# VALUATION OF HUMAN LIFE FOR ROAD SAFETY PROGRAMS IN NEW ZEALAND

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*ABSTRACT:* *This paper summarises and discusses research in New Zealand on placing a value on lives saved through road safety programs and policies.*

*Increasing pressure to reduce Government expenditure in New Zealand means that policies and programs in the field of road safety will need to be more critically examined.*

*The method of valuation described by the paper uses in part a human capital approach with proxy valuations for non market occupations and extends this further in valuing the unemployed and elderly using social welfare transfer payments as a measure of society's values.*

*The paper briefly discusses the alternative 'willingness to pay' method of life valuation and explores reasons why this has not been adopted.*

*Views expressed in the paper are those of the author and do not necessarily reflect those of the New Zealand Ministry of Transport.*

Pearce NZ method (crude) assessed human capital value averaged over the full population.

This method gives a weighted average by person type (sex, age, employment status etc) based on the road accident fatality profile (e.g. gives more weight to young males who are more likely to kill themselves). Gives lower values [Fig 1 v. Fig 2] because there are more lower paid, high unemployment (young) people proportionately.

# LIFE VALUATION

## INTRODUCTION

New Zealand research into accident costs, including placing a value on loss of life, for use in road safety and roading programmes parallels the work on this subject in Australia. (As outlined in Somerville and McLean (1981) and Wigan (1982).) This paper describes the method which is presently used in New Zealand and its origin, describes some recent work by the Economics Division of the New Zealand Ministry of Transport and gives reasons why an alternative "willingness to pay" methodology is not expected to be adopted.

The idea of placing a value on human life should not be new or abhorrent to a group of transport researchers and economists. Such a value must be considered either explicitly or implicitly when evaluating alternatives involving road safety. Even if a decision maker initially considers the sanctity of human life to have infinite value he will usually be forced to reconsider when it comes to diverting resources from other purposes to life saving activity.

The method of determining such a value has been the subject of debate for a number of years with the recent literature on the subject strongly arguing for valuation in terms of the sum of the perceived values of changes in probability of death for a large number of individuals. Usually termed the "willingness to pay" approach.

However, those who are involved in roading and safety evaluations in New Zealand have taken a more pragmatic approach by using variations of a human capital method of valuation. This paper explores the reasons for this, including some reasons which I hope are more than just pragmatic.

## THE PRESENT METHOD

The present valuation method used in New Zealand is inadequate and is in the process of being changed for reasons which will be obvious from my description. The method employed by the New Zealand Road Research Unit and also adopted informally by the New Zealand Ministry of Transport derives from the work of Sherwin (1976) (also reported in Sherwin and Jackson (1978)) who draws on the work of Paterson (1973).

Sherwin takes gross national expenditure and divides by the population in the "productive" age group of 20 to 64 years. This annual productivity (or annual expenditure per "productive" person) is then applied to various age groups taking account of their expected working lifetime. Annual expenditure is discounted at 10% per annum to give net present values.

Sherwin agrees with Paterson that averaging productivity over all adult members of the household obviates the need to consider imputing a value for housewives' services because the household as a whole is considered as a productive unit. In my view this merely substitutes the (irrelevant) returns to non labour factors of production for the value of housewives' services not included in the national accounts.

Sherwin and Paterson follow in the footsteps of Reynolds (1956) and Petty (1690) in dividing national income, including non labour elements, by working population. However Reynolds adds in an assumed output per housewife. Petty does not use discounting and includes women and children as part of the working population (perhaps correctly in 1690).

An unfortunate anomaly occurs when the values obtained are used in cost benefit analyses conducted for the New Zealand National Roads Board who use a 15% discount rate to rank projects. The values derived by Sherwin (using a 10% discount rate) ought to be (but are not) reduced by about 30% to take account of this.

Subtraction of Consumption

Sherwin differs from Paterson in that, although he does the calculations, he does not advocate the subtraction of the discounted value of the deceased's consumption. The argument for subtraction of consumption is that while society loses production it saves on consumption. It is now generally agreed by economists that consumption should not be subtracted. Society is viewed as including those individuals whose lives will be lost. For those individuals their own consumption has value and so is part of the social loss contingent on death.

