Australasian Transport Research Forum 2021 Proceedings
8-10 December, Brisbane, Australia
Publication website: http://www.atrf.info

Valuing Life when Roads are Increasingly Safe

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Abstract

"I guess it comes down to a simple choice, really. Get busy living or get busy dying" Andy Dufresne's choice made me think of the surveys and studies commissioned by Government over the last 30-40 years to work out the Value of Statistical Life (VOSL) which is possibly the most profound value used in economic Cost Benefit Appraisal.

The New Zealand Ministry of Transport commissioned a study half a life-time ago in 1989-90 that worked out VOSL at just under $2 million; this was after half the sample was discarded for inappropriate responses. A similar survey undertaken a decade later was dismissed due to *'unresolved policy issues'* and a survey in 2017 produced a value of $8.3 million but on the basis of an accident rate out by a factor of 100.

Overseas experience in estimating VOSL has not been much better. That's apart from the sanguine Germans who have stuck to a straightforward Human Capital approach of valuing foregone income from premature death plus humanitarian costs which has produced a VOSL half that of New Zealand.

Andy's US Government has gone for reviewing wage rate risk studies that have little to do with road accident risk but which have produced a prodigious VOSL of NZ $15 million. Canada and Transport for NSW have values much higher than New Zealand that have been mysteriously calculated by the Canadians and mercurially factored by the NSW researchers.

So how much of VOSL is real as opposed to a figment of Government purpose? This paper argues that it is more the latter since VOSL has increased whilst road fatality risk has decreased. Had VOSL declined in line reducing accident risk or at least remained constant (after adjusting for inflation) it would have been more difficult to justify safer behavioural controlling initiatives.

The rise in VOSL reflects Government ambition to *"keep us safe"* as articulated in the New Zealand Government's *'road to zero'* program. A laudable ambition viewed on its own, despite being ultimately unachievable, moving closer towards it comes at a cost of higher petrol prices, higher vehicle charges, more police fines and higher taxation. Then there are the 'indirect' costs of slower travel times, greater inconvenience from extra regulations (mandatory bicycle helmets for example) and less freedom to live our lives just how we'd like. Government may help forestall our death at a largely hidden cost but as William Munny wisely muttered to the Schofield Kid *"we've all got it coming, kid"*.

1. Introduction

If I told you that there were 5.4 fatalities on New Zealand roads per 100 billion vehicle kilometres driven, would you feel safe driving, cycling or crossing the road? This figure is relevant because it was the reference statistic that 72 respondents were asked to bear in mind

when answering a survey to estimate the Value of Statistical Life (VOSL) using a Contingent Valuation (CV) survey in 2017. The survey, which estimated a VOSL of $8.3 million, was undertaken by Denne-Kerr (2018) for the New Zealand Transport Agency (NZTA). It was a pilot survey for an intended national survey to replace a value estimated 30 years previously by Guria-Miller (1991) for the Ministry of Transport.

If your answer was *"No - you wouldn't feel safe"* then think again! The actual accident rate on New Zealand roads in 2017 was 7.2 fatalities per billion vehicle kilometres (vkm). That's around one hundred times worse than the reference statistic of 5.4 fatalities per 100 billion vkm that was shown to respondents on the Denne-Kerr questionnaire.

If the statistic had been true, instead of 377 deaths on NZ roads in 2018 there would have been only four. Although tragic for the people and families concerned, it would have been a remarkable collective achievement that would have been applauded by Associate Minister for Transport who announced a 'road to zero' road toll strategy in 2019, Strang (2019).

Does it matter as it's only a statistic? Yes, it does matter because it's a fundamental concept behind the CV approach to estimate the Value of Statistical Life (VOSL). If people can't understand or differentiate between the accidents rates presented then it invalidates the approach and the resultant estimates. This is because VOSL is based on changes in the likelihood of death and not the price someone would pay to avoid certain death.

The first use of VOSL was in 1968 by Schelling in an article *'The Life You Save May Be Your Own'* in which he distinguished between "identified lives" and "statistical lives." Identified lives are miners trapped in a mine or a child with a terminal disease and who need saving now. Statistical lives are unidentifiable people saved in the future from regulations such as car safety belts, lower speed limits on roads, mandatory bicycle helmets and investments in rail (argued to be safer than road transport).

The US Environmental Protection Agency (EPA) provided the following definition of VOSL: *"Suppose each person in a sample of 100,000 people were asked how much he or she would be willing to pay for a reduction in their individual risk of dying of 1 in 100,000, or 0.001%, over the next year. Since this reduction in risk would mean that we would expect one fewer death among the sample of 100,000 people over the next year on average, this is sometimes described as "one statistical life saved." Now suppose that the average response to this hypothetical question was $100. Then the total dollar amount that the group would be willing to pay to save one statistical life in a year would be $100 per person × 100,000 people, or $10 million. This is what is meant by the "value of a statistical life",* EPA (2014).[1]

For transport in New Zealand, VOSL has been used to value the economic cost of road fatalities, estimate the benefit of road safety initiatives and appraisals of transport projects where safety levels is estimated to vary (e.g. passenger rail v car evaluations). The value has also been used by other Government Ministries such as the Health because unlike the USA,

[1] The EPA no longer likes the term VOSL as it gives *"the misleading impression that a "price" is being placed on individual lives--as a mugger who says, "Your money or your life!?"* The EPA prefers 'Value of Mortality Risk' (VMR) with reporting as dollars per micro-risk per person per year, where a "micro-risk" represents a one in a million chance of dying.

transport has been the only Ministry to have estimated VOSL despite transport fatalities accounting for only 1% of total deaths in 2016 (327 of 31,398).

Having described the concept of VOSL, Section 2 looks at how the 'official' VOSL used in New Zealand originated from a 1989-90 survey when roads were far more dangerous. Since then, fatalities have reduced as they have in comparable countries overseas as section 3 shows with Germany exemplar and USA mediocre. Section 4 looks at the trend in VOSL highlighting the increases in the state of NSW Australia, Canada and particularly the USA due to changes in method whereas in Sweden, UK, Australia, New Zealand and particularly Germany, VOSL has increased far more modestly. Section 5 describes how each country has set its VOSL then section 6 shows the resultant VOSL to be inversely correlated with the road fatality rate. Section 7 returns to the challenges of using surveys to estimate VOSL as have been used in NSW and New Zealand with section 8 arguing that problems in estimating VOSL and a single 'equity' value at that, render it inept for meaningful economic appraisal.

2. VOSL in New Zealand

The VOSL of $4.37 million reported by the New Zealand Ministry of Transport in 2019 derives from a thirty year old study by Guria-Miller (1991) in which 655 respondents were asked questions about their WTP for various risk reductions. The questions were asked in terms of their own personal risk, their family's risk and the risks of other people and considered (1) driving on a safer road but paying a toll (2) taking a course on road safety (3) additional safety features to a car; (4) living in a neighbourhood where the probability of being in a motor vehicle accident is lower and (5) funding roadway and pedestrian safety through higher taxes.[2] Table 1 presents the results for single individuals (households of one person), family members and all people. Around 90% of the sample were family members so the 'all people' value mainly reflects the family member estimate.

