The economics of road safety: investment pays

Lessons from road safety policy analyses in Norway and Sweden

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INTRODUCTION

Road safety has been greatly improved in many OECD countries the past thirty years. Since the number of road accident fatalities reached its peak level around 1970, the number of fatalities has been reduced by more than 50 % in many countries, including France, Great Britain, the Netherlands, Denmark, Sweden, Finland and Norway – to name just a few. Progress has not always been steady, and in most countries there have been periods when there was no decline in the number of road accident fatalities. In the long term, however, the trend has been clear.

Is it still possible to reduce the number of road accident fatalities in the OECD countries, or have all cost-effective road safety measures already been implemented? To answer this question, a road safety policy analysis must be made. A road safety policy analysis is a systematic examination of major policy options for road safety, aiming to estimate the improvement that can be attained by implementing road safety measures. Such analyses have been made in many countries. The presentation in this paper is based on road safety policy analyses in Norway and Sweden. In Norway, major road safety policy analyses have been made three times (Elvik, Muskaug and Vaaje 1984, Elvik 1999, Elvik 2007). In Sweden, a similar analysis was made in 2000 (Elvik and Amundsen 2000). The main results of the most recent policy analyses for Norway and Sweden have been reported in scientific journals (Elvik 2001, 2003, 2008).

Norway and Sweden are among the safest countries in the OECD. Using the number of road accident fatalities per 100,000 inhabitants as an indicator of road safety performance, Norway and Sweden are usually among the top five countries. Figure 1 shows the ranking of countries by the number of fatalities per 100,000 inhabitants in 2005 (source IRTAD).

One might think that in comparatively safe countries like Norway and Sweden, most cost-effective road safety measures have already been introduced, and prospects for further improving road safety by means of cost-effective road safety measures would be small – at least smaller than, say, 20 or 25 years ago. However, the policy analyses that have been made for these countries do not support such a point of view. On the contrary, these analyses show that there are still major opportunities for improving road safety.

