



## **When users of congested roads may view tolls as unjust**

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### **Abstract**

Though congestion tolls can increase social welfare, the public often opposes them. One explanation for the opposition is that a road user views a congestion toll as punishment for the damage he causes others. Since a user suffers from congestion, he believes that he has already suffered some punishment and therefore it is unfair or unjust to impose a toll in addition. We assume that a person views a congestion toll as unjust if the toll exceeds the difference between the congestion externality a road user generates on others and the uncompensated externality he suffers from others. We explore the implications of such a view. We illustrate how to determine the toll that satisfies this criterion of justice and how the socially optimal toll violates the criterion. We examine how the just toll varies with the parameters of the model. We discuss the implications of alternative definitions of justice and possible extensions of the basic model considered.

*Keywords:* Congestion tolls; Unjust tolls; Social optimum.

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### **1. Introduction**

Though congestion tolls can increase social welfare, the public often opposes them. A common explanation in the literature for political opposition to congestion tolls is that users of the road suffer a loss of utility. A well-known policy implication of this literature is that redistribution of the toll revenue to users (for example, through reducing other taxes or through investments in capacity) would increase political support for congestion tolls.

The public may also object to road pricing when they view a congestion toll as a punishment or as a penalty. The so-called double-payment argument reflects the view. This view was well summarized in a report to the European Commission: "Road users are the true victims of congestion and have to pay for it by longer and longer commuting times. Why should they pay twice for being stuck in queues?" (Harsman, et

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al., 2000). The double-payment argument or view appears to explain much political opposition to congestion tolls. Though inconsistent with determination of the toll that would maximize social welfare (as it is presented in economic literature), it provides a powerful argument for political debate (capable of affecting people's emotions and of echoing their views about fairness, etc). If, however, the externality an individual road user generates were much larger than the congestion he suffers, even road users and their representatives might see the double-payment argument as having little moral force, and the public might find it fair to charge some toll. The literature has not evaluated this possibility or hypothesis. We do.

We thus explore implications of assuming that a road user views a congestion toll as a punishment or as a penalty. This leads us to consider such issues as fairness, equity and justice. (We use, following the literature, "fairness" as a general term that covers both "equity" and "justice.") The formulation of justice discussed in this paper reflects justice as viewed by consumers rather than by government as a social optimizer (or by the authors of this paper). That is, we focus on positive statements, aiming to explore the implications of certain attitudes of consumers, rather than making normative statements suggesting a just toll as an optimal policy.

The paper can be seen as consisting of two parts. First, Sections 3-6 review literature which deals with these issues, discuss the concepts of equity and justice as defined in this paper, and summarize behavioural assumptions. Second, Sections 7-12 illustrate the concepts in terms of a simple economic model of road congestion, derive a just toll and compare it to the socially optimal toll, explore how the just toll may depend on different parameters of the model and on alternative ways of defining justice, and discuss extensions of the model and analysis.

## **2. Literature**

Considerations of fairness appear in all ethnographically or historically recorded societies (Brown, 1999). Biological evidence that people care about fairness is provided by Camerer (2003): subjects whose brains were imaged while presented with an unfair offer showed greater activity in the bilateral anterior insula of the brain, revealing that such an offer created negative emotions. Experimental studies by economists also suggest that fairness considerations are important determinants of human behaviour (see the survey by Fehr and Schmidt, 2003). Even monkeys appear to react with anger to inequitable reward distributions (Brosnan and de Waal, 2003).

Considerations of justice explain some attitudes of the public toward reforms and toward compensation. The psychologists Baron and Jurney (1993) report that some subjects opposed reforms that they recognized would improve matters. Subjects justified such resistance by noting that the reform would harm some group (despite helping many others), that a choice would be taken away, or that costs and benefits would be distributed unfairly. In a study on attitudes toward penalties and compensation in tort law, Baron and Ritov (1993) find that penalties were independent of their deterrent effect on behaviour, that penalties were greater when paid directly to the victim than when paid to the government, and that many people assign compensation not in terms of the injury but, in terms of setting the balance right between the injurer and the victim. For a recent discussion of equity as applied to transportation, including a survey of the literature, see Raux and Souche (2004).

