Valuing Transport Safety in Australia

Working Paper

The value of transport safety is an important input to decisions on policies and investments with safety implications and for measuring the burden of transport accidents to the community. There are a number of approaches which may be used in valuing transport safety. The purpose of this Working Paper is to provide an appraisal of the approaches available and issues involved in valuing transport safety along with a survey of international developments.

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VALUING TRANSPORT SAFETY IN AUSTRALIA

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FOREWORD

The value of transport safety is an important input to decisions on policies and investments with safety implications and for measuring the burden of transport accidents to the community. There are a number of approaches which may be used in valuing transport safety. The purpose of this Working Paper is to provide an appraisal of the approaches available and issues involved in valuing transport safety along with a survey of international developments.

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ABSTRACT

There are two main purposes in assessing the socio-economic consequences of transport accidents. The first is to provide a monetary estimate of the safety benefits that might result from a publicly funded project for inclusion in a cost–benefit analysis. A second purpose is to assess the burden of transport accidents to the community.

A number of approaches to valuing transport safety are examined. Based on a review of literature the two main approaches (human capital and willingness to pay) are discussed along with international developments.

It is concluded that there appears to be a sufficient case for Australian policy makers to consider using the willingness to pay approach to valuing transport safety in future project evaluation. A number of policy implications arising from what are likely to be higher estimates of the value of transport safety using the willingness to pay approach are discussed.

CHAPTER 1 INTRODUCTION

In assessing the economic implications of transport accidents, policy analysts have two major objectives. One is to obtain a monetary estimate of the safety benefits that ensue from implementing a publicly funded project or program. The estimated value of the safety benefit is used in cost–benefit analyses. A second objective is to assess, in monetary terms, the extent of accident consequences in order to illustrate the burden of transport accidents to the community.

The loss of life and property, together with the injury and damage that occur as a result of transport crashes, represents a major burden on the Australian community. The Bureau of Transport and Communications Economics (BTCE) estimated that road crashes alone cost Australia $6.1 billion in 1993 (BTCE 1994). Aviation accidents cost the community around $76 million in 1993, while rail accident costs were estimated at $69 million and maritime accident costs were $316 million (BTCE 1995a, 1995b, 1995c).

Safety is an important consideration to transport users and, consequently, an important aspect of transport projects or programs. If scarce resources are to be allocated efficiently and equitably in transport investment by decision makers, safety effects should be weighed explicitly and evaluated along with other costs and benefits in the decision making process.

Any allocative decision that affects individual risk levels implicitly places a priority or a value on human life or injury. In measuring the value of 'safety', policy analysts do *not* seek to value the lives of individuals, either as specific persons or in terms of sanctity of human life. Policy analysts concerned with public sector projects aim to assess the value placed *by the community as a whole* on protecting any or all of its members from death or injury. That is, it is the more general statistical concept of human life or avoidance of injury that is being valued. The distinction between the value of a known life and the value of a 'statistical' life is conceptually important. It helps to explain why very large sums of money are often spent saving individual lives in comparison to the sums involved in saving 'statistical lives' (Dalvi 1988, p. 8).

There are a number of approaches which could be used to value transport safety, or more specifically, statistical life or injury. The value of transport safety may differ depending on the approach used. Consequently, the allocation of resources in the Australian economy and, in particular, the transport sector could depend upon the approach used to value transport safety.

Valuing transport safety has implications for the provision of road, rail, air and sea transport, their associated users, providers and regulators and for all levels of government. The relative value of safety in different transport modes will determine the desirability of channelling scarce resources to modes where safety is valued most.

Also, there are broader policy implications arising from valuing transport safety. The value of a statistical life or injury has important policy implications for life saving services such as health services, fire, police and search and rescue services. The insurance market is another area where estimates of the value of statistical life play an important role.

The objective of this study is to determine which approach is applicable to the two main purposes of assessing the socio-economic consequences of transport accidents. This study presents the main approaches used for valuing transport safety and examines current practice in Australia as well as developments in other countries.

CHAPTER 2 APPROACHES TO VALUING SAFETY

MAIN APPROACHES

Several approaches have been proposed for valuing transport safety. These include implicit value, insurance value, court award, valuation of time, human capital and the willingness to pay approach (BTCE 1992 and Jones-Lee 1989):

- The *implicit value* approach involves determining a value of life from the investments made by society, through its political process, which affect mortality rates. In this approach the value of statistical life is reflected implicitly in past public sector decisions and is treated as indicative of the appropriate level at which to set explicit costs and values for future decisions. By examining past decisions for and against projects with potential safety effects, it may be possible to place an upper and lower bound on implicit values of statistical life.

  For example, suppose that there is a choice between two mutually exclusive projects which have the same costs but differ in regard to the expected reduction in fatalities and other benefits (see table 2.1). The choice between project A and project B reveals an implicit value of life. If project A is chosen then the implicit value of life is less than $200 000, as the additional 3 lives saved in project B are valued less than the $600 000 worth of other benefits in project A. If project B is selected then the implicit value of life would be at least $200 000.

TABLE 2.1 IMPLICIT VALUE OF LIFE

	Costs ($)	*Expected reduction in fatalities*	*Other benefits ($)*
Project A	1 000 000	2	1 100 000
Project B	1 000 000	5	500 000

Source Jones-Lee 1989, p. 5.

If past decisions are reasonably consistent, implicit values will have a broadly similar order of magnitude. However, the main drawback relating to the implicit value approach centres on the lack of consistency (Jones-Lee 1989). Empirical evidence suggests that without explicit values placed on safety effects there is likely to be inconsistency and consequent inefficiency in the allocation of scarce resources. Evidence from both the United Kingdom and the United States indicates widely divergent implicit values of life from past decisions affecting safety—from £1000 to £20 000 000 a statistical life (Jones-Lee 1989, p. 26). The implicit value approach would be legitimate only if past public sector decisions had been based on appropriately defined costs and values.

- The *insurance value* approach relies on the premium paid and the probability of being killed in a specific activity, to calculate the value placed by an individual on life.

  Using life insurance as a proxy for valuing transport safety has a number of drawbacks. Life insurance would only reflect anticipated net output losses of the individual because the main motivation of the policy holder is to cover the expected financial requirements of dependants in the case of his or her death (Jones-Lee 1989). Further, people with no dependants may place high values on their own safety and yet may rationally hold no life insurance. Although injury insurance might provide a rough indication of anticipated gross output losses, it would still not reflect individuals' preferences for transport safety.

- The *court award* approach values life in terms of the sums awarded by the courts to the next of kin of the deceased involved in a transport accident as compensation from the party held to be responsible for the death.

  The relevance of using court awards to value transport safety depends on the underlying legal principles concerning compensation. Under the Australian and UK legal systems the functions of the civil law are not penal or deterrent. In the United Kingdom, dependants of the deceased involved in a transport accident can expect to recover damages from wrongful death which only reflects their share of the income that the deceased would have earned had he or she survived. Such damages do not cover any 'subjective' losses such as grief and suffering (Jones-Lee 1989, p. 25). Australian court awards for transport accidents are similarly linked to the age and lost earnings of the deceased as well as the number of dependants (David Attwood, Transport Accident Commission, Victoria, pers. comm. 5 July 1995).

  In the United States, on the other hand, damage awards do play a minor deterrent role so that court awards for subjective losses to surviving dependants can be very large (Jones-Lee 1989). To the extent that such awards reflect societal values, they represent a potentially valid means of valuing injury or loss of life. However, US court awards for subjective losses are arbitrary, with judgements varying for individual cases, which diminishes their usefulness in valuing safety (Jones-Lee 1989, p. 25).

- The *valuation of time* approach measures the value of an individual's remaining life expectancy in terms of the aggregated value of time over this period.

  The valuation of life in terms of time (leisure and/or working) gives no indication of an individual's valuation of a reduction in physical risk. The value of working time is indicative of an individual's marginal productivity. However, using the value of working time and expected working hours will provide only an approximation of an individual's actual gross output.
- The *human capital* approach values an individual as a productive entity and essentially involves discounting to a present value the future earnings stream of an individual.
- The *willingness to pay* approach is based on the amount an individual would be willing to pay for a safer life and involves individual valuations of small changes in risk to life.

Of these differing approaches for estimating the value of transport safety, only the human capital approach and the willingness to pay approach receive serious consideration in the literature. These are discussed in detail below.

Much of the following discussion is based on previous work done by the BTCE (Motha 1990; BTCE 1992).

HUMAN CAPITAL

Description

The human capital approach to accident costing is an ex post (after the event) accounting approach which focuses on the victim's potential output or productive capacity (BTCE 1992). An attempt is made to measure the impact of death or injury on current and future levels of output or gross national product. In some cases, an attempt is made to include a value for pain, suffering and grief of the victim (or their dependants, relatives and friends) by using insurance payments or court compensation payments.

In this approach the major component of the cost of an accident is the present value of the victim's future output lost as a result of premature death or disability. Earnings are usually calculated before tax, given that the perspective is essentially that of output. The method uses the labour market as a surrogate for the non-existent market for human life, and many of the difficulties with the approach have their origin in the inadequacy of labour market measures as a proxy. For a person whose services are not marketed, such as those involved in household or community duties, imputations of service value are typically made. Vehicle damage, medical costs and other costs may also be included as separate components to obtain a value of transport safety.

The human capital approach assumes full employment and the absence of technological change that would alter the relative marginal productivity of different types of labour over time (BTCE 1992). In empirical work an estimate is usually made of the future growth in real earnings or labour productivity, and this is incorporated in future earnings streams. In Australia the value of a statistical life used to cost transport accidents and in cost–benefit analyses is about $616 000, in 1992 dollars (BTCE & EPA 1994, p. 55).

Strengths and weaknesses

The main advantage of the human capital approach is that it is simple to use.

On the other hand, the human capital approach focuses almost exclusively on output, which is unlikely to be the sole aim of government policy. The market wage is used as a proxy for the value of the individual's marginal product. However, labour market imperfections, such as wage discrimination, could produce inaccurate estimates. Because earnings are used to value a statistical life, the human capital approach systematically undervalues the elderly and children (Rice, MacKenzie & Associates 1989; Haight 1994). The approach has therefore been modified, in some cases, to take into consideration factors outside the scope of national output including the contribution of home makers and the value of non-financed externalities such as pain, suffering and grief of a crash victim (or their dependants, relatives and friends). However, some intangible costs such as pain, suffering and grief, are difficult, if not impossible, to measure properly on an ex post basis.

