justified. However, it is not clear whether Lindberg had taken into account the mechanisms that currently exist to internalise those losses: scope for friends and family to separately insure the drive and insurance taken out by the driver that may already incorporate a value for grief by loved ones.[17]

The question of whether the cost of emergency response and crash prevention expenditures should be regarded as an external accident cost is slightly more complex. It is not made clear why road users should be singled out to cost recover these costs when a community choice appears to have been made to fund them through the tax system. In the words of one analyst:

> …unwanted distributional consequences of trying to internalize all costs of traffic injury must be weighed against the loss in efficiency entailed by a system that protects people from paying the full costs of an injury (Elvik 1994 p. 729)

A secondary consideration is mechanisms currently operate the recover some of the system costs from road users. In the event of accidents, there is often provision for the costs to be reimbursed from compensation payments that may follow from a legal settlement. Another method is the imposition of a tax on motor vehicle insurance. In some countries, such as France, car insurance tax is specifically designed to cover some social security expenses linked to road injuries (INFRAS 2000, p. 144).

4.5 Traffic volume externalities

From an economic perspective, if a vehicle entering a traffic stream changes the expected accident cost facing those already in the stream *and* if this change is not reflected in the prices signals facing the new entrant, then an accident externality will be generated. The accident cost of the entering vehicle has two distinct components: the costs faced by the driver and those imposed on other road users. The U.S. Transportation Research Board described this as follows:

> The expected accident loss from the added trip is the risk of accident involvement that the added vehicle itself incurs, plus the change in risk to the added vehicles using the facility (TRB 1996 p. 68).[18]

If the accident cost of the added trip (the marginal accident cost) increases or decreases the average accident cost, then an externality would be generated—which could be positive or negative. An increase in average accident cost arising from the entrant of an extra vehicle would imply an external cost while a reduction would imply an external

16 While this would be market solution, it is not to say that it would the most efficient solution. The Coase Theorem (Coase 1960) suggests that if property rights were clearly defined and enforceable and bargaining costs low, then the market outcome (whether the property owners or the road users bear the roadside property risk of an accident) would be efficient. However, in the absence of such conditions, societies generally resort to laws that assign liability to road-users.

17 At least one major insurance company reports that it is possible to take out life insurance on anyone that is an Australian citizen and over the age of 16.

18 The term 'risk' appears to have been used as a shorthand for 'expected cost' through abstracting from variations in the severity of accidents.

benefit. [19] The critical determinant is the functional relationship between traffic flows and accident costs.

4.5.1 Functional relationship between accident costs and traffic volume

The relationship between accident *rates* and traffic flows is straightforward.

> If accidents are a random event and drivers take no adjusting behaviour, then one would expect the number of rod accidents to increase as the square of the traffic flow (Dickerson, Peirson and Vickerman in Lindberg 1999 p. 13).

There has been some modelling of the relationship between accident rates and vehicle flows.[20] Vickrey (1968) using data from Californian freeway driving in the early 1960s, estimated that the marginal accident rate was 1.5 times the average rate, indicating an external cost.[21] Vickrey went on to make the case that economic efficiency would be best served by exacting from every individual involved in an accident, a payment equal to the full amount of the damage so inflicted, regardless of fault or relative contributory negligence. [22] If three or four vehicles were involved then the total payment would be three or four times the total cost of the accident.[23]

Elvik (1994) found that the presence of an accident externality was not so predictable concluding that the 'relationship between traffic volume and the number of injuries is not known in sufficient detail to determine whether the marginal external costs of traffic injury are equal to the average external costs (Elvik 1994 p. 731). Dickerson *et al* (1998) reviewed the empirical modelling of the relationship between road traffic accidents and traffic flows, noting Newbury's conclusion that the number of road accidents is proportional to flow, based on the 1982 US Federal Highway Cost Allocation Study. From their own analysis they concluded that the accident-flow relationship is non-linear and varies significantly between different road classifications and traffic volumes—while the externality is typically close to zero for low to moderate traffic flows, it increases substantially at high traffic flows. Also, at some point of increasing traffic flows, the 'accident externality is transformed into a congestion externality" (Dickerson *et al* in Lindberg 1999 p. 13).

Recent research by Edlin and Karaca-Mandic (2003) examined the extent to which an increase in traffic density in a given (U.S.) state increases (or decreases) insurance premiums. By using insurance premiums as a proxy for accident costs the researchers concluded that the marginal external accident cost could be twice the average although in some low density states there may be no accident externality (p. 19).

The functional relationship between traffic volume and accident costs determines the level and nature of traffic volume accident externalities. If the expected accident costs are proportional to traffic flow, then there would be no externality. An external cost is

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[19] For further reading see TRB (1996), Committee for Study of Public Policy for Surface Freight Transportation 1996, Dickerson *et al* (1998) and Walters (1961).

[20] Jan Owen Jansen (1994) demonstrated statistically that crash externalities occur only if average accident rates and severity are sensitive to traffic volumes. For elaboration, see Gómez-Ibáñez (in Greene *et al* 1997 p. 164).

[21] Note that 'accident rate' is not synonymous with 'accident cost'.

[22] While Vickrey qualified this general conclusion somewhat, he regarded the qualifications as inconsequential.

[23] With the excess funds collected being considered as part of the scarcity rent for use of the facilities (Vickrey 1968 p. 4).

generated if expected accident costs increase faster than traffic volume—an external benefit if accident costs increase slower than traffic volume.

