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Published in:
Empirica: Journal of applied economics and economic policy

Publication date:
1989

Empirica – AUSTRIAN ECONOMIC PAPERS

The Economics of Traffic Accidents on Austrian Roads: Risk Lovers or Policy Deficit?

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1. Introduction

Comparison of the number of fatalities per million vehicle kilometers for various countries reveals remarkable differences in road safety (see *U. N.,* 1987). For Austria this indicator (0.036) is about 1.5 times the respective figure in West Germany (0.023), 1.9 times that in the U. K. (0.019), and 2.3 times that in the U. S. (0.016). In relative terms, then, the death toll on Austrian roads is more than double that in the U. S.

This paper deals with economic aspects of traffic safety, in particular with the problem of measuring benefits of reducing traffic accidents. Since it is the aim of traffic safety policy to reduce the number and/or severity of traffic accidents, benefits of these policies are important to measure. In a cost-benefit framework (see *Mishan,* 1972, 1982, *Schofield,* 1987) such measures provide a guideline for the public authority responsible for traffic safety policy. A major element of benefits of reduced traffic accidents is person related, and concerns deaths and injuries. So, the valuation of changes in risk of mortality and injury are of crucial importance to the overall result. However, it is also the most uncertain and most controversial element in the analysis.

Evaluating the societal costs embodied in these figures is an interesting and challenging task in itself (see, e. g., *Schofield,* 1987, *Jones-Lee,* 1976, *Jones-Lee — Hammerton — Abbott,* 1987). As will be seen in Section 2.3 completely different results can be derived from the application of different methods. The international comparison of fatality rates just presented, however, raises an additional policy related question. As will be discussed more fully in Section 2.2, policy makers can be viewed as producers of traffic safety. Their "product", traffic safety, is consumed by the general public. This "market", however, is distorted by public good characteristics of the product, externalities, and limited competence of agents (see Section 2), all hampering the coordination between supply and demand of traffic safety. Nevertheless, coordination between supply and demand also in this market is essential for an efficient allocation of resources (see Section 2.2), and therefore needs to be accomplished some other way.

The cross-national differences may therefore result from two different scenarios with different implications for national traffic safety policies:

1. Differences between the countries may lead to distinct demand for traffic safety. Efficient policy makers would react by supplying road safety in accordance to demand by equating marginal benefits and marginal costs of safety measures. The observed differences in

road safety would just be the result of the producer efficiently reflecting the distinct evaluations by consumers.

2. If, on the other hand, road safety is evaluated similarly in the various countries, the observed discrepancies are the result of cross-national differences in either supply of safety or the coordination between supply and demand. In the first case the countries would use different technologies for producing road safety while in the second case the safety market would be in disequilibrium in some countries.

We will come back to this point in Section 4 of the paper. This section presents the results of a contingent valuation study for Austria, attempting to estimate the economic value of reductions in risk of death. In Section 2 we will discuss some of the imperfections in the market for road safety and their implications for road safety policy. We will focus upon the implications for resource allocation and the guidance cost-benefit analysis may provide. Furthermore, the problem of evaluating human life and health will be discussed in general and with respect to two methods which are consistent with the theoretical basis of cost-benefit analysis. In Section 3 we present the results of our own empirical analysis which applies the contingent valuation method to derive willingness-to-pay estimates for improved safety. Section 4 summarizes the paper and draws some general conclusions.

2. Theoretical and methodological issues

2.1 Consumer reactions and imperfections in the market for traffic safety

The traditional, "technological" approach to traffic safety "treats people as passive in that it assumes that roadway users do not respond to changes in the traffic environment" (*Blomquist,* 1988). With this assumption, changes in the technology of the transport system have full impact on transport safety, since they will not be counteracted by behavioural changes of drivers. For example, it is assumed implicitly that people do not drive faster on broader streets, in light traffic, or when wearing safety belts.

In contrast, from an economic point of view drivers adjust their behaviour to derive the best net result. This "economic" approach takes into account that people have some control over risk faced in the transport system. People can choose between modes differing not only in terms of speed, convenience, and monetary cost, but also in terms of risk of accident. Drivers can adjust the speed of travel, the frequency of rests, maintenance of the car, etc., to either reduce the risk of accidents or to reduce travel time and expenses. They will choose the combination of actions which provides the highest level of satisfaction.

