Accident Externality Charges

Jan Owen Jansson

Accident Externality Charges

Jan Owen Jansson

Accident Externality Charges

By Jan Owen Jansson*

1. Accident Costs in Optimal Road Pricing

The pricing-relevant cost of road use that should equal price $P$ at an optimum consists basically of three main elements: the cost inflicted on the producer of road services; the cost inflicted on fellow road users; and the cost inflicted on "third parties", or the rest of society.

So far as urban road services for car traffic are concerned, most attention was originally focused on the second element — the "congestion cost", as it was called. This component is a product of the traffic volume and the change (that is, increase) in the user cost caused by an additional unit of traffic. The existence of the third component has more recently brought the old idea of road pricing to the top of the agenda. This component is made up of costs caused by air pollution, noise, vibration, and so on. The pricing-relevant accident cost is also normally confined to the third component of $P$ because the motor-vehicle user collective does not bear all accident costs. This has been the main stand from the beginning of the road pricing discussion. A closer look at the literature, however, reveals some notable suggestions for extending the accident externality concept; Vickrey (1968, 1969), OECD (1985), and Newbery (1988) all boost the optimal level of $P$, explicitly or implicitly, by including a substantial accident cost also in the second, user-cost component.

2. Problem and Purpose

At a common facility like a road, the users' interference with one another takes two related forms: a reduction in speed to avoid collisions when traffic density goes up, and an increase in (multi)-vehicle accidents in spite of speed moderation. Some excellent well-known works on congestion theory and road pricing exist, where the speed-flow relationship forms the basis for modelling congestion delay. Mention can be made of the pioneering contributions by Walters (1961 and 1968), the Smeed Report (1964), and a recent survey, Goodwin and Jones (1989). Strangely enough there is very little in the mainstream road pricing literature about "traffic accident theory", the natural counterpart to congestion theory. After all, if a conventional "value of life" is applied to fatalities, total

* Swedish Road and Transport Research Institute and University of Linköping, Sweden.
accident cost in road transport is something like half the total cost of travel time, so the relationship between traffic accidents and the intensity of traffic may also be very important for road pricing.

The outstanding theoretical contribution to this area was made as early as 1968 by William Vickrey (at the same time, incidentally, as Walters’ famous World Bank study on the Economics of Road User Charges appeared, where, however, accident costs were discussed very little). It is quite possible that a main conclusion drawn by Vickrey is wrong, because its empirical basis was weak, namely that, like travel time, the accident rate increases with increases in traffic flow. This remains to be finally settled.

Vickrey’s work was not followed up for a long time. It was twenty years before a discussion of accident externalities at the intellectual level of Vickrey’s original work appeared. In Newbery (1988) the costs of accidents receive an appropriate treatment in a comprehensive survey of the theory and practice of “Road User Charges in Britain”.

The issue at stake can be pinpointed by a triple division of the pricing-relevant accident cost. Possible accident externalities caused by additional cars in a road traffic system can take the form of:

1. increasing accident risk for other cars;
2. increasing accident risk for unprotected road users;
3. accident spillover effects on the rest of society including net output losses, ambulance transport, hospital treatment, and so on.

The first item is the controversial one: does it exist, or is the accident risk independent of the car traffic volume?

David Newbery recognises that “the key element in determining the accident externality cost is thus the relationship between traffic flow and accident rates, where the evidence is sketchy, to say the least” (Newbery, 1988, pp. 171-72). He argues on a theoretical basis “that, holding constant the road system and the characteristics of the drivers and vehicles (all of which evolve over time), the probability of accidents depends on the number of encounters (that is, passings). Then accidents will increase as the square of the traffic flow” (Newbery, 1988, p. 169). However, he then qualifies this argument relying on “common sense and experience”, which speak for a somewhat weaker accident number/traffic flow relationship, and mentions that Vickrey (1968, 1969) cites evidence from California freeway driving which suggests that the marginal accident rate was 1.5 times the average, not twice, as would be implied by the simple square-law. Newbery also regrets that the COBA manual of the British Department of Transport, as well as the US Federal Highway Cost Allocation Study, which otherwise is praiseworthy, present no hard evidence on this point, but assume the average and marginal accident rates with respect to traffic flow to be equal. This seems to be an accepted highway engineering convention in other countries, too.