A number of researchers such as Schelling (1968), Mishan (1971), Rice, MacKenzie & Associates (1989), Jones-Lee (1989), Miller and Guria (1991), Miller (1993) and Sladen (1994) have criticised the human capital approach both on conceptual and empirical grounds. The major objection to the human capital approach, in a cost–benefit analysis framework, is that most people value safety principally because of their aversion to the prospect of their own and others' deaths and injury, rather than because of a concern to preserve current and future levels of output and income (Jones-Lee 1990). Miller and Guria (1991, p. 2) state that the approach ignores the 'lost joy of living'. Earnings do not take into account the intensity of the desire of individuals to live and to vary their survival probability. Consequently, the human capital approach does not take into account the 'value of life' to members of society.

Application

The BTCE used a modified version of the human capital approach to estimate the social cost of road, rail, aviation and maritime accidents in Australia in 1988 (BTCE 1992). The basic framework for the estimation process consists of costs relating to loss or partial loss to society of the productive capacity of accident victims and other individuals affected by accidents, the cost of resources used in accident-related activities as well as an estimate of pain and suffering of a non-fatal accident victim. The number of factors that could be included in the costing framework was limited by data constraints. It is emphasised in the study that the overall estimate of accident costs should be considered as a lower bound.

Several accident categories were separately estimated and combined to yield the total cost for each transport mode. The cost categories included lost earnings, forgone family and community contributions, pain and suffering of the victim, property damage, insurance administration, losses to non-victims based on forgone production, travel delay, hospital and rehabilitation, medical, accident investigation, legal and court, ambulance and search and rescue (BTCE 1992).

In the BTCE study, tables of working life were used to calculate loss of output. The human capital approach is actuarial in that it allows for age-specific and gender-specific expectations of working life to be incorporated in calculations of lost output due to premature death or injury (see BTCE 1992, appendix IV, p. 103).

The pain and suffering estimates related only to non-fatal accident victims and did not include the family and friends of victims. It was also assumed that those who died in transport crashes did not bear pain and suffering. The BTCE used court awards for general damages as a proxy for the pain and suffering endured by an injured crash victim (BTCE 1992). These general damages include pain and suffering of the victim, loss of amenities of life and expectation of life. However, as pointed out in the study, this measure has its limitations.

WILLINGNESS TO PAY

The willingness to pay approach to valuing transport safety focuses on the ex ante evaluation of the benefits of safety measures, for inclusion in cost–benefit analysis. The allocation of scarce resources in a socially optimal way calls for consistent and clearly specified procedures in the decision making process for the valuation of desirable and undesirable effects of a project. Cost–benefit analysis is a widely used technique for gaining an appreciation of the social desirability of undertaking an economic project. The problem for public sector decision makers is how to define a general concept like 'social welfare' so that meaningful objectives can be defined on which to base project appraisal. Cost–benefit analysis normally assumes that the government has a number of aims, such as growth in employment or a safe and healthy environment (Sugden &

Williams 1985; Perkins 1994). The usual objective is to maximise the change in aggregate per person gross national product, measured in terms of people's willingness to pay for goods and services.

Cost–benefit analysis organises information to help in making decisions about the allocation of resources. Costs and benefits are each expressed in money terms as far as possible and so are directly comparable with one another. More importantly, costs and benefits are valued in terms of the claims that they make on, and the gains they provide to the community as a whole. The perspective is a 'social' one rather than that of any particular individual, organisation or group. (Normal financial analysis of a commercial project is similar in nature, but excludes broader social effects because its focus is that of an individual person or firm.) Cost–benefit analyses may be used to compare alternative courses of action by reference to the net social benefits produced by each option.

Some costs and benefits are difficult to value. These costs and benefits are therefore sometimes presented separately to the decision maker for assessment in conjunction with quantified estimates of the net social benefits of an activity. However, the strength of the analysis may be weakened if significant costs and benefits go unvalued. The objective of a cost–benefit analyst is to assist the decision maker to make a decision which is consistent with efficiency in the allocation of resources, particularly in areas where for one reason or another private markets cannot or do not achieve this outcome. Consequently, assigning values to as many costs and benefits as possible is an important aspect of cost–benefit analysis.

Description

The willingness to pay approach to valuing transport safety is based on the principles of welfare economics. A change that makes at least one member of a community better off without making anyone worse off is a Pareto improvement. Undertaking a project or program provides an actual Pareto improvement if there is an appropriate set of transfers of money (compensation) between gainers and losers. If these transfers do not actually take place then the change is referred to as a potential Pareto improvement. Sugden and Williams (1985, p. 90) state the potential Pareto improvement criterion lies at the heart of cost–benefit analysis and it requires that changes in people's welfare should be measured by their 'willingness to pay'.

If there is no observable market for a commodity then the demand curve will be difficult to estimate. This is the case when evaluating the impact of public policies which are associated with transport safety (a reduction in physical risk). Consequently, a measure of the strength of people's preferences for safety is needed. An appropriate measure of the extent of a person's preference for anything is the maximum amount that they would be willing to pay for an extra unit of the commodity (Varian 1990). In principle, this amount reflects not only the person's valuation of the desired commodity (an improvement in transport safety) relative to other potential objectives of expenditure but also the individual's ability to pay, which is itself a manifestation of society's overall resource constraint (Jones-Lee 1990).

An assumption of the potential Pareto improvement criterion is that social decisions should, as far as possible, reflect the preferences and attitudes to physical risk of those who are likely to be affected by the decisions. In the case of government funded projects or programs involving safety, these preferences are effectively summarised by the amounts that individuals would be willing to pay (or would be willing to accept in compensation) for changes in the probability of death or injury during a forthcoming period (Jones-Lee, Hammerton & Philips 1985).

The amount an individual would be willing to accept in compensation may be greater than the amount he is willing to pay. The choice of measure, using willingness to pay or willingness to accept compensation, depends in part on a judgement about where property rights lie. Although still subject to debate, research into the disparity between willingness to pay and willingness to accept compensation as measures of market value suggests that using willingness to pay may correspond more closely to market values than do measures using willingness to accept compensation (Coursey, Hovis & Schulze 1992).

The initiation of a probabilistic approach to valuing safety is attributed to Drèze (1962) and developed by Schelling (1968), Jones-Lee (1969) and Mishan (1971). Drèze (1962) considered the valuation issue in terms of the probability of death and individual decision making under conditions of uncertainty.

The outcome of most public programs to save lives is a reduction of mortality and morbidity rates, and it is this reduction, according to Schelling (1968, p. 127), that policy analysts should be attempting to value. People implicitly place a value on safety every day (such as seat belt use or speeding) and it is this informal decision making process that policy analysts are endeavouring to replicate. Schelling (1968) argues that the human capital approach essentially measures loss of livelihood due to premature death rather than the value of life and that willingness to pay is conceptually superior to the human capital approach. When assessing the outcome of public programs the value of safety should reflect a person's pure preference for safety rather than in terms of effects on output (Jones-Lee 1969, 1990).

Based on the potential Pareto improvement criterion the willingness to pay approach to valuing transport safety can be applied to a wide range of public projects and programs, from the provision of street lighting and treatments at intersections (such as traffic lights and roundabouts) to regulation regarding the use of seat belts.

Reduction in physical risk

The willingness to pay approach involves the valuation of risk reduction rather than directly assigning a specific value to life or injury. The variations in safety afforded by public sector projects will typically take the form of very small reductions in the probability of death or injury for any one individual during the forthcoming period. Although the discussion in this paper focuses on statistical life the same approach can be applied to valuing a statistical injury. In applying cost–benefit analysis a reduction in risk is normally calculated in units of statistical life and statistical injury.

An individual's willingness to pay divided by the reduction in the risk of death is simply the person's marginal rate of substitution of wealth for a reduction in the risk of death. Consequently, the value of avoiding one statistical death (or the value of a statistical life) is given by the mean, over the affected group, of individual marginal rates of substitution of wealth for a reduction in the risk of death (Jones-Lee 1990).

For the population at risk, for example a group of 100 000 people, a safety improvement may reduce the probability of death during the forthcoming period (say, one year) by 1 in 100 000 for each member of the group. Consequently, the expected number of deaths within the group during the forthcoming period (a year) will be reduced by precisely one, and the safety improvement is described as involving the avoidance of one 'statistical death' (Jones-Lee 1990). If the individuals in the group are willing to pay, on average \$x for the 1 in 100 000 reduction in the probability of death associated with the safety improvement, then the aggregate willingness to pay will be \$x × 100 000. If \$x was equal to \$20 then the aggregate willingness to pay for the improvement in safety by the group would be \$2 million. Consequently, dividing \$20 by the individual risk reduction (1 in 100 000) suggests that the average person in the group considers the value of a safe and healthy life to be \$2 million.

However, this value estimation does not imply that most people would actually pay \$2 million to avoid dying prematurely. The estimate is based on the small amounts people regularly pay to reduce physical risk and reflects both their willingness to pay (preferences) and ability to pay (wealth).

To simplify further the measurement process the value of a statistical life will be effectively independent of the precise size of the affected group (for example, 100 000 people) and the precise pattern of individual risk reductions (for example, 1 in 100 000) if the following conditions apply (Jones-Lee 1990, p. 41): first, that a safety improvement entails a reduction in the expected number of fatalities of precisely one; second, that individual probability reductions are small, as is the case for the safety improvement of most public projects and programs; and finally, that the characteristics of the affected group of individuals are not significantly atypical.

If people behave rationally in response to the risks that they and their families perceive, their behaviour should reveal the price they would be willing to pay to reduce the risk of death or injury (Miller & Guria 1991). The value will include:

- the family's monetary costs of illness, injury and death;
- the impacts on quality of life, including pain and suffering of the injured and their loved ones;
- the sense of security families derive from being safe and healthy; and
- people's disinclination to gamble involuntarily with their lives and livelihood.

Previous research suggests that some people are willing to pay for others' safety as well as their own safety (Jones-Lee 1976; Mishan 1971; Needleman 1976; Jones-Lee, Hammerton & Philips 1985; Viscusi, Magat & Forrest 1988; Miller & Guria 1991). If the individual's valuation of risks pertain to other members of their society, then their willingness to pay should include this consideration. The amount that people would be willing to pay for others' safety is appropriate if altruism is exclusively focused on a reduction in physical risk (Jones-Lee 1990, p. 42). Consequently, the amount that some people are willing to pay for a reduction in physical risk would reflect their aversion to the prospect of their own and others' death or injury. Although it appears appropriate for values of statistical life to reflect the amount that people would be willing to pay for an improvement in others' safety, the circumstances and amount are still subject to debate (Jones-Lee 1990).