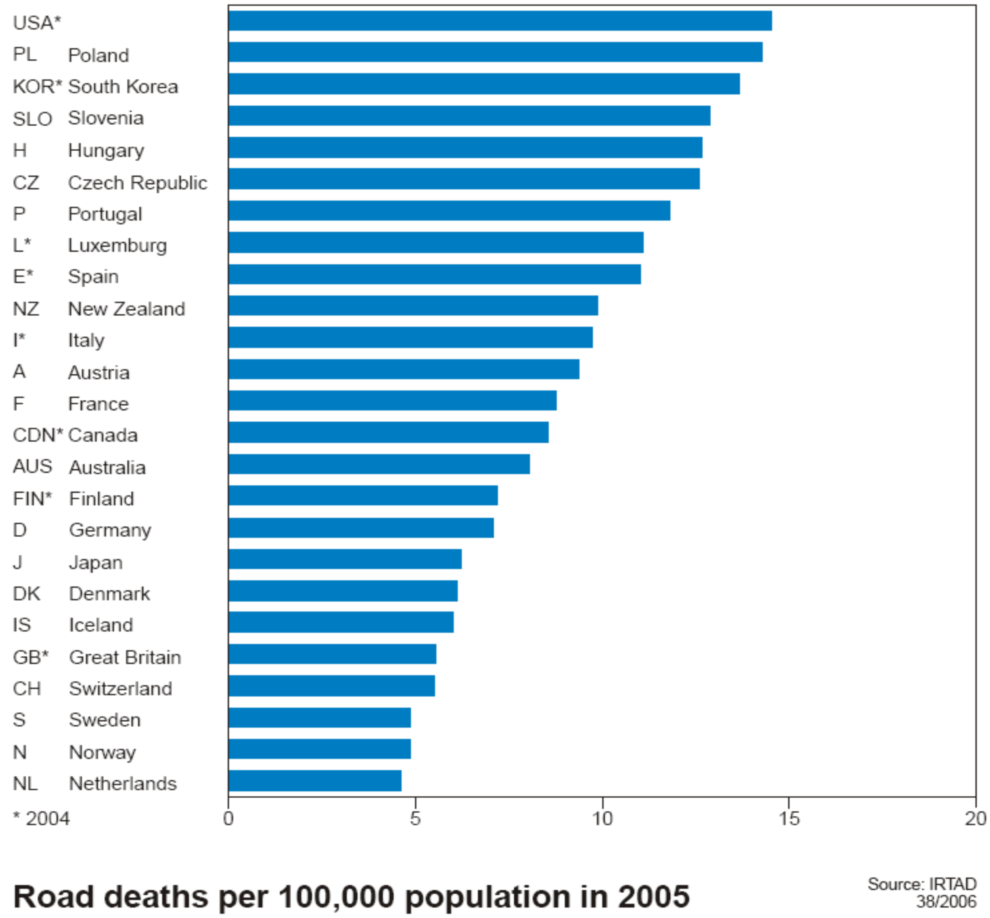

Figure 1: Road accident fatalities per 100,000 inhabitants in selected countries in 2005. Source IRTAD

WHAT IS A ROAD SAFETY POLICY ANALYSIS?

Before presenting the results of the road safety policy analyses that have been made for Norway and Sweden, it is perhaps useful to explain briefly what a road safety policy analysis is. Figure 2 summarises the main stages of such an analysis.

The analysis starts by describing current road safety problems and assessing their relative importance. This analysis identifies main targets for intervention. The next stage, which is sometimes performed in close conjunction with stage 3, is to develop policy targets. Quantified targets for improving road safety are increasingly used, although in Norway politicians have so far been reluctant to adopt a quantified road safety target.

The third, and possibly most important, stage of the analysis to conduct a broad survey of potentially effective road safety measures and assess which of these have got a potential for improving road safety. The result of this survey is a list of road safety measures that are carried forward to a more detailed assessment of the contribution they can to improving road safety.

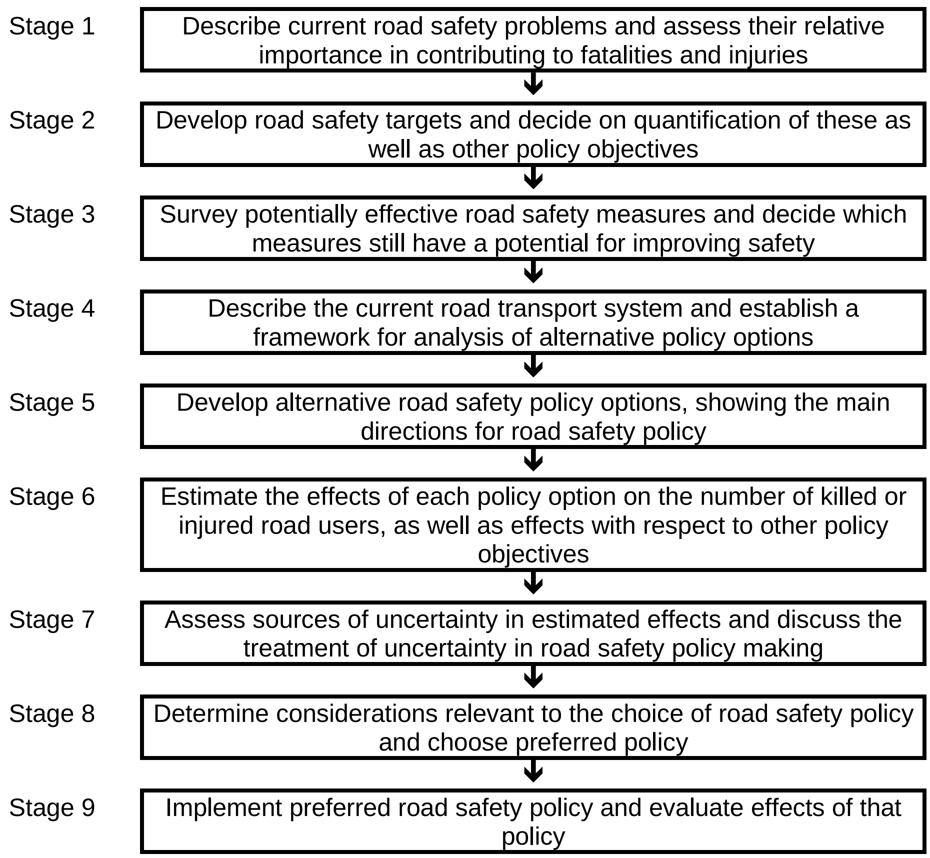

Figure 2: Stages of a road safety policy analysis. Based on Elvik 2007

When road safety measures have been identified, the next stage (4) is to establish the framework for the analysis. This involves determining key parameters for analysis, such as:

- For how many years will a road safety programme be carried out
- Will the road safety programme include measures designed to influence the amount of travel and its split by mode, or are these factors not targeted for policy intervention
- Monetary valuation of non-market goods, which, in addition to safety, include travel time (for private travel) and environmental factors
- Whether current spending limits are regarded as binding or increased spending on road safety can be permitted

- The discount rate to be used in cost-benefit analyses of road safety measures.