In the U. S., *Peltzman* (1975) triggered a long debate about whether or not safety policy is able to lower fatality rates. His conclusion is that once one controls for other important factors like the age of drivers, average speed, alcohol consumption, etc., the extra contribution of safety policy is negligible. *Cantu* (1980) extended Peltzman's analysis and reached similar conclusions. *Graham — Garber* (1984), *Crandall — Graham* (1984) and *Crandall et al.* (1986) derived a much greater positive effect of regulation on occupant safety. However, they also show evidence of increased non-occupant danger, which supports the view that people's reactions at least partially offset the effects of better safety standards ("risk compensation").

However, the result that safety policy can hardly reduce risk by no means implies that the system is in equilibrium and that there is no need for traffic policy. From a theoretical point of view the performance of the transport system is distorted by a number of imperfections which destroy its ability to reach an optimum automatically. Some important imperfections are

— externalities in the behaviour of the agents in the transport system,

— "public good" characteristics of transport infrastructure and traffic safety in particular,

— limited competence of drivers and systematic errors in the perception of accident risk.

The trade-off between occupant and non-occupant safety found by some of the studies mentioned above is a good example for externalities in risk behaviour. Unsafe driving behaviour not only increases the driver's own risk of death but also that of other people on the streets. In particular those who are less well protected (pedestrians, cyclists, motorcyclists) bear costs which are the result of other people's behaviour. This not only leads to a distortion in modal split but also to an insufficient level of traffic safety.

Transport infrastructure and traffic safety measures also display features of public goods. Street lighting, road maintenance, snow clearance, speed limits, alcohol consumption regulations are examples of safety related elements which are characterized by non-rivalry and non-exclusion.

The third problem with an automatically optimized transport system is related to peoples knowledge and perception of risk (see, e. g., *Slovic — Fischhoff,* 1982). Research by *Svenson — Fischhoff — MacGregor* (1985), for example, indicates that drivers believe they are more skillful and safer than average and therefore tend to underestimate the risk of their traffic behaviour. Another line of research in behavioural psychology shows that people have problems processing information on low probability, high loss events (*Kunreuther,* 1976), and that people's behaviour is influenced by the framing of a decision (*Kahnemann — Tversky,* 1979). Both effects are leading to systematically biased behaviour.

This last type of problems is particularly discomforting since it questions subjective rationality, a cornerstone in economic theory. Analysts studying traffic safety have investigated this problem (*Blomquist,* 1977, *Hammerton — Jones-Lee — Abbott,* 1982). There is evidence that this is not a severe problem in this field. Their work shows that people can at least rank sources of risk adequately and react to changes in risk in a reasonable way.

Nevertheless, all these arguments make it very unlikely that the transport system will obtain an optimal level of traffic safety automatically. Particularly the observation that increased occupant safety may be accompanied by reductions in non-occupant safety calls for traffic safety policy.

2.2 The optimal design of traffic safety policy

Since traffic safety policy is just one in a number of public obligations the question of its optimal design arises. Economic theory tells us that resources are allocated optimally when they are used to provide the highest marginal benefit. In the ideal world of neoclassical economic theory, which is characterized by perfect competition and absence of externalities and public goods, optimal resource allocation is achieved automatically. Although these conditions can hardly ever be achieved the criterion proves to be useful in more realistic situations as well. Cost-benefit analysis rests upon this branch of theory and tries to mimic the ideal conditions. It tries to correct for market imperfections and to evaluate intangibles to obtain the correct measures for comparing costs and benefits of some proposed investment.

Since traffic safety and other safety related policies aim for reducing damage to human health and property, cost-benefit analysis in these areas needs to evaluate human life and health. On ethical grounds, some policy makers argue that human life is not subject to valuation at all and that cost-benefit analysis is therefore inappropriate in this case. Nevertheless, policy makers frequently make decisions which directly or indirectly affect human life and health. They allocate budgets, establish standards, and choose a specific level of enforcement. With all these activities policy makers trade off risks for human life and health against costs (and other aspects as well) and thus implicitly value risks to human life and health and in so doing reveal their evaluation. The cost-benefit framework can help bring these implicit valuations into the open.

Some of the objections against cost-benefit analysis in this area probably stem from the fact that the instrument is misunderstood as a substitute for policy making. In reality, cost-benefit analysis is but one policy making tool. At the very least it provides a useful and consistent framework in which to consider issues (*Drummond*, 1981). "It embodies a systematic approach to decision making, a way of thinking methodically about the impacts of decisions rather than by 'flying the seat of the pants'" (*Schofield*, 1987, p. 221). It is hard to see why policy makers who have to make decisions affecting human life and health should not take advantage of this instrument.

2.3 Methods for evaluating human life and health

There is no doubt that fatalities and injuries are a major negative impact of transportation. In 1983, for example, 1,756 people were killed on Austrian roads and 64,791 injured (19,774 of them severely).