Neither economic theory nor empirical evidence suggest that there is any reason to expect that the value of a statistical life based on the willingness to pay approach will be the same in all circumstances. The willingness to pay for a reduction in physical risk will vary in different circumstances reflecting consumer preferences and property rights regarding safety (Evans 1994a). The type and level of risk and income are important factors affecting the value of a statistical life. People may be willing to pay a premium for a reduction in risk in circumstances which may involve protracted suffering, or where there is the prospect of dying in a certain type of accident such as those involving air or sea transport rather than road transport. The premium may also reflect their aversion to being in a situation where risk is out of their control. Consequently, an examination of previous research may not yield a single value for a statistical life based on the willingness to pay approach which policy makers can adopt generally as appropriate for valuing physical risks. Table 2.2 illustrates the range in estimates of the willingness to pay for a reduction in the risk of a fatality used by US government agencies. Some may consider that the range of estimates is a complicating factor which undermines its adoption by government for valuing transport safety. However, others may consider this aspect an important strength of the approach, reflecting the preferences of members of society to various circumstances involving a reduction in risk.

TABLE 2.2 ESTIMATES OF THE VALUE OF STATISTICAL LIFE IN THE UNITED STATES

Agency	*Year adopted*	*Value A$m 1991*
Department of Transport:		
Land	1986	1.9
Air	1986	2.2
Water	1986	1.3
Department of Agriculture	1985	1.4
Office of Management and Budget	1985	1.3–2.5
Environmental Protection	1983	2.1–10.2
Consumer Product Safety Commission	1981	2.5
Occupational Safety and Health Administration	1983	2.5–4.5
Nuclear Regulatory Commission	1979	8

Note Using the willingness to pay approach.

Source Miller & Guria 1991, p. 7.

It has also been argued that the willingness to pay approach fits well with the shift away from bureaucratic decision making process toward participatory democracy in the market economies. The shift has been intensified by an increasingly educated community and dissatisfaction with the dissolution of representative democracy and a move to negotiated bargaining systems between interests (Withers, Throsby & Johnston 1994). Through the willingness to pay approach, participatory democracy can be incorporated into transport safety policies through community preferences (Viscusi 1993).

Components of a safety improvement

An individual will value the prospect of a safety improvement for two reasons. First, and most importantly, the individual will value the safety improvement because it reduces their own and other's likelihood of death or injury (Jones-Lee 1990). Second a reduced fatality or injury rate will reduce the real resource and output losses associated with death or injury. There is the anticipated reduction in real resource costs borne by society due to the avoidance of material damage (such as vehicles and road barriers) and also a reduction in medical and legal costs. Output losses are included because when an individual dies prematurely the rest of society loses the excess of what the individual would have produced during the remainder of his or her life over and above what he or she would have consumed. The output loss figure is an estimated average for this loss, net of consumption.

Criticisms of willingness to pay

A number of criticisms have been levelled at the willingness to pay approach in valuing transport safety. For a detailed discussion of the criticisms see Jones-Lee (1989, pp. 17–23). While some criticisms may be easily dismissed, others have focused the attention of advocates of the willingness to pay approach on resolving contentious issues.

The willingness to pay approach has been criticised because of problems in the relationship between individual preferences and interests and the quality of individual perceptions of risk (Hauer 1994). Fromm (1968) questioned the validity of the willingness to pay approach on the grounds that individuals usually ignore the external social costs in making personal decisions and that some actually derive a positive utility from taking small risks. Most people have on occasion behaved in a manner that may disregard their own or other peoples' safety. Few people would know the probability of a fatality or injury by various causes. For the approach to be successful, and depending on the method used to estimate their willingness to pay, people need to be informed and give careful consideration to their decisions regarding transport safety. It seems likely that, given adequate information concerning safety and time for careful reflection, most people would prefer that public sector decisions reflect their informed and carefully thought through preferences (Jones-Lee 1989).

The willingness to pay approach has been criticised because of problems concerning equity. In cost–benefit analysis changes in utility are usually simply aggregated on the assumption that the marginal utility of money is the same to everyone, rich and poor. While the assumption may address economic efficiency in valuing transport safety it may be at the expense of equity in terms of the social objective. Consequently, policy makers need to assess the importance of equity relative to efficiency when valuing transport safety.

Some people might arrive at quite different conclusions concerning a particular source of physical risk even when they have access to identical 'full' information about these risks. It has been argued that these differences mean that government decisions will not always be both democratic (reflect individual preferences) and consistent (constitute rational decisions in relation to a given set of well informed probability judgements). However, these cases are rare as the preconditions for a conflict between democratic and consistent decision making are a significant divergence in individuals' decisions about risk and a large divergence between the way in which competing decisions benefit or harm affected individuals (Jones-Lee 1989, p. 20).

It has been argued that for coherence of government decision making the value of statistical life should be independent of the size of the population at risk (and hence of the magnitude of the variations in individual risk). For example, a 'coherent' government ought to be indifferent between two options that involve one death per one thousand people or one death per one million people because it is certain that under either option a life will be lost. This argument highlights the difference between those who favour coherence and advocates of the willingness to pay approach for whom democracy is important. For marginal changes in risk, government decisions should take account of the preferences concerning risk by the members of society.

There are objections to the willingness to pay approach based upon the limitations of the hypothetical compensation test (transfers of money between gainers and losers) relevant to the potential Pareto improvement criterion. Critics argue that compensation tests should be applied to ex post outcomes rather than ex ante variations in risk. This argument regarding compensation revolves around the question of what should be assessed—certainty of death or injury, or a change in the probability of physical risk. It would seem appropriate that if people's preferences are to be taken into consideration when measuring changes in welfare, then ex ante variations in risk should be used.

Another criticism of the willingness to pay approach for a reduction in physical risk concerns the existing probability of a person surviving. Using the willingness to pay approach there will be a tendency for resources to be directed towards safety improvements for people currently facing high levels of physical risk at the expense of expected lives saved overall. For example, in an extreme case a terminally ill person may be willing to spend large sums on possible cures with very low probabilities of success. Consequently, in such cases the willingness to pay approach tends to favour projects which may reduce high levels of risk relative to projects which minimise the expected number of lives lost (Jones-Lee 1989, p. 23).

There are doubts about the reliability of empirical estimates of an individual's willingness to pay for a reduction in risk. The main concern centres on the problem that under certain circumstances people have difficulty with probability concepts and their ability to digest the information needed to make rational choices is limited. As well there is the possibility of 'strategic' behaviour whereby individuals deliberately misrepresent their willingness to pay if they believe that the commodity in question is likely to be publicly provided.

While the various criticisms do not undermine the theoretical foundations of the willingness to pay approach they highlight the difficulties in estimation. The criticisms should be noted in formulating the methodology to estimate the value of statistical life and injury.

Acceptance of willingness to pay

The willingness to pay approach has gained support from a growing number of economists as the favoured method for estimating the value of a reduction in physical risk (Evans 1994b; Elvik 1995). A willingness to pay valuation of risk reduction is perceived by many economists as comprehensively measuring the value placed on life and safety by individuals and as incorporating subjective welfare costs such as pain, suffering and grief. Miller and Guria (1991) state that support for the willingness to pay approach is documented in Bailey (1980), Thompson (1980), Jones-Lee (1982), Hills and Jones-Lee (1983), Menzel (1986), National Safety Council (1988), Mishan (1988), Gillette and Hopkins (1988), Scodari and Fisher (1988), King and Smith (1988) and Miller, Lutcher and Brinkman (1989).

Governments are increasingly adopting the willingness to pay approach. For example, the US Office of Management and Budget (1989) and the Department of Commerce (1991) advocate its use. In the United Kingdom, the Department of Transport and the Health and Safety Executive adopted willingness to pay values for statistical life and are developing non-fatal statistical injury values. The UK Treasury in 1991 gave 'unequivocal and emphatic' advice that government bodies should adopt the willingness to pay approach to the valuation of safety (Jones-Lee & Loomes 1994, p. 84). In 1991 the New Zealand Ministry of Transport adopted willingness to pay as the appropriate method for valuing transport safety (Miller & Guria 1991).

In Europe a report on the socio-economic cost of road accidents, undertaken by the European Commission, recommended that 'for ex ante cost–benefit analysis values of safety ought to be defined and estimated by measuring people's preference for safety per se' (European Commission 1994, p. 69).

International developments in valuing transport safety are discussed in chapter 3.

Estimation

Although the willingness to pay approach in the valuation of transport safety is well grounded in economic theory, there are difficulties in its estimation.

A number of methods have been developed to estimate the willingness to pay for non-marketed commodities such as safety. The methods have traditionally been categorised as *revealed preference*, or 'indirect' valuation, and *stated preference* or 'direct' valuation (Adamowicz, Louviere & Williams 1992, p. 1).

A *revealed preference* by consumers for market or non-market goods is derived 'indirectly' from observation of actual choice behaviour of consumers in the marketplace. The objective is to develop models of choice from that behaviour. The revealed preference category has two main variants:

- consumer market studies that examine consumption and activity choices affecting people's safety; and
- *hedonic pricing* methods applied mainly to the labour and property markets. Hedonic *wage* (or compensating wage differentials) studies focus on occupational risks.

In a *stated preference* approach consumers are usually placed in a setting of a hypothetical market such that they do not make any behavioural change, but merely state how they would behave. One form is *contingent valuation,* a specialised application of stated preference most frequently used to value non-market goods. Consumers are asked what they would be willing to pay, or accept in compensation, for those goods. Stated preference experiments could also take the form of *conjoint analysis,* which evaluates consumer trade-offs for complex goods or services, but this approach does not appear to have been directly applied in the safety area.

Revealed preference methods

With the revealed preference, or observed behaviour method, an attempt is made to identify and observe choices in situations in which people trade off wealth against physical risk.

Applied to consumer market studies, revealed preference methods can be used to estimate the value of risk reduction to the individual from observations of voluntary purchases of risk reducing goods or other consumption activity (Dalvi 1988, p. 15).

Revealed preference methods can also be applied to labour markets where riskier occupations can be expected to carry a wage premium to compensate for risk; termed *hedonic wage.* The variants of revealed preference are discussed in turn.

