U.S. copyright law (title 17 of U.S. code) governs the reproduction and redistribution of copyrighted material.
A new approach to valuing a life

Robert J. Brent

*Fordham University, Bronx, NY 10458, USA

Received November 1986, revised version received June 1990

Because the issue of how to put a monetary value on a life will always be controversial, this paper presents an alternative approach that can in certain circumstances avoid the use of monetary values. The alternative approach uses time as the numeraire. This numeraire can handle both the ex ante and ex post approaches to valuing a life. After showing how a simple two-period consumer choice problem can be translated into terms of time, the paper considers an application that involves reformulating the data used to evaluate the 55 mph speed limit decision in the United States.

1. Introduction

Many transportation decisions involve some sort of trade-off between the value of time and the value of life. One travel mode is usually quicker, while the other is safer. Such a trade-off may be implicitly made, as with an individual making the choice whether to travel to work by car or train. But, it must be made explicitly in the government decision whether to impose or remove a speed limit on the highways. The standard practice in cost–benefit analysis is to convert both time and lives into monetary terms so that the two magnitudes can be compared. This seems necessary when the journey or project involves a financial outlay. However, it is less necessary when no financial commitment is required, as with the speed limit decision. And it is unfortunate if, like Broome (1978), one considers there are fundamental problems in putting a money value on a life.

The approach taken in this paper is to use time to replace money as the numeraire for cost–benefit decisions involving the time/safety trade-off. The life of an individual can be considered to consist of a specified period of time on earth. A safety hazard can then be viewed as a reduction in the life expectancy of an individual. This expected time reduction can then be compared with the time saved by avoiding the safety precaution, whether it

*My thanks go to John Broome and A. Myrick Freeman III who provided comments on previous versions of this paper. Freeman III in particular provided a number of suggestions for improvement that have been incorporated into this version. The referees of this journal, and one of the editors, have also made helpful suggestions. However, I alone am responsible for errors or views expressed in any part of the paper.

0047-2727/91/$03.50 © 1991—Elsevier Science Publishers B.V. (North-Holland)
involves taking the faster but less safe mode, or the time involved with complying with the legal speed limit or use of seat belts. Although not the first to conceive of the value of a life in terms of time [see, for example, Duval (1983)] the approach taken is novel in that it considers both the costs and benefits in time terms. It thus enables monetary evaluations to be avoided completely.

The current best practice to valuing a life can be found in the work of Thaler and Rosen (1975) and Blomquist (1979). They all follow the lead of Schelling (1968) who suggested that rather than value life itself, which may be considered to be infinite, one should value the changed probability of life caused by the project decision. Since individual behavior often reveals an implicit monetary value of different survival probabilities, as for example in the choice of occupation, a more tractable problem is obtained.

While it seems fair to say that this view remains the dominant one in the literature, a problem still exists for the case where the loss of life is a certainty. I am not here necessarily discussing matters from the ex post vantage point where, after the event, the outcome is known. What I have in mind is the situation where the probability of one person dying is known with probability one. For example, a doctor may have to decide to whom a heart is to be transplanted when there are two potential recipients and only one donor.

Under the new methodology a solution to the certainty case is possible (and finite). If it is expected that all persons live 'three score years and ten', then a time numeraire evaluation of a certain death is 70 years of foregone life for a new born baby, and 5 years to a person who has just reached the official retirement age. Not everyone would agree that the transplanted heart should be given to the infant rather than the senior citizen. But, most will concede that the time method is fairer than deciding matters on the basis of how much money each is willing to pay for the heart.

If one accepts the time method for dealing with certain deaths, it can be adopted by anyone who adopts the ex post school of life valuation. However, I would like to examine further the safety time/life saved issue from the viewpoint of the new methodology within the mainstream ex ante school of thought. In the model, the time approach can be derived from the monetary approach (and vice versa). But, there are two main reasons for using the time approach. (a) The time method has many practical advan-

---

1 See Buchanan and Faith (1979), Jones-Lee (1979) and Williams (1979), and the reply by Broome (1979).

2 Incidentally, there is one clear case where Broome would seem to be right to reject an individual's evaluation of the probability of losing one's life. This would be where individuals combined are involved in a zero sum game in terms of lives. For example, if each gladiator in a fight to the death considered it worthwhile to accept a million dollars for a 50 percent chance of dying, a government decision-maker would be justified in dismissing these evaluations as they require society incurring a certain loss of life.
tages. Current practice has to convert both safety time and lives saved into monetary terms; while to use time as the numeraire one only needs to quantify separately the lives saved part of the trade-off. Also, there are no inflation or price index problems when dealing with time as the numeraire. (b) There are, as we shall see in section 4, some important different policy implications from using the time approach. These differences are entailed in the aggregation process by which effects for different individuals are summed to obtain the social outcome.