As already mentioned the most difficult aspect of evaluating the benefits of improved safety is in imputing a value to the effects on human life. Measuring impacts on physical goods can be done simply by using some pricing system, but when it comes to human fatalities, analysts are faced with the problem of attaching a value to a non-market good. Since we are dealing with changes in risk, the commodity to be valued is the life of an unknown member of a large group (i. e., a statistical life), not the life of a specific individual.

The economic theory behind cost-benefit analysis suggests that the missing price information be substituted by the amount people are willing to pay for the respective "product". Internationally, "there is a growing awareness that (this willingness-to-pay approach is) a conceptually more satisfactory way of addressing the issue of accident loss savings" (*Schofield,* 1987, p. 120) than the traditional techniques which attempt to evaluate the lives of specific individuals (for Austria see *Pfleger — Brandstätter — Gehmacher,* 1980, *Faller et al.,* 1986, *Bundesministerium,* 1987; a critical evaluation of these studies can be found in *Maier — Weiss,* 1989). In brief, the traditional techniques treat people as investment goods and evaluate the damage to this investment good. This approach is not justified by economic theory (*Schofield,* 1987, *Maier — Weiss,* 1989).

The aim of the willingness-to-pay approach is to estimate individual's marginal rate of substitution between money and the good one is interested in, in our case the reduction of the risk of being killed in a car accident. Deriving the value of a statistical life is trivial from this figure. Denote the i-th individual's marginal rate of substitution by MRS_i. In a population of N individuals avoidance of 1 statistical death per time period requires a risk reduction of $\frac{1}{N}$. The amount people are willing to pay for this reduction of risk in that time period is therefore $\sum_i MRS_i \frac{1}{N}$ or simply the average marginal rate of substitution.

There are two approaches to this problem, namely the hedonic price and the contingent valuation method. They differ by the way they derive MRS. The hedonic price method uses observable behaviour and applies econometric methods to isolate the required estimate. The contingent valuation method is implemented by taking a survey in which individual respondents are directly asked for their marginal value of safety.

Traditionally economists were skeptical about the validity of answers one gets to hypothetical questions and therefore favoured the hedonic price method. It uses actual market transactions in labour and consumer goods markets where risk differences are observable. Since it is quite difficult to identify a market-like relationship in the field of traffic safety direct applications in this area are rare. *Blomquist* (1979) estimates a probit model for seat belt usage and derives a figure of $ 370,000 (1978 US dollars) for the value of life therefrom. *Winston — Mannering* (1984) evaluate the risk of severe injury from people's choice of automobile make and model.

A large number of hedonic price studies was performed in the labour market. Empirical estimates display a large range of values (between 6 million in 1982 dollars) and debate continues over which factors are responsible for this dispersion. Recent reviews of evidence from the labour market on the value of a statistical life may be found in *Gegax — Gerking — Schulze* (1987), *Weiss — Maier — Gerking* (1986), and *Dillingham* (1985). For Austria two studies are available (*Weiss — Maier — Gerking,* 1986, *Christl,* 1986). Both use data from the Austrian microcensus but yield quite different results. Weiss — Maier — Gerking find a quadratic relationship between earnings and risk to fit the model best and get highly significant coefficients on the risk variables. These imply a value of AS 55 million for 1 statistical life. Christl, on the other hand, uses 22 different indicators for working conditions in his estimations. For the variable "risk of accident, risk of injury" he gets one positive and two negative coefficients in three estimations, where one negative parameter is significant at the 5 percent level. This leads him to the conclusion that there are no compensating wage differentials and that consequently no marginal value of safety measure can be derived therefrom.

The hedonic price method suffers from the problem of disentangling the relevant influence from correlated factors and identifying the exact content of the measured relationship. In the context of traffic safety also the problem arises, whether measures derived from the labour market can be transferred directly. Transferability is particularly doubtful when estimates are based on a subsample of workers (e. g., only blue collar) and therefore reflect only this group's preferences. A further problem with the hedonic price method is of particular importance in our context. It is usually specified in reduced form and thus implicitly assumes market equilibrium. Since the road safety market lacks a coordinating price mechanism the hedonic price method seems inadequate in this instance.

The contingent valuation method does not suffer from this problem. By using a questionnaire technique to directly ask respondents for their willingness to pay we can derive information about the demand function without assuming market equilibrium. In designing the questionnaire accordingly one can focus on certain aspects more specifically and identify subcomponents like the value of reduced risk for other car passengers. These advantages are contrasted by the fact that the resulting estimates are subject to biases arising from several sources. The most important are:

— Hypothetical bias, which may result from the hypothetical nature of the problem stated. Since the respondents are not penalized for errors they might not adequately take into account budget and time constraints.