Consumption and activity

An estimate can be derived of what consumers are willing to pay for the risk reduction associated with a consumption activity by means of a risk to benefit trade-off.

An example of people's risk-related consumption and activity is given by Blomquist (1979) who focused on willingness to trade time and inconvenience for safety, in terms of consumers' decisions to wear or not to wear car seat belts, in the absence of enforcing seat belt legislation. In the same vein Dardis (1980) investigated the demand for smoke detectors. Ghosh, Lees and Seal (1975) effectively produced a value of statistical life for road safety based on a time, fuel consumption and safety trade-off associated with an optimal motorway speed.

Dalvi (1988, p. 17) showed that studies of risk-related consumption yield consistent estimates of the value of life. Dalvi concluded that as the method relies on market prices of safety equipment, it implicitly assumes that consumers would not have purchased the products if the prices had been any higher. Some people would be prepared to pay a higher price, hence the values derived are a lower bound of the value of physical risk reduction (injury or death) based on the willingness to pay approach.

Although markets do exist for certain types of safety devices (seat belts and crash helmets) the vast majority of safety improvement devices are non-marketed public goods. For example, once a safe road is constructed it tends to make life safe for all who travel on it.

Markets for the restricted range of safety improvement devices (that are also genuine private goods) will provide information only about welfare effects of safety improvement afforded by these devices. This information is of little use to public decision makers engaged in cost–benefit analysis for safety investment encompassing a wide range of safety improvements (Jones-Lee 1976, p. 13).

There is also uncertainty as to whether observed choices are based on adequate consumer information and on reasonably observed perceptions of risk, although this is a general problem associated with the willingness to pay approach (Dalvi 1988, p. 36).

Hedonic pricing

Hedonic pricing is a commonly used revealed preference method. In the hedonic pricing method, a good (usually expensive or complex, such as property) is viewed as a bundle of attributes or characteristics (such as the property's location, aspect and views). The market price of the good reflects the combination of different levels of attributes or characteristics possessed by the good (Daniels 1994, p. 375, and pers. comm. 25 July 1995).

Daniels (1994) refers to several transport applications of the hedonic method: (1) valuing accessibility to freeways and public transport routes; (2) the impact of road noise and aircraft noise on property values (citing Nelson 1979, 1982); and (3) the use of hedonically derived values to price noise attenuation (Reynolds 1992).

The hedonic pricing method is relevant to valuation in transport safety, and has been recommended for that purpose by Carson (pers. comm. 7 March 1995).

Compensating wage method. Hedonic pricing is perhaps most commonly applied in the labour market. The compensating wage method relies on wage differentials paid for workers in hazardous jobs (BTCE 1992, p. 79), in compensation for a higher on-the-job risk of death or injury. Wage differentials are used to estimate an individual's willingness to pay for a change in physical risk. The estimation process is not straightforward as the wage rate will usually reflect a range of job characteristics or attributes.

Compensating wage differentials have formed the basis of studies by Thaler and Rosen (1976) and Viscusi (1978) and other overseas researchers. In the only known local study, Kniesner and Leeth (1991) developed an aggregated wage–risk model for Australia, based on the likelihood of a work-related injury. The authors developed variables conditioning the equilibrium level of wages, and included in their compensating wage differential the characteristics of sellers and buyers of labour, and the workers' compensation system.

The underlying assumption of the hedonic wage method is that the wage rate paid for a job reflects forces of supply and demand on the labour market (Dalvi 1988, pp. 11–12). Given that the market functions freely, a bargaining situation arises with employers vying for lower wages to compensate for expenditure on enhanced safety, and employees vying for higher wages to compensate for higher risk. Ideally an equilibrium is reached, termed a *hedonic wage*, which reflects a component for safety. However, if there are inadequate alternative job opportunities (significant unemployment) wages may not be bid up appropriately.

The revealed preference method has the advantage of basing estimates on real choices but has difficulty in finding a pure wealth-to-risk trade-off, and so it is usually necessary to disentangle the effects of other factors. Easily identifiable trade-offs may involve biased samples of individuals (deep sea divers) whose riskier occupations involve a clearly identifiable premium. In valuation of life studies the method provides information only at a highly aggregated level, such as the market wage equilibrium for risk (Dalvi 1988, p. 10).

The risk premium that emerges in the labour market will reflect the worker's marginal rate of substitution of wealth for risk of death or injury only if certain assumptions are met (Dalvi 1988). Two key assumptions are, first, that the labour market operates freely and is in equilibrium and second, that workers perceive work place safety risks correctly. Violation of the first assumption can introduce valuation bias. For example, union bargaining power may push the risk premium higher than it would be under competitive conditions.

With the second assumption, very little is known about the factors that may influence a person's perceptions of risk. Workers may not have full knowledge of on the job risks of injury or death. Also, some risks are not known at the time that wages are set (Daniels, pers. comm. 25 July 1995). For example, carcinogenic properties of chemicals may not manifest themselves for a number of years.

Studies using risk of death factors by occupation tend to estimate smaller values per statistical life than those examining risk of death factors by industry.

There is also the possibility of worker sampling bias according to the level of risk. High risk industries, such as building and construction, may attract workers who are less risk averse. This is reflected in empirical results which show that at higher levels of risk, the value of life is often less.

There may be problems in using the results of wage–risk studies in the transport sector. Wage–risk studies focus on the operation of the labour market, and the types of risks (accidents on the job) may not be the same as the kinds of risks that are of interest to investment appraisals in the transport sector. Although some wage–risk studies have considered a wide range of occupations and both men and women, for the most part only one population group (male blue collar workers), is examined (Dalvi 1988, p. 35). As a consequence the value of risk reduction estimated from these studies may be biased.

Estimates of the value of statistical life from studies based on compensating wage differentials show a wide variation depending on the population exposed to the risk, the nature of the risk and individuals' income levels (Viscusi 1993, p. 1942). Viscusi found that most of the estimates of the value of life were clustered in the US$3 million to US$7 million range (A$4.3 million to A$10.1 million).

Stated preference methods

Stated preference methods involve direct survey in a hypothetical market setting. The methods are particularly suited to obtaining unambiguously marginal rates of substitution from targeted individuals. In the transport safety area, stated preference approaches may require respondents to place monetary values on changes in risks of death or injury, particularly in the context of proposed projects to improve safety.

Jones-Lee, Hammerton and Philips (1985) reported on a sample survey in the United Kingdom on individual attitudes to transport safety and its valuation. One of their findings was that respondents were principally concerned with avoidance of death or injury *per se*, rather than with the effects on future output and income. Valuations of statistical life varied, most significantly, with the respondents' income and age.

Miller and Guria (1991) conducted market research on road safety to recommend a value for statistical life in New Zealand. They found that few demographic characteristics affected values in a systematic way. Both the Jones-Lee and Miller and Guria studies concerned themselves with respondents' marginal rates of substitution of wealth-risk either with reference to themselves only, or to themselves and to others. The latter reflected the respondents' altruism of paying for others' safety.

Contingent valuation

Contingent valuation is a technique most frequently used for eliciting values for non-marketed goods. Elicited values are contingent on a hypothetical market situation described to the respondents (Carson, Mitchell, Hanemann, Kopp, Presser & Ruud 1995, p. 3; Daniels 1994, p. 376). Respondents are presented with a choice situation in which they have an opportunity to buy or sell the good or service in question. The contingent market approach normally defines: the good or amenity of interest, the existing level of provision, possible increments or decrements, the institutional structure under which the good is to be provided, and the method of payment.

The contingent valuation technique can either elicit people's willingness to pay for specified changes in the quality or quantity of a good or their willingness to accept compensation for a well specified degradation in the provision of that good. Respondents state what they would be willing to pay if a market existed for the commodity in question. Willingness to pay is most commonly used because it resembles familiar consumer purchase decisions. Daniels (1994, p. 376) provides further insights into the interpretation of willingness to pay and willingness to accept compensation.

A major attraction of the contingent valuation approach is its potential breadth of application: it is not limited to cases where direct or related markets exist (Department of Finance 1991). The contingent valuation technique has been used to value a wide range of non-market goods. It is by far the most frequently used method in environmental evaluation, for which demand has increased significantly in recent years (Carson, 'Pricing the Priceless' seminar, 6 March 1995), particularly in the United States.

Contingent valuation is well suited to new situations including the pricing of passive use values[1] with reference to the environment. Carson, Mitchell et al. (1995, p. 3) assert that contingent valuation is generally recognised as the only technique for the estimation of passive use values. They apply it to a contingent valuation survey of lost passive use in the estimation of damages arising from the 1989 *Exxon Valdez* Alaskan oil spill.

Contingent valuation is discussed comprehensively in Mitchell and Carson (1989). The conceptual underpinnings of the contingent valuation method are articulated by Fisher (1994) and in discussions of Fisher's paper by Hanemann (1994) and Diamond (1994).

A collection of papers[2] critical of the contingent valuation method appears in a volume edited by Hausman (1993). The critics contend that contingent valuation surveys of passive use values lead to inconsistent or unreliable results

1. Previously termed *non-use* or *existence values* (Carson, Mitchell et al. 1995, p. 1).

2. Revised versions of research funded by Exxon.

and do not have the capacity to measure consumer economic preferences. For example, Diamond, Hausman, Leonard and Denning (Hausman 1993, pp. 58–62) demonstrate inconsistent contingent valuation responses (concerning a wilderness area) when elicited in two different ways, in a survey phenomenon called 'embedding' (or 'nesting'). On the other hand, Carson (Hausman 1993, p. 87) questions Diamond's survey methodology on the basis that it was a telephone survey of a very difficult to describe good.

A bibliography of contingent valuation studies by Carson, Wright, Carson, Alberini and Flores (1995) contains over 2100 entries. A number of the studies deal with the value of life but few address transport safety. As transport safety involves an assessment of small changes of risk, Carson (pers. comm. 7 March 1995) proposed that other methods, including household production function and hedonic pricing, are more amenable to analysis of transport safety.

Application of contingent valuation. The contingent valuation approach normally makes use of a questionnaire or survey. It proceeds as if a market existed for reducing the risk of death, hence is subject to the customary defects of non-binding responses and strategic behaviour of respondents.

Methods of eliciting contingent valuation data are described by Daniels (1994, p. 377) and Dalvi (1988, p. 18). The methods include open ended questions (respondents are asked how much they are willing to pay for a good), contingent bidding or iterative questions (a starting point price is incrementally increased to see if the respondent would still be willing to pay it until a maximum is reached), and referendum questions (which require a yes or no answer).