### 3. Three kinds of justice

The examination of the issues related to fairness, equity and justice goes back to Aristotle, who distinguished three kinds of justice:

1. *Compensatory justice*, which concerns compensating the victims of wrongdoing;
2. *Distributive justice*, which concerns assigning benefits and burdens; and
3. *Retributive justice*, which concerns punishing of crimes or harm caused others.

All three approaches are relevant when considering congestion tolls. In the context of congestion pricing, compensatory justice and distributive justice (equity) have been extensively studied by economists; retributive justice has not.

In principle, we can consider these justice issues from the viewpoint of a social optimizer (social-welfare maximizing government) or from the viewpoint of a road user. In this paper, we focus on the user; that is, we explore how a person's views on these issues affect his behaviour and choices and the implications of all this.

### 4. Consumer's evaluation of a congestion toll

The findings reported in Sections 2 and 3 are consistent with the idea that in evaluating a policy, people look not only at the effects of the policy on their own utility, but also whether it is consistent with their views about fairness – both in terms of its effects on different people (distributive justice) and as a punishment or penalty (retributive justice).

We assume that a person, when evaluating (or voting for) a policy, here a congestion toll, is influenced by (at least) three kinds of issues or factors:

1. *Utility maximization*, through comparing a consumer's own position before and after a policy or toll is introduced;
2. *Equity*, which reflects a person's concern of how a policy or toll differentially affects different people; and
3. *Justice*, which involves comparing the penalty a person pays to the damage he causes and has suffered.

These three factors, or behavioural drivers, broadly correspond to the three kinds of justice identified in Section 3. (Consequently, we henceforth also call distributive justice as equity, and retributive justice simply as justice.) These factors typically work in parallel, and thus a consumer's overall evaluation results from their joint impact. Which argument has most weight in any particular case is an empirical question.

It may be natural to assume that when deciding whether to drive, a person typically cares only about his own utility. That is, a person does not normally make equity and justice related considerations or comparisons on a daily basis when deciding whether to drive (and so ignores the externality he creates). In this paper we consider those occasions (which are less common) when a person is evaluating (considering whether to vote for) a toll. Also in this context, we can assume that each road user knows that the toll reduces his utility (assuming the revenues are not returned to users), and that he cares about this. (The economics literature widely discusses how the utility of road users

declines if the toll revenue is not returned to them.) Therefore, if the toll revenue is not returned to a user, a utility-maximizing user would prefer (vote for) a zero toll. However, when evaluating a congestion toll, people may also care about fairness (social) aspects more generally, both in terms of distributive justice or equity and in terms of retributive justice.

## 5. Justice compared to equity

*Equity*, or distributive justice, concerns how a policy, here a road toll, differentially affects different people. One definition would call an allocation equitable if continuing users of the road enjoy at least as high a utility as when the toll is zero, or if their reduction of utility is within certain “acceptable” limits. As the term equity suggests, particular attention is paid to the effects of the toll on different consumers.

*Justice*, or retributive justice, concerns penalizing or punishing people who harm others. In the case of road travel, the harm is the congestion externality that road users cause each other. In normal situations considered in this paper, a road user both generates an externality on other users (increasing their travel time) and suffers an uncompensated externality generated by other users. (In Section 12, however, we briefly discuss asymmetric externalities.) We then define justice in terms of the damage a person causes others compared the damage he suffers from others: a just toll equals the difference between these two. Our conception of justice thus compares the toll to the congestion externality a road user generates on others and to the uncompensated externality he suffers from others.<sup>1</sup>

*Equity* thus assumes that a person may be concerned not only with his own utility (or with the utility of his own group), but also with the effect of a toll on the utility of other groups. Consideration of equity leads to a cost-benefit type of comparison of the pre-toll and after-toll situations.

Essential to *justice* – and in contrast to equity as we define these two terms – is that a just toll and just allocation is based not on comparisons of utility, but on comparisons of damages caused and suffered, independently of the comparison of the pre-toll and after-toll situations. (However, in Section 10 we discuss implications of expanding our basic definition of justice to allow for utility comparison.)

The rest of this paper focuses on retributive justice, and the implications of people’s concern about this. While for equity considerations it would be necessary to assume different types of people using a road, for our considerations of retributive justice we can assume that all users are identical. However, in Section 12 we discuss situations where different road users are involved.