Table 1: Guria-Miller 1990 Value of Statistical Life Survey

Question	Sample		VOSL $000 (1990 NZ Dollars)		
	Valid Response	Valid Percent^	Single Individual	Family Member	All People
1. Safe Toll Road	308	47%	2,254	1,970	2,009
2. Road Safety Course	296	45%	1,121	1,496	1,437
3. Safer Car	226	35%	1,272	1,920	1,849
4. Safer Neighbourhood	500	76%	1,469	1,910	1,871
5. Taxes for Road Safety	108	16%	755	2,623	2,297
Average	288	44%	1,374	1,984	1,893

After discarding slightly more than half the responses for reasons such as arithmetic inaptitude, refusals and ill-judged response, the average VOSL was calculated at $1.9 million. For the last WTP question concerning 'taxes for road safety' the authors reported that many respondents *"were getting impatient".* Mentioning taxes brought *'refusals and protest bids of*

[2] Two other questions on driving speed in bad weather and a combined fatality/injury reduction question were not included the final results tabulation.

zero'. One interviewer labelled the responses *"unprintable"*. Of the five questions, the most *"revealing"* was the safer road question:

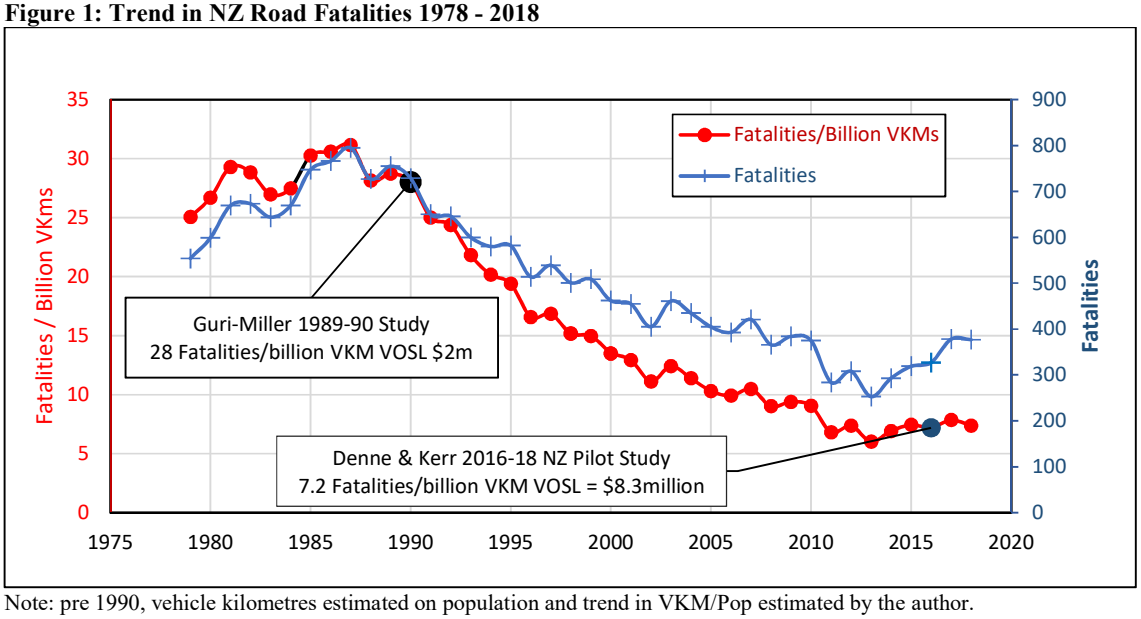
> Imagine that you have to travel in a car for a distance of 20 kilometres each weekday for some reason. You can use two different routes – one a high risk road and the other a low risk road but before you can travel on the low risk road you must pay a toll. Assume the time taken to travel on each road is the same. The toll road will reduce your risk of dying in an accident (for each year you travel) from 6 in 10,000 to 3 in 10,000. How much would you pay per one way trip to use the toll road?

Of the 47% of responses treated as valid, most gave *'one coin responses of either 50 cents or a dollar'*. Given that the difference in fatality risk was 3 in 10,000, to get the single individual VOSL of $2.25 million, the toll needed to have averaged $1.30 per trip and respondents to have used the safe road for exactly one year.[3]

In terms of the difference between single individuals and family members, Guria-Miller argued that the lower VOSL for single individuals was because *"when they died there are 'no spouse and children to grieve or struggle to pay the rent"*. More single individuals were 'old' who have *'less years to live'* or 'young' who have many years left but *'parakite and bungee-jump'* rather than middle aged and mature.

In Figure 1, the resulting 1990 Guria-Miller VOSL together with the 2016-18 Denne-Kerr estimate are superimposed on a graph of New Zealand road fatalities. As can be seen, fatalities peaked at 795 in 1987 just before the Guria-Miller survey started and then began trending down to a low of 253 in 2013. Fatalities then increased to 378 in 2017 just prior to the Denne-Kerr survey. In terms of distance driven, the highest fatality rate was 31 per billion vkm in 1987 and the lowest in 2013 with 6 per billion vkm. In 2017, the fatality rate was 7.2 per billion vkm.

Figure 1: Trend in NZ Road Fatalities 1978 - 2018



Note: pre 1990, vehicle kilometres estimated on population and trend in VKM/Pop estimated by the author.

In terms of context, Guria-Miller undertook their survey when roads were unsafe and Denne-Kerr when they were much safer.

[3] $1.30 x 520 weekday trips p.a. = $67,600. Difference in fatality is 3/10,000 so $67/600 ÷ 3/10,000 = $2.25m

It is also worth noting that the $8.3 million Denne-Kerr figure only accounted for the respondent's WTP whereas the Ministry of Transport added emergency/medical costs, legal costs and vehicle damage and property costs onto the Guria-Miller figure raising it by $100,000.[4]

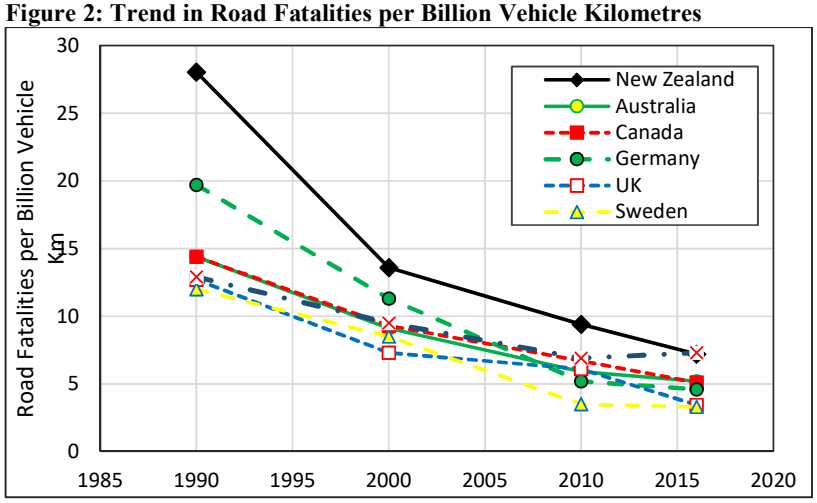
3. The decline in road fatalities internationally

Roads have been getting safer overseas as well as in New Zealand. The International Transport Forum (ITF) publishes an annual Road Safety Report for 41 countries. Figures for Australia, Canada, Germany, UK, Sweden and USA are compared with New Zealand in Table 2 with Figure 2 plotting the trend in fatalities per billion vkm.