Despite the advice of economists the net figure is the one which is used by the National Roads Board. This reflects the attitude taken by the roading engineers at the "head office" level that a "conservative" approach should be taken to evaluations. This is because of the claimed tendency for those advocating the project to be optimistic about benefits and costs. This was also a reason behind the use of a 15% discount rate.

Sherwin's figure for consumption per annum per individual is gross national expenditure less educational expenditure and less gross capital formation, divided by the population. Educational expenditure is averaged over the population in the 0-19 age group and subtracted where appropriate Not surprisingly negative values are obtained for those in the 0-4, 5-6 and over 60 age groups, other groups having positive values.

Pain, Grief and Suffering

The present method recognises that there is more to preventing death than the effect on society in terms of lost production. The choice of a sum to represent the less tangible items of pain, grief and suffering is made by arbitrarily taking the figure necessary to bring the largest negative value of life up to zero. The effect is to increase the average life values by about 44 percent. It is not clear whether this value includes suffering to the deceased, his or her friends and relatives, or both.

The Values Used

The life values used in cost benefit analysis by the National Roads Board are combined with a number of other accident cost elements and expressed in terms of a cost per injury accident. Including the allowance for "pain, grief and suffering", the life values make up a significant 31% of the cost per injury accident.

The last major review was by Cox (1979) who updated Sherwin's figures using an inflation index. This simple updating by an inflation factor did not fully take into account consumption and income changes since 1972/73.

As shown in Table 1, I have recalculated Sherwin's figures directly for three recent years using national income and population data for those years rather than directly update his 1973 estimates.

TABLE 1 — Life Values, Present Method

| | 1978/79 | 1979/80 | 1980/81 |
|---|---|---|---|
| Gross | $75,000 | $90,000 | $101,000 |
| Net | $35,000 | $40,000 | $ 45,000 |
| Pain, Grief and Suffering | $34,000 | $42,000 | $ 47,000 |

As a simplification I have taken life expectancy and the age and sex characteristics of road accident fatalities for the calendar year 1979 and applied them to all three years. Figure 1 shows how the life values change with age, life values net of consumption are negative for those over sixty and under ten.

## THE HUMAN CAPITAL APPROACH

Research conducted for the Economics Division of the New Zealand Ministry of Transport (published in Main (1982)) has used previously ignored occupation, as well as age and sex, data for New Zealand road fatalities in 1979 and 1980 to value their cost to society. Troy and Butlin's (1971) analysis of motor accidents in A.C.T. also takes occupational (or specific income) data into account, but I know of no other.

Although titled "the human capital" approach the method significantly departs from a strict application of human capital theory. This departure largely concerns the values placed on those not employed and those past retirement age for whom social welfare payments are taken as a lower bound of their worth to society.

### The Method

For each fatality whose occupation, sex and age was known, an assessment of current and future earnings was made. Allowance was made for income progressions as individuals gained skills related to their occupation. Age sixty was taken as the retirement age in every case. For each age and sex group, labour force participation rates were applied to determine time on average spent not employed.

Mortality rates by age and sex were also applied to take account of those who would have died in any case. Unfortunately labour force participation and mortality rates were not available on an occupational basis.