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<sup>1</sup> A related consideration may affect the views of consumers toward taxes which control externalities. A person may oppose such a tax because he dislikes the reminder that he hurt others. In contrast, taxes not aimed at controlling what is viewed as bad behaviour may be subject to less opposition. A voter may prefer a tax on labour over a tax on pollution because working is not considered evil. Similarly, a property tax is not viewed as a punishing wrongdoing (there is nothing wrong with owning property), and so a voter may have no emotional objection to a property tax. Nor is a parking fee associated with punishment. This reasoning suggests that since going to work is viewed as good behaviour, taxes on commuters will be viewed more favourably than are taxes on other types of trips.

## 6. Consumers and retributive justice

To summarize the discussion above, the key assumptions behind our conception of (retributive) justice are that:

1. A person who views a toll as a punishment or penalty may ask whether the punishment is fair or just.<sup>2</sup>
2. A person recognizes that his travel can increase the congestion others suffer, and thus in principle can view some toll that aims to correct that damage as just.
3. A person compares the damage he causes others with the damage others cause him.
4. A person views a toll that equals the difference between the damage he causes and the damage he suffers from other as just and hence acceptable.

Thus, while our conception of justice has an individual viewing a congestion toll as penalizing a person (including himself) for the damage he causes others, the individual may within certain limits see the punishment as just. More particularly, he thinks that the amount of the penalty should be reduced by the damage the person himself already suffered. When viewing a congestion toll as punishment, a person may, depending on the conditions, regard the punishment as just or unjust, and hence acceptable or unacceptable.

## 7. Model of road congestion

Following the standard analysis of congestion, let a road user both suffer a congestion externality from others, and create one on others. Let  $q$  be the number of road users and let the cost of travel per person be  $C(q)$ . The marginal social cost of a person's travel is  $d[C(q)q]/dq=C(q)+qC'(q)$ ,<sup>3</sup> that is, the sum of the cost he incurs or pays,  $C(q)$ , and the externality he generates,  $qC'(q)$ . Denoting the cost of travel when no-one else travels by  $C(0)$ , a user's damage from congestion is  $C(q)-C(0)$ . For the moment, we simplify by letting  $C(0)=0$ .

Denote by  $D(q)$  the marginal willingness to pay for a trip, and let  $t$  be the congestion toll. Then in equilibrium  $D(q)=C(q)+t$ . Figure 1 illustrates the situation. The social optimum number of trips is  $q^{opt}$ ; this would be the equilibrium if each person fully allowed for the externality he generates  $q^{opt}$ . Alternatively,  $q^{opt}$  can be supported as an equilibrium by the socially optimal toll  $t^{opt}$ . And,  $q^f$  is the equilibrium number of users when a person ignores the externality he creates and when the toll is zero.

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<sup>2</sup> Of course, consumers may have different views of what is the penalty. One view is that the penalty consists of the decline in consumer surplus. If, however, each user makes only one trip, then the decline in consumer surplus is the same as the increase in the consumer's cost of travel. Accordingly, another view is that the penalty consists of the increase in the user's cost of travel following imposition of the toll.

<sup>3</sup> Our analysis ignores people who respond to the toll by ceasing to make the trip. These people cause no congestion, and thus should not be punished. But yet they suffer from the congestion, equal to the consumer surplus they would enjoy were traffic free-flowing. Consideration of these people would make a toll which is just even smaller. One way of extending the model to consider such people is to look at the aggregate externality users generate, and compare that to the aggregate loss of utility of users from imposition of the toll.