The first step in trying to establish the new approach will be to formulate a simple two-period consumer choice problem in terms of the recommended alternative numeraire. This provides a framework that will guide subsequent discussion. It will show in what sense a unit of time used in a life-saving activity can be thought comparable to time generated by a greater life expectancy. The next step will be to illustrate how the new approach deals with a typical value of time/value of life problem. The data will come from the appraisal of the 55 mph speed limit by Forester, McNown and Singell (1984) – hereafter, FMS. Finally, a statement of some qualifications and implications of the new approach is presented.

2. Consumer safety choices in terms of time

We start by examining an individual’s choices concerning the allocation of safety time. However, the intention is ultimately to consider the choices from a social perspective. Within the confines of an individualistic social welfare function, individual evaluations are to count. But, the social decision-maker is to make interpersonal comparisons of utility, income or, in our case, also of time, when aggregating the individual evaluations.

Consider the choices that an individual may make within a two-period model where the total time available in each time period is $T_i$. In the first period, this time can be used to generate wage income (and consumption) by working $T_{iW}$, or it can be used for life safety $S$:

$$T_i = T_{iW} + S. \quad (1)$$

$S$ is to be measured in terms of time. In the subsequent application it is given by the extra time required to make a journey subject to the legal speed limit. The reason why any time would be devoted to $S$ is that by so doing it is expected that there is more time available in period 2, and thereby more future earnings and consumption;

$$E[T_2] = P(S)T_2 \quad (2)$$

where $E[T_2]$ is the expected second-period time available. $E[T_2]$ is made
known to the individual through actuarially fair insurance markets.\textsuperscript{3} It depends on the product of the probability $P$ of surviving to the second period and the length of time in the second period. Eq. (2) uses Blomquist's specification of the probability as an increasing function of $S$.

Using the relations expressed in eqs. (1) and (2), the choices available can be summarized in the form of the individual's lifetime budget constraint, $B(S)$, which specifies the present value of expected wage income:

$$B(S) = wT_1 + wE[T_2]/(1 + r)$$

or

$$B(S) = w(T_1 - S) + wP(S)T_2/(1 + r),$$

where $w$ is the wage rate per unit of time and $r$ is the relevant discount rate.

To be consistent with this budget constraint, any variations in the allocation of safety time must be such that $B(S)$ is unchanged. Alternatively, we can think of the consumer maximizing the present value of lifetime wage income. In either case we have

$$dB(S)/dS = -w + wP(S)T_2/(1 + r) = 0,$$

which on rearranging becomes:

$$P(S)T_2/(1 + r) = 1.$$  \hspace{1cm} (6)

Eq. (6) has a simple interpretation. The left-hand side denotes the present value of the expected future time that results from the current life-saving activity. It is this that constitutes the 'value of life' in the model. Since current time is the numeraire, a unit is set equal to 1. Eq. (6) then states that, in equilibrium, the present value of expected future time produced by $S$ must equal the unit of current time given up.

3. An application to the 55 mph speed limit decision

FMS estimated the separate influence of the speed limit on the number of fatalities to be 7,466 per year. In return, individuals had to spend 456,300 extra years on the highways because of being forced to travel at slower speeds. The 55 mph speed limit was a typical example of time being traded in the expectation of saving lives. The procedure followed by FMS was to

\textsuperscript{3}For the significance of the existence of actuarially fair insurance markets, as opposed to the Robinson Crusoe case, see the paper by Shepard and Zeckhauser (1982).
convert both lives and time into monetary terms.\textsuperscript{4} Firstly, $561,000 was used to value a life, this being the 1981 equivalent of the figure suggested by both Thaler and Rosen (1975) and Blomquist (1979). Then a wage rate of $7.45 (the rate for non-agricultural workers) was used to value time. Net benefits were negative, with a benefit–cost ratio of only 0.25. On the basis of these estimates, FMS argue that the speed limit was not 'cost effective'.