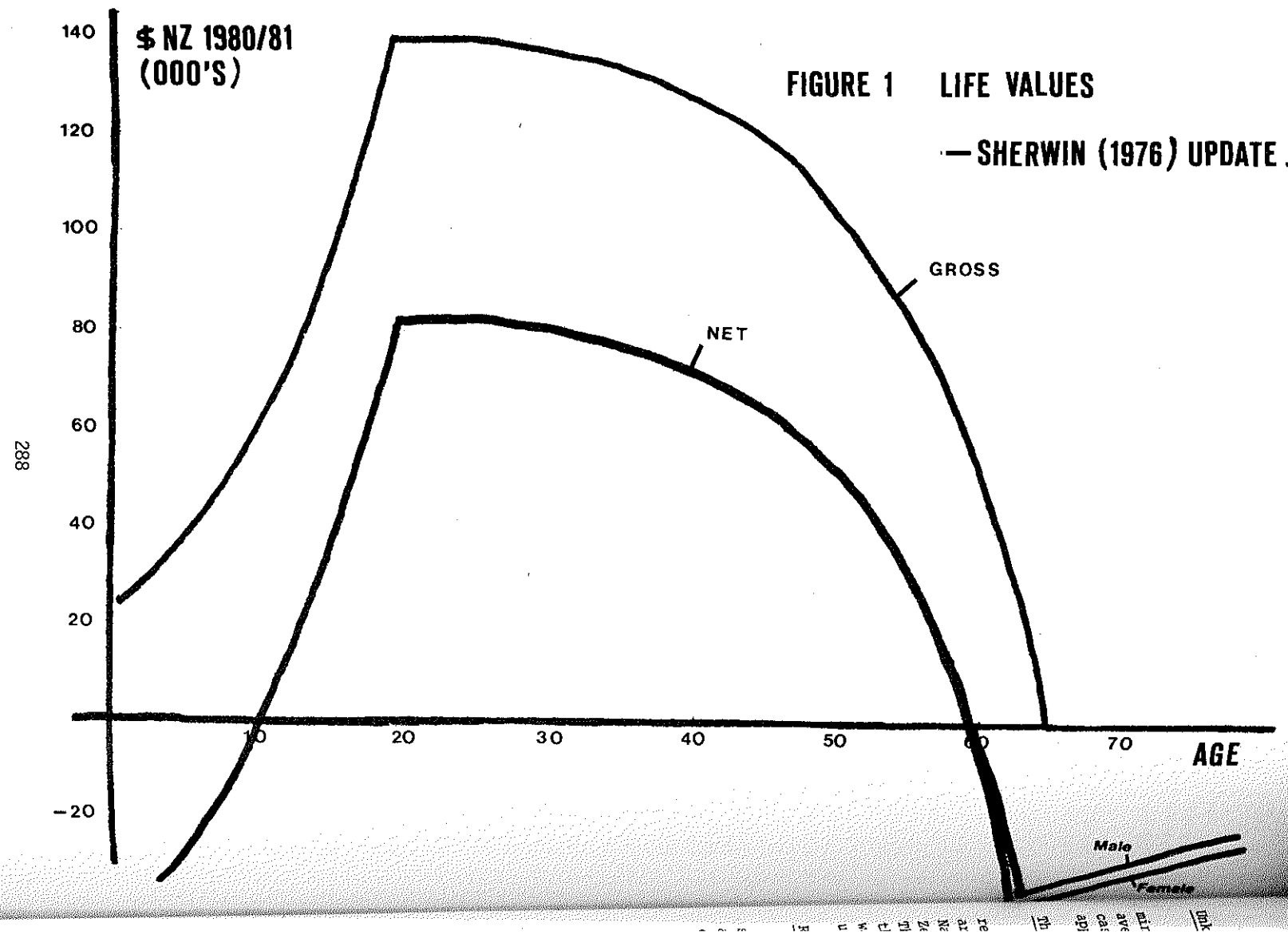



FIGURE 1 LIFE VALUES

— SHERWIN (1976) UPDATE.

Unknown Occupations

For those whose occupations were unknown (40% in 1979) legal minimum wages were applied from age twenty, progressively increasing to the average male and female wage by age 26 in the case of males, and 23 in the case of females. Mortality and labour force participation rates were applied as above.

The Unemployed

For those who were unemployed the unemployment benefit was taken to represent their value to society. It was recognised that benefit payments are transfer payments and so do not reflect the use of real resources in National Income terms, but the benefit payment was taken as the amount New Zealand society was prepared to pay to keep an unemployed person alive. This valuation was applied up to the retirement age of 60. This measure of the value of the unemployed was also applied to a person whose occupation was known, for that proportion (in a probabalistic sense) of his life spent unemployed as determined by the relevant labour force participation rate.

Retired and Other Beneficiaries

Those whose occupation was listed as either single parent or sickness beneficiary were valued by the appropriate benefit paid by society as a measure of their worth up to the age of 60. For those whose occupation was listed as retired and for the expected lifetime years of all fatalities beyond the age of 60 the old age benefit (termed national superannuation in New Zealand) was similarly used.

Students

Children and students were treated differently from other groups in that no values were assigned until the age of 19. From then on average male and female earnings were applied as for those with unknown occupations.

For all the above groups mortality and, where appropriate, labour force participation rates were applied as for persons whose occupations were known.

Housewives

Where the deceased had housewife recorded as the occupation an opportunity cost concept was used using the costs of marketed domestic service alternatives. These included child care facilities, baby-sitting fees and household cleaning services.

Account was taken of average numbers and ages of children and their different needs over the otherwise expected lifetime of the deceased housewife.

