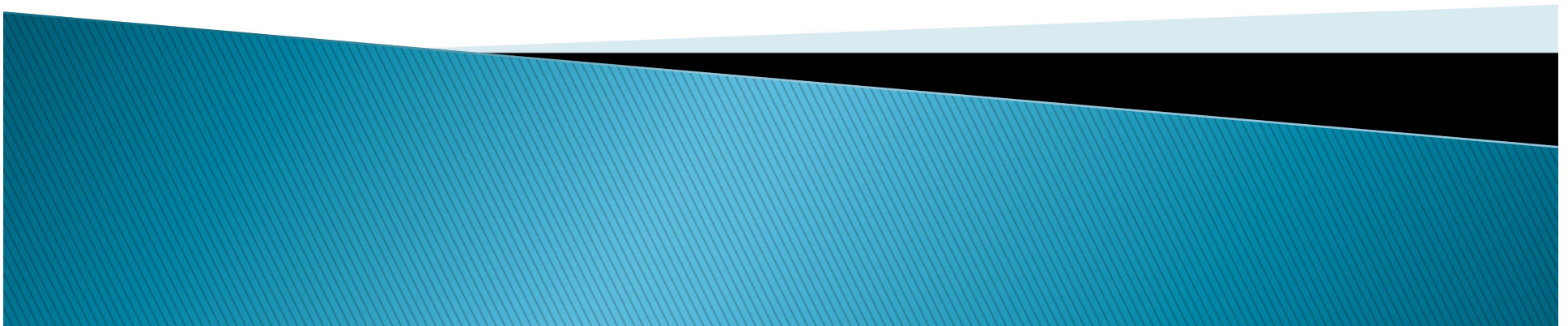
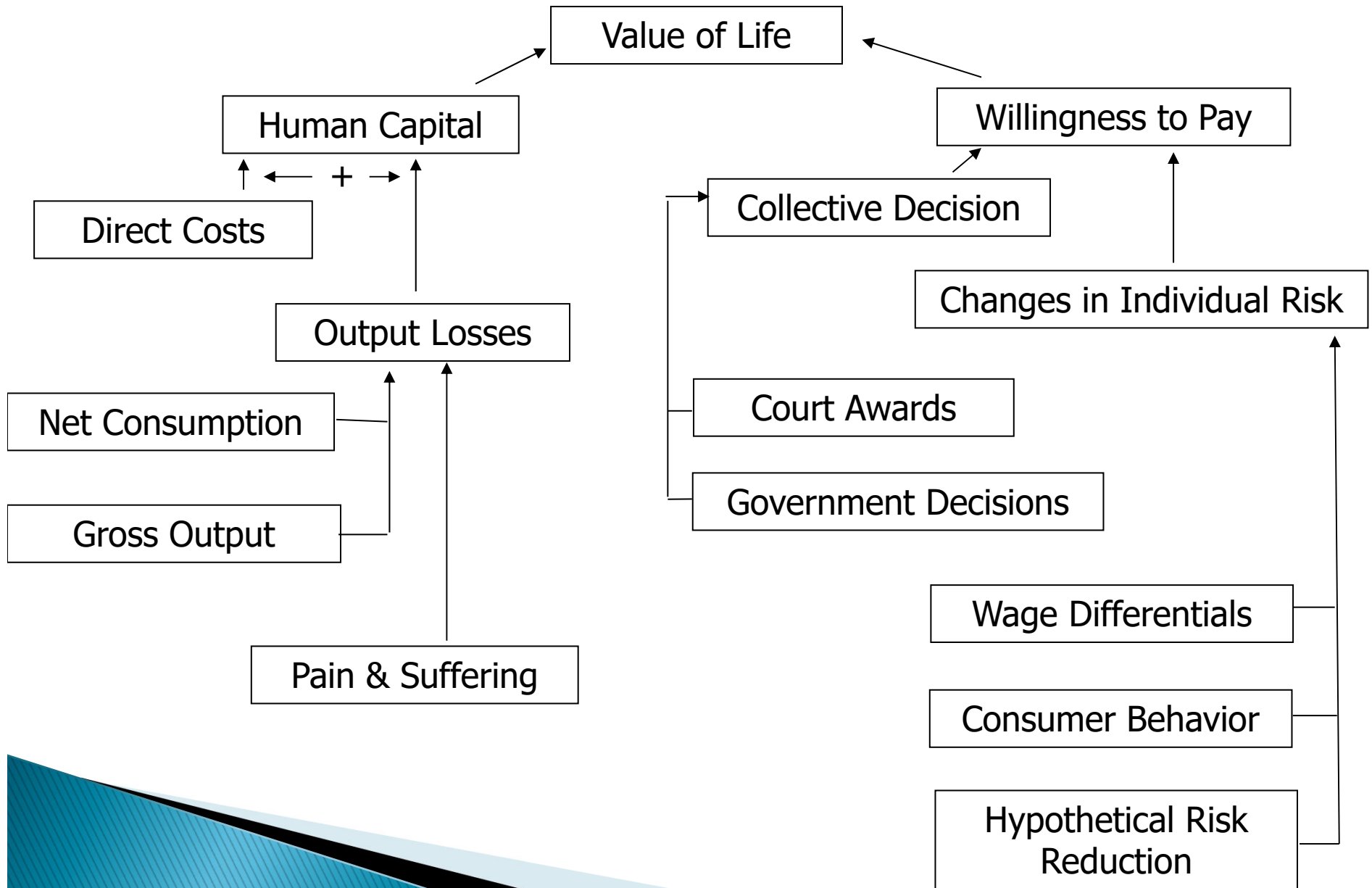