Table 2: International Comparison of Road Fatalities

Country	Fatalities				per 100,000 Population				per Billion Vehicle Kms			
	1990	2000	2010	2016	1990	2000	2010	2016	1990	2000	2010	2016
NZ	729	462	375	327	21.4	12.0	8.6	7.0	28.0	13.6	9.4	7.2
Australia	2,331	1,817	1,351	1,296	13.7	9.5	6.1	5.3	14.4	9.1	5.9	5.2
Canada	3,963	2,904	2,238	1,898	14.3	9.5	6.6	5.2	14.4	9.3	6.7	5.1
Germany	11,300	7,503	3,648	3,206	14.2	9.1	4.5	3.9	19.7	11.3	5.2	4.6
UK	5,402	5,402	5,402	5,402	9.4	6.1	3.0	2.8	12.7	7.3	6.1	3.4
Sweden	772	591	266	270	9.1	6.7	2.8	2.7	12.0	8.5	3.5	3.3
USA	44,599	41,945	32,999	37,461	17.9	14.9	10.7	11.6	12.9	9.5	6.9	7.3
Note: Germany 1991 (not 1990)												

Figure 2: Trend in Road Fatalities per Billion Vehicle Kilometres



As can be seen, NZ has low fatalities because of its low population but has a higher fatality rate than five of the other six countries. For 2016, the 327 road fatalities in New Zealand compared with 1,296 in Australia and 37,461 in the USA. When expressed in terms of population, NZ had the second highest rate of 7 road fatalities per 100,000 double that of UK and Sweden. Only the USA had a higher rate (11.6 per 100,000).

[4] Traffic delays on other road users from road crashes were not added.

In 1990, NZ had the highest fatality rate per vehicle kilometres driven with 28 per billion vkm. Germany was second with 19.7 (in 1991 just after unification with East Germany). The other five countries had rates half that of New Zealand's (12 to 14 per billion vkm).

By 2016, fatalities per kilometre had fallen markedly for all seven countries. The rate for New Zealand declined to 7.2 fatalities per billion vkm which brought it into alignment with the other countries. In fact, New Zealand became marginally safer than the USA. Comparing 2016 with 1990, shows Germany to have reduced its fatality rate per vehicle kilometre by the greatest percentage (-77%) and the USA by the least (-44%). New Zealand achieved the second biggest reduction (-74%).

Safer vehicle design, mandatory seat belts, stricter drink driving laws, improved road design (crash barriers, median strips, rumble strips), sealing rural roads, reduced speed limits, stricter traffic policing, brighter street lighting, improved pedestrian and rail crossing facilities, road safety campaigns etc have all contributed to the lower road toll.

4. Value of statistical life

Some of the factors that have contributed to the improvement in safety have been subjected to Cost Benefit Appraisal. The VOSL has a role in determining the Benefit to Cost ratio. After reviewing 24 New Zealand transport projects that cost a combined $2.4 billion (2010 prices) Wignall (2017) came up with a 2% benefit share for safety. The projects included 19 road, 2 Traffic Demand Management and 3 Public Transport projects. Time savings provided 80% of benefits and vehicle operating cost savings, emissions reductions and health benefits contributing 18%. It should be noted that VOSL also has a role in determining the benefit of emission reductions and the health benefits from walking and cycling.

Government calls for safer roads often refer to the social cost of road crashes. The 2019 New Zealand Government's *"Road to Zero"* report claims "*if we continue as we are, we estimate that around 3,000 people will have lost their lives between now [2019] and 2030 approximately 30,000 people will have been seriously injured with ongoing or long-term consequences. The social cost of these tragedies would be about NZ$45 billion in today's dollars.* For comparative purposes, New Zealand's GDP was around NZ$200 billion in 2020 making the Ministry's estimate of the social cost of road crashes around 2% of GDP.

The VOSL used in *'Roads to Zero'* and CBA of the 24 projects in the Wignall review derives from the Guria-Miller estimate. Had the Denne-Kerr value been used, the social cost of road crashes and the estimate of safety benefits would have doubled to 4%.

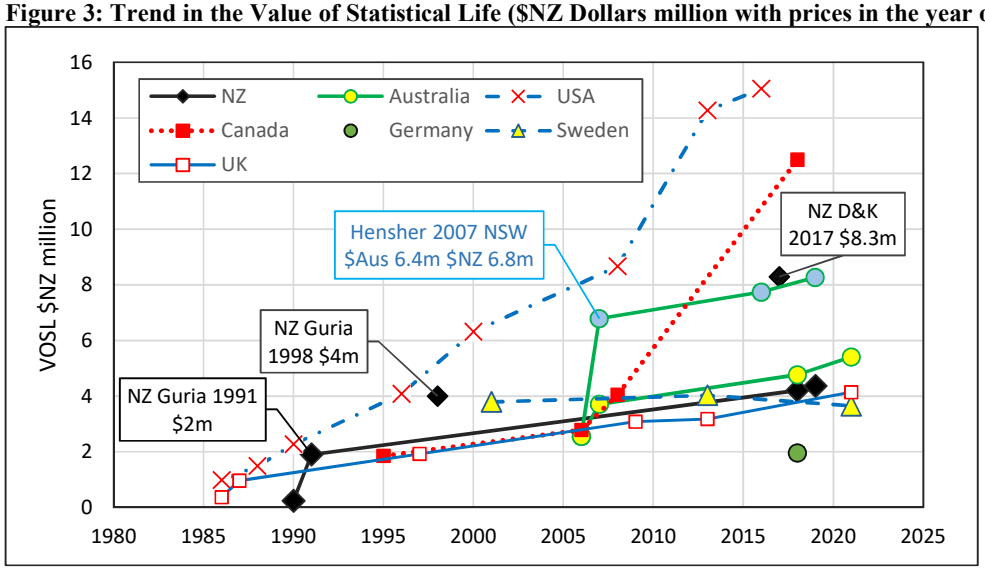
When compared to overseas, New Zealand has a similar VOSL to the UK and Sweden which have used CV surveys similar to Guria-Miller. The USA values the statistical life of its citizens the most. In 2016, the USA VOSL was $NZ 15.1 million based on wage-rate risk surveys. Germany had the lowest value of $NZ 2 million based on a Human Capital (HC) approach. Australians at NZ$5.4 million were valued a little higher than New Zealanders except in NSW where Transport for NSW (TfNSW) has set VOSL at $NZ 8.3 million based on a CV survey was similar to the Denne-Kerr (see section 5).