In addition a valuation of the husband's lost leisure time was made. It was assumed that the equivalent of 2 hours per week day and 4 hours per day in the weekend was involved valued at the average male wage. This is taken to reduce to about half when a child reaches 16 and to nil at 19.

An alternative, which gives the same result, is to assume the whole of 8 working hours per week day and 16 hours per day in the weekend are involved valued at one quarter the average male wage consistent with value of travel time. An (at first sight) apparently overgenerous assumption was made that some form of child care is involved until the housewife's children reach the age of 19 although a higher figure would need to be used if one were to apply average female wages instead (even when adjusted for labour force participation, and including unemployment payments and mortality rates).

For example, a deceased housewife aged 23 is valued at $9,500 p.a. up to age 27, $8,600 p.a. between 28 and 33, $8,000 p.a. between 34 and 38, $5,900 p.a. between 39 and 43, and $3,300 between 44 and 50. (1979 dollar values.)

The average female wage at the same time was $7,500 p.a. but allowing for unemployment and normal mortality this would be factored down to $4,600 for the same housewife between 51 and 54 and $3,800 between 55 and 60.

## THE RESULTS

The life values obtained are shown in Table 2 below.

TABLE 2 — Life Values — Human Capital Method

| As At | Male | Female | All Casualties |
|---|---|---|---|
| 1 November 1979 | $75,000 | $29,000 | $61,000 |
| 1 November 1980 | $84,000 | $36,000 | $68,000 |
| 1 November 1981 | - | - | $78,000 |

Figure 2 depicts (for November 1980) the difference between male and female values and how these change with age. The low number of female casualties means that less confidence can be placed on the relative female values.

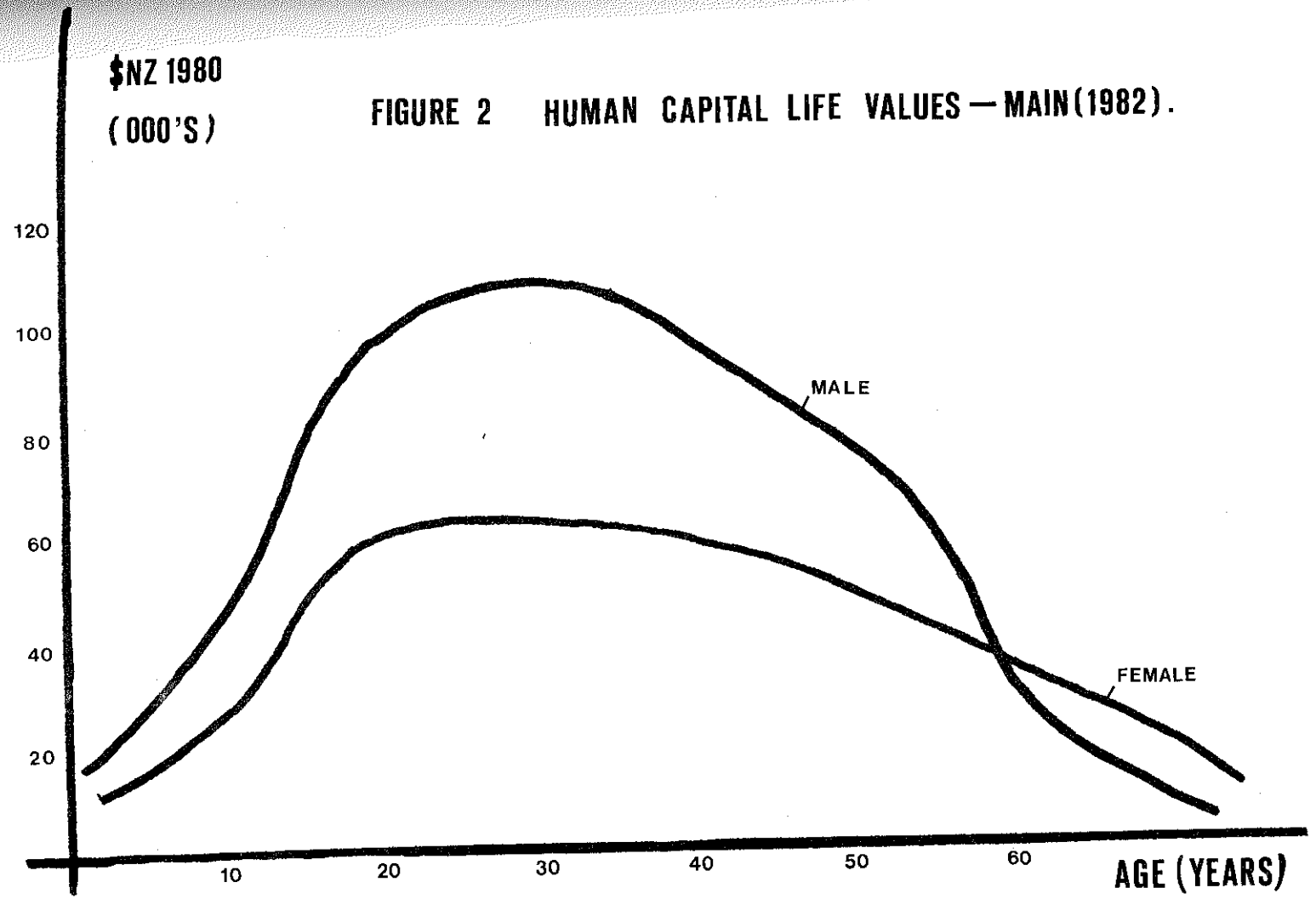
The values in Table 2 can be compared with the gross values in Table 1 although Table 2 values are as of a specific date rather than for a complete year.