Value of Life and Traffic Injury Costs

Fall 2021



Valuation of Transportation Safety



Human Capital

- ▶ Medical Costs
- ▶ Emergency Services
- ▶ Property Damage
- ▶ Administrative expenses
- ▶ Issues:
 - Large uncertainty
 - Some costs would have been used even if collision has not happened



Human Capital

- ▶ Net of Consumption
 - Excess of expected output over their expected consumption during the remaining lifetime
 - In other words, it is to the benefits passed to future generations
- ▶ Gross Output
 - The victim's total output (victim's own loss)
- ▶ Issues:
 - Negative excess output
 - Children and older people are less valued
 - Uncertainty about future earnings and discount rate



Pain & Suffering

- ▶ Emotional losses caused by motor vehicle crashes (mental & physical)
- ▶ So far, only measured by courts
- ▶ Issues:
 - Difficult to measure
 - When death occurs, the burden of the emotional loss is beard by the family
 - Court awards in the US include a punishment in addition to pain & suffering



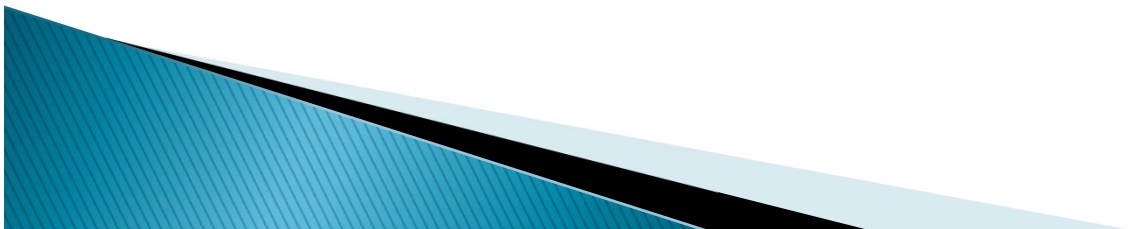
Willingness to Pay

- ▶ Based on the premise that people are better judge of their own welfare
- ▶ Known as “Compensation Variation”
- ▶ Characteristics:
 - Collective Risk or Decision
 - Changes in Individual Risk
 - Value of Statistical Life: aggregating values of entire population and dividing it by the number of deaths avoided



Collective Risk

- ▶ Court Awards Compensation
 - No consistency among decisions for same type of injury
 - More lawsuits are filed for different types of injury (negligence easier to prove)
- ▶ Government Decisions
 - Governments continually make decision on acceptability of risk (policy)
 - Decisions are different for different probability of death
 - Rejection of proposals for reducing fatalities (building versus still birth)



Individual Risk

▶ Wage Differentials

- Pay versus risk of fatal and non-fatal injury
- Differences in definition and measurements of risk
- Work related risk versus all risk
- Characteristics different: Union jobs versus non union job
- Workers don't have all the information about risk
- Perception of risk among same work force is different



Individual Risk

- ▶ Consumer Behavior
 - Purchasing safety equipment
 - Health related (cigarettes, eating)
 - Types of vehicles
 - Traffic related behavior (crossing, seatbelts)
 - Issues:
 - People do not know the true risk
 - Same issues as HC (discount rate, etc.)