Vickrey and others (for example, the report of the Swedish Committee of Inquiry into road traffic costs and charges, Kommunikationsdepartementet, 1978) are impressed by the undeniable fact that when two cars collide, which is a relatively frequent type of road traffic accident, the two cars inflict “external costs” on each other; hence there are accident externalities within the car traffic collective. However, one has to take a less myopic view
to address the possible accident externality problem (1) in the triple division above, and consider the relationship between expected accident costs and traffic volume. That relationship does not follow unequivocally from the nature of car accidents. The dilemma is that empirical studies with a view to establishing a functional relationship between traffic accidents and probable determinants like traffic flow are very difficult because of the fortunate fact that accidents are rare occurrences. In a cross-section study, where traffic behaviour on different roads constitutes the observations, the observation period has to be rather long in order to arrive at a reasonably representative number of accidents in each particular case (road). And during such a long observation period, explanatory variables like weather conditions, the state of the road, the composition of traffic, as well as the traffic flow, do not stay constant. A lot of averaging is inevitable, which greatly reduces the accuracy of the data.

My point here is that externality problem (2) above, which alternatively could be labelled the "mixed road-user problem", is potentially the most important aspect of accident externality pricing, because no matter how car accidents depend on traffic flow, more cars probably means a higher accident risk for unprotected road users. Looking more deeply into this problem raises some difficult issues central to the urban transport problem, which will be addressed after the model discussion below.

3. Basic Models

To develop a theory of accident externality pricing, a simple model is useful, first of a transport system where only cars exist, and then of a transport system of mixed traffic.

3.1 Homogeneous car traffic only

In the road network under consideration the risk for each car of being involved in an accident is \( r \) per unit of time; \( r \) is a function of the traffic volume:

\[
  r = r(Q)
\]

where \( Q = \) total car-kilometres.

In line with the simple approach originally proposed by Mishan (1971), the expected total accident cost, \( TCA \), can be viewed as consisting of the willingness to pay for reducing the accident risk to zero both on the part of the motorists themselves, and on the part of their dependants, relatives, and friends, as well as the cold-blooded accident costs borne by the rest of society. Thus,

\[
  TCA = (a + b)rQ + cnA
\]

where:

- \( A = \) number of accidents;
- \( n = \) average number of cars involved per accident;
- \( a = \) willingness to pay for reducing the actual risk to zero of a representative motorist;
January 1994

Journal of Transport Economics and Policy

\[ b = \text{willingness to pay for reducing the actual risk to zero of the dependants of a} \]
\[ \text{representative motorist;} \]
\[ c = \text{the cold-blooded cost per car involved in an accident borne by the rest of society.} \]

Note that the cold-blooded part of the total accident cost can be calculated by taking the product of the average cost per accident of net output losses, ambulance transport and so on and the expected number of accidents, whereas the warm-blooded part can be calculated only on the basis of revealed or stated preferences for risk reductions.

The basic idea of accident externality pricing, like congestion pricing, is to charge motorists the difference between the social and the private marginal accident cost. The former is given by \( \frac{\partial TC}{\partial Q} \), and the latter is equal to \( (a + b)r \) — this is the main case — or just \( ar \), depending on whether or not the representative motorist takes dependants' suffersings into account when making travel decisions. The pricing-relevant accident cost, \( P_A \), constituting the optimal charge in respect of accident externalities, is consequently derived like this in the main case:

\[
P_A = \frac{\partial TC_A}{\partial Q} - (a + b)r
= (a + b + c)(r + Q\frac{\partial r}{\partial Q}) - (a + b)r
= (a + b + c)Q\frac{\partial r}{\partial Q} + cr.
\] (4a)

Introducing the following elasticity,

\[ E_t^Q = \frac{\partial r}{\partial Q}, \]

the pricing-relevant cost can also be expressed as follows (ignoring the possibility of unawareness of dependants’ suffersings):

\[
P_A = (a + b + c)r E_t^Q + cr \] (4b)

It is an open question whether motorists really consider cost item \( b \). Some researchers even go so far as doubting whether they consider \( a \); in other words, it is said that the perceived accident cost is nil. Turvey (1973), for example, argued that it would be quite reasonable to charge road vehicles for their own expected accident costs to make the drivers fully aware of the risk.