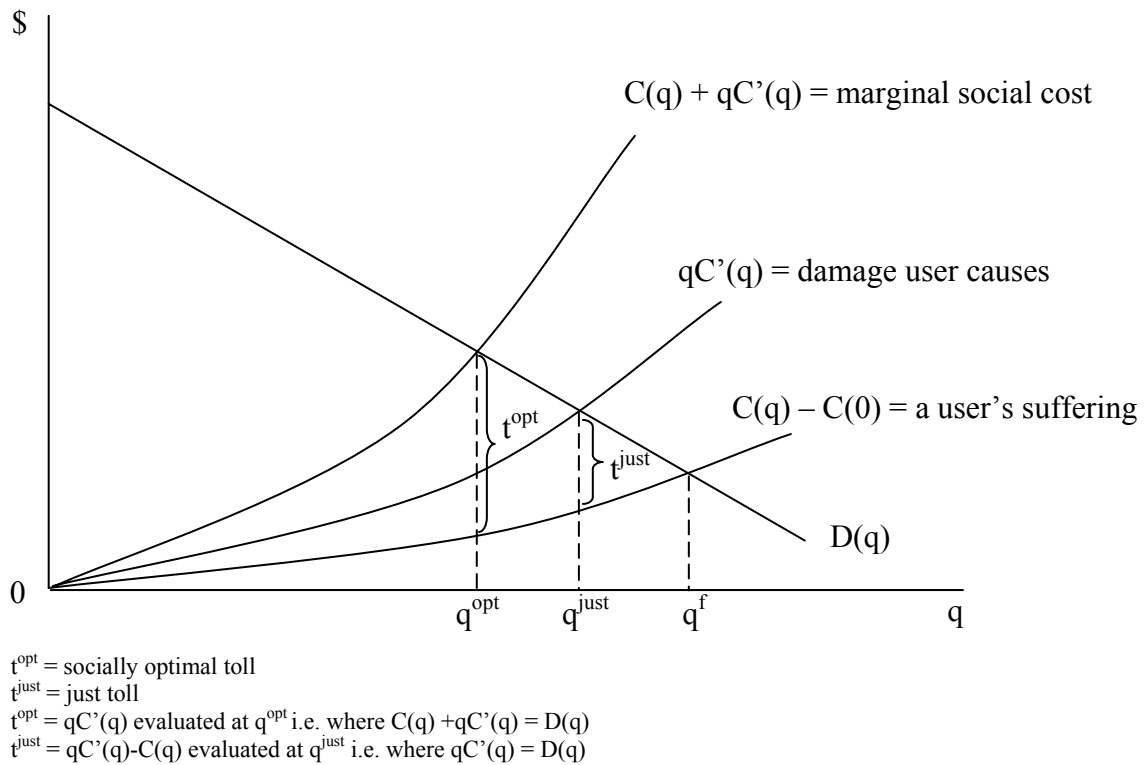


Figure 1: The socially optimal toll and the just toll.

## 8. Just congestion toll

Since the analysis is interesting only if the toll is positive, we assume the damage a user causes exceeds the damage he suffers. Given the assumptions of our model (in Sections 6 and 7), the damage a user causes exceeds the damage he suffers if  $qC'(q) > C(q)$ , or if  $C'(q) > C(q)/q$ . For a convex function, which gets steeper as we move to the right, the inequality is satisfied. Since we can assume that the average cost curve is convex, this means that in normal cases a positive just toll can be determined. In Figure 1, the convexity property of the cost function is assumed to hold for all  $q > 0$ . Here we can view  $q^{just}$  as a just solution, and as an equilibrium which is supported by toll  $t^{just}$ , i.e. the maximum just toll.

We can also think that, in principle,  $q^{just}$  could be realized as an equilibrium if a consumer, as a behavioural assumption when deciding whether to drive, cared about the difference between the damage he generates on others and the damage he suffers from others. That is, rather than fully allowing for the externality he generates (fully internalizing this in his behaviour), which would lead to the social optimum  $q^{opt}$  as the equilibrium, a person may care only about the difference between the externality he generates and the damage he himself suffers from others.

Figure 1 shows that, under the conditions stated above, the just toll is always smaller than the toll which maximizes social welfare. Also, given that revenues from the toll are not returned to a consumer, a user's utility under the just toll is greater than under the socially optimal toll.

## 9. Effect of free-flow speed

We defined in Section 7 the damage that a user suffers from others as  $C(q)-C(0)$ , where  $C(0)$  is travel time under free-flow conditions. In many practical cases free-flow speed will be determined by a speed limit: the lower the speed limit the higher is travel time  $C(0)$ . This suggests that the lower is the speed limit, the smaller is the damage a person suffers from others. This would mean, other things equal, that under a wider set of conditions the damage a person suffers is smaller than the damage he causes. (In Figure 1, the larger is  $C(0)$ , the smaller is  $C(q)-C(0)$  for any  $q>0$ . For  $q=0$  the difference is nil anyway.) This in turn would mean that a given toll could more likely be viewed as just. (In London the speed limit may have been low, and therefore the congestion toll may have been viewed as just.)