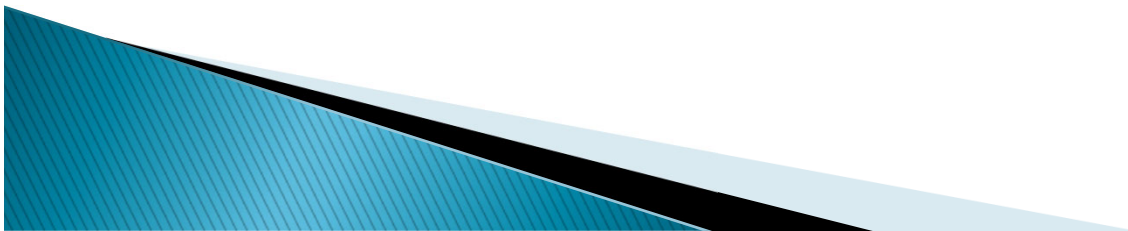
Individual Risk

- ▶ Hypothetical Risk Reduction
 - Subjects are surveyed about their risk and safety habits
 - Issues:
 - Subjective versus perceived risk
 - Wording of questions
 - Accidental deaths versus medical deaths
 - A wide variety of possible values



Summary

- ▶ All methods have problems
- ▶ Subjective versus perceived risk (crashes are extreme events)
- ▶ The wide variety in value of life has a significant impact on safety investments and interventions
- ▶ What are the alternatives?



Comprehensive Crash Costs (per person)

Table 2.3 Comprehensive Crash Costs (per Person) (2018 Dollars)

Severity of Injuries	Costs
Fatal (K)	\$10,855,000
Incapacitating (Type A)	\$1,187,000
Non-Incapacitating (Type B)	\$327,000
Possible (Type C)	\$151,000
No injury (Property Damage Only or PDO)	\$50,000

(Source: NSC¹)



Value of Life in Health Community

Ranked by Number of Deaths

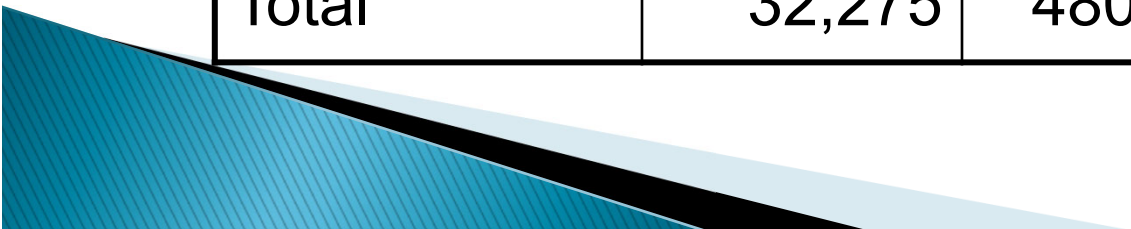
Conditions	Direct Costs*	Indirect Costs*	Total Costs*
Heart Disease – 724.3 ¹	101.8	81.3	183.1
Cancer (all) – 538.9	27.5	68.7	96.1
Stroke – 158.1	28.3	15.0	43.3
Pulmonary Disease – 114.4	21.6	16.2	37.3
Pneumonia and Influenza – 94.8	18.6	7.0	25.6
Injury (all) – 93.2	89.0	248.0	338.0
Digestive – 64.6	44.1	54.1	98.2
Suicide – 29.3	NA	10.2	NA
Kidney Diseases – 26.3	26.2	14.1	40.3
Chronic Liver Disease – 24.9	1.2	2.1	3.2

*In Billion of dollars, ¹ in 1,000s (1998)

Values not all from the same year

Cancer Related Death and Costs in Texas

Age Group	Number	Years of Life Lost	Costs (\$1000)
0-14	124	8,600	110,343
15-29	264	14,200	284,587
30-44	1,428	55,800	1,143,212
45-59	5,447	143,900	2,280,012
60-74	12,513	189,300	1,079,004
75+	12,499	68,900	77,665
Total	32,275	480,700	4,974,822