The alternative procedure that is being recommended is to work in units of years of life rather than money. FMS actually present all the required information to use the different numeraire.\textsuperscript{5} The average age of a highway user in 1981 was 33.5 years with a life expectancy of 42.5 additional years. Thus the total savings, the expected benefits, were 316,558 years of life (7,466 times 42.5). The costs involve the 4.8 mph slower speed caused by the 55 mph law. Given the total mileage (in 1978), this translates to 2,220,556 million extra hours on the road. Multiplying this by an average vehicle occupancy of 1.8 persons per car, makes the costs equal to 3,997 million hours, or 456,279 person years. Eq. (6) states that when allocating their time, consumers will equate at the margin an hour of future expected benefits to an hour of current costs. 316,558 years expected to be saved (when discounted) is therefore commensurate with the 456,279 years foregone. The undiscounted net benefit in terms of years of life was $139,721. The maximum benefit–cost ratio in terms of time would have been 0.69.\textsuperscript{6} This supports FMS's overall conclusion. Only now the speed limit should be designated as being not 'time effective'.

4. Some implications of the new approach

Williams (1981) has also used the time numeraire approach to measure the non-resource effects of a policy (or treatment) on the health of an individual. His numeraire was 'one year of healthy life expectation'. He suggested that to aggregate across individuals one should adopt the 'egalitarian–humanitarian' ethic. This requires that a year of healthy life should be regarded the same irrespective of age, sex, etc. In the 55 mph speed limit application, we adopted this value judgment.

On the other hand, Williams considered that adding the resource effect (which was measured in money) to the non-resource effect (which was measured in time) was like mixing sugar and sand. The individual, safety

\textsuperscript{4}FMS actually present three figures for the value of life, and four for the value of time – see their table on p. 638. However, all pairs of time and life values give the same overall assessment of the speed limit. So for simplicity the text deals with just one pair of estimates.

\textsuperscript{5}See footnotes 5 and 6 of FMS.

\textsuperscript{6}Any positive discount rate would lower the ratio. Kula (1984) estimated the social time preference rate to be 5.3 percent for the United States and 5.2 percent for Canada. But, note that Brent (1989) found an implicit value between 70 and 73 between behind FmHA farm ownership loans in New York State.
time, allocation decision, which was modeled in section 2, overcomes this
impasse. An hour's worth of individual A's resource effect (time) can be
traded off against an hour's worth of individual A's benefits (the present
value of increased life expectancy, also measured in time) on a one-for-one
basis. So we are, in our social evaluation of the speed limit decision,
combining the egalitarian ethic of equal weighting across individuals with an
equal weighting scheme across category of effect (resource and non-resource).

Even with an equal weighting across individuals and across categories, one
is in principle free to adopt unequal weighting of hours for an individual
within a category (though we did not do this in our speed limit application).
In this way the time numeraire approach could be made to fit in nicely with
the time trade-off approach of cost-utility analysis. Torrance (1986) explains
how life with a chronic illness is traded-off against a shorter, but healthy, life.
Using this process one obtains different qualities for a year of life. This
approach could carry over to our context in the following way. Similar to a
Quality Adjusted Life Year (QALY), one could use a 'quality adjusted' time
numeraire. That is, one could try to uncover how many minutes an
individual would give up to forego driving time and experience an hour of
free time. Uncommitted time would then be the real numeraire if one did not
treat all hours that accrue to an individual equally.

The time numeraire approach is more in line with the human capital
school, and not the willingness-to-pay school of Thaler and Rosen,
Blomquist and Broome. Each individual was endowed with a fixed amount
of time in the first period, and therefore can be given equal weight, provided
that individuals are valued equally in society's welfare function. But, the
policy implications are very different from the standard human capital
approach based on lifetime earnings. For those in paid employment, the
standard approach ceases to value a person's life beyond retirement age. For
those who do not get paid, i.e. the young, the disabled, the retired, and those
working at home, their lives have no monetary value. However, with the time
approach, all of these persons' lives will be given a value equal to their life
expectancy.

5. Summary

Because the issue of how to put a monetary value on a life will always be
controversial, this paper presented an alternative approach that can, in
certain circumstances, avoid the use of monetary values. The alternative
approach involves the use of time as the numeraire. This approach is flexible
enough to deal with both the ex ante and ex post schools of thought on the
life evaluation issue. Attention was then given to the safety time/life saved
issue, from the viewpoint of the new numeraire, within the context of the
mainstream ex ante position. After showing how a simple two-period
consumer choice problem could be translated into terms of time, the paper considered an application that involved reformulating the data used to evaluate the 55 mph speed limit decision in the United States. Some implications and qualifications of using the new approach were discussed.

References


Duval, E., 1983, Essai sur la Valeur de la Vie et la Valeur du Temps, Cahier D'Etude no. 58 (Organisme National de Securite Routiere (ONSER)).