Table 3: Value of Statistical Life VOSL NZ$

Country	Local Currency million	NZ$ Exchange Rate^	NZ $m	Year of Estimate
NZ	4.4	1.00	4.4	2019
Australia	5.1	1.06	5.4	2021
NSW Australia	7.8	1.06	8.3	2019
Canada	10.5	1.19	12.5	2018
Germany	1.1	1.75	2.0	2018
UK	1.9	1.92	3.7	2021
Sweden	22.0	0.17	3.7	2012
USA	9.6	1.57	15.1	2016
^ September 2021 exchange rates				

In contrast to the downwards trend in fatalities per vehicle kilometre, VOSL has trended upwards and spectacularly so for the state of NSW in Australia, Canada and the USA as can be seen in Figure 3. For New Zealand, had the Denne-Kerr 2017 figure of $8.3 million been adopted, VOSL would be on a par with NSW rather than being similar to the UK, Sweden, federal Australia and would be quadruple that of the conservative Germans.

Figure 3: Trend in the Value of Statistical Life ($NZ Dollars million with prices in the year of estimate)



5. How statistical life has been valued

Countries have adopted different ways of deciding their 'official' VOSL. Each of the six countries tabulated in Table 3 are now reviewed.

New Zealand transport agencies have included road crash costs in Cost Benefit Appraisals since the 1980s. Before the Guria-Miller study in 1989-90, VOSL was calculated using a Human Capital (HC) approach (see Germany below). In 1990, the last year of its use, VOSL was NZ$235,000 but was considered *'embarrassingly conservative'* by Guria-Miller. The Ministry of Transport replaced it by the Guria-Miller VOSL of $2 million (including emergency costs). In 1997-99, Guria was involved in a second survey where respondents were asked to choose between two hypothetical residential areas (one area with better road safety but higher living costs) Guria (1999). The estimated VOSL was $4 million (1998

prices) but the Ministry of Transport decided not to adopt the figure ostensibly because of *'unresolved policy issues'*. They continued with the previous 1989-90 estimate applying economic indices to update the figure such that by 2019 it had increased to $4.4 million.

Germany of the seven countries in Table 3 is the most sanguine about the value of its citizens with the ITF reporting a VOSL of €1.12 million for 2018, ITF (2020). The value was calculated using a human capital (HC) approach that valued lost income growth (including the shadow economy, housework and voluntary work) and added humanitarian costs, medical, emergency, legal and traffic delays).

Sweden has derived its VOSL from CV studies similar to Guria-Miller. A 1998 study used graph paper with 100,000 squares and dots to describe driving risk, Persson et al (2001). Respondents were told that the risk could be reduced by 10%, 30%, 50% or 99% and asked how much they would be willing to pay for the lower risk. The estimated VOSL was SEK 22 million in 2001 prices. A review by Miller who co-designed the NZ survey with Guria praised the pretesting and representative sampling but criticized the description of risk levels that contributed to respondents "*giving a response that sounds reasonable in order to satisfy the interviewer rather than express uncertainty".* Indeed, for six of seven WTP questions despite varying risk, the Swedes gave median answers of 100 kroners. In consideration, Miller after *"some hesitancy"* viewed the values as *"credible"*. In 2013, the recommended VOSL was SEK 23.7 million (6% higher than the Persson estimate).

The **UK** undertook the first major CV survey to estimate VOSL. The survey was undertaken in 1982 by Jones-Lee et al (1985) and had a sample size of 1,150. Prior to the study, the UK had adopted a VOSL of £190,000 for road appraisals that had been calculated using the HC approach. The CV study was similar to the Guria-Miller and Persson studies and came up with a VOSL of £1.4 million (1985 prices). A review by Dalvi (1988) pointed out that many respondents misunderstood the base risk. Jones-Lee agreed, remarking that a third of respondents had the same WTP for two different risk changes and some even had a lower WTP for bigger risk reductions. Concerns about the approach amongst the steering group and implications of reweighting policy from speedier journeys towards safety led to a VOSL of £0.5 million being adopted in 1987, Jones Lee (2015). A decade later in 1991, the UK Department of Transport commissioned another survey. The survey asked a set of questions about how much respondents would pay annually to have a set of safety features in their car that would reduce the chance of a fatal accident. In addition, a set of 'standard gamble' (SG) questions were asked in which respondents were asked to think of an accident that required hospitalization and two treatments. The first treatment option had a certain prognosis. The second had the chance of normal health if successful or death if unsuccessful. The chances of success and failure were varied until the respondent was indifferent between the two treatments. The response found the CV approach to give higher values than the SG which was largely due to an insensitivity to the chances of death. The findings did not lead to a change in VOSL however. A third national survey by Carthy et al (1998) "chained together" CV and SG questions. The WTP to avoid an injury was first estimated using CV questions regarding risk to injury. The estimates were then "chained" to the response to SG questions about the relativity between death and injury. After removing outliers, a range in VOSL of £0.5 million to £1.6 million was estimated. It took until 2009 for the Department of Transport to adopt the findings of the Carthy survey with a VOSL of £1.6 million. Thus value

has subsequently been updated using inflation and GDP/capita indices, Jones Lee et al (2015) so that by July 2021 it had reached £2.15 million.

In **Australia**, the Bureau of Transport and Regional Economics (BITRE) used a 'modified' HC approach described as the forgone economic contribution to society from both workplace and household participation from the age at which premature death occurs to the end of the expected natural life, BITRE (2006). BITRE viewed the HC approach as providing a straightforward way to calculate a verifiable value reflecting age and gender differences in output losses to society and providing a lower bound cost for the death and injury of road crashes. BITRE 'modified' the HC approach figure for premature deaths to young and old by adding a proxy for quality of life losses. The resultant VOSL was $Aus 2.4 million in 2006 prices.

In NSW, Transport for NSW (TfNSW) replaced the HC value with the value from a WTP survey of 213 residents of Sydney and Bathurst undertaken by Hensher-PWC for the NSW Roads and Traffic Authority in 2007, Hensher (2009). Section 7 discusses the study in more detail. The estimated VOSL was Aus $6.4 million, a 266% increase on the BITRE value.

Elsewhere, the Department of Prime Minister & Cabinet (2021) recommends a value of $5.1 million in August 2021 prices based on a review undertaken by Abelson (2008). Public agencies were recommended to adopt a VOSL of $Aus 3.5 million in 2007.