Crash Costs and National Economy

Table 1
Costs of road accidents as a percentage of GNP in different countries^a

Country	Year	Total costs of road accidents		Gross national product (GNP)	Costs as percent of GNP	
		Lost quality of life included	Lost quality of life excluded		Lost quality of life included	Lost quality of life excluded
Bangladesh	1997	7495	5519	1 616 309	0.5	0.3
Denmark	1997	14 145	11 281	1 080 550	1.3	1.0
Finland	1990	9487	5417	501 734	1.9	1.1
Germany	1994	43 380	39 150	3 368 689	1.3	1.2
Italy	1997	36 968	32 497	1 143 875	3.2	2.8
Korea	1996	10 986	7142	422 540	2.6	1.7
Netherlands	1993	12 353	9527	614 165	2.0	1.6
New Zealand	1991	3691	764	83 072	4.4	0.9
Norway	1995	21 540	10 975	928 700	2.3	1.2
Sweden	1995	44 672	14 519	1 649 900	2.7	0.9
UK	1990	11 193	2726	550 273	2.0	0.5
US	1988	334 011	116 597	5 820 336	5.7	2.0
Mean value (unweighted)					2.5	1.3
Mean value (weighted by GNP)					3.1	1.4

5.7

5.7

^a Values in national currencies. Amounts in millions.