An important part of a road safety policy analysis, is to develop alternative policy options (stage 5). These may include:

- “Business-as-usual”: to continue present policy without making major changes in it
- “Maximum efficiency”: to introduce road safety measure only to the extent that they are cost-effective, i.e. marginal benefits exceed marginal costs
- “Vision Zero”: a road safety strategy based on key elements of Vision Zero as the ultimate ideal for road safety
- “Maximum potentials”: all road safety measures are used to the maximum conceivable extent, in order to see how far it in principle is possible to improve road safety when current spending limits are disregarded.

For each policy option, a road safety policy analysis includes a detailed estimation of the effects on safety that can be attained by implementing the road safety measures included in that option (stage 6). In all the policy analyses used as examples in this paper, a cost-benefit analysis of each road safety measure was also performed.

The results of any road safety policy analysis will be uncertain (stage 7), and it is instructive to identify the sources of uncertainty and discuss these. This may, for example, serve as a basis for developing a research programme designed to reduce uncertainty.

It may not always be possible to base the actual use of road safety measures strictly on the results of the policy analysis (stage 8). Other considerations, not formally addressed as part of the policy analysis may enter. Examples of such considerations will be given in discussing the results of the most recent policy analysis for Norway.

As a final stage of the analysis, implementation of the road safety programme and an evaluation of its effects has been included (stage 9). It is important to systematically evaluate the effects of road safety programmes. Road safety policy is most successful when it employs all opportunities that arise for learning and feeds new knowledge back into the policy making process.

ROAD SAFETY POLICY ANALYSES IN NORWAY AND SWEDEN

Norway 1984

The first road safety policy analysis for Norway was reported in 1984 (Elvik, Muskaug and Vaaje 1984). It included 45 road safety measures, and for each of these up to four alternative levels for use of the measure were defined. The analyses referred to alternative policy options for use of the road safety measures during the period 1982-1993 (12 years). Four policy options were developed:

1. Continuing present policy
2. Maximum efficiency based on cost-benefit analyses
3. Balancing total costs and benefits, i.e. continuing to use road safety measures until total benefits equal total costs
4. Strengthening present policy, i.e. increasing the use of road safety measures whose benefits exceed the costs.

Two alternatives for traffic growth were used. The presentation given here highlights results based on high traffic growth. Table 1 presents key results.

Table 1: Key results of road safety policy analysis for Norway 1984

Key outcome variables	Continue present policy	Maximum efficiency	Balancing benefits and costs	Strengthen present policy
Baseline number of fatalities (1979-1981)	379	379	379	379
Expected number of fatalities in 1993 without measures	447	443	443	443
Expected number of fatalities in 1993 with measures	390	350	296	321
Actual number of fatalities in 1993	281	281	281	281

The analysis indicated that if present policy was continued, the number of fatalities would not be reduced by 1993. The baseline number of fatalities was the annual mean number during 1979-1981. In all other policy options, the number of fatalities was estimated to be reduced. The actual number of fatalities in 1993 was 281, considerably lower than even the best policy option. It should be noted, however, that the count of fatalities in 1992 was 325. In 1994, 283 fatalities were recorded. This shows that random fluctuation can greatly influence the number of fatalities. Using the mean for the years 1992-1994, the count was 296, which is identical to the predicted outcome for strengthening present policy.

It is not known whether all road safety measures were actually implemented and actually had the effects on road safety that were estimated in the policy analysis. It is, however, reasonable to believe that the policy analysis did have some influence on actual policy. Spending on minor engineering treatments was increased in 1985. Police enforcement was increased in during the period from 1986 to 1993. An additional factor, not foreseen in the policy analysis, was a downturn of the business cycle from about 1990, leading to less growth in traffic. In fact, traffic did not grow at all between 1990 and 1993.