The values of life generated by the approach are typically (although not always) higher than in other approaches. For example, a study of the willingness to pay for a coronary care unit that would reduce the risk of death from heart attack generated a value of only $38 000 per statistical life.

On the other hand, studies of willingness to pay for improved airlines and reduced cancer mortality have generated values of $8.4 million and $1.2 million respectively (Landefeld & Seskin 1982). Jones-Lee, Hammerton and Philips (1985) estimated a mean value of statistical life of about £1.5 million sterling (about $3 million) in the context of improved road accident safety (Department of Finance 1991).

Advantages and disadvantages. The survey approach enables large samples to be obtained and is flexible, allowing many questions to be asked on a given topic thus enhancing the descriptive and explanatory powers of the analysis, and allowing scope for many questions to be asked (Dalvi 1988, p. 19).

The main criticisms made are the hypothetical nature of the questions and the incentive for strategic behaviour by respondents to influence outcomes.

Mitchell and Carson (1989) detail possible sources of bias in contingent valuation.

An advantage of a questionnaire is that it allows researchers to gain insight into the respondent's thinking and elicit values not reflected in the actual (revealed preference) trade-offs. Researchers can tailor the survey instrument and sampling procedure to provide precisely the kind of information that is required. The questionnaire approach generates estimates of marginal rates of substitution for particular individuals (Dalvi 1988, p. 10).

There are, however, practical limitations. In particular, the method assumes that respondents have sufficient information[3] to be reasonably accurate, that they will be sufficiently interested to apply themselves conscientiously to the task, but that they will not be personally interested in the outcome of the survey to the extent that this factor alone could influence their valuations.

With an incentive to 'free ride', for example, strategically motivated respondents may conceal their true preference—in the expectation that the good will be provided anyway and they will be able to avoid paying for it. The method also assumes away the basic difference between actual and hypothetical markets, namely that it is only in the former that people suffer a cost (for example, regret at having paid too much), if they get their valuation wrong.

The merits and limitations of contingent valuation are the subject of continuing debate, typified in Hausman (1993). Supporters of the method attest that many of the difficulties of contingent valuation can be largely overcome with the aid of sophisticated survey design. Evidence for this is drawn from contingent valuation studies in the United States that are accompanied by public referenda (Mitchell & Carson 1989; Department of Finance 1991).

The extent to which 'embedding' is a problem in contingent valuation appears to be unresolved. Kahneman and Knetsch (1992) present apparent evidence of an embedding effect in contingent valuation. Knetsch (1993, p. 19) concludes from this that contingent valuation results 'can be of little or no guide to allocation policies or basis for damage assessments'. Kahneman (Hausman 1993, p. 461) identifies two types of embedding. One, called 'perfect embedding', involves different commodities, one of which includes another, yet contingent valuation responses are not sensitive to the difference. Thus, willingness to pay for car safety improvements may not differ regardless as to whether a driver's air bag only is provided or both a driver's and a passenger's air bags are provided. The second, 'regular embedding', refers to different

3. Daniels (pers. comm. 25 July 1995) in turn notes that contingent valuation studies, compared with other stated preference studies, often require large amounts of information to be provided to the respondent, risking 'information overload'.

contingent valuation values obtained for the same commodity with different ways of asking the question.

Fisher (1994) tried to reconcile embedding with consumer theory; Diamond (1994) disagreed. Harrison's (1992) critique of the Kahneman and Knetch (1992) paper argues that their evidence is insufficient to test the implied embedding effect.

Another issue concerns the presentation of changes in probabilities of risk. Evidence suggests that respondents are not generally able to discriminate between small changes in the probabilities of risk, and that their response is sensitive to the initial level of risk being presented (Dalvi 1988, p. 20). Like any survey method, contingent valuation is most useful when respondents understand the attributes as the analysts intended. Risk and probability are difficult to value, whatever the method (Daniels, pers. comm. 25 July 1995).

Conjoint analysis

Conjoint analysis, often referred to as 'experimental or stated choice analysis' is a recent development in stated preference. Conjoint analysis portrays consumer decisions as a trade-off among multi-attribute goods or services (Hair, Anderson, Tatham & Black 1992, p. 378). The conjoint method makes use of choice simulators to predict consumer choices across a number of alternative goods or services formulations. A considerable degree of realism can be achieved by ensuring that respondents think in terms of their real-life situation (income, etc.).

Since its first introduction in the marketing literature in the early 1970s, conjoint analysis has become one of the most widely applied marketing research methods for understanding and predicting consumer and customer trade-offs, decisions and choices (Louviere 1992). Although conjoint analysis techniques were well known and applied in psychology prior to their introduction into marketing, they are now used in geography, transport, urban planning, sociology and other areas.

There has been rapid growth in the commercial use of conjoint analysis in marketing research in the United States. In transport, these methods received increasing attention in the United Kingdom from 1979.

Conjoint analysis does not appear to have been directly applied to the area of valuing safety. There may be scope, therefore, for some innovative research in this regard.

Louviere (1992) attributes the generic term conjoint analysis to Green and Srinivasan (1978), who use it in reference to a number of paradigms in psychology, economics and marketing that are concerned with the quantitative description of consumer preferences and trade-offs. The conceptual foundation of conjoint analysis arises from the theory of consumer demand, especially from work by Lancaster (1966) who proposed that a consumer's utility for an economic good could be decomposed into separate utilities for characteristics or benefits provided by that good.

According to Louviere, this decompositional view of the consumer's utility formation process has come to be widely accepted as a reasonable approximation to the market behaviour of consumers, although the processes involved in the decomposition are still subject to debate. One of conjoint analysis' foundations rests on random utility theory-based models of consumer behaviour.

Random utility theory, first proposed by Thurstone (1927), suggests that consumers tend to choose (buy, etc.) those alternatives that they like best, subject to constraints, such as income and time (Louviere 1992). There is some fluctuation of consumer choice from one occasion to another, explained by a random component in the consumer's utility function, U_i:

$$U_i = V_i + \varepsilon_i \qquad \text{eqn(1)}$$

where V_i is the observable or systematic component of utility and ε_i the stochastic random component.

The probability that a consumer will choose alternative *a* from a choice set of competing alternatives C is:

$$P(a \mid C) = P[(V_a + \varepsilon_a) > (V_j + \varepsilon_j)], \text{ for all } j \in C \qquad \text{Louviere (1992), eqn(2)}$$

That is, the probability of choosing alternative *a* from choice set C is equal to the probability that the observable utility of *a* plus its associated random error component is higher than the observable utilities and random components of all other alternatives in C.

A variety of probabilistic discrete choice models can be formulated by making different assumptions about the distribution of the random component ε_a. McFadden's (1974) choice model distributed as IID Gumbel (or Extreme Value Type I) is probably the most computationally appealing and tractable (Louviere, 'Pricing the Priceless' seminar, March 1995).

Random utility theory suggests that consumers seek to maximise their utility subject to constraints, that is, as equation (2) indicates, they seek to choose that alternative with the highest systematic and random component sum.

Utility functions essentially describe choice behaviour. Varian (1990) illustrates this with a commuter choice example. The alternative choices of taking public transport or driving to work can be thought of as representing a set of different characteristics, such as travel time, waiting time, out-of-pocket costs, comfort, convenience, and so on. Hensher has widely applied the stated choice approach to a valuation of travel time savings (citations in Hensher 1995, p. 12). With careful experimental design conjoint analysis can be a powerful analytical tool.

Household production function

A neoclassical economic perspective on households is that households allocate their resources in an optimal way. Part justification for this assumption is that inefficient households will either not form or will not survive. Households form and dissolve with family units, in a market not dissimilar to any other market.

The proposition is therefore that families engage in utility maximisation, although Eatwell, Milgate and Newman (1988, vol 2, p. 676) do not agree.

Carson (pers. comm. 7 March 1995) has suggested that a household production function approach could be used to value transport safety, on the basis that the approach is amenable to small changes that characterise the analysis of risk. It is presumed that the analysis would set out to include, in a family unit's utility maximisation process, its willingness to pay for an incremental reduction in the risk of injury or death. In other words, the willingness to pay for risk reduction would be traded against costs of other consumption within the family unit's disposable income.

Willingness to pay estimates

Contrary to criticism of willingness to pay estimates, such as the claims by authors in Hausman (1993), there is reason to conclude that willingness to pay studies of good quality yield reasonably consistent results. Miller (1990) examined 65 studies that estimated the value of a statistical life generally from peoples' responses as to how much they would pay for incremental changes in survival probabilities. The studies employed four willingness to pay methods: (1) hedonic wage–risk trade-off; (2) market studies involving consumption of safety products; (3) behavioural studies which examined risk-avoidance in inherently risky situations; and (4) contingent valuation surveys, probing willingness to pay for small changes of risk.

Miller selected 47 studies out of the 65 which he deemed to be of reasonably good quality. To compare values from these studies, Miller made adjustments to study measurements so that all were interpreted in terms of behaviour using after-tax dollars. The studies were also adjusted to reflect differences in the accuracy of fatality risk perception between situations. Miller (1990, p. 18) derived from this analysis both a mean and median value of life of US$2.2 million (1988 dollars) and a standard deviation of US$0.65 million. These figures translated to around A$2.75 million ± A$0.8 million (1988 dollars). Miller inferred from these figures a figure of roughly US$1.5 million (about A$1.9 million) for the enjoyment of life and avoidance of pain and suffering.

CHOICE OF APPROACH

In summary, the human capital approach is an ex post (after the event) valuation of statistical life and injury. The focus in the approach is on output or lost earnings. While intangible costs such as pain, suffering and grief could be added, there are significant difficulties measuring these costs on an ex post basis. This is particularly so when valuing pain, suffering and grief experienced by the dependants, relatives and friends of a fatal crash victim.

The willingness to pay approach is an ex ante valuation of the benefits of a safety measure associated with a publicly funded project or program. The approach is based on the theory of welfare economics and attempts to estimate what members of society would pay for a reduction in physical risk. Its focus is on the interests, preferences and attitudes to risk of those who are likely to be affected by a project or program. Because the approach reflects the community's desire or preference to avoid death or injury it automatically incorporates the associated humanitarian factors such as the avoidance of pain, suffering and grief.