International Comparison of Costs

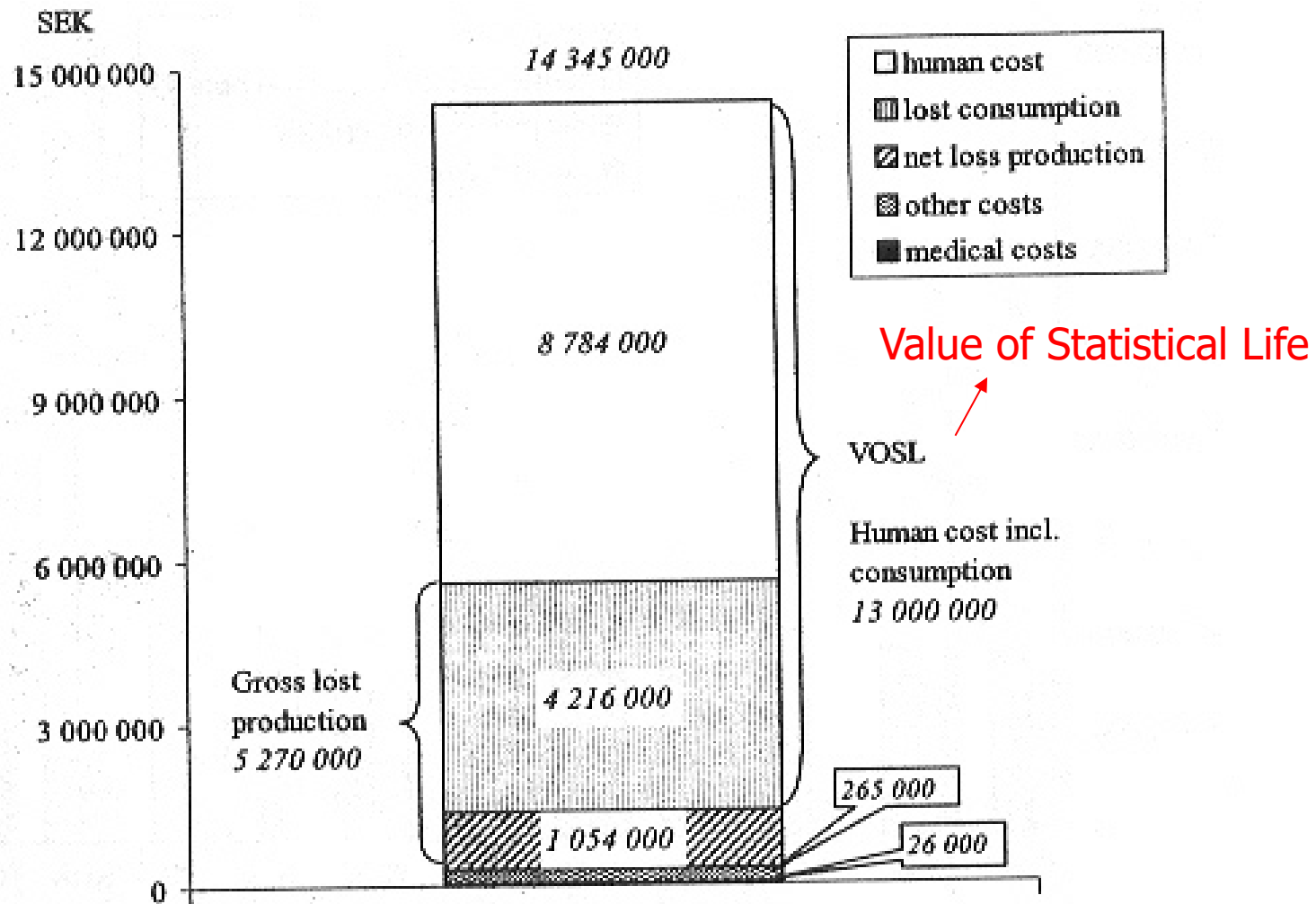
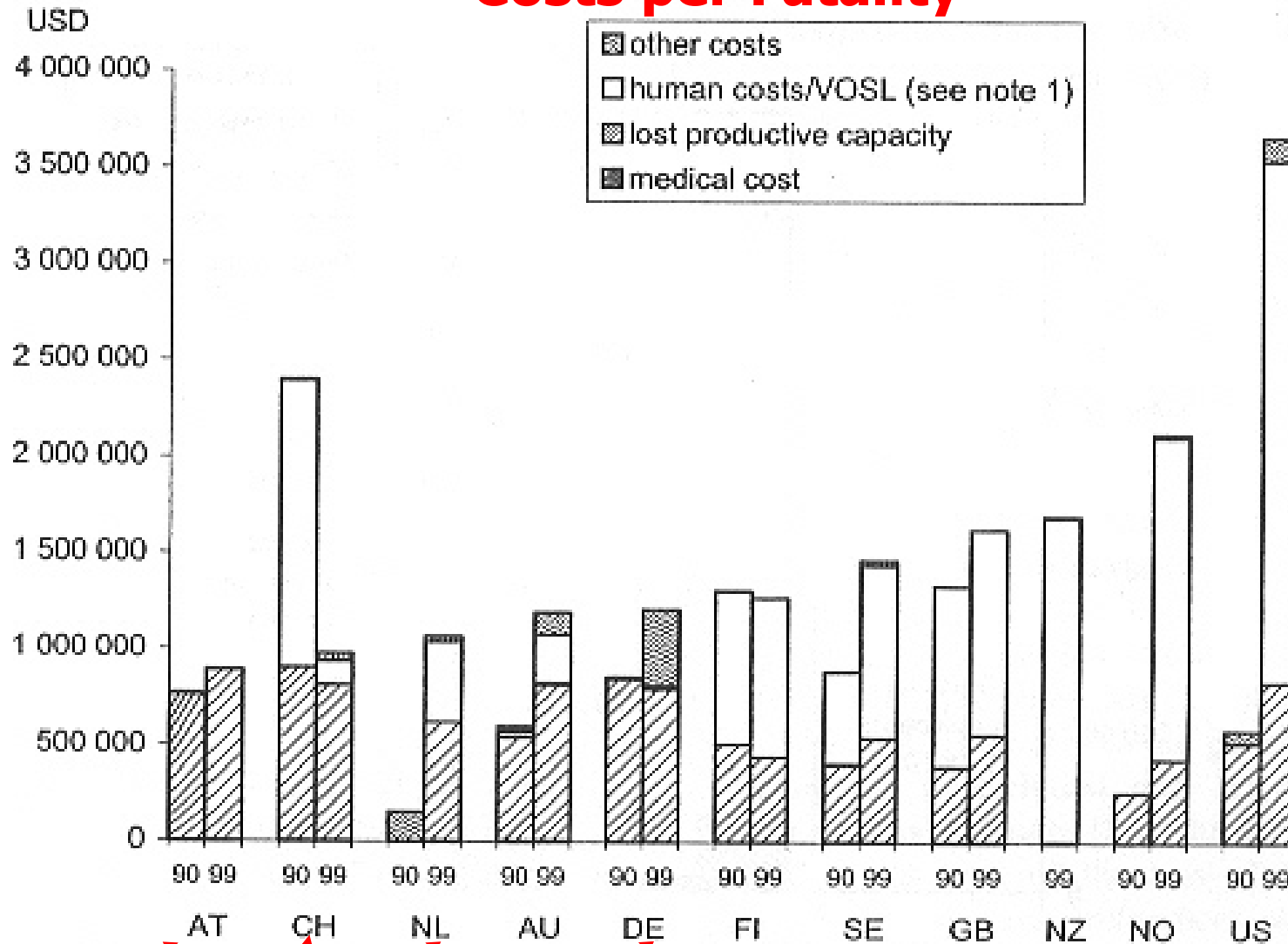


Fig. 1. Costs per fatality in Sweden, SEK 1999. Source: Persson and Cedervall (1991), SIKKA (1999).