Within NSW, different VOSL are used. The NSW Department of Industry has adopted the Abelson VOSL. In Table 1 of their 2018 CBA Guiding Principles, a VOSL of Aus $4.35 million is recommended for amongst other things, the evaluating the safety of high risk dams, NSWDOI (2018). Curiously, flooding that might drown someone would have a cost of $4.35 million but not if the person was driving over a bridge and washed away when the cost would be $7.8 million if evaluated by TfNSW. For NSW Treasury, this must represent a dilemma when assessing the relative economic merit of stronger dams as proposed by the Department of Industry versus stronger bridges proposed by TfNSW.

The upshot of all this is that in Figure 3, the 'line' for 'Australia' bifurcates with a lower line for public agencies in general and a higher line for transport appraisals in NSW.

In **Canada**, the 1994 Cost Benefit Guide of Transport Canada recommended a VOSL of $C1.56 million (1994 prices) based on a review of international studies and practices. Apparently, a higher VOSL of $C2.5 million had been used for aviation during the 1980s, Lawson (1989). In 2018, the Economic Analysis Directorate of Transport Canada (EADC) reported a WTP method had produced a VOSL of C$3.05 to $C5.05 million, EADC (2008). The ITF (2020) Country report tabulated the cost of road accidents in 2018 and wrote that the VOSL figure was *"calculated using the WTP approach"* but no further details were provided. A Canadian researcher asked to shed some light on the official VOSL in writing this paper commented: "*the Canadian federal government provides little leadership for land transport planning. It occasionally sends provincial and municipal governments a little money, particularly prior to elections, but Transport Canada provides almost no technical support as far as I am aware. There is nothing like the Australian Transport Assessment and Planning, the New Zealand Transport Agency, the UK Department for Transport or the USDOT".*

In the **USA**, the VOSL adopted by the US Department of Transport (USDOT) derives from a review of wage rate - risk surveys. These surveys have been based on the premise that wage rates acceptable to workers increase with safety risk. Clearly there are issues in deriving population VOSL from just workers as in 2021, the US labour force participation rate was 62% implying that 38% of the USA were something other than workers. The rural sector also tends to get left out because although it has higher than average occupational risk, low remuneration means the sector doesn't fit the risk-pay paradigm the researchers want. There are also statistical issues in disentangling the safety risk and the multitude of factors affecting wage rates in the employment sectors that researchers do assess. Then there is the difference in the safety risk perception of the workers versus the researcher so to get round these problems, some studies have used 'stated preferences' about hypothetical jobs, pay and risk. This raises the problem that stated preferences aren't as reliable as revealed preferences.

Different agencies have adopted different VOSL. In 2016, the Department of Agriculture had a VOSL of US$8.9 million and the Environmental Protection Agency (EPA) US$10 million. The USDOT VOSL was close to the EPA at US$9.6 million probably because they reviewed the same wage-rate studies. All three values are markedly higher than the other six countries. This is apart from Canada which probably based its 2018 VOSL on the USA.

The US values have increased remarkably over time. In 1986, the recommended VOSL for transport was US $630,000 so over the next thirty years, VOSL increased 14-fold. The biggest leap was in 2013 when VOSL jumped 66% to US$9.1 million. Unlike the UK, the leap did not result from a commissioned survey but the difference in two reviews. A 2008 review considered four meta-analyses that had been published between 1995 and 2000 that gave VOSLs from US$2 to US$7 million whereas a 2013 review considered fifteen wage rate – occupation risk studies but discounted six as being 'unreliable', Thomson (2015). The remaining nine produced an average VOSL of US$9.1 million (2012 prices). None of the nine studies had any obvious link to road transport accident risk.

6. VOSL, Fatality Rate and Politics

Figure 4 plots VOSL against the road fatality rate for the seven comparison countries. As can be seen, VOSL was higher when road fatality rates were lower. This is opposite to how the public would have been expected to respond if surveyed about their WTP at different fatality rates as in the Guria-Miller and Denne-Kerr studies.

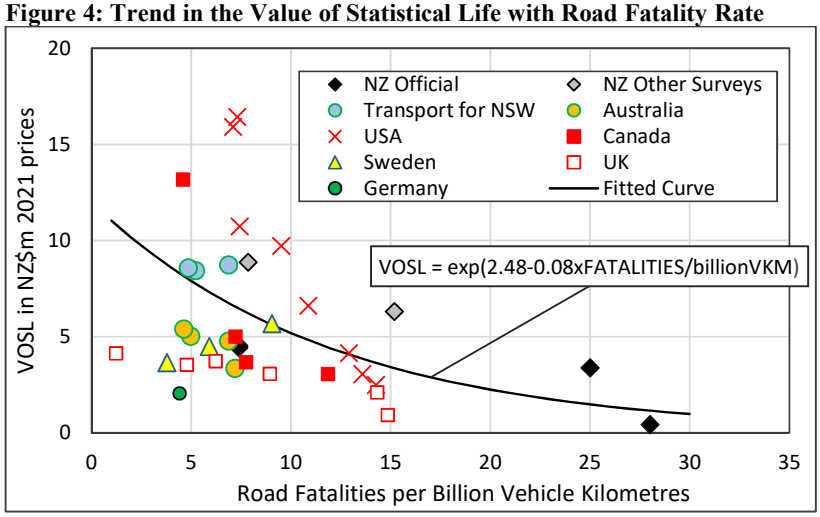
To create the graph, the VOSL figures for each country were converted into NZ dollars at the 2021 exchange rate then expressed in 2021 prices using the NZ CPI inflation index.

In theory, people should be willing to pay more, the greater the fatality risk (as will be discussed in section 7).[5] If WTP had been related to risk, the predicted line in Figure 4 would have sloped upwards to the right. Admittedly confounded by different countries and different methods used in different years and changing attitudes regarding risk, the graph does show Government setting a higher VOSL when road fatality rates are lower. A higher VOSL can help Government achieve their aims. As roads become safer, initiatives to reduce the accident rate still further become harder to justify. That is unless VOSL is increased. This is

[5] The same would have been true for the US wage rate risk studies which are based on the premise that workers demand higher wages for riskier jobs.

why Bosworth (2017) cites public choice theory as an explanation for the rocketing VOSL in the USA. Public choice theory posits politicians as seeking re-election and bureaucrats as seeking bigger budgets. A higher VOSL helps both by getting their policies and initiatives over the 'Cost-Benefit' hurdle and this feeds through to the academics and consultants commissioned by Government to research what the VOSL should be. How acceptable would a study be if it recommended a reduction in VOSL?