Apart from the issue of cost perception, the crucial empirical question concerns the value of \( E_t^Q \). The “square-law” referred to by Newbery would mean that \( E_t^Q \) is unity. This is clearly on the high side. Vickrey’s California observation would make it equal to 0.5, and Newbery’s compromise between Vickrey’s evidence and highway engineering conventional wisdom puts it equal to 0.25.

The critical question can be formulated more acutely by asking not just whether the accident risk depends on the traffic volume, but also whether the cost per accident depends on the traffic volume. Sooner or later the cost of an average accident is affected by traffic flow. As traffic density rises and speed falls, the severity of a representative accident falls, too, and the question is whether this offsets the (possible) progressivity in the number of accidents with respect to traffic volume. It is theoretically quite possible that the total
accident costs increase less than in proportion to the traffic volume in the range where the volume/capacity-ratio is relatively high.

If \( E_{20}^1 = 0 \) (and awareness of \( a+b \) is assumed) it is clear from the above that the whole accident externality charge comes to \( cr \), and total revenue of accident externality charges will just cover total costs inflicted on the rest of society, \( cA \).

In "Turvey’s case" the accident charge would come to \( (a+b+c)r \), which could be some ten times higher than the value of \( P^A \) in the main case, given the proportion of \( a+b \) to \( c \) typically assumed in road investment cost-benefit analysis. In the case where it can be assumed that motorists' perceived accident cost excludes the sufferings of dependants the accident charge would be \( (b+c)r \), which also would be many times higher than \( P^A \) in the main case.

A demonstrated difference between the actual and perceived cost that might apply to the item \( ar \) is, however, a rather weaker justification for a corrective charge than a true externality. The item \( br \) is a sort of semi-externality. It is a cost inflicted on others, which, however, should be taken into account by every responsible and sympathetic adult road user. To include \( br \) in the road user charges would be “to add insult to injury” to use a famous slogan by early road pricing critics (for example, St. Clair, 1964).

The following discussion of a mixed traffic system is confined to the main case.

### 3.2 Mixed Traffic

More intricate problems arise where road users constitute appreciably different threats to each other. Heavy lorries and light cars, trains and road vehicles at rail/road-crossings, motor cars and unprotected road users are three obvious pairs, between which the total injury and damage of a collision is normally very unequally distributed.

This case is discussed in a model where just two kinds of road users exist — homogeneous cars and cyclists. It is appropriate to distinguish three types of accidents that can occur: accidents where only cars are involved (single-car as well as multi-car accidents); accidents involving cars and bicycles; and accidents where only bicycles are involved. To sharpen the distinctions, the first-mentioned type of accident could be defined such that the number of bicycles in the system does not matter, and the last-mentioned type of accident such that the number of cars is inconsequential. Then the pricing-relevant cost of the first and third categories of accident are derived in the same way as was shown in the previous model of just car traffic. Therefore the following discussion is focused on the second category of accidents. To simplify notations it is assumed that just one cyclist is involved in each of those accidents (which cannot be very far from the truth). Thus:

\[
X = X(Q,M) \tag{5}
\]

\[
r = X/M = r(Q,M) \tag{6}
\]

where:

\( X = \) number of traffic accidents involving both cars and bicycles: “car/bicycle-accidents”;

\( Q = \) total car-kilometres;
\( M \) = total bicycle-kilometres;
\( r \) = expected number of car/bicycle accidents per bicycle-kilometre.

The point here is that the victims of this category of accident, involving both cars and cyclists, are practically always the latter. In the model the risk of injury and damage for car drivers is assumed to be zero.

The expected car/bicycle-accident cost \( TC^x \) is written analogously to equation (2):
\[
TC^x = (a + b)rM + cX
\]  
(7)

For expository reasons the cost parameter designations \( a, b \) and \( c \) remain the same as in the previous model, although cyclists rather than motorists are the victims in the present case. The pricing-relevant car/bicycle-accident cost for cars, \( P_{\text{car}}^X \), and the pricing-relevant car/bicycle-accident cost for bicycles, \( P_{\text{bike}}^X \), are derived as before by taking the difference between the social and private marginal cost. It should then be remembered that the private car/bicycle-accident cost of cars is nil. Then
\[
P_{\text{car}}^X = \frac{\partial TC^x}{\partial Q} = (a + b + c) \frac{\partial r}{\partial Q} M
\]  
(8)

\[
P_{\text{bike}}^X = \frac{\partial TC^x}{\partial M} - (a + b)r = (a + b + c)(r + \frac{\partial r}{\partial M} M) - (a + b)r
\]  
(9)