— Strategic bias may result from respondents suspecting a specific use of the results. They might want to see particularly low or high figures and therefore give strategic answers. Also respondents might want to please the interviewer and give answers they guess he wants to hear instead of their own evaluation.

— Instrument bias may result from specific techniques used to derive estimates. If respondents are given an ordered list of measures and asked to pick one their answers might be biased toward the mean. Similarly, in a bidding game the final estimate might be influenced by the starting value.

Although these problems should be taken seriously, recent research suggests that particularly over strategic bias concern may be unwarranted (*Brookshire — Crocker,* 1981, *Brookshire et al.,* 1982, *Hammerton — Jones-Lee — Abbott,* 1982, *Cummings — Brookshire — Schulze,* 1986, *Jones-Lee — Hammerton — Abbott,* 1987).

Applications of the contingent valuation method are far less numerous than hedonic price studies. A full-scale application was worked out in Great Britain (*Jones-Lee — Hammerton — Abbott,* 1987). Respondents ranked death third in the perceived severity of injury, behind severe head injury and paralysis. These respondents revealed a willingness to pay to avoid death at approximately £ 2 million. A similar estimate was obtained in a contingent valuation experiment framed in a labour market context by *Gerking — de Haan — Schulze* (1988). Injuries commonly associated with automobile accidents, such as fractures and internal damage, ranked surprisingly close behind, with avoidance values of 1.5 million. In another survey, a life was valued through the willingness to pay for a flight on an airline with a better safety record. This survey yielded a figure of £ 3.0 million (*Jones-Lee,* 1976).

3. A contingent valuation study for Austria

This section presents results of a transport related contingent valuation pilot study for Austria and is based on 98 completed interviews. They were conducted in Vienna and in Neulengbach, a small rural place in the vicinity of Vienna, in order to be able to identify urban-rural differences. The sample was drawn randomly from the telephone directories. We did not experience unusual rates of non-response. Preliminary results of this study can be found in *Maier — Weiss* (1989) and *Kopetzky* (1989).

The questionnaire we used is based on that constructed by *Jones-Lee — Hammerton — Abbott* (1987). We use the following three evaluation questions(1):

— Question 1 asks for the willingness to pay and the compensation required for 4 different changes in risk. The problem is framed in terms of the choice of carrier on a business trip. Versions A and B ask for the amount people are willing to pay for risk reductions of 4/100,000 and 7/100,000, respectively. Versions C and D ask for the compensation required to have them accept risk increases of 8/100,000 and 24/100,000 (willingness to accept). There is evidence in the literature that willingness-to-accept measures are higher than willingness-to-pay estimates (*Knetsch — Sinden*, 1984, *Brookshire — Coursey*, 1987, *Coursey — Hovis — Schulze*, 1987, *Viscusi — Magat — Juber*, 1987).

— Question 2 asks for the willingness to pay for the installation of some safety feature in a car which reduces risk by 5/100,000. In the first variant of the question (Version A), this safety feature protects only the driver while in the second (Version B) it protects the passengers as well. Thus, comparison of the results provides an estimate for the evaluation of passenger's safety. Since the benefits from this investment can be gained throughout the lifetime of the car the amount people are willing to pay also relates to this period and we expect considerably higher estimates from this question.

— Question 3 finally asks for the willingness to pay for a city-wide road improvement which improves safety of all road users by 3/100,000. The two variants differ in the way the money is said to be collected. Version A assumes a door-to-door collection and thus allows for free-riding behaviour while in Version B the money is collected by taxes.

To perform the computations sketched in Section 4 we have to derive an estimate for an individual's marginal rate of substitution (MRS_i). Suppose a respondent is asked what he is willing to pay for a reduction in risk of fatal accident from 8/100,000 to 6/100,000 and that the answer is b_i. Then the appropriate estimate for MRS_i (i. e., the income change due to a unit change in risk) is

$$(1) \quad MRS_i = \frac{b_i}{2 / 100{,}000} = \frac{b_i \, 100{,}000}{2}.$$

The average of this figure across all respondents is interpreted as the willingness to pay for a risk reduction which reduces the expected number of deaths by 1(2). It is sometimes referred to as the value of saving 1 statistical life or the marginal value of safety (MVS). Table 1 presents 8 such estimates, which correspond to the variants of the evaluation questions.