Figure 4: Trend in the Value of Statistical Life with Road Fatality Rate



After the research is complete, the findings get boiled down into to a single 'equity' value that treats everyone alike irrespective of their age or income. Different VOSL for different sections of society would be politically *"unconscionable"* as Senator Boxer of California claimed in 2003 when the EPA proposed to reduce the VOSL for people aged 65 and older because research proved shown a lower WTP for risk reduction, Cameron (2010). Indeed in 2004, the US Congress prohibited the EPA from underwriting an analysis on age adjustments to the VOSL (H.R. 2673).

Having one VOSL is akin the *'equity value of private travel time'* adopted by TfNSW and other jurisdictions in their Cost Benefit Guidelines despite their own surveys proving that non commuting public transport users have a significantly lower value of time than do car drivers and passengers, Douglas and Jones (2018).[6]

Indeed, modern day Cost Benefit Appraisal (CBA) rarely adopts WTP values as such preferring 'equity' values instead. As a consequence, CBA no longer measures the change in allocative economic efficiency. Nash astutely comments that it is now possible for a CBA to conclude that a project improves welfare when in fact it does the opposite, Nash (2010). Nevertheless transport CBA retains the descriptor *'economic evaluation'* and gets referred to as such by politicians touting a Benefit Cost Ratio above 1.0 to the public and claiming that this supports their project or policy.

[6] The value of 'paid' travel time savings e.g. truck and bus drivers, trades-people and company business trips has usually been at the wage rate plus on costs.

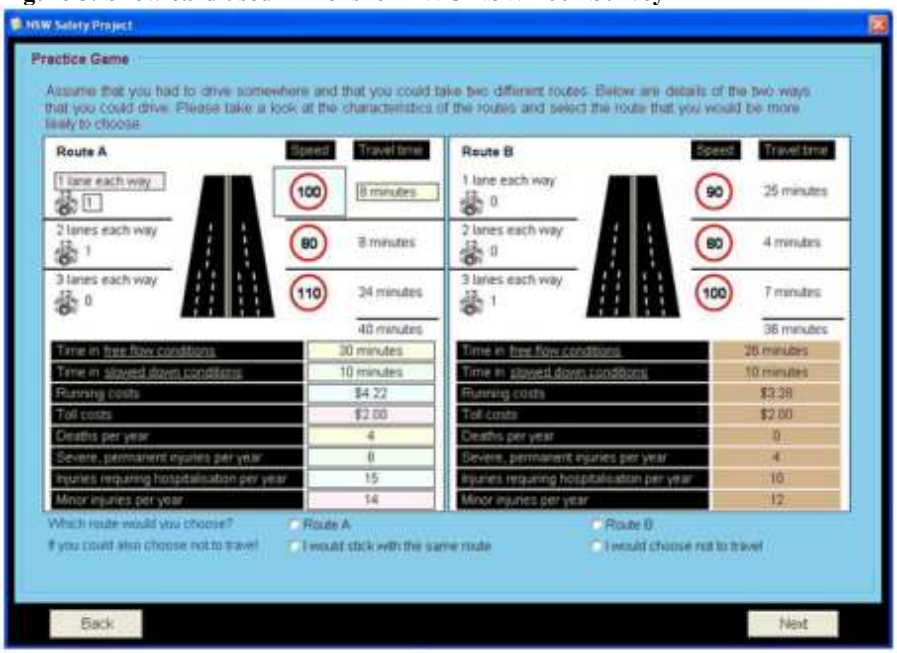
7. Fatality Rates in Australasian VOSL Surveys

Two CV surveys undertaken in Australia and New Zealand illustrate the problesm in trying to estimate the VOSL by reference to road accident numbers and rates. The two surveys have been previously mentioned: one was by Hensher-PWC in 2007 and the other was a decade later by Denne-Kerr in 2017.

The Hensher NSW 2007 survey was referenced by Denne-Kerr in developing their questionnaire. Indeed, one member of the Denne-Kerr team was a member of the Hensher group. It is therefore not surprising that the two questionnaires were quite similar. That is apart for one important aspect. The NZ questionnaire referenced the numbers of fatalities per number of vehicle kilometres driven whereas the Hensher survey only gave the number of fatalities per year.

Figure 5 shows an example show card used in the Hensher 2007 survey.

Figure 5: Show card used in Hensher-PWC NSW 2007 Survey



On route A, there are 4 fatalities per year on a 40 minute trip and zero fatalities per year for a 36 minute trip on route B. How respondents factored in their relative exposure to a fatal accident is not known. After analyzing the response, Hensher estimated WTP figures of Aus$0.92 per trip for an urban route and Aus $3.99 per trip for a non-urban route. These figures are not dis-similar to the WTP tolls of 50 cents to $1 estimated by the 1989-90 Guria-Miller survey. However Guria-Miller specified the reduction in fatality risk as 3 in 10,000. There is no mention of the fatality risk on the Hensher questionnaire. The failure to describe the risk probabilities in the Hensher questionnaire has been acknowledged as a ‘fatal flaw’ by reviewers Abelson and Viscusi.[7]

In order to calculate a VOSL from the survey responses, Hensher used accident rates, trip volumes and trip distances but the calculation is not known and as the risk probabilities were

[7] Via email from Peter Abelson 17th October 2021.

not given to the respondents, it would be happenstance if the respondents' perceived figures matched those of the researcher.

The resultant VOSL of Aus $6.4 million in 2007 represented a 266% increase on the Aus$2.4 million figure calculated by BITRE in 2006 using a modified HC approach.

In developing their survey, Denne-Kerr (like Guria-Miller before them) decided that accident rates had to be provided to respondents: *people have difficulty processing very small probabilities, which has led to adoption of the [Figure 6] approach that provides survey participants with information on the total number of crashes on each route in a specified period. This approach has been employed previously (Antoniou 2014; Hensher et al 2009; Niroomand and Jenkins 2016; Rizzi and Ortuzar 2003; Rouwendal et al 2010). However, this specification of the crash attributes does not permit recovery of VoSL without making some extremely strong and untenable assumptions."* To avoid making such assumptions, Denne-Kerr included the reference statistic *'per 100 billion kilometres travelled'* on their questionnaire as can be seen in Figure 6.

However '100 billion' should have just been 'billion'. Given Denne-Kerr, two peer reviewers and the client failed to spot the error, how could the respondents have been expected to have answered the choices as intended since they were asked to respond in a hypothetical environment 100 times safer than actuality? They were effectively asked to compare 2 deaths divided by 100,000,000,000 versus 1 death divided by 100,000,000,000 in context of a 3 hour, say 200 km trip. Both chances of death are infinitesimally small so neither statistic should have influenced the respondent's choice.

Deriving the VOSL from the responses will also have depended on what Denne-Kerr assumed. Was a billion or a 100 billion vehicle kilometres used since two widely different VOSL of $82,900 and $829 million result?

Like the Guria-Miller, Jones-Lee and Persson studies, the survey would have difficulty passing a 'scope' test demonstrating a clear relationship between risk and WTP as defined by Czajkowski & Hanley (2009).