Norway 1999

The next road safety policy analysis for Norway was reported in 1999. This analysis comprised the period 2002-2011 and was prepared as part of the national transport plan. Results were estimated for the year 2012. A total of 59 road safety measures were included. Five policy options were developed. These were:

1. Continuing present policy
2. Maximum efficiency based on cost-benefit analyses
3. Cost-effectiveness, i.e. a strategy based on safety effects only, disregarding effects for mobility and the environment
4. The Vision Zero option
5. Maximum potentials, i.e. using all road safety measures to the maximum possible extent, regardless of cost.

Table 2 summarises the results of the analysis. Only four of the policy options are shown, as the cost-effectiveness option and the Vision Zero option turned out to be very similar.

Table 2: Key results of road safety policy analysis for Norway 1999

Key outcome variables	Continue present policy	Maximum efficiency	Vision Zero strategy	Maximum potentials
Baseline number of fatalities (1997-1999)	300	300	300	300
Expected number of fatalities in 2012 without measures	372	372	372	372
Expected number of fatalities in 2012 with measures	338	189	154	124
Projected number of fatalities in 2012	235	235	235	235

The analysis, like the one reported in 1984, found that continuing present policies will not reduce the number of fatalities. All other policy options that were analysed were associated with a reduction in the number of fatalities. Based on a trend line fitted to the count of fatalities during the period 1970-2007, the projected number of fatalities in 2012 is 235. This is below the number estimated if road safety policy as of 1999 had been continued, but above the number estimated for the other policy options. So far in 2008, there has been a marked increase in the number of road accident fatalities in Norway – in fact a sharper increase than observed in any other year after 1970. It is too early to tell if this signifies a more lasting slowdown of the trend towards fewer fatalities, or if it is an aberration. For the time being, the best that can be done is to make forecasts based on the period 1970-2007.

In theory, as shown in Table 2, it is possible to reduce the number of fatalities considerably. However, the maximum potentials option is very expensive and not economically realistic.

Sweden 2000

The policy analysis made for Sweden in 2000 was very similar to the one made for Norway in 1999. The policy options were similar to those developed in the analysis for Norway in 1999. Main results are shown in Table 3.

Table 3: Key results of road safety policy analysis for Sweden 2000

Key outcome variables	Continue present policy	Maximum efficiency	Vision Zero strategy	Maximum potentials
Baseline number of fatalities (1994-1998)	554	554	554	554
Expected number of fatalities in 2012 without measures	613	613	613	613
Expected number of fatalities in 2012 with measures	528	316	230	180
Projected number of fatalities in 2012	439	439	439	439

As in the other analyses presented so far, the analysis for Sweden found that continuing present policy was the least effective option. This policy option was nevertheless expected to result in a very small reduction of the number of fatalities. The other policy options were associated with greater improvements in road safety. The projected number of road accident fatalities in 2012, based on a trend line fitted to data for 1970-2007, is 439. This is below the number predicted if the road safety policy pursued in Sweden in 2000 had continued, but above the numbers predicted for the other policy options. Thus, road safety policy in Sweden has become more effective since 2000, but not as effective as, for example, the maximum efficiency policy option would be.

Norway 2007

The final policy analysis to be presented is for Norway in 2007. The analysis was made as part of the national transport plan for the term 2010-2019. Results are given for the year 2020. The plan covers use of road safety measures during the period 2007-2019. The following policy options were developed:

1. Continuing present policy
2. Maximum efficiency based on cost-benefit analyses – first best options

3. Maximum efficiency based on cost-benefit analyses – constrained to domestic policy options
4. Strengthening present policy, i.e. increasing the use of road safety measures whose benefits exceed the costs.

To a large extent, these policy options are the same as those used in previous analyses, but an important difference is worth noticing. The maximum efficiency option, which is a policy option based strictly on cost-benefit analysis, was developed in two versions. One version can be labelled "first best" and implies that all road safety measures are used optimally regardless of who funds these measures and regardless of who controls them. In recent years, a number of new safety features have been developed for cars. Some of these are rapidly penetrating the market already, like electronic stability control and side-impact airbags. It was assumed that these safety features would continue to spread in the coming years as the car fleet turns over. There are, however, a number of other safety systems that are, as yet, not being demanded by car buyers. These include systems for intelligent speed adaptation (ISA-systems), of which there exist several versions that have all been tested technically and found to function well; accident recorders (black boxes) that store important data about vehicle handling and control immediately before an accident; alcohol ignition interlocks, which at their current stage of development are likely to be too expensive for car owners in general, but may be cost-effective for drivers convicted of drinking and driving.