International Comparison of Costs

Costs per Fatality



Austria

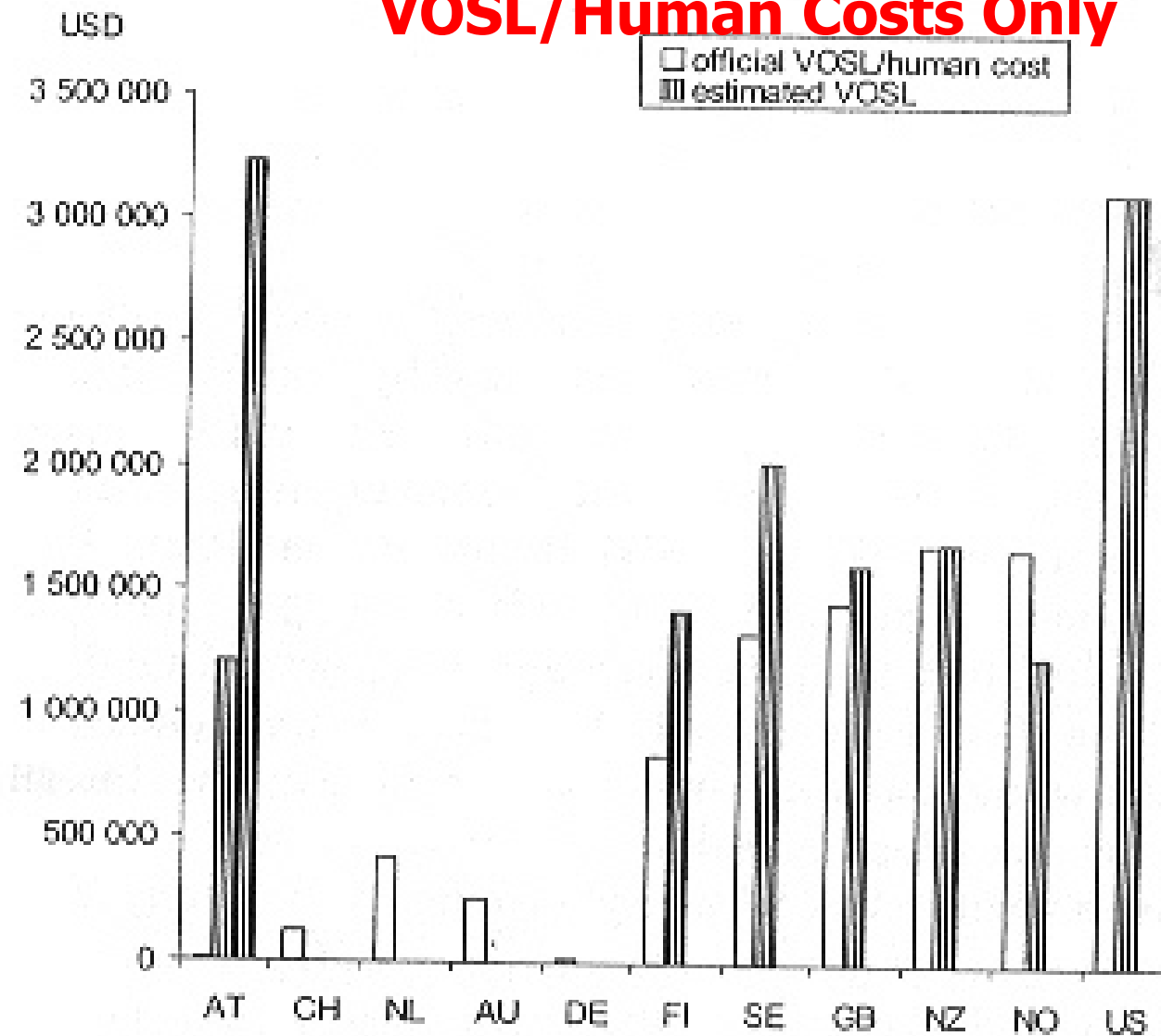
Switzerland

Netherlands

GE
(Germany)