Figure 6: Example Survey Show Card in Denne-Kerr 2018 NZ Survey

Below is an example of how screens should look. Refer to the excel document for values displayed for each game

Out of the two alternatives shown, which one would you prefer to take?

Please select one

	Route One	Route Two
Average travel time	3 hours 15 minutes	3 hours 0 minutes
Lateness	10% of trips delayed by 40 minutes	10 of trips delayed by 45 minutes
Heavy traffic	20%	10%
Trip Cost	$15	$20
Fatalities per 100 billion kilometres travelled	2 deaths 50% higher than an average NZ highway	1 death 10% lower than an average NZ highway
Serious Injuries per 100 billion kilometres travelled	10	2
Minor Injuries per 100 billion kilometres travelled	20	5

○	○	○	○	○	○
Strongly prefer Route One	**Weakly** prefer Route One	**Slightly** prefer Route One	**Slightly** prefer Route Two	**Weakly** prefer Route Two	**Strongly** prefer Route Two

Behavioural economist Kahneman (2012) in *"Thinking Fast and Slow"* (p143) made the observation that there is *"a basic limitation in the ability of our mind to deal with small risks: we either ignore them altogether or give them far too much weight – nothing in between".* Likewise, Sunstein (2001) found that for insurance premiums, the WTP did not vary amongst risks of 1 in 100,000, 1 in 1 million and 1 in 10 million.

What did people read into the questions? Some probably discounted the risks altogether viewing themselves as 'safe' drivers. Others probably responded on behalf of society (accidents being unacceptable) taking account government pronouncements (e.g. New Zealand's zero death toll target). Others may have considered the inconvenience of traffic accident delays so chose the road with the least number of accidents.

Denne-Kerr (op cit) commented that *"once interviewers explained what is meant by 'per 100 billion kms travelled' approximately half the face to-face respondents either asked for more explanation, or the interviewer felt their response meant it was required. Two face-to-face respondents talked about the number of 'deaths per year' later in the survey and another said he was thinking about a total number of deaths or injuries on the road and did not tie that back to either a time period, or distance. This suggests, without the assistance of an interviewer, it is likely that respondents will not pay full attention to the frequency or fully understand what is meant"* (page 85).

With these definitional and methodological problems in relating risk to WTP, the declaration by Haussman (2012) that CV surveys are *"hopeless"* may not be too severe a criticism of their ability to estimate VOSL with any meaningfulness.

8. Closing tribute

Between 1990 and 2016, New Zealand road safety improved markedly with fatalities per vehicle kilometre reducing 74%. Similar reductions occurred in five of the six countries reviewed. The exception was the USA where the decline was less (43%).

Meanwhile the Value of Statistical Life (VOSL) has shot up in the opposite direction increasing 17-fold in New Zealand from $240,000 in 1990 to $4.37 million in 2019. The biggest increase was in 1991 when the Human Capital (HC) estimate was replaced by a Contingent Value (CV) estimate of $1.9 million.

Overseas VOSL has increased by leaps and bounds too. The greatest increase was the USA where VOSL increased from US$630,000 in 1986 to $US 9.6 million (NZ $15 million) in 2016. The biggest leap occurred in 2013 when a set of wage rate-risk studies, seemingly unrelated to transport risk, were used to revalue VOSL skywards.

Germany has been an exception with VOSL remaining low and only rising to €1.1 million in 2018 (NZ $2 million). This is because Germany has kept to the HC approach. Australia now has two rates. The Department of Prime Minister & Cabinet reported Aus$5.1 million in 2021 based on an international review of studies whereas Transport for NSW has a value of Aus $7.8 million that originates from a 2007 CV survey. The survey was similar to one undertaken in New Zealand in 2017 which if adopted would have seen VOSL double to $NZ 8.3 million.

Has an escalating VOSL helped reduce the road toll? Probably not, since the USA (where VOSL has increased the most) had the lowest percentage reduction in fatalities (-43%) whereas Germany, where VOSL has remained steadfastly low (13% of the USA) achieved the biggest percentage road toll reduction (-77%). Germany is also famous or infamous (depending on your point of view) for not having a federally mandated speed limit on its 'autobahns'. A maximum of 130kph is 'advised' with powerful cars reaching speeds over 300kph but with vehicles that can't achieve 60kph being 'verboten'.[8]

In setting VOSL, the trade-off with travel time has been acknowledged. Indeed it was why New Zealand did not adopt a 1999 survey value and why the UK revised the 1987 figure downwards to avoid reweighting policy towards safety and away from speedier journeys.

Admittedly, as we move into the 2020s looking backwards through our rear-view mirror at the priorities of last century's transport ministers and bureaucrats is no more than transport nostalgia. Modern day officialdom is a different kettle of fish. For many, a high VOSL is clear signposting they care about *'keeping us safe'*. It helps them seek and spend funds to drive us down the 'road to zero' fatalities but at a slower and slower pace. How VOSL is derived is less concerning. If you can get a high value by reviewing wage-rate risk studies then so much the better. Why attempt bleeding edge research to estimate a reliable value by asking the people? Even if the public can fathom the choices (which does not appear to have been managed satisfactorily yet), the answers need to be first screened, then usually adjusted, then factored and lastly distilled into a single 'equity' value. Reversing back to a human capital approach that values what we can do whilst we are busy alive would be eminently sensible.

So returning to Andy Dufresne? What did he choose? He chose to risk everything, leave the safe confines of Shawshank, drive down to Zihuatanejo and 'get busy living'.

Acknowledgements

I would like to acknowledge Peter Abelson of Applied Economics and Matthew Jones of TfNSW for their comments and suggestions.

References

Abelson, P. (2008), "*Establishing a Monetary Value for Lives Saved: Issues and Controversies"*, Working Paper 2008–02, Office of Best Practice Regulation, Department of Finance and Deregulation, Canberra.

BITRE (2006) *"Cost of road crashes in Australia 2006"* Bureau of Infrastructure, Transport and Regional Economic, Report 118
https://www.bitre.gov.au/sites/default/files/report_118.pdf

Bosworth R.C., Hunter A. and Kibria A (2017) *"The Value of a Statistical Life: Economics and Politics"* Report by Strata dated March 2017.

[8] Enforced speed limits are enforced on urbanized, substandard, accident-prone, or under construction stretches and on speed-unrestricted stretches, an advisory speed limit of 130kph applies.

Cameron, T.A., (2010) *"Euthanizing the value of a statistical life"* Review of Environmental Economics and Policy 4.2 (2010): 161-178.

Carthy T., Chilton S., Covey J., Hopkins L., Jones-Lee M., Loomes G., Spencer, A. (1998). *"On the Contingent Valuation of Safety and the Safety of Contingent Valuation: Part 2 - The CV/SG "Chained"* Approach. Journal of Risk and Uncertainty, 17(3), 187–214. https://doi.org/10.1023/a:1007782800868

Cropper, M.L., Hammit J.K., and Robinson L.A., (2011) *"Valuing mortality risk reductions: progress and challenges".* No. w16971. U.S. National Bureau of Economic Research, 2011.