Introducing the elasticities
\[
E_{rQ}^X = \frac{\partial r}{\partial Q} \quad \text{and} \quad E_{rM}^X = \frac{\partial r}{\partial M},
\]
the pricing-relevant cost can also be expressed like this:
\[
P_{\text{car}}^X = \frac{TC^x}{Q} E_{rQ}^X
\]  
(8a)

\[
P_{\text{bike}}^X = \frac{TC^x}{M} E_{rM}^X + rc
\]  
(9a)

The total revenue from accident externality charges in this case comes to the following expression:
\[
TR^X = TC^x (E_{rQ}^X + E_{rM}^X) + cX
\]  
(10)

What can be said about the sum of the two partial elasticities?

In the previous discussion of the car-traffic-only case, it was argued that strict proportionality between the number of accidents and the traffic volume represents a rather conservative view of this relationship, whereas a quadratic function is the upper limit for the traffic volume-dependence of the number of accidents. This corresponds, of course, to constant accident risk, and accident risk proportional to traffic flow, respectively.

In the present case, a corresponding specification of the likely shape of the car/bicycle-accident function \( X(Q, M) \) is, first, to assume this function to be homogeneous, and then to argue that homogeneity of degree one and degree two, respectively, are the natural limits for the strength of the relationship between number of car/bicycle-accidents and car and bicycle traffic volume. In the former extreme case \( X \) increases in proportion to a simultaneous proportionate increase in \( Q \) and \( M \), and in the latter extreme case \( X \) increases in proportion to an increase in either \( Q \) or \( M \), keeping the other constant. Translated in terms of the partial risk-elasticities this means that
Table 1

Car/bicycle-accident Externality Charges, 
Assuming an Accident Function Homogeneous of Degree One

<table>
<thead>
<tr>
<th>$E_{rQ} = -E_{rM}$</th>
<th>$p_{\text{car}}$</th>
<th>$p_{\text{bike}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>$c r$</td>
</tr>
<tr>
<td>0.5</td>
<td>$\frac{TC^X}{2Q}$</td>
<td>$-\frac{(a + b - c)r}{2}$</td>
</tr>
<tr>
<td>1</td>
<td>$\frac{TC^X}{Q}$</td>
<td>$-(a + b)r$</td>
</tr>
</tbody>
</table>

From equation (10) it is immediately seen that the corresponding assumed limits for the total revenue from accident externality charges are $cX$, that is, the total accident spillover costs borne by the rest of society, often referred to as the "total accident cost responsibility" of the road user collective, and $TC^X + cX$, which is a large amount, some ten times more than the total accident cost responsibility $cX$ at the lower limit.

The most interesting aspect of the matter, however, is the distribution of the total cost responsibility between the two road user categories considered. The relative charges on cars and bicycles are determined by the relative risk elasticities, $E_{rQ}$ and $E_{rM}$. If the sum of these two is kept constant at zero (the conservative assumption), it follows that $E_{rQ} = -E_{rM}$, and the three cases shown in Table 1 are instructive.

In one unlikely extreme case, where $E_{rQ} = 0$, cars pay nothing, and the bicycles take on the whole cost responsibility, $cX$, for car/bicycle-accidents. This case is unlikely, simply because it seems highly improbable that an increasing number of cars in the system could leave the accident risk for a given number of bicycles constant. In the other extreme case, where $E_{rQ} = 1$, cars pay the total accident costs of car/bicycle-accidents, $(a + b)rM + cX$, both the part incurred by cyclists, and the part falling on the rest of society. The interesting curiosity of this case is that bicycles should receive a subsidy amounting to $-(a + b)r$ per bicycle-kilometre (to make the total cost responsibility of road users for car/bicycle-accidents remain at $cX$). The logic of this is that on the assumption that $E_{rM} = -1$, more bicycles in the system will not result in further car/bicycle-accidents, which in turn means that the risk for the original cyclists will fall. Whether possible or not, this seems somewhat far-fetched. A more neutral assumption is that more cars and more bicycles in the system will each lead to more car/bicycle-accidents. Setting the two risk elasticities at 0.5 and $-0.5$ respectively, gives the interesting result that cars should pay half the total accident costs. This will be much more than the total part falling on the rest of
society, $cX$, since $a + b$ exceeds $c$ some ten times. So the conclusion of the latter extreme case remains to a large extent that cyclists should be paid for using the roads, as long as an increase in bicycle traffic means that the risk of car/bicycle-accidents will be falling.