Making new vehicle safety features mandatory is outside the power of the Norwegian government. Vehicle safety standards in Europe are promulgated by the United Nations Economic Commission for Europe or the European Commission, or both these bodies acting in concert. It was therefore decided to develop a version of maximum efficiency constrained to measures within the control of the Norwegian government. Main results of the policy analysis are shown in Table 4.

Table 4: Key results of road safety policy analysis for Norway 2007

Key outcome variables	Continue present policy	Maximum efficiency – first best	Maximum efficiency – domestic	Strengthening present policy
Baseline number of fatalities (2003-2006)	250	250	250	250
Expected number of fatalities in 2020 without measures	285	285	285	285
Expected number of fatalities in 2020 with measures	190	138	171	143
Projected number of fatalities in 2020	222	222	222	222

Projecting fatalities to 2020 is obviously highly speculative and the results are uncertain; however if the trends observed during 1970-2007 continue, 222 fatalities are predicted in 2020. All policy options result in a lower number of fatalities. The best policy option is the unconstrained maximum efficiency option.

COMPARISON OF RESULTS OF POLICY ANALYSES

The results of the road safety policy analyses presented in this paper have a number of striking similarities as well as differences. As far as the similarities are concerned, the following are worth highlighting:

1. All analyses have found that road safety policy can be made more effective. Continuing present policy is not the most effective option.
2. There is considerable scope for improving road safety. Compared to the number of fatalities predicted if nothing is done, the analyses found that:
    a. Fatalities can be cost-effectively reduced by 33 % (Norway 1984)
    b. Fatalities can be cost-effectively reduced by 49 % (Norway 1999)
    c. Fatalities can be cost-effectively reduced by 48 % (Sweden 2000)
    d. Fatalities can be cost-effectively reduced by 52 % (Norway 2007)
3. The above estimates all apply to the maximum efficiency policy option, which consists only of road safety measures whose benefits exceed the costs.
4. The costs of implementing the maximum efficiency option are, remarkably, not greater than current spending on road safety measures.
5. The scope for cost-effective improvements in road safety has not diminished over time, but appears to be even greater today than 25 years ago.
6. For each new round of road safety policy analysis, new measures have been introduced.

There are also differences between the analyses. These appear when a closer examination is made of the type of road safety measures that make the greatest contribution to improving safety. The three policy analyses made for Norway have been compared with respect to the main types of road safety measures contributing to the estimated reduction of the number of fatalities according to the maximum efficiency policy option (this option was included in all the analyses). The results of the comparison are shown in Figure 3.

When the three policy analyses are compared, it is evident that there have been major changes in the contributions various types of road safety measures can give to improving road safety. In the 1980s, it was still traffic engineering measures that could contribute the most to improving road safety. In the most recent policy analysis, by far the largest contribution is attributable to vehicle safety features.

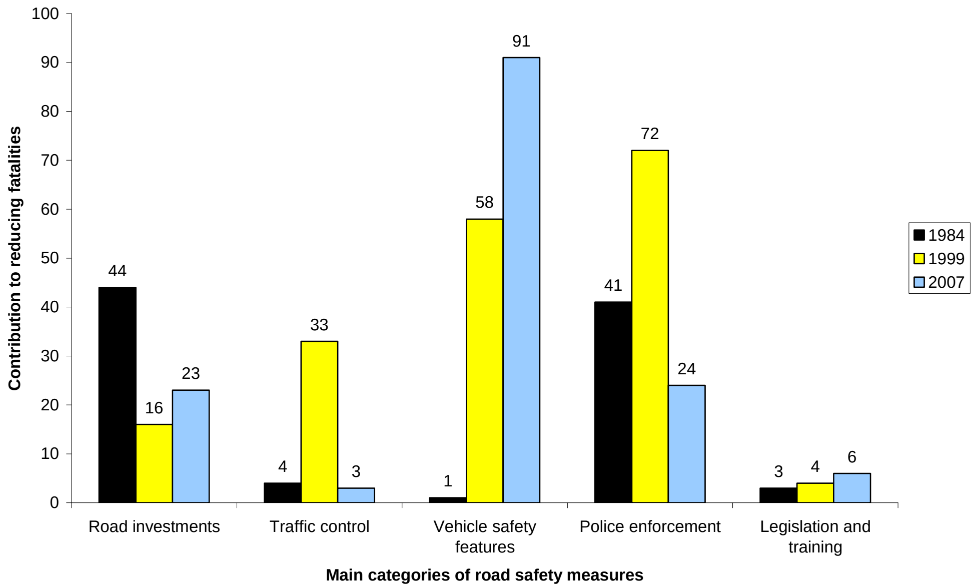

Figure 3: Main types of road safety measures that can reduce road accident fatalities in Norway according to policy analyses in 1984, 1999 and 2007