As expected, the estimates we get from Question 2 are higher than the results from other questions. The ratio is between 5 and 7. This indicates that people correctly depreciate this investment over a period of years. Also the first variant of Question 3 yields the expected lower figure than the second variant. The effect of free-riding is estimated to be about AS 16 million. The value for saving a life as displayed in Table 1 is in the range between AS 36 and 47 million. This is in line with the evidence which can be found in the literature (e. g., *Jones-Lee — Hammerton — Abbott*, 1987, *Gerking — de Haan — Schulze*, 1988). Also, it roughly corresponds to the hedonic price based estimates in *Weiss — Maier — Gerking* (1986). However, our figures are in sharp contrast to previous traffic safety values for Austria which were based on traditional techniques (e. g., *Pfleger — Brandstätter — Gehmacher*, 1980, *Faller et al.*, 1986).

Table 1

The marginal value of safety for different contingent goods

	Cases	*MVS*	*SE*
		Million AS	
Question 1			
Version A	93	38.17	6.31
Version B	94	36.29	5.81
Version C	94	46.62	2.35
Version D	96	44.67	2.46
Question 2			
Version A	87	261.24	41.37
Version B	87	328.40	45.87
Question 3			
Version A	91	16.89	2.88
Version B	87	32.51	4.38

Comparison of the 4 estimates for Question 1 shows that the estimates for Versions C and D, which ask for willingness to accept additional risk tend to be larger than those for Versions A and B, asking for the willingness to pay for a risk reduction. Similar results have been found by *Knetsch — Sinden* (1984), *Brookshire — Coursey* (1987), *Coursey — Hovis — Schulze* (1987), and *Viscusi — Magat — Juber* (1987). It is also supported by the work of *Kahnemann — Tversky* (1979, 1986).

To further analyse the risk evaluations obtained multiple regressions with individual evaluations as dependent and socioeconomic characteristics as explanatory variables were performed. The result of this analysis is presented in Table 2(3). Explanatory variables are defined as follows:

INC^{MED} = dummy variable; $INC^{MED}=1$ if the individual's net household income falls into the range of AS 10,000 to 20,000 per month,

INC^{HIGH} = dummy variable; $INC^{HIGH}=1$ if the individual's net household income is higher than AS 20,000 per month,

SEX = respondent's sex, SEX = 1: female,

ACCIDENT = 1 when respondent had been involved in a severe traffic accident before,

EDUCATION = respondent's level of education; EDUCATION = 5 for respondents with a university degree, EDUCATION = 4 for those with highschool degree ("Matura"), etc.,

URBCAR = 1 for respondents from Vienna owning a car,

AGE = respondent's age,

HH-SIZE = size of the household,

CHILDREN = respondent's number of children.

Table 2

Regression analysis of individual's marginal value of safety by socioeconomic characteristics

	Question 1	
	Version A	Version B
Intercept	—79.62*	—45.72
INC^{MED}	9.52	3.69
INC^{HIGH}	41.08**	41.32**
SEX	— 7.14	— 5.21
ACCIDENT	—13.89	—17.89
EDUCATION	— 4.05	— 3.92
URBCAR	45.07**	43.74**
AGE	6.47**	4.76**
AGE^2	— 0.07**	— 0.05**
HH-SIZE	— 7.23	— 7.36
CHILDREN	—18.76	5.86
$\bar{R}^2$	0.21	0.21

* . . . significant at the 10 percent level, ** . . . significant at the 5 percent level.

By subdividing the data set, *Maier — Weiss* (1989) conclude(4) that higher income, older, more educated people and respondents with children tend to reveal higher willingness to pay. If we take into account socioeconomic characteristics simultaneously, because of the relationships between them this result is only partially retained. The most important factor explaining willingness to pay for traffic safety is the respondent's age. It enters with a highly significant positive coefficient for the linear term and a highly significant negative coefficient for the quadratic term. This implies a concave relationship between age and willingness to pay. The marginal value of safety seems to be pretty low for young people — in some socioeconomic groups young people even have a negative *MVS* — but increases rapidly. The *MVS* reaches its maximum at an age of about 50 years and decreases afterward according to the quadratic function. It is interesting to see that we get this result although we control for most other important socioeconomic characteristics. So, we have to interpret it purely as an age effect, which means that people's attitude towards risk apparently changes considerably with age. This is in sharp contrast to the human capital method which implies that values of life decline with age.

The most important variable from the point of view of economic theory, income, shows an interesting pattern. Moving from low to medium income does not yield coefficients which are statistically different from zero. Only when moving to the high-income category we get coefficients which are significant at the 5 percent level. The *MVS* for high-income people is almost AS 40 million higher than that of low-income people. As expected, the coefficient for medium income is positive but lower than that for high income in both equations.