However, it should be remembered that cyclists should be charged on account of bicycle accidents (that is, accidents involving no cars, only one or more bicycles) both the costs of bicycle accidents falling on the rest of society and the possible additional charge required in case the number of multi-bicycle accidents increases more than in proportion to bicycle traffic volume. The need to subsidise cyclists will disappear, if these charges exceed the subsidy on account of car/bicycle-accidents.

### 4. A Numerical Illustration

As mentioned at the outset of subsection 3.2, cars and bicycles are just one pair of unequal road users, with profound implications for the distribution of the total accident cost responsibility between different road user categories. In urban areas a division between protected and unprotected road users seems to be the most important categorisation for calculating accident externality charges. It would be interesting to see if it is possible to arrive at a likely order of magnitude of the accident externality charges on urban motor vehicle traffic indicated by the preceding theory. Looking at equation (8a) we see that data for the total unprotected road user accident cost per motor-vehicle-kilometre are required, as well as the value of the elasticity $E_{Q}^{x}$.

In a comparative study of accidents in city traffic carried out at the Swedish Road and Traffic Research Institute (VTI) as part of the international “Future of the Automobile” project, the figures given in Table 2 were compiled (Jansson, 1984). Because total traffic volume data were too uncertain the numbers of fatalities are related instead to the number of cars registered in the administrative areas in which the accidents recorded occurred.

It is notable that, in total, two-thirds of the people killed by road traffic in these cities were unprotected road users: pedestrians, cyclists and riders of various motorbikes. About half of the people injured in road traffic were unprotected road users. The two cities representing “the New World” — Adelaide and Perth — were substantially different in this respect. There unprotected road users constitute 43 per cent of fatalities and only 9 per cent of total injured persons in road traffic accidents. The reason for this large difference is easily explained by reference to Table 4. Unprotected road user exposure is minimal in the car-based towns and cities of the USA and Australia. However, being unprotected as well as rare makes them very overrepresented among those killed in traffic accidents.

A critical assumption for calculating accident externality charges is that cars, buses and lorries are involved in the great majority of unprotected road user casualties.

From national statistics we know that in a relatively low-risk country like Sweden, approximately one unprotected road user is killed and ten are seriously injured per 100 million motor-vehicle-kilometres in urban areas. These figures are twice to three times as high in some other European countries, and still higher risks apply in other parts of the world. In a number of developing countries, figures more than twenty times as high are reported.
At present the Finnish, Swiss and Swedish National Road Administrations apply values of "a statistical life" of about US$2,000,000 per fatality and a value of US$400,000 per seriously injured person. (A number of other European countries use much lower values, while in the US higher values are used. For a discussion of the concept of the value of a statistical life, see Jones-Lee, 1989.) These values are applied in the numerical example in Table 3, where the results of a modest "sensitivity analysis" are presented. On the one hand the value of $E_{t0}$ is varied in the likely range, and on the other hand, so is the number of unprotected road user casualties per 10^8 motor-vehicle-kilometres.

It may be remembered that the current operating costs of cars are something like $0.20 per kilometre, so the issue of the cost responsibility for the sufferings of unprotected victims of traffic accidents is not just of academic interest. As distinct from congestion tolls, which should bite mainly in peak periods, accident externality charges should apply fully also in off-peak periods. In many cities in the developing world, where the risk to unprotected road users is well outside the range covered in Table 3, road user charges calculated in accordance with the principle suggested here, and on the basis of the life and limb evaluations applied in OECD countries would make car travel almost prohibitively expensive.
Table 3

Accident Externality Charges on Motor Vehicles in Urban Areas
on account of Accidents Involving Unprotected Road Users
(US Dollars per Kilometre)

<table>
<thead>
<tr>
<th>Values of $E_{x,q}$</th>
<th>Number of Killed and Seriously Injured Unprotected Road Users per 100 million Motor-Vehicle-Kilometres</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 and 10</td>
</tr>
<tr>
<td>1/3</td>
<td>0.02</td>
</tr>
<tr>
<td>2/3</td>
<td>0.04</td>
</tr>
<tr>
<td>1</td>
<td>0.06</td>
</tr>
</tbody>
</table>

5. Acceptability Problems

Road pricing has always met with great problems of gaining popular acceptance. Each of the different components of the pricing-relevant cost of road use has its individual acceptability problems to cope with.