As mentioned before, new vehicle safety features can be introduced in two ways: either by the market mechanism or by legislation, making new safety feature mandatory from a certain date. In recent years, several new vehicle safety measures have been introduced mainly by way of the market mechanism:

- The sale of new cars has shifted to models that score 5 stars in the European New Car Assessment programme (EuroNCAP). These cars provide better protection against fatal or serious injury in crashes.
- An increasing share of new cars have complete air bag systems, including not just frontal air bags, but also side impact protection.
- Electronic stability control is standard equipment on most new cars offered today.
- Seat belt reminders are offered in most new cars.
- Some makes, in particular Volvo and Saab, and to some extent Toyota, offer enhanced protection against neck injury in rear impacts.

These vehicle technologies are likely to continue to penetrate the market in the coming years, thereby contributing to a trend towards fewer fatalities. However, several other vehicle safety features are not offered as standard equipment today and are not demanded by most car owners. These include:

- Various forms of ISA-systems (Intelligent Speed Adaptation)
- Accident data recorders

- Cars designed so as to reduce the severity of pedestrian injury
- Impact attenuators on heavy vehicles
- Intelligent cruise control
- Alcohol ignition interlocks

These safety features can contribute greatly to improving road safety. Unfortunately, it is likely that introducing them will be a slow process unless it is speeded up either by making the equipment mandatory or by otherwise stimulating demand for it.

While, in principle, there are still major opportunities for improving road safety, there is, more than before, reason to worry whether these opportunities will actually be taken. The technology is there, but we hesitate to introduce it. ISA-technology, for example, has now become so cheap and reliable that an economic case against it can no longer be made. Alcohol ignition interlocks are still too expensive to justify their use in all cars, but the cost of these devices is also likely to go down.

HARD CHOICES MUST SOON BE FACED

Automotive technological innovation is global. The market for motor vehicles is global. Except for large countries, like the United States, it is unlikely that any single country will be able to set its own, national vehicle standards and effectively enforce them. Smaller countries, like Norway and Sweden, are not in a position to set their own vehicle safety standards – although as a car-producing country, Sweden has an advantage in being able to support technological innovations developed by Swedish car manufacturers. If Norway were to try to set its own vehicle safety standards, one or both of the following are likely to happen:

1. The European Union would rule the standards discriminatory and in violation of the basic rules of the internal market, to which Norway belongs through the EEA treaty.
2. Vehicle manufacturers would simply ignore the standards, since Norway is a very small market and the Norwegian government would not be in a position to enforce the regulations.

To harvest the benefits of vehicle safety technology, road safety policy must therefore increasingly be developed at the international level. We are now close to the point where, by installing digital maps, global positioning systems, accident data recorders, and microcomputers in each car, it is technologically feasible to:

1. Continuously monitor a number of aspects of driver behaviour that are important for safety, such as:
   a. Speed
   b. Headway

c. Lane changes
d. Use of daytime running lights
e. Seat belt wearing

2. Collect complete and accurate accident data, eliminating the problem of incomplete accident reporting.

These technologies can be applied to create a much more sophisticated and fair system of marginal cost pricing of transport than we have been able to so far. A large part of the external costs of driving, in particular accident costs, can be internalised by means of an appropriate scheme of road pricing. The revenue from such a system can be paid back as a reward to those drivers who drive safely. This could create much stronger incentives for safety than those facing drivers today.

To obtain these benefits, we must, however, accept technology that monitors our behaviour in minute detail at all times and all places. Very many people would object to this, arguing that it violates freedom and privacy. It is certainly correct that privacy is violated. As for freedom, that is somewhat more debatable. The monitoring system would leave drivers with the opportunity to speed – but they would be caught every time and would have to pay for it every time. But in principle, if only an advisory ISA is used, the freedom to speed would remain intact.

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