## 10. Effect of alternative definitions of justice

Since a toll reduces travel, thereby reducing congestion and travel time, the increase in a user's cost (cost including the toll) is less than the level of the toll. This raises the question whether a user would allow this reduction in costs in his criterion for justice, and what would be the implications of this. A user who did consider the reduction in travel time would be willing to accept a higher toll as a just toll the higher his cost of travel would be in the absence of the toll. Indeed, the model of Section 7, when appropriately incorporating the comparison between utility before and after the toll, implies that the toll viewed as just would be higher when a user recognizes the reduction in travel time induced by a toll than when he does not.

## 11. Justice and quantitative restraints on travel

The conception of justice as defined here applies to a policy that aims to correct a person's behaviour i.e. in our case reduce the congestion externality his behaviour generates. More specifically, it only applies to pricing policy with tolls or fees as relevant instruments. In particular, justice issues as considered here do not arise in the context of quantitative restraints on travel. This may partly explain why quantitative restraints are more often implemented than road tolls.

## 12. Extensions

So far we considered situations where all road users are identical. The analysis argued that a primary consideration in acceptance of congestion tolls is whether the generators of the externality are also its victims. When they are, as in the analysis above, a corrective tax can be viewed as adding insult to injury. But if users differ, in the sense that one group causes more damage than the other, then even those who generate the damage may view a corrective tax as just.

### *12.1 Multi-passenger vehicles*

The externality generated by a vehicle is independent of the number of passengers in the vehicle. The standard (economic) approach to congestion tolls would therefore give no discount to car pools. In contrast, the justice approach would consider that the congestion externality per vehicle is higher the more passengers in it, and so would call for a discount, that is a smaller congestion toll, on vehicles with multiple occupants. Here a large group (single-occupant cars) generates damage to a small group (car pools).

### *12.2 Controlling other externalities*

Other examples of asymmetric externalities can occur with cigarette smokers, with electric utilities generating pollution transported elsewhere, with upstream cities which pollute downstream cities, and with trucks which slow down other vehicles because trucks poorly negotiate urban roads or steep inclines. In these cases, typically, a small group hurts a large group (while the large group little hurts the small group).

## **13. Conclusion**

The practice of economics can be frustrating: economists offer well-founded advice, which policymakers ignore. The advice might be ignored for many reasons: voters and policymakers don't understand the analysis; special interests oppose the proposal; the policy would redistribute income in undesirable ways; government is too busy with other issues; the policy has effects which the economist ignored; voters and policymakers use considerations other than the effects of policy on the profits of firms or on the utility of consumers. This paper considered the last explanation.

Considerations of morality or of justice often enter political discourse. Prohibitions on torture, prostitution, or abortion clearly fall into this category. So do some "sin taxes," such as those on alcohol. We believe that voters and elected officials may view congestion tolls in a similar way: they are designed not only to affect behaviour, but also to punish people for inflicting damage. The interesting complication is that the people who cause the damage are also the people who suffer the damage, and so road users may believe that they already bear some punishment. We formalized this argument, describing the congestion toll that meets a reasonable criterion of fairness or of justice. This toll, though positive, is less than the standard socially optimal toll. Considerations of justice do not therefore preclude the imposition of a congestion toll, but they do cause the public to oppose the high tolls that standard economic analysis recommends.

And considerations of justice can suggest the design of tolls which will make them more acceptable. The general principle is that the toll should be lower the greater the damage a person suffers from congestion: inner-city residents living near congested areas should be charged a lower toll than are commuters; the toll on a car with multiple passengers should be lower than on a single-occupant car; trucks, which are inherently slow-moving even with no congestion, should be charged a higher toll than are fast-moving cars.



### *Notation*

C(q) - Cost of travel time to each user

D(q) - Marginal value of trip

t - Congestion toll

q - Number of users

### *Acknowledgements*

We are grateful for comments by the referee and participants at the seminar "On current issues of policy implementation and evaluation" held in Kuhmo, Finland, July 14-15, 2004.

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