Perhaps surprisingly the Table 2 values are much lower than the values obtained using Sherwin's method despite the inclusion of social welfare benefits and imputed valuations for housewives.

The reason for lower values is principally that road fatalities come mainly from the lower paid occupations and from age groups with initially relatively high unemployment levels and little or no work skills.

As I shall explain later this has implications for attempting to assess life values via "willingness to pay" methods.

FIGURE 2 HUMAN CAPITAL LIFE VALUES — MAIN (1982).



The exploring of reasons why the method above gives lower than expected human capital values leads to the question of whether wages of lower paid workers represent their cost to society.

Particularly during a period of high (or any?) unemployment the cost to society is an adjustment cost, rather than a complete loss.

This could involve training of a replacement, or if there are little or no skills involved the effect on production of a firm may be nil. The human capital method implicitly assumes either no unemployment or that the wage rate truly represents the marginal product of labour.

## THE ALTERNATIVE

The main alternative to the human capital method is the "willingness to pay" method. Other alternatives which look at compensation payments and insurance payments are not discussed in this paper. Nor do I intend to comprehensively discuss the "willingness to pay" method, other than to outline its main features.

The "willingness to pay" valuation can be obtained by:

— observation of the behaviour of decision makers;

— observation of individual behaviour; or

— questioning individuals.

### Implied Decisions of (Government) Decision Makers

This method seems to me to beg the question. Politicians have their own values and may not be interested in the values chosen by fellow politicians. Inevitably life valuations would take a sharp upwards leap immediately after some sort of disaster. Mooney (1977) quotes examples of implied valuations ranging from UK£20 million in relation to building regulations down to UK£50 for an investment which prevents stillbirths.

### Implied Values of Individuals

This method would seem to hold more promise. Methods here include examining wages associated with risky occupations and observing the market for the purchase of life saving or accident preventing devices. A problem is to distinguish death prevention from a number of other factors.

Melinek (1974) finds a range of values: UK£87,000 from decisions to use pedestrian subways rather than running the risk of being run over; UK£28,000 from market research concerning willingness to pay extra for safer tobacco; and UK£200,000 from employment related statistics.

It is observation of the behaviour of individuals which should reveal most about their perception and value of risk. Blomquist (1979) obtains a value of US$370,000 by examining car seat-belt usage.

## The Questionnaire Method

In this method individuals are questioned about their response to hypothetical situations which change the probability of death by accident to themselves, or to society at large including themselves. According to Hammerton, Jones-Lee and Abbott (1982) the method produces values ten times the values obtained from output based methods.

## Willingness to Pay

The rationale for examining the effect of road safety changes in terms of the value placed on probability reduction by individuals lies in the concept of Pareto improvements in individual utility being the basis of cost benefit analysis.