One can only guess at the acceptability problems that would face accident externality charges when their full implications are made clear to the driving public. There are several reasons why this part of optimal road pricing may meet with particularly strong opposition.

5.1 Ex Post Pricing?

There is an important difference between congestion and accident externalities in so far as every car contributes to the congestion more or less equally, whereas many motorists would claim that they have never caused, and will never cause an accident, and would regard high accident externality charges as very unfair.

It is true that a particular category of road user, for example all those driving passenger cars, will contain a mixture of angels and villains, motorists with an unblemished driving record and "unlucky" fellows. Ex ante pricing will treat everyone alike. A possible way of making accident externality pricing acceptable may be to switch to ex post pricing. This could mean that one does not have to pay any accident externality charges as long as one is not involved in an accident. This has a superficial appeal. No one can complain that he pays for costs that he has not caused. On second thoughts, however, it will be clear that it would be very difficult to assess the pricing-relevant cost for each road user in actual accidents involving two or more road users (compare the Vickrey paradox). Moreover in practice ex ante and fully fledged ex post pricing would not differ very much. When an accident actually occurs, the payment demanded of the road users involved could be very
Accident Externality Charges

J. O. Jansson

Table 4

Modal Split of Worktrips in 1980

<table>
<thead>
<tr>
<th>City</th>
<th>Car %</th>
<th>Public Transport %</th>
<th>Walking, Cycling %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hong Kong</td>
<td>3</td>
<td>62</td>
<td>35</td>
</tr>
<tr>
<td>Tokyo</td>
<td>16</td>
<td>59</td>
<td>25</td>
</tr>
<tr>
<td>Singapore</td>
<td>24</td>
<td>60</td>
<td>16</td>
</tr>
<tr>
<td>New York</td>
<td>30</td>
<td>58</td>
<td>12</td>
</tr>
<tr>
<td>Stockholm</td>
<td>34</td>
<td>46</td>
<td>20</td>
</tr>
<tr>
<td>Paris</td>
<td>36</td>
<td>40</td>
<td>24</td>
</tr>
<tr>
<td>Copenhagen</td>
<td>37</td>
<td>31</td>
<td>32</td>
</tr>
<tr>
<td>London</td>
<td>38</td>
<td>39</td>
<td>23</td>
</tr>
<tr>
<td>Munich</td>
<td>38</td>
<td>42</td>
<td>20</td>
</tr>
<tr>
<td>Vienna</td>
<td>40</td>
<td>45</td>
<td>15</td>
</tr>
<tr>
<td>Hamburg</td>
<td>44</td>
<td>41</td>
<td>15</td>
</tr>
<tr>
<td>Zürich</td>
<td>45</td>
<td>34</td>
<td>21</td>
</tr>
<tr>
<td>West Berlin</td>
<td>48</td>
<td>37</td>
<td>15</td>
</tr>
<tr>
<td>Boston</td>
<td>48</td>
<td>34</td>
<td>18</td>
</tr>
<tr>
<td>Washington</td>
<td>49</td>
<td>39</td>
<td>12</td>
</tr>
<tr>
<td>San Francisco</td>
<td>49</td>
<td>40</td>
<td>11</td>
</tr>
<tr>
<td>Frankfurt</td>
<td>54</td>
<td>19</td>
<td>27</td>
</tr>
<tr>
<td>Amsterdam</td>
<td>58</td>
<td>14</td>
<td>28</td>
</tr>
<tr>
<td>Chicago</td>
<td>59</td>
<td>33</td>
<td>8</td>
</tr>
<tr>
<td>Toronto</td>
<td>63</td>
<td>31</td>
<td>6</td>
</tr>
<tr>
<td>Sydney</td>
<td>65</td>
<td>30</td>
<td>5</td>
</tr>
<tr>
<td>Melbourne</td>
<td>74</td>
<td>21</td>
<td>6</td>
</tr>
<tr>
<td>Adelaide</td>
<td>78</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>Brisbane</td>
<td>78</td>
<td>17</td>
<td>5</td>
</tr>
<tr>
<td>Denver</td>
<td>82</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Detroit</td>
<td>84</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>Perth</td>
<td>84</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>Los Angeles</td>
<td>86</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>Houston</td>
<td>94</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Phoenix</td>
<td>94</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>