Also, the variable *URBCAR*, a dummy variable for urban car-owners yields statistically significant coefficients in both equations. People living in Vienna who own a car care considerably more for traffic safety than people from Neulengbach or Viennese without a car. They are willing to pay about AS 45 million more for the same risk reduction. It seems that this group's experience with traffic and road hazards leads to a higher *MVS*. The interaction variable *URBCAR* clearly outperforms separate dummy variables for urban location and car-ownership.

All the variables discussed so far yield statistically significant parameters in both regressions. However, it is also interesting to see which variables remain insignificant. Most prominent, education seems to be unimportant for people's risk evaluation(5). The negative coefficients even suggest that higher education reduces people's *MVS*. Also the dummy variable indicating whether a respondent has been involved in a serious car accident yields statistically insignificant negative coefficients. The sign might be the result of a reverse relationship between risk evaluation and chance of accident. People with a lesser degree of risk aversion (i. e., lower *MVS*) face a higher risk of car accident.

Two additional variables with insignificant negative coefficients are the respondent's sex and the size of his household. The first one is rather surprising, since women are often thought to care more about safety than men. The household size variable takes into account the number of people over which the household income is spread. A larger household reduces per-capita income and thus reduces *MVS*. Therefore the negative sign is expected. The insignificance of the coefficients is in line with the weak performance of the income variable. The coefficient of the variable "number of children" is insignificant in both equations and changes signs. Therefore, little can be said about this variable.

In general the two estimations presented in Table 2 are consistent. The coefficients are similar in quantity as well as significance. This provides additional evidence for the quality of our data. The evaluation of road safety seems to be dominated by age rather than gender, experience of traffic accidents, education, and to some extent even income. So, as compared to the bivariate analysis in *Maier — Weiss* (1989) some influences vanish in the multivariate analysis (number of children, education), while others gain importance (car-ownership, urban location).

The empirical results presented above provide some information about the quality of the data set and the validity of the method. The *MVS* measures in Table 1 show all the expected relationships. The standard errors are reasonably small given the small size of the sample. Also the two regressions presented in Table 2 yield meaningful and consistent results. A stricter test can be obtained from the questionnaires directly. Since the different versions of the questions are closely related they provide the basis for consistency checks at the respondent level (see *Maier — Weiss*, 1989). When checking our data we found that only 3 respondents gave inconsistent answers. We conclude that there is little basis for questioning the validity of the data and the results. Hypothetical bias does not seem to be a problem, since responses are in general consistent. Despite the small sample size in this pilot study the contingent valuation method seems to be quite promising in the context of road safety. A final evaluation, of course, would require a full-scale investigation.

4. Summary and conclusions

This paper discussed some economic aspects of traffic safety and presented an empirical investigation of the value of traffic safety in Austria. This value is of crucial importance for the overall design of traffic safety policy since it is the dominant element in the benefit of traffic safety policy. According to the principles of cost-benefit analysis resources should be allocated to traffic safety policy as long as its (marginal) benefits exceed its (marginal) cost.

In Section 2 of the paper we establish an economic perspective and review some of the recent discussion in the U. S. We list a series of imperfections in the transport system, which make it very unlikely that the system will obtain an acceptable level of traffic safety automatically. This provides a theoretical basis for traffic safety policy. However, it has to be understood that people react to policy measures and sometimes counteract traffic safety policies.

Next we discuss the cost-benefit framework in more detail and point out what cost and benefits are in the area of traffic safety. We argue that in a safety context efficient allocation of scarce resources requires the evaluation of human life and health. Moreover, we make the point that any allocation of resources between policy areas implies and reveals valuations for human life and health.

Another problem to which we turn in this section is how to evaluate human life and health. We focus our attention on methods which are consistent with the principles of cost-benefit analysis and discuss the hedonic price and the contingent valuation in some detail. It turns out that in a traffic safety context the contingent valuation method is more appropriate. Both methods typically yield values which are substantially larger than the ones derived from more traditional approaches.

Section 3 presents an attempt to measure the "value of (a statistical) life" for Austria by means of a contingent valuation approach. We obtain a "marginal value of safety" (*MVS*) of almost AS 40 million, meaning that in Austria people are willing to trade AS 40 million per period of time for a risk reduction which reduces the expected number of fatalities over this time period by 1. This figure is substantially higher than the AS 6.8 million computed in the context of the Austrian "Gesamtverkehrskonzept" (*Faller et al.*, 1986, *Bundesministerium*, 1987). Nevertheless, our figures are in line with other contingent valuation studies.