There are a number of criticisms of the willingness to pay approach. The most notable are the problems in the relationship between individual preferences and interests and the quality of individual perceptions of risk, and doubts about the reliability of empirical estimates. There is a wide variation of estimates relating to the value of a statistical life, in part due to the fact that in theory willingness to pay will vary depending upon the circumstances, and reflect individual preferences to avoid physical risk. Consequently, it is difficult to choose a particular value for use in cost–benefit analysis. However, despite these criticisms the willingness to pay approach to valuing transport safety is gaining increased acceptance amongst economists and has been adopted by governments in the United States, the United Kingdom, Sweden and New Zealand.

Because of the difficulties in estimating the willingness to pay for a reduction in physical risk it seems worthwhile investigating whether there is a relationship between the human capital and willingness to pay approaches. However, there is no reason to suppose that individuals' discounted future earnings bear any particular relationship to what they could pay to reduce the likelihood of their deaths (Schelling 1968). The reason pertains to the fundamental difference in the two approaches to valuing a statistical life: one approach focuses on a person's willingness to pay for a small reduction in risk, while the other focuses on a person's lifetime earnings. Linnerooth (1979) concluded that there is no relationship between the willingness to pay and human capital approaches in valuing a statistical life. Blomquist (1979, 1981) and Rice, MacKenzie & Associates (1989) found that the value of a statistical life based on the willingness to pay approach is greater than the human capital approach.

It has been argued that in some situations the human capital approach may be the more appropriate approach for valuing a statistical life. For example, Robertson (1986) asserts that victims of suicide may place a very low implicit value on their own lives and so suicide prevention programs (such as fencing railways) would not attract funding under a consistently applied willingness to pay approach. The human capital approach, on the other hand, would yield high values because of the associated loss of gross output of the victim. However, the willingness to pay approach may still offer insights into valuing suicide prevention programs relating to transport. Most importantly, other members of society would be willing to pay to reduce the incidence of suicide and this willingness would not be in terms of future earnings lost alone. The avoidance of trauma suffered by the family and friends of the victim and others such as the train driver also need to be considered. Many factors leading to suicide can be resolved by medical intervention and counselling and temporal aspects should be considered. The victim may have given quite different values of safety improvement a day, a month or a year ago.

The two approaches may give relatively different estimates of the value of transport safety by age group. The human capital approach tends to give higher values for young people at the expense of the aged because the approach is based on future earnings forgone. It could be argued that the willingness to pay approach might favour the aged at the expense of the young if it is assumed that older people tend to be wealthier and may place greater emphasis on reducing physical risk. However, this seems an oversimplification. For instance the aged may be concerned about the safety of others and may be willing to pay for safety programs and projects that mainly benefit the young. But the willingness to pay approach may still give higher absolute values than the human capital approach in assessing the value of transport safety for the young.

An important criterion in assessing the suitability of the approaches depends upon the purpose for which the value of transport safety is used. The two main purposes for assessing the socio-economic consequences of transport accidents are for indicating the economic burden or cost of transport accidents and for valuing statistical life and injury for use in cost–benefit analysis.

An important difference between the human capital (ex post) and willingness to pay (ex ante) approaches to valuing a statistical life centres on the starting point of the analyses. For the ex post approach the starting point is valuing the cost of an individual's death after a crash, mainly lost earnings. The human capital approach does not take into account the 'value of life' to members of society. Earnings do not take into account the degree of intensity of the desire of individuals to live and to vary their survival probability. For the ex ante approach the starting point is before the event and reflects an aversion, by the members of society, to the prospect of their own or others' death or injury.

In choosing between the two approaches the aim of policy makers also needs to be clarified. If their aim is primarily centred on avoiding loss of output resulting from a premature death or injury, then the human capital approach may be appropriate. If, however, the aim of policy makers is to assess welfare changes reflecting the aversion to physical risk of members of society then willingness to pay would appear to be the appropriate approach.

The economic burden or cost of transport accidents is mainly used for comparative purposes between different the modes of transport. The human capital approach is suitable to estimate the cost of transport accidents given that it is an ex post approach to valuing statistical life and injury and if the primary focus of policy makers is on lost output.

In the economic literature most of the discussion about the choice of approach used to value transport safety centres on cost–benefit analysis. The willingness to pay approach is preferable for use in cost–benefit analysis because it is consistent with the theory of welfare economics. The approach reflects the desire of members of society for transport safety associated with publicly funded projects or programs. The approach is compatible with the notion that the government and the community may well expect government agencies to optimise social welfare rather than merely minimise operating costs or maximise profits (Perkins 1994). Justification for choosing the willingness to pay approach for valuing transport safety is further strengthened by developments in other countries.

CHAPTER 3 INTERNATIONAL DEVELOPMENTS

Historically there have been four general phases in valuing transport safety (Elvik 1995, p. 244, based on a survey of twenty countries). The value has increased significantly over the period as a result of changes in the valuation approach. During the first phase, in the 1950s and 1960s, accident costs were based on the net loss of output approach with no allowance made for lost quality of life. In this approach consumption was subtracted from lost production. During the 1960s and 1970s, the second phase involved the gross output approach which focused on the lost production of the victim. In the third phase (1970s until the late 1980s) an arbitrary value for pain, suffering and grief was added to the gross value of lost output in some countries. Finally, starting in the late 1980s, a number of countries switched to the willingness to pay approach.

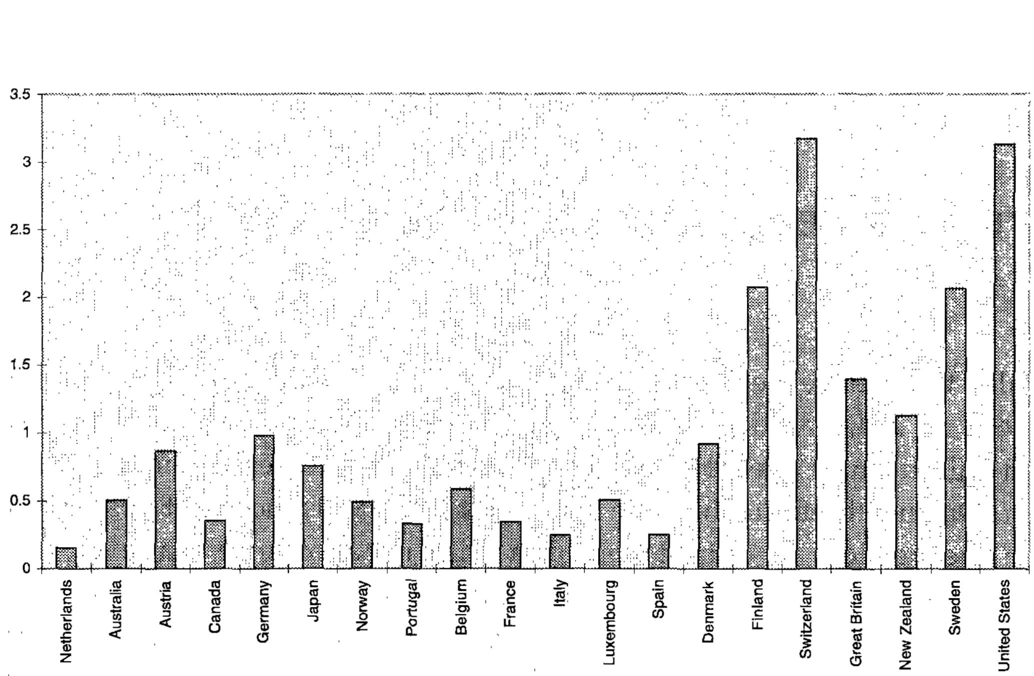
In a survey of approaches to value traffic accident fatalities Elvik (1995) divided twenty countries into five groups:

- Countries using the net loss output approach only: The Netherlands.
- Countries using the gross loss of output approach only: Australia, Austria, Canada, Germany, Japan, Norway and Portugal.
- Countries combining the loss of output approach with the court awards approach: Belgium, France, Italy, Luxembourg and Spain.
- Countries combining the loss of output approach and valuation of lost quality of life based on public decisions: Denmark, Finland and Switzerland.
- Countries using the willingness to pay approach: the United States, United Kingdom, Sweden and New Zealand.

Consequently there is a wide range in the valuation of a traffic accident fatality between countries (figure 3.1).

The following is a synopsis of how willingness to pay was adopted in three countries (the United Kingdom, New Zealand and the United States) that have comparable legal and administrative structures to those of Australia.

FIGURE 3.1 VALUE OF STATISTICAL LIFE (1991)



Source Elvik (1995).

UNITED KINGDOM

The United Kingdom changed its approach to valuing statistical life during a time of major advances both in the theoretical foundations of valuation and in the methods used for empirical estimation (Dalvi 1988).

Historically, the human capital approach was used to value life and safety; initially in its 'net' output form and subsequently in terms of a victim's 'gross' output. In the 'gross' output case the value of life equated to the discounted present value of lost future output of a victim. The 'net' output method deducted, from the lost output, the present value of the future consumption that the victim would have enjoyed if he or she survived.

Both forms of the human capital approach had been widely criticised (Dalvi 1988, p. 4) on philosophical grounds (mainly for reducing human life to money equivalent of lost output) and on the inability of the method to reflect people's 'pure' preferences for safety (Jones-Lee 1990, p. 40). The critics emphasised empirical evidence that people had an aversion to the prospect of death and injury *per se* rather than reflecting a concern for future levels of output.

The UK Department of Transport initially based its valuation of road accident costs on the 'net' output approach first put forward by Dawson (1967). This created an illogical situation of negative overall figures being generated for so called 'non-productive' persons (predominantly the old, the young and female) because their consumption levels exceed their production. To ensure that there were no negative values for life, an arbitrary fixed amount (derived from court awards) was added to reflect the subjective costs of pain, grief and suffering (Dalvi 1988, p. 4).

Valuation moved to a 'gross' basis on the rationale that the valuation measured the benefits of accident cost reduction and so it was right to include consumption of those individuals who avoided becoming casualties. In 1978, as an outcome of the Leitch Committee, all valuations were uniformly increased by 50 per cent in response to criticisms that human capital did not reflect subjective costs. This amounted to a temporary solution preceding major advances in empirical valuation.

Willingness to pay

The willingness to pay approach was first developed in the form of a questionnaire-based study by Jones-Lee, Hammerton and Philips (1985) which was commissioned by the UK Department of Transport. It involved a nationally representative sample survey carried out in 1982 by National Opinion Polls Ltd with a stratified random sample drawn from England, Scotland and Wales.

