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Problems in determining the optimal use of road safety measures

Rune Elvik [a, b, *]

[a] Institute of Transport Economics, Gaustadalleen 21, NO-0349 Oslo, Norway
[b] Department of Civil Engineering, Aalborg University, Sohngårdsholmvej 57, DK-9000 Aalborg, Denmark

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ABSTRACT

This paper discusses some problems in determining the optimal use of road safety measures. The first of these problems is how best to define the baseline option, i.e. what will happen if no new safety measures are introduced. The second problem concerns choice of a method for selection of targets for intervention that ensures maximum safety benefits. The third problem is how to develop policy options to minimise the risk of indivisibilities and irreversible choices. The fourth problem is how to account for interaction effects between road safety measures when determining their optimal use. The fifth problem is how to obtain the best mix of short-term and long-term measures in a safety programme. The sixth problem is how fixed parameters for analysis, including the monetary valuation of road safety, influence the results of analyses. It is concluded that it is at present not possible to determine the optimal use of road safety measures precisely. One may at best determine a range that is likely to contain the optimal use of a set of measures.

1. Introduction

Public finances are under great pressure in many countries and it is more important than ever before for the public sector to spend money as efficiently as possible. There is therefore an interest in analyses aiming to determine the optimal use of policy instruments in many areas of public policy, including road safety policy. Previous analyses (Elvik, 2001, 2003a) have found that current policy priorities for road safety are inefficient, i.e. road safety measures are not used optimally. An optimal use of road safety measures means that each measure is used to such an extent that its marginal benefits equal marginal costs. If used optimally, road safety measures will provide the largest possible surplus of benefits over costs.

It is, however, not possible to determine the optimal use of road safety measures very precisely. Both costs and benefits of road safety measures are imprecisely known (Elvik 2010a) and there are poorly understood interactions between these measures with respect to their effects on safety (Elvik, 2009). At the current state of knowledge, a policy analysis can therefore only determine a range of safety outcomes which are likely to result from an optimal use of road safety measures. Improved knowledge may narrow this range, but it will never become zero.

This paper discusses some problems in determining the optimal use of road safety measures that have not been dealt with extensively in previous analyses. These problems include:

1. How can the baseline (reference option) for estimating the effects of road safety measures be established?
2. How can targets for intervention be optimally selected?
3. How can policy options be developed that minimise the risk of indivisibilities or irreversible decisions that are suboptimal?
4. How can interdependencies between measures be managed in a way that prevents suboptimal priorities from being set?
5. How can an optimal mix between long-term and short-term measures be determined?
6. How do fixed parameters for analysis (discount rate, etc.) influence the optimal use of road safety measures?

2. Establishing the baseline (reference option)

To estimate the effects of a road safety measure, or set of measures, one has to answer the following question: How is safety likely to develop if the measures are not introduced? Once this counterfactual condition has been described, changes in safety that will result from use of a set of road safety measures can be

* Institute of Transport Economics, Gaustadalleen 21, NO-0349 Oslo, Norway. Tel.: +47 48 94 33 53.
E-mail address: re@toi.no.

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estimated. How best to model the expected development of road safety in the absence of the safety measures whose effects the analyst wants to estimate is an issue that has hardly received any attention in the literature. An interesting discussion of the issue, including a method which at least partly solves the problem is presented by Broughton and Knowles (2010). The method involves trying to estimate the contribution road safety measures has made to the past trend and then re-estimate the trend by removing the contribution made to it by road safety measures. Figs. 1 and 2 illustrate this approach. Fig. 1 is based on a recent Norwegian study of factors that have contributed to reducing the number of fatalities and seriously injured road users from 2000 to 2012 (Høye, Bjørnskau, & Elvik, 2014).

Fig. 1 identifies four main groups of factors that have contributed to the declining trend. The trend has been projected to 2024. This projection assumes that the factors that generated the declining trend from 2000 to 2012 will continue to do so at the same rate until 2024. Is such an assumption reasonable? Vehicles are likely to continue to become safer, but the safety systems that started to penetrate the market during 2000–2012 will mostly have reached full penetration before 2024. Unless new safety systems are developed, the contribution from safer vehicles will therefore become smaller and be close to zero by 2024. Road user behaviour became safer from 2000 to 2012, in particular in terms of lower speed and increased seat belt wearing. Seat belt wearing in Norway now exceeds 95% and cannot be expected to continue to increase at the same rate as from 2000 to 2012. The tendency for speeds to become lower is also likely to flatten out.