Czajkowski, Mikołaj, and Nick Hanley. *"Using labels to investigate scope effects in stated preference methods"* Environmental and Resource Economics 44.4 (2009): 521-535.

Dalvi, M. Q. (1988) *"The value of life and safety: A search for a consensus estimate".* London: Department of Transport.

Denne-Kerr et al (2018). *"A pilot study to determine the relative value of non-market transport impacts of investment"* report by Tim Denne, Geoff Kerr, David Glover, Michael Winder and Louis Wright. NZ Transport Agency research report 648 dated December 2018. https://www.nzta.govt.nz/assets/resources/research/reports/648/648-a-pilot-study-to-determine-the-relative-value-of-non-market-transport.pdf

Department of Prime Minister and Cabinet (2021) *"Best Practice Regulation Guidance Note Value of Statistical Life"* by Department of Prime Minister and Cabinet, Office of Best Practice Regulation Australian Government. https://obpr.pmc.gov.au/resources/guidance-assessing-impacts/value-statistical-life

Douglas and Jones (2018) *"Estimating the value of private travel time for NSW"* Australasian Transport Research Forum 2018 https://www.researchgate.net/publication/328792364_ESTIMATING_THE_VALUE_OF_PRIVATE_TRAVEL_TIME_FOR_NSW

EADTC (2008) *"Estimates of the Full Cost of Transportation in Canada"* TP 14819E 2008-08-22 Synthesis report https://publications.gc.ca/collections/collection_2009/tc/T22-165-2008E.pdf

Environmental Protection Agency (2014) *"Mortality Risk Valuation"* US EPA 2014. https://www.epa.gov/environmental-economics/mortality-risk-valuation

Guria, J and Miller, T. R (1991). *"The Value of Statistical Life in New Zealand Market Research on Road Safety".* Wellington, Land Transport Division, Ministry of Transport.

Guria, J., Jones, W., Jones-Lee, M., Keall, M., Leung. J., and Loomes G., (1999), *"The Values of Statistical Life and Prevention of Injuries in New Zealand"*. Report prepared for the New Zealand Road Safety Trust and the Land Transport Safety Authority, New Zealand.

Hausman, Jerry. *"Contingent valuation: from dubious to hopeless"* The Journal of Economic Perspectives 26.4 (2012): 43-56.

Hensher Group Pty Ltd (2007) *"RTA NSW road safety project. Estimating the willingness-to-pay for road safety improvements".* Input to PwC Report for Roads and Traffic Authority of NSW.

Hultkrantz, L., & Svensson, M. (2012). *"The value of a statistical life in Sweden: A review of the empirical literature"*. Health Policy, 108(2–3), 302–310.

ITF (2020) Germany country report of the International Transport Forum IRTAD Road Safety. OECD. https://www.itf-oecd.org/sites/default/files/germany-road-safety.pdf

ITF (2020) Canada country report of the International Transport Forum IRTAD Road Safety. OECD. https://www.itf-oecd.org/sites/default/files/canada-road-safety.pdf

Jones-Lee M.W., Hammerton M., Philips P.R. (1985) *"The Value of Safety: Results of a National Sample Survey"* Economic Journal 95 (March), 1985 pp 49-72.

Jones-Lee, M., Chilton, S., Metcalf, H. & Nielsen, J.S. (2015). "*Valuing gains in life expectancy: Clarifying some ambiguities".* Journal of Risk and Uncertainty; 51 (1), 1 -21.

Kahneman D. (2012) *"Thinking Fast and Slow"* Penguin Press

Lawson, John (1989): *"The Value of Transportation Safety"*. Final Report. Transport Canada Report No. 10569.

Miller, T. (1990) *"The Plausible Range for the Value of Life—Red Herrings among the Mackerel",* Journal of Forensic Economics 3(3), 1990 pp 17-39. https://www.researchgate.net/publication/247945996_The_Plausible_Range_for_the_Value_of_Life--Red_Herrings_Among_the_Mackerel

Nash, C.A. (2010). *"Current debates on the cost-benefit analysis of transport projects in Great Britain".* Seminario Sobre Evaluacion Economica de Proyectos de Transporte. Madrid, Spain.

NZ Government (2019) *"Road to Zero New Zealand's Road Safety Strategy 2020-2030"* report published December 2019 https://www.transport.govt.nz/assets/Uploads/Report/Road-to-Zero-strategy_final.pdf

Niroomand, N and GP Jenkins (2016) "*Estimating the value of life, injury and travel time saved using a stated preference framework".* Accident Analysis & Prevention 91: 216–225.

NSW Department of Industry (2018) *"Safe and Secure Water Program – Cost Benefit Guiding Principles"* March 2018. https://www.industry.nsw.gov.au/__data/assets/pdf_file/0004/148324/SSWP-CBA-Guiding-Principles-Mar2018.pdf

Persson U. Norinder A, Hjalte K and Gralen K (2001) *"The Value of a Statistical Life in Transport: Findings from a New Contingent Valuation Study in Sweden"* Journal of Risk and Uncertainty 23(2); 121-134.

Rizzi, LI and J de Dios Ortúzar (2003) "*Stated preference in the valuation of interurban road safety".* Accident Analysis & Prevention 35, no.1: 9–22

Rouwendal, J, A de Blaeij, P. Rietveld and E. Verhoef (2010) *"The information content of a stated choice experiment: A new method and its application to the value of a statistical life"* Transportation Research Part B 44: 136–151. *Rouwendal et al (2010).*

Schelling, T.C, (1968) *"The life you save may be your own".*

Strang (2019) "*Road to Zero: Everything you need to know about the government's new safety strategy" RNZ* 17th July 2019. https://www.rnz.co.nz/news/political/394542/road-to-zero-everything-you-need-to-know-about-the-government-s-new-safety-strategy

Sunstein C. R. (2001) *"Probability Neglect, Worst Cases and Law"* Available at SSRN. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=292149

Thomson K. (2015) *"Guidance on Treatment of the Economic Value of a Statistical Life (VSL) in U.S. Department of Transportation Analyses- 2015 Adjustment"* Memorandum to Secretarial Officers Modal Administrators dated June 17th 2015. https://www.transportation.gov/sites/dot.gov/files/docs/VSL2015_0.pdf

Transport Canada (1994) *"Guide to Benefit-Cost Analysis in Transport Canada"* TP11875E, published September 1994. http://www.evaluaciondeproyectos.es/EsWeb/Recursos/guias_acb/PDF/3.pdf

Wignall (2017) *"Economic Re-evaluation of New Zealand Transport Investments"* Australasian Transport Research Forum Auckland 2017. https://www.australasiantransportresearchforum.org.au/sites/default/files/ATRF2017_031.pdf