Respondents were asked questions such as how much extra they would be willing to pay (when buying a new car) for an additional safety feature that would reduce driver and passenger risks by various specified amounts. Other questions tested the quality of respondents' perceptions of transport risks, their ability to deal with probability concepts, and the veracity and stability of the valuation responses.

The study produced values for *own* statistical life (discussed in chapter 2) which ranged between £0.5 million and £2.2 million in 1982 prices according to whether they were mean or median responses. Drivers' value of *passenger* statistical life implied by mean responses was about £0.5 million. The authors concluded that the value of own statistical life for transport risks was estimated as *at least* £0.5 million and more probably around £1.5 million in 1982 prices (A$0.84 million and A$2.53 million respectively). In 1989 values these figures were revised to £0.68 million and £2.0 million respectively (A$1.4 million and A$4.1 million).

A similar exercise broadly based on the UK questionnaire was conducted in Sweden by Persson (1989) and in Austria by Maier, Gerking and Weiss (1989).

By 1988, and following a review of valuation methods in consultation with experts, the UK Department of Transport changed from the 'gross output' based procedure to a willingness to pay approach for all transport modes (Jones-Lee 1990, p. 47). The value of statistical life was set at £500 000 in 1987 prices (A$1.12 million), more than double the 1985 'gross output' figure. Jones-Lee (1990) contends that the UK government set its value at the lower end of the range of estimates 'presumably reflecting a desire to temper radical change with an element of caution' (Jones-Lee 1990, p. 46). The value of a statistical life has been routinely increased each year in line with an index of gross domestic product per person (Evans 1994a).

The UK Treasury gave 'unequivocal and emphatic advice that bodies such as London Underground Limited should adopt the willingness to pay approach to the valuation of safety' (Jones-Lee & Loomes 1994, p. 84).

Jones-Lee and Loomes report on a survey of commuters on how they felt about a particular reduction in risk on London Underground compared with a similar reduction in risk on the roads. The exercise implied that there was an overall premium of about 75 per cent in regard to the 'scale' of an accident and 'context'. Scale refers to the number of probable fatalities resulting from an accident on the underground relative to the number of fatalities in a car crash. If a fatal accident did occur on the underground, it would be likely to involve 25 to 30 deaths. 'Context' refers to commuters' aversion to physical risk on the underground relative to road transport. Underground commuters are willing to pay a premium for a greater level of safety because they are not in control of the vehicle and to reflect their aversion to dying below ground. Relative to the willingness to pay value of statistical life (excluding direct costs) for road transport (£635 000) the implied figure for the value of statistical life for an improvement in safety on the underground was about £1.1 million (about A$2.4 million).

Non-fatal injuries

The willingness to pay approach has been extended to value statistical non-fatal injuries. A study was undertaken to estimate utility losses for various types of injury (O'Reilly et al. 1994, p. 55). Estimated values of avoidance of 'serious' injury were produced based on a range of utility loss scales. The value of preventing a 'serious' non-fatal injury was set at £74 480 in 1992 prices (A$170 500).

NEW ZEALAND

The New Zealand government decided to adopt a willingness to pay approach to value transport safety largely as a result of a consensus reached by participants in a 1989 workshop (Cough & Meister 1990).

Criticisms raised at the workshop regarding the human capital approach included its undervaluation of children, the elderly, minorities and women, and non-valuation of the lost joy of living. Conversely, the willingness to pay approach was deemed to have acquired a 'conventional methodology' status among academic economists (Miller & Guria 1991, p. 3).

The value of a statistical life in New Zealand was NZ$235 000 using the human capital approach. Although more than 50 'reliable' willingness to pay studies worldwide had already estimated values of statistical life, workshop participants strongly urged the New Zealand government to adopt its own valuation. A survey involving a questionnaire was undertaken in 1989–90.

The exercise was timely in that it 'piggybacked' as a supplement on the Ministry of Transport's periodic survey of New Zealand travel patterns. This reduced the cost of the exercise to around NZ$100 000.

Based on the questionnaire, survey respondents drove more slowly in adverse weather, thus 'buying' safety with time. This established a functional relationship between value of life and value of travel time. Questions in the survey probed respondents' willingness to pay for reductions in own risks, other family members' risks and the risks of other people on the road. Values of statistical life were computed according to alternative risk-reducing solutions; namely, driving on a safer toll road, taking a course on road safety, adding safety features to a car and living in a safer roads neighbourhood.

Valuations were sought for both fatal and non-fatal risks, and for travel time. Responses ranged quite widely within and between the proposed safety measures, and according to own and family members' safety. The overall valuation of life was based on response averages.

Analysis essentially involved the following rationale (Miller & Guria 1991, pp. 10–12): the willingness to pay values of a husband for his own safety and that of his wife were averaged, and the figure was multiplied by the number of family members. The respondent's dollar value for own risk reduction was subtracted from this figure and the result was divided by the number of remaining family members.

Average values of statistical life obtained from a set of risk reduction choices presented in the survey ranged from NZ$1.4 million to NZ$2.3 million (A$1.16 million to A$1.9 million) in December 1993 dollars, with an overall average of NZ$1.9 million (A$1.57 million).

The estimate (NZ$1.9 million) represents the willingness of families to pay for a reduction of fatal risks to their members. About a third of the respondents were also willing to pay something to protect the lives of the general public, on average NZ$350 000 per life saved (A$289 000).

Based on the survey results the recommended value of statistical life was NZ$2 million. The value matched empirically derived values of life based on travel time costs set at 60 per cent of the wage rate for drivers and 45 per cent for passengers. The travel time costs were proposed by Miller (1989) following a review of other countries' literature. Consequently, the New Zealand government adopted a value of statistical life of NZ$2 million set at April 1990 prices (A$1.49 million). The value is revised each year using an index based on wage rates.

The adopted value fell mid-range between the willingness to pay values used for road transport in the United States (NZ$2.5 million or A$1.86 million) and the United Kingdom (NZ$1.7 million or some A$1.2 million). A survey of 50 'reliable' studies in a number of countries produced a range from NZ$1.5 million to NZ$6 million (A$1.1 million to A$4.5 million) (Miller & Guria 1991, p. 6). The New Zealand NZ$2 million also fell in the mid-range of the values from the 50 studies after adjusting for differences in the GDP per person between countries.

While it could be argued that the assumptions were fairly heroic, various consistency checks were applied to the responses. To add to its credibility the NZ$2 million value of life matched well with Miller's proposed values of travel time, and fell in the mid-range of the 50 studies worldwide. The study report was reviewed by a number of researchers in the field including Professors Jones-Lee and Viscusi.

Miller and Guria (1991, p. 7) argued that for consistency the willingness to pay approach should also be used to value non-fatal injuries, pointing to New Zealand, US and UK studies.

Miller and Guria (1991, p. 8) contend that changing the value of statistical life to the new higher value implies more safety regulation and more investment in safety-related projects relative to other projects, but that the change was unlikely to alter the prime targets for safety improvement. However, there is no record of any empirical analysis being carried out by Miller and Guria to support this hypothesis.

Guria (1993) subsequently prepared social cost estimates of traffic accidents by injury severity for use by the New Zealand Land Transport Safety Authority in economic evaluation of safety programs and policies.

UNITED STATES

The earliest large scale empirical study based on the willingness to pay approach of valuing statistical life for transport safety was a revealed preference study by Blomquist (1979) in the United States. The study focused on people's willingness to trade time and inconvenience for safety, through their decisions to wear or not to wear car seat belts in the absence of compulsory seat belt legislation.

Jones-Lee (1990) reports that Blomquist arrived at a preferred value of statistical life in excess of US$368 000 in 1978. This converted to about A$900 000 in 1989 prices. Blomquist based his estimates on the premise that people who wear seat belts must place a value on safety improvement that is at least equal to the time and inconvenience costs of wearing them.

Between 1979 and 1989 a number of US government agencies adopted values of statistical life based on the willingness to pay approach (Miller & Guria 1991, p. 7). The US Department of Transport adopted the willingness to pay approach for valuing land, air and water transport safety in 1986 (see table 2.2). A value equivalent to A$1.9 million was being used in both federal and state land transport safety analyses. A report by Turner-Fairbank Highway Research Center, McLean for the Federal Highway Administration (Department of Commerce 1991, p. 3) states that 'comprehensive life and injury [or, willingness to pay] values[4] are the preferred valuation method for benefit–cost and regulatory analysis'.

By the late 1980s willingness to pay had come to be a widely accepted approach to valuing statistical life in the United States. Agencies recommending the approach included the Federal Highway Administration, the National Safety Council and the US Office of Management and the Budget.

Viscusi, Magat and Forrest (1988) conducted a survey in the United States of people's private and altruistic valuations of risk reduction from insecticide. The risk-dollar trade-offs revealed by consumers averaged US$2080 and US$3680 (about A$2600 and A$4600) per injury pair prevented within the household; consumers were willing to pay much less for injury pairs prevented in the rest of their state and even less for injury pairs avoided in the United States as a whole. The authors conclude, however, that the summed altruistic values for other individuals exceeded the private valuations, which suggests that altruism may be an important component of the benefits from risk reduction programs.

4. The report avoids the name 'willingness to pay' on the grounds that revealed preference studies, such as those involving safety-enhancement consumption, represent how much people actually pay to reduce safety risks, not what they are willing to pay.

CHAPTER 4 LIKELY OUTCOMES OF ADOPTING WILLINGNESS TO PAY

There would be a number of important implications for policy if the willingness to pay approach for valuing transport safety were adopted in Australia. On the basis of overseas results, it could be expected that there would be a substantial increase in the value of safety (statistical life and injury). From a policy perspective, such a change would not only affect cost–benefit results of transport projects and programs but would also have wider implications.

FUNDING

If policy makers decided to switch to the willingness to pay approach in valuing transport safety, then the value of a statistical life could be expected to increase significantly. Consequently, an important question for the policy maker is what effect the increase in the value of safety might have on the size and allocation of the transport budget.

While it could be expected that expenditure on transport safety would rise, the increase would be limited by the rapidly increasing marginal cost of avoiding additional fatalities.