high indeed, if all the costs were to be exacted, as they should be in an optimal \textit{ex post} pricing system. Compulsory traffic accident insurance seems necessary (i) to avoid claims of millions of dollars on uninsured optimists that cannot be met when such an optimist, say, kills an unprotected road user in the traffic; and (ii) to exact the whole expected accident cost to the rest of society (the c-component of expressions (3) and (7)) from road users who are killed. The latter requirement is macabre, but it is logical that a counterpart
to the c-component in an ex ante pricing scheme should be included in the ex post claims on everybody involved in road accidents, also the victims killed. And it cannot be taken for granted that every road user voluntarily takes an insurance for payments demanded after his death in an accident.

A comprehensive and compulsory system of insurance premiums covering the ex post costs inflicted on fellow road users (provided that they could be calculated) as well as the claims from the rest of society when an accident occurs, would in fact be the same as an ex ante accident externality pricing system.

5.2 Market solution limitations
A different kind of problem is connected to a very basic urban transport issue. Which group of road users has first-priority "right" to roads and streets: the protected or the unprotected road users? This matter is viewed very differently in different parts of the world. An obvious reason for this is that the share of transport by foot and bicycle in total urban personal transport varies substantially between urban areas in different countries.

In an international city traffic "sourcebook" by Newman and Kenworthy (1989) worktrip modal split data for 1980 for thirty big cities are given. In Table 4 these data are reproduced in order of increasing car share.

The cities in Table 4 form a continuum with respect to the car share; nevertheless three groups have been distinguished. In the first group, containing the city-states of Hong Kong and Singapore, and the mega-cities of Tokyo and New York, as well as a number of big European cities, the car share does not exceed 40 per cent. In the second group it goes up to 58 per cent, and in the third group the share continues to rise to still higher levels with Houston and Phoenix reaching a maximum of 94 per cent. The salient feature of the third group is, however, the extremely low share of walking and cycling.

As is suggested by combining Table 2 and Table 4, a relatively low number of accidents involving unprotected road users is achieved if conflicts between car traffic on one hand and pedestrians and cyclists on the other hand, are avoided. This is achieved by "separation", for example, by fencing off pedestrians from crossing the road except at signal-controlled crossings, as may be seen in many British high streets. There are, of course, other ways of traffic separation, which are less discriminatory towards pedestrians. To what extent should protected and unprotected road users be encouraged to mix?

It is difficult to see that accident externality pricing is sufficient to solve the mixed traffic dilemma. A corner solution may be preferable in some cases before an interior solution of mixed traffic. But which corner is, in that case, to be aimed at? This question has probably different answers under different circumstances. To determine whether car-free roads, or pedestrian- and bicycle-free roads in the downtown area, or in a particular residential area are to be preferred, is a complicated public choice which is best made at the municipality and/or neighbourhood level. Where a mixed traffic system is chosen, accident externality charges may have a role to play in the determination of the best mix. The point made in the foregoing discussion is, however, that in many cases, under plausible conditions, the charges may be so high that a corner solution is indicated, although it is not indicated which corner is right.
Accident Externality Charges

J. O. Jansson

References


Date of receipt of final manuscript: November 1993
Forskar för ett liv i rörelse.
Research for an active community.

Statens väg- och transportforskningsinstitut har kompetens och laboratorier för kvalificerade forsknings- uppdrag inom transporter och samhällesekonomi, trafiksäkerhet, fordon, miljö samt för byggande, drift och underhåll av vägar och järnvägar.

The Swedish Road and Transport Research Institute has laboratories and know-how for advanced research commissions in transport and welfare economics, road safety, vehicles and the environment. It also has research capabilities for the construction, operation and maintenance of roads and railways.