International Comparison of Costs

VOSL/Human Costs Only



Costs by Crash Typology

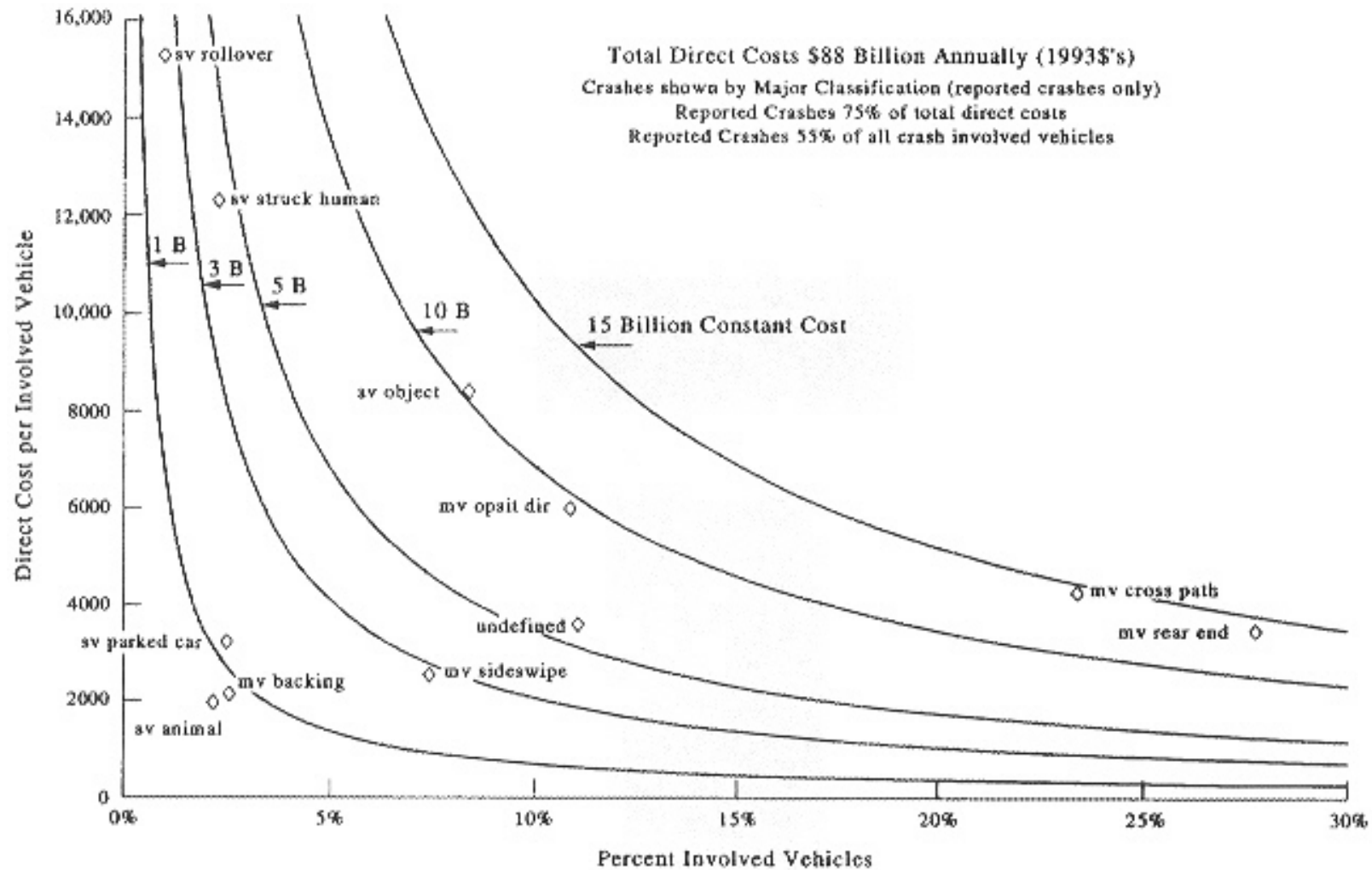


Fig. 1. Direct cost per crashed vehicle and percentage of crashed vehicles for police-reported crashes by crash geometry.