5 Is the solution improving the mechanisms for internalising accident costs?

There are two broad institutional mechanisms for internalising the external accident costs of road use: insurance and the legal system. Enforcement of the road rules represents an *ex ante* attempt at forcing road users to face the cost of unsafe driving practice.[24] Presumably the penalties associated with behaviour reflect the higher accident risks associated with the behaviour. Stricter enforcement of road rules is technically possible. It is possible that the greatest gains (in terms of internalising accident costs) would be achieved from basic measures, such as ensuring that all drivers were licensed and vehicles were covered by minimum insurance. With modern vehicle identification techniques this should soon (if not already) be both technically and economically feasible, with only the political will being the final requirement.

The second institutional mechanism for internalising the accident costs of road use is the legal system, principally the law of tort. This provides the basic framework for ensuring that road users bear the cost of the damage they impose on others. Whether a system of strict liability or negligence is adopted the outcome will be the same *if* the courts set the level of due care to the socially optimum level of care.[25]

5.1 Insurance—good or bad?

An aversion to risk and catastrophic costs encourages many road users to voluntarily seek insurance to deal with these legally-enforced responsibilities, on top of the compulsory third-party insurance. However, insurance has been criticised because it protects transport users against accident risks, thereby changing their behaviour (e.g. Litman 2003) Elvik (1994 p. 279) found that while the evidence was conflicting, it generally held that measures that reduced accident costs borne by individual road users tended to increase the number of accidents.

It is also argued that the up-front nature of the insurance payments, only vaguely related to accident risk, fails to send accurate signals about the day-to-day cost of road use. As one commentator observed:

> …once the lump sum insurance cost of admission to car registration is paid insurance cannot put cost pressure on decisions about whether or not to take a trip…auto insurance provides ‘‘unlimited free mileage’ (Butler 1996)

It is generally accepted that there is significant scope for more finely differentiated and more actuarially-correct insurance premiums. Much of Vickrey’s influential 1968 paper focussed on the potential contribution of improvements in the structure of insurance payments. While there have been some improvements since 1968 in that a few insurance companies are trialing Pay-As-You-Drive insurance, lump sum payments still dominate.[26]

However, the lump sum payment of insurance does not completely abrogate the variable accident cost of road use. There still remain considerable incentives to avoid accidents, such as payment of excess, loss of no-claim-bonus and the personal risk and nuisance factor associated with accidents. Also, there are many goods and services where consumers can choose between fixed or variable costs or a combination of both. The

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[24] A separate paper could be written on whether penalties should reflect the expected cost of behaviour or the actual cost.

[25] Shavell (2003) provides a lucid explanation of this point http://ssrn.com/abstract=379802

[26] See Litman (1999, 2004 and 2005) for more detail.

literature reveals little concern over the fact that many consumers choose the fixed cost options for homes, cars, gym membership and mobile phones, thereby reducing their variable cost and risking the 'over consumption'.

There is appeal in the argument that improving the insurance system represents an efficient option for internalising the external cost of accidents. The scope for more actuarially-correct insurance charges will be increase significantly when global positioning systems become standard equipment. The Final Report of the Expert Advisors to the High Level Group on Infrastructure Charging concluded that:

> …a sophisticated insurance structure based on detailed risk information and reflecting the different variable components of the costs of accidents is the most satisfactory available means of internalising the external costs of transport accidents (Lindberg 1999).

A pertinent question for policymakers is whether there are currently any administrative or regulatory barriers to a more efficient insurance system.[27]

5.2 Rigorous enforcement of road rules

The legal system represents an important mechanism to internalise external accident costs. The rigorous enforcement of the road rules, particularly the apprehension of unregistered and unlicensed drivers, would reduce the external component of accident costs. However, such enforcement is not costless—either in a budget or political terms.

6 Conclusions

Accident costs are an important component of road transport costs. If, as some analysts estimate, a significant proportion of these costs are external, then the level of road use would be higher than is in the community's interest. Even if motoring taxes offset these external costs, it is unlikely that the structure of the taxes would correct the signals facing road users.

The estimation of external accident costs is very complex, raising both conceptual and measurement problems. In the absence of clear direction from the theory, it is understandable that simple definitions are often utilized. The range of popular measures include a share of total accident costs, the difference between total accident costs and total insurance premiums, costs imposed on non-road users (system costs being the main ones) and costs arising from the disparate vulnerability of road users. Most of these measures incorporate the concept of fault.

The more complex measure of accident externalities, one completely unrelated to fault, can appear to be quite alien. However, when presented as simply one component of external accident cost—the traffic volume externality—and that which is analogous to congestion, it can be more readily appreciated. This component of external accident cost draws on the potential difference between average and marginal accident costs. If the marginal accident cost equals the average accident cost, there is no traffic volume externality. An external cost exists where the marginal accident cost of a new entrant to the traffic stream is greater than the average accident cost. Conversely, where the marginal accident cost is lower than the average accident cost (say through the reduced accident severity due to the increased congestion) then there is an external benefit. While the functional relationship between accident *rates* and traffic flow is predictable, there remains a significant challenge in determining the functional relationship between accident *costs* and traffic flow.

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[27] It was necessary to introduce enabling legislation in Texas before Progressive's Pay-As-You-Drive insurance system could be introduced.

There is a three part message for policy makers. Facilitating improvements in law enforcement and in the insurance system would encourage the internalisation of external accident costs. The recovery of system costs is a separate issue that needs to be approached with a wider framework in mind. The most difficult area is the traffic volume externalities. This is an area requiring more research into the functional relationship between traffic flow and accident costs and into the link between congestion externalities and traffic volume externalities.

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