Jones-Lee (1976), who is the principal contemporary exponent of the method, identifies three major components of life valuation applicable to any individual. The first, which need not concern us here, is the individual's share of the reduction in resource costs associated with the death of others (such as property damage). The second is the "reduction in his share of loss of net output owing to the death of others", and the third, the "reduction in the risk of his own death or the death of anyone he cares about". Jones-Lee takes the net output for the second component. Thédié and Abraham (1961) note allowances for what they call "affective injury", which correspond to Jones-Lee's third component, compensate for deduction of consumption. It is apparent for an individual that he will take into account his future consumption in his willingness to pay for a reduction in probability of death. Presumably his income, his life expectation and his rate of time preference will be factors which affect the value placed on this future consumption (of life?).

The debate over the method has largely centred on measurement problems, consistency of individual responses and on the ability of individuals to conceive of the difference between small probabilities of say, 1 in 10,000 compared with 1 in 20,000.

Jones-Lee (1976) acknowledges that the value in relation to increasing probability reduction is exponentially increasing and asymptotic to a reduction from 1 to 0 (i.e. the value of a reduction in the probability of death increases to infinity as the probability of death becomes certain). Thus for different road safety measures different values must be used to take account of different probabilities.

Proponents of the system do not appear to agree about whether a decision maker can adjust the surveyed values to allow for income redistribution and/or to allow for less than perfect knowledge of accident probabilities.

Mishan (1971) has no doubts, he states that: "... in determining whether a potential Pareto improvement has been met economists are generally agreed — either as a canon of faith, as a political tenet, or as an act of expediency — to accept the dictum that each person knows best his own interest."

It is known that individuals tend to overestimate low risks and underestimate high risks.(1) Following Mishan's argument above, one would ignore the fact that individuals are demonstrably wrong about probabilities and use their perceived values. A further complicating factor is pointed out by Akerlof and Dickens (1982) who discuss the economic implications of "cognitive dissonance". Individuals might place a value on a reduction in the probability of death if asked but in practice place much less value on it, believing in fact what they want to believe.

A potential accident victim will thus believe that the accident has nil or a less than realistic probability of happening to him whenever he places himself at risk.

## REJECTION OF "WILLINGNESS TO PAY"

In giving my reasons for not proceeding with a "willingness to pay" approach in its entirety I need to discuss the implications of firstly the impact of perceived and actual risks; and secondly the question of discount rates.

### Perceived and Actual Risks

Some individuals are willing to pay and even can be observed to pay for a perceived reduction in the probability of death. They may not in fact experience such a reduction at all even if they do perceive it, due to overestimation of low risks. Should a decision maker spend money to achieve a Pareto improvement based on imaginary improvements in road safety for those individuals?

More likely on the other hand are individuals who experience a real reduction in the probability of death but do not necessarily believe it. The group of the population who put themselves most at risk believe they are not at risk because there is a psychological benefit in believing so. The decision maker is now in a position of spending or not spending money to achieve a real improvement in road safety without a Pareto improvement in individual utility.

### Discount Rates

The second relevant factor is the rate of time preference which will be different for different individuals. Furthermore, the discount rate of the decision maker may be fixed in order to be consistent with other sectors of government.

This factor is important if the values obtained by "willingness to pay" are dependent on the discounting of the future, which seems likely.

Jones-Lee (1976) acknowledges that the values placed by individuals on a reduction in the probability of death are a decreasing function of age and an increasing function of wealth. (It is implicitly obvious that the

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1 For example, *see* Slovic, Fischhoff and Lichtenstein (1980).

rich will value their lives more than the poor but less so that the elderly will value their lives at a lower level albeit in a probabilistic way.)

Schelling (1968) goes further to suggest that the values are "a function of present and future income ...".

This is in accord with work on discount rates in the United States (Hausman (1979)) estimating implied real discount rates in consumer choice which are inversely related to income (ranging from 10% real for high income earners to 40% real for low income earners).

## DECISION MAKERS' PERSPECTIVE

It would seem to me that the Pareto optimal decision is to base life values on actual observation of those placing themselves at risk despite the measurement and other problems related to perception and discount rates above.

Even so, a decision maker may reject the values so obtained because:

(a) he may be interested in real rather than simply perceived improvements; and

(b) he is constrained to use a particular rate of time preference or discount rate.

## CONCLUSION

Where does this leave us? Obviously the human capital approach only goes part of the way. However, given that gross rather than net values are used (i.e. not subtracting consumption) and we have added in a social welfare measurement of society's willingness to maintain life then the gap is narrowed somewhat.

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