With these figures at hand we can come back to the question where the remarkable cross-national differences in road safety mentioned in Section 1 come from. Since our estimates do not differ substantially from figures found for Great Britain and the U. S. this phenomenon seems to result from differences at the supply side rather than differences in evaluation. In Section 1 we have mentioned two possible reasons for this result, namely 1. differences in production technology, and 2. market disequilibrium. Although it is sometimes argued that Austria's high fatality rates result from transit or high road construction costs due to rugged terrain, in our view neither of these arguments is very convincing. The first one pushes the demand-side argument one step down and applies it to foreigners. The second neglects that road safety can be improved by other factors as well, like lower speed limits, stricter enforcement, information campaigns, etc. If the road safety market were in equilibrium these factors should be of particular importance in Austria given the high road construction costs.

In our view there is more support for the argument that the market for road safety is in disequilibrium. Since this market lacks a coordinating price mechanism, safety policy relies on other sources of information for its decisions. Until recently the only evaluations available in Austria were based on inadequate methods and severely underestimated the value of road safety. By basing its decisions on these estimates safety policy in Austria produces less safety as is demanded by the public.

By multiple regression analysis we analyse which factors influence people's evaluation of safety. It turns out that age has the strongest impact while income, which is an obvious candidate according to economic theory, performs much weaker. Interestingly enough, urban car-owners value road safety significantly higher than others. This result should be of some interest to Austrian automobile associations.

The implications of our empirical results are obvious. People in Austria are concerned about traffic safety and willing to trade a considerable amount of money for improved safety. The estimates are comparable to those which were derived for other countries. Basing resource allocation — either directly or indirectly — on the lower values resulting from more traditional approaches leads to a severely understocked traffic safety policy and therefore to a suboptimal policy design and waste of resources.

5. References

Blomquist, G., "Economics of Safety and Seat Belt Use", Journal of Safety Research, 1977, 9, pp. 179-189.

Blomquist, G., "Value of Life Saving: Implications of Consumption Activity", Journal of Political Economy, 1979, 87, pp. 540-558.

Blomquist, G., The Regulation of Motor Vehicle and Traffic Safety, Kluwer Academic Publisher, Boston, 1988.

Brookshire, D. S., Coursey, D. L., "Measuring the Value of a Public Good: An Empirical Comparison of Elicitation Procedures", American Economic Review, 1987, 77, pp. 554-566.

Brookshire, D. S., Crocker, T. D., "The Advantage of Contingent Valuation Methods for Benefit-Cost-Analysis", Public Choice, 1981, 36, pp. 235-252.

Brookshire, D. S., Thayer, M. A., Schulze, W. D., d'Arge, R. C., "Valuing Public Goods: A Comparison of Survey and Hedonic Approaches", American Economic Review, 1982, 72, pp. 165-177.

Bundesministerium für öffentliche Wirtschaft und Verkehr, Österreichisches Gesamtverkehrskonzept — Beamtenentwurf, Wien, 1987.

Cantu, O. R., "An Updated Regression Analysis on the Effects of the Regulation of Auto Safety", Yale S. O. M. Working Paper, 1980, (15).

Christl, J., "Werden unangenehme Arbeitsbedingungen durch höhere Löhne ausgeglichen? — Ein Test der Theorie kompensierender Lohndifferentiale", Wirtschaft und Gesellschaft, 1986, 12, pp. 33-42.

Coursey, D. L., Hovis, J. J., Schulze, W. D., "The Disparity Between Willingness to Accept and Willingness to Pay Measures of Value", Quarterly Journal of Economics, 1987, 102, pp. 679-690.

Crandall, R. W., Graham, J. D., "Automobile Safety Regulation and Offsetting Behavior: Some New Empirical Estimates", American Economic Review, 1984, 74, pp. 328-331.

Crandall, R. W., Gruenspect, H. K., Keeler, T. E., Lave, L. B., Regulating the Automobile, The Brookings Institution, Washington, D. C., 1986.

Cummings, R. G., Brookshire, D. S., Schulze, W. D., Valuing Environmental Goods: An Assessment of the Contingent Valuation Method, Rowman & Allanheld Publishers, Totown, N. J., 1986.

Dillingham, A. E., "The Influence of Risk Variable Definition on Value-of-Life Estimates", Economic Inquiry, 1985, 24, pp. 277-294.

Drummond, M. F., "Welfare Economics and Cost-Benefit Analysis in Health Care", Scottish Journal of Political Economy, 1981, 28, pp. 125-145.

Faller, P., Metelka, M., Riebesmeier, B., Brauneis, H., Ökonomische Analyse und Bewertung von Unfallfolgen im Rahmen der österreichischen Verkehrssicherheitsplanung, Schlußbericht der Untersuchung U 3.01/GVK-Ö, im Auftrag der Bundesministerien für öffentliche Wirtschaft und Verkehr sowie für Bauten und Technik, Wien, 1986.