The term demographic changes in Fig. 1 refers to road user groups that experienced a particularly large decline in the number of fatalities and serious injuries from 2000 to 2012. Again, it is prudent not to assume that such changes will continue until 2024. The final factor listed in Fig. 1, safer roads, should obviously not be included in any reference option, since one of the purposes of developing such an option is precisely to assess the need for further measures to make roads safer. Thus, it may be concluded that a conservative prediction for the term 2012–2024 should not include the effects of any of the factors that produced the declining trend during 2000–2012. Fig. 2 presents such a prediction and contrasts it with the projection of the trend established during 2000–2012.

It is seen that the two predictions differ clearly. As a basis for assessing the need for road safety measures, the counterfactual prediction is more relevant because it does not implicitly assume that past road safety measures will continue to be used and contribute to a declining trend.

3. Optimal selection of targets for intervention

The selection of targets for intervention, i.e. deciding where and when to introduce a certain road safety measure arises for all road safety measures that are used at the local level. This applies to all measures related to road design, traffic control and police enforcement. An optimal plan for selecting the locations for using a road safety measure specifies an order of selection that maximises the expected benefits of the safety measure. This means that, all else equal, a safety measure will first be implemented at the location where it produces the largest reduction of accidents or injuries, then at the location where the effect is second biggest, and so on.

It is difficult to develop a method ensuring that targets for intervention are selected this way. This principal problem is that selecting locations for safety treatments in practice takes place at the local level of government and is strongly influenced by site-specific characteristics that are difficult or impossible to include in a general model for optimal selection. Empirical studies (Elvik, 2004) have found that sites selected for safety treatment tend to have high traffic volume. The number of accidents is strongly related to traffic volume; all else equal, sites with a high traffic volume would therefore be expected to have a high expected number of accidents. It has been found, however, that in Norway it is almost as common for sites with an abnormally low accident rate (accidents per million units of exposure) to be selected for treatment as it is for sites with an abnormally high accident rate.

Accident rates, as conventionally estimated, are subject to large random fluctuations. Any model for selecting sites for treatment should be based on good estimates of the long-term expected number of accidents, not a short-term count that to a very large extent reflects random variation. Selecting locations for treatment according to the empirical Bayes (Hauer, 1997) estimate of the expected number of accidents is an attractive option. The empirical Bayes (EB) method for road safety estimation utilises two sources of data regarding safety to develop estimates that are site-specific and

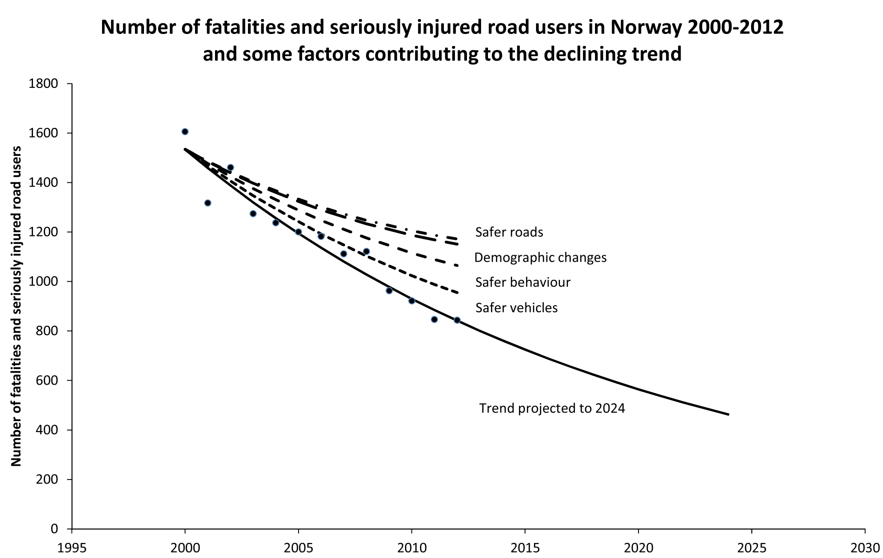

Fig. 1. Number of fatalities and seriously injured road users in Norway 2000–2012 and some factors contributing to the declining trend.

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