Costs by Crash Typology

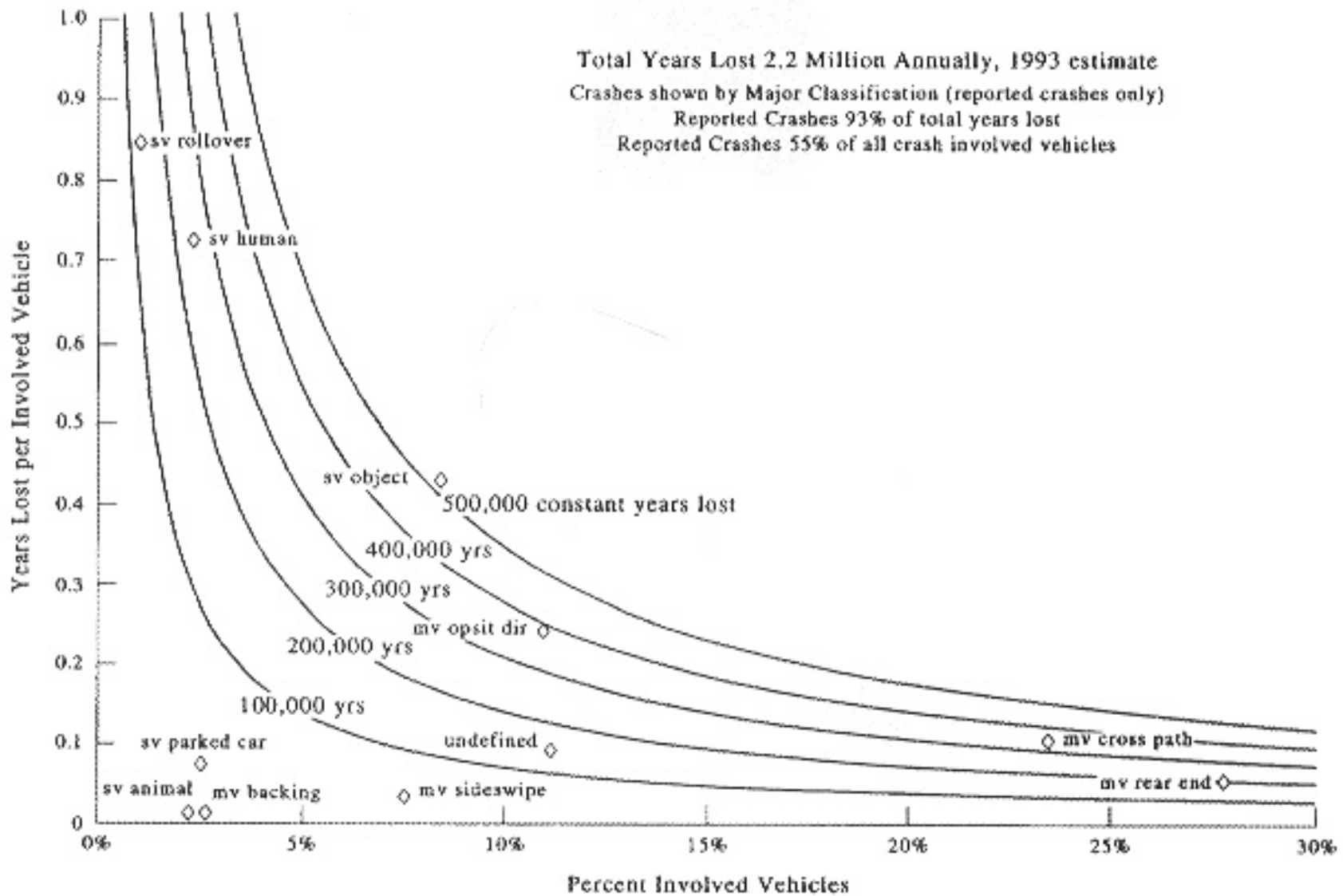


Fig. 2. Years of life and functioning lost per crashed vehicle and percentage of crashed vehicles for police-reported crashes by crash geometry.

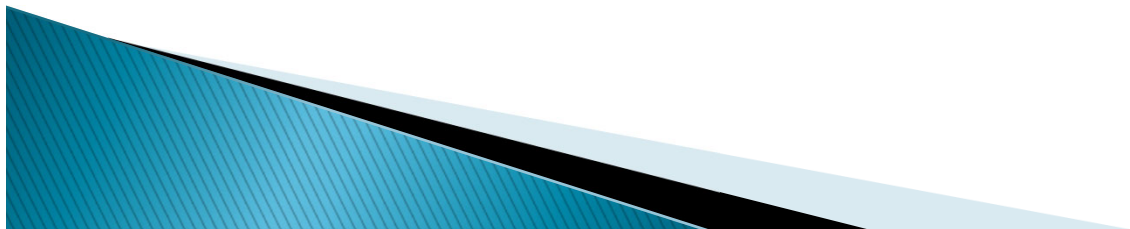
Costs by Crash Typology

	Direct cost (\$)	Life years	# Crashed vehicles