Gegax, D., Gerking, S., Schulze, W., Perceived Risk and the Marginal Value of Safety, University of Wyoming, Department of Economics, Laramie, Wy., 1987 (mimeo).

Gerking, S., de Haan, M., Schulze, W., "The Marginal Value of Job Safety: A Contingent Valuation Study", Journal of Risk and Uncertainty, 1988, 1, pp. 185-199.

Graham, J. D., Garber, St., "Evaluating the Effects of Automobile Safety Regulation", Journal of Policy Analysis and Management, 1984, 3, pp. 206-224.

Hammerton, M., Jones-Lee, M. W., Abbott, V., "The Consistency and Coherence of Attitudes to Physical Risk: Some Empirical Results", Journal of Transport Economics and Policy, 1982, 21, pp. 181-199.

Jones-Lee, M. W., The Value of a Life: An Economic Analysis, University of Chicago Press, Chicago, Ill., 1976.

Jones-Lee, M., Hammerton, M., Abbott, V., The Value of Transport Safety: Results of a National Sample Survey, Policy Journals, Newbury, 1987.

Kahnemann, D., Tversky, A., "Prospect Theory: An Analysis of Decision under Risk", Econometrica, 1979, 47, pp. 263-291.

Knetsch, J. L., Sinden, J. A., "Willingness to Pay and Compensation Demanded: Experimental Evidence of an Unexpected Disparity in Measures of Value", Quarterly Journal of Economics, 1984, 99, pp. 507-521.

Kopetzky, C., Verkehrssicherheit und die ökonomische Bewertung von menschlichem Leben und Gesundheit, Diplomarbeit an der Wirtschaftsuniversität Wien, 1989.

Kunreuther, H., "Limited Knowledge and Insurance Protection", Public Policy, 1976, 24, pp. 227-261.

Maier, G., Weiss, P., "Kosten-Nutzen-Analyse und Verkehrssicherheit: Die Bewertung von Leben und Gesundheit", Verkehrsannalen, 1989, 35, pp. 13-28.

Mishan, E. J., Elements of Cost-Benefit Analysis, Allen & Unwin, London, 1972.

Mishan, E. J., Cost-Benefit Analysis, 3rd Ed., Allen & Unwin, London, 1982.

Peltzman, S., "The Effects of Automobile Safety Regulation", Journal of Political Economy, 1975, 83, pp. 677-725.

Pfleger, E., Brandstätter, G., Gehmacher, E., "Güterverkehr und Verkehrssicherheit", in Bauer, H., Gehmacher, E. (Eds.), Gesellschaftliche Folgen des LKW-Verkehrs in Österreich, Institut für empirische Sozialforschung, Wien, 1980.

Schofield, J. A., Cost-Benefit Analysis in Urban & Regional Planning, Allen & Unwin, London, 1987.

Slovic, P., Fischhoff, B., "Targeting Risks", Risk Analysis, 1982, 2, pp. 227-234.

Svenson, O., Fischhoff, B., MacGregor, D., "Perceived Driving Safety and Seatbelt Usage", Accident Analysis and Prevention, 1985, 17, pp. 119-134.

U. N., Statistics of Road Traffic Accidents in Europe, New York, 1987.

Viscusi, K., Magat, W., Juber, J., "An Investigation of the Rationality of Consumer Valuations of Multiple Health Risks", Rand Journal of Economics, 1987, 18, pp. 465-479.

Weiss, P., Maier, G., Gerking, S., "The Economic Evaluation of Job Safety. A Methodological Survey and Some Estimates for Austria", Empirica, 1986, 13(1), pp. 53-67.

Winston, C., Mannering, F., "Consumer Demand for Automobile Safety", American Economic Review, 1984, 74, pp. 316-320.

6. Notes

(1) A copy of the questionnaire can be obtained from the authors on request.

(2) Both elements are defined for a specific period of time. For example, it gives the amount people are willing to pay per year for a risk reduction reducing the expected number of deaths per year by 1.

(3) We restrict the discussion to the two willingness-to-pay questions, since estimating people's willingness to pay is the main focus of this contribution. Regressions for the other questions gave similar but sometimes less pronounced results. These estimates are available from the authors on request.

(4) This analysis was based on only 48 interviews as compared to 98 interviews available for the present paper.

(5) Of course, the specification we have chosen implies equal increments between all adjoining levels of education. We have tested more sophisticated specifications but could not derive a more powerful model.

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