Jones-Lee (1989) illustrates the effect of increasing the value of statistical life on the UK road budget expenditure by developing a crude cost function for safety. Jones-Lee's cost function for road safety shows the relationship between incremental annual road safety expenditure and incremental annual avoided fatalities. If the value of statistical life were increased from £192 000 to £260 000 there would be an increase in the number of safety-related projects undertaken, resulting from the improved benefit–cost ratios associated with the projects. On Jones-Lee's estimates, an additional expenditure of £70 million would save an extra 300 lives a year (this expenditure is 4 per cent of the central and local governments' annual budget for new road construction and improvement). If the value of a statistical life was increased from £192 000 to £500 000, then an estimated £180 million would be spent on safety and this would save an additional 600 lives (10 per cent of the road budget). If the value was increased from £192 000 to £1.5 million, an additional 900 lives would be saved for £390 million (22 per cent of the road budget). These results imply that above the £1.5 million value of a statistical life the additional number of lives saved would be expected to fall rapidly.

Another important question relating to funding is how a change in the magnitude of the value of safety might affect the ranking of public sector investment projects.

For the purposes of this study, a sensitivity analysis was undertaken on intersection treatments analysed in the Black Spot Program (BTCE 1995d). Intersection treatments included roundabouts, channelisation and new traffic signals. The results of the analysis indicated that there could be an effect on project ranking if there was an increase in the value of a statistical life. The value of a statistical life was varied from $780 000 (human capital) to $1.5 million, $2.0 million and $2.5 million (assumed willingness to pay). There was no change in the ranking of projects because of the similarities between the safety treatments. However, the benefit–cost ratios for roundabouts and channelisation increased significantly as the value of statistical life increased, while there was little change in the ratio for new traffic signals, reflecting differences in the safety benefit.

A sensitivity analysis was carried out in the United Kingdom as part of the Leitch Committee Report (1977) on Trunk Road Assessment (Jones-Lee 1989). In the analysis the value of avoidance of a fatality increased from the actual 1976 level of £42 000, to £68 000 and £250 000. The sensitivity analysis was carried out on twenty five road schemes, which was considered to be a representative sample of the roads program. In both scenarios there was a significant change in the ranking of the schemes. Some low cost schemes which had a relatively high safety component became highly beneficial.

When the willingness to pay approach was adopted in the United Kingdom the effect on the allocation of the road budget was forecast. The Department of Transport expected that there would be only a small difference in the economic appraisal of large road schemes where 'mobility' benefits were the largest component. However, for smaller road projects the increase in the value of safety (statistical life) was expected to lead, in general, to a shift away from time saving projects to those which improved safety (Jones-Lee 1990).

In New Zealand, while no formal evaluation has been carried out, the increase in the value of safety has led to more investment in safety-related projects relative to other projects (Dr Jagadish Guria, NZ Ministry of Transport, pers. comm. 2 September 1996).

On the basis of the available evidence, an increase in the value of safety in Australia could thus be expected to lead to a change in the ranking of transport projects and programs. If the willingness to pay approach was adopted in Australia it would be worthwhile to monitor and measure the extent of the change by comparing the rankings of projects and programs using both approaches.

CONSISTENCY

Although much of the discussion in this study has centred on the value of statistical life, it would be appropriate to extend the methodology to valuing a statistical injury. Externalities related to transport such as noise and pollution might also be valued using the willingness to pay approach. Indeed some road transport authorities already use the willingness to pay approach in valuing noise (Roads and Traffic Authority 1993).

Consistency would also be an important consideration in adopting the willingness to pay approach for valuing a reduction in physical risk for all transport modes. As discussed in chapter 2, the value of a statistical life or injury will differ under different circumstances. As a result, people may be willing to pay a premium for a reduction in physical risk on rail, air or sea compared with road.

Any significant differences in premiums for risk in different modes would imply that governments should focus expenditure on those modes where users indicate a higher willingness to pay for safety. However, there is a need to exercise caution in drawing hard and fast conclusions. Users might well express a very high willingness to pay for aircraft safety, but air travel is already very safe by comparison with road. Basing safety expenditure on consumer preferences, when the quality of individual perceptions of risk is poor, could result in inefficiently diverting scarce resources to an area where attainable increments in safety benefits are lower than elsewhere. Although poor perceptions of risk might be improved by providing more information, such concerns should be taken into account when formulating the methodology to estimate the value of transport safety.

It would be preferable if the willingness to pay approach were also to be applied to other life saving areas where the value of a statistical life or injury was used in cost-benefit analysis. The general adoption of the willingness to pay method across sectors would improve transparency in the decision making process and increase efficiency in the allocation of resources. Other life saving areas include health services, police and search and rescue services. In the

United Kingdom the Health and Safety Executive adopted the willingness to pay value of statistical life of £500 000 (Jones-Lee 1990, p. 48).

COST

The cost of implementing the willingness to pay approach could vary depending on the implementation strategy. For example, values could be adopted from other countries or through Australian research. For the latter option, the willingness to pay approach would require extensive surveys using sophisticated techniques. There would be a trade-off between the cost of implementing the willingness to pay approach and consistency and thoroughness. To ensure consistency and thoroughness, the surveys would need to be applied separately to different modes of transport and to various injury types, as well as to loss of life. As with the human capital approach, estimates would need to be updated every few years to account for factors such as inflation and changing preferences for safety. Costs could be minimised, however, if all Australian governments adopted a cooperative, coordinated approach to the task.

The balance that policy makers choose between projects, programs and regulation to improve transport safety will be important in determining the level and allocation of expenditure. The assumed increase in the value of statistical life and injury would not only operate through cost–benefit analyses for projects and programs but also through less direct means involving safety regulation. Regulations such as safety standards, speed limits and culpable driving laws may be tightened and enforced more stringently if the results of cost–benefit analysis incorporating a higher value of statistical life and injury are adopted. Tightened regulations may require little government expenditure.

There may be problems in assessing the extent and speed of improvements in transport safety following any switch to the willingness to pay approach and an assumed higher value for a statistical life. It may take a number of years for the safety improvements to filter through because of limited funding and because results of cost–benefit analyses may not be strictly applied. Funding arrangements between Commonwealth, State and Territory and local government may also have an important effect. Total road expenditure by government was estimated at $5706 million in 1994–95, of which the Commonwealth accounted for 27 per cent, States and Territories 42 per cent and local governments 31 per cent (BTCE 1996). An increase in the value of safety might lead to more smaller road projects being undertaken, the primary responsibility of which is with local government. Consequently a review of road funding arrangements between Commonwealth, State and Territory and local government may be required.

There would be some savings resulting from a reduction in costs associated with fewer fatalities and injuries, because of more safety-related projects and programs being undertaken. Costs thus avoided would include hospital, ambulance and police services, vehicle damage and fewer compensation claims and time off from work. Reduced costs could help compensate governments for the costs involved in commissioning surveys to estimate willingness to pay values of safety.

OTHER ISSUES

Advocates of the willingness to pay approach assert that for a democratic society the appropriate starting point for analysing risk-money trade-offs is the value that individuals bearing the risk place on the improvement in safety (Jones-Lee 1989, p. 290; Viscusi 1993). By incorporating the wishes and attitudes of those that will be affected by public investment decisions, it is claimed, the cost–benefit analyst will gain a better understanding of the welfare change affecting members of society. However, while willingness to pay is an important criterion it should not be the sole criterion by which safety effects are judged.

The adoption of the willingness to pay approach in valuing transport safety would be likely to affect the insurance market. For example, government policy requires all Australian carriers to be insured against liability for death or injury of an airline passenger. Higher values imputed for statistical life may result in higher insurance premiums.

Adoption of the willingness to pay approach and the assumed increase in the value of safety would bring Australia into line with other countries with similar economic and social characteristics. This may be an important aspect with regard to the adoption of safety developments and international best practice. Overseas developments in transport safety improvements (whether technological or policy driven) should, from a logical perspective, be adopted faster in Australia than would be the case if a lower value for transport safety based on the human capital approach were retained.

CHAPTER 5 CONCLUSIONS

The loss of life and property, together with the injury and damage, that occurs as a result of transport accidents represents a major burden on the Australian economy. It would be unrealistic to seek to prevent all transport accidents. However, policy makers are concerned to reduce the incidence and severity of accidents. To assist them in allocating resources efficiently to this task, it is essential that estimates of the value of transport safety are as realistic and accurate as possible.

Willingness to pay and human capital are the two main approaches used to value transport safety. The human capital approach has been used to date in Australia both for measuring the economic burden or cost of transport accidents and for project evaluation through cost–benefit analysis.

The human capital approach is an ex post (after the event) valuation of statistical life and injury. The focus in the approach is on output or lost earnings. While intangible costs such as pain, suffering and grief could be added, there are significant difficulties measuring these costs on an ex post basis. The advantage of the human capital approach is that it is relatively straightforward and easy to calculate. The human capital approach is suitable to estimate the economic burden or cost of transport accidents if the primary focus of the policy makers is on lost output or earnings resulting from premature death or injury.

The willingness to pay approach is an ex ante valuation of the benefits of a safety measure. The approach is based on the theory of welfare economics and attempts to estimate what members of society would pay for a reduction in physical risk. Its focus is on the interests, preferences and attitudes to risk of those who are likely to be affected by a publicly funded project or program.

There are difficulties in estimating the value of transport safety using the willingness to pay approach. Further research is warranted in areas such as the differences between subjective and objective probabilities of risk in different transport modes, problems associated with aggregating utilities, and the reliability of contingent valuation analysis in valuing safety. However, despite these concerns the willingness to pay approach to valuing transport safety is gaining increased acceptance amongst economists and has been adopted by governments in a number of countries.

An important issue relating to the selection of the approach used to value transport safety, for the purpose of cost–benefit analysis, concerns differences in values that result from each approach. If the two approaches produced similar estimates of the value of transport safety the issue of selecting an approach would be less problematic. However, overseas research suggests that the value of transport safety (statistical life) based on the willingness to pay approach may be three or four times higher than estimates based on the human capital approach. The approach used to value transport safety could therefore have important implications for the allocation of resources in the Australian economy.

On the basis of the research undertaken there appears to be a sufficient case for Australian policy makers to consider using the willingness to pay approach for valuing transport safety in future Australian project evaluation.

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Abbreviations

AGPS	Australian Government Publishing Service
BTCE	Bureau of Transport and Communications Economics
EPA	Environmental Protection Authority
USGPO	United States Government Printing Office

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ABBREVIATIONS

A$	Australian dollar
BTCE	Bureau of Transport and Communications Economics
GDP	gross domestic product
GNP	gross national product
£	pound Sterling
NZ$	New Zealand dollar
UK	United Kingdom
US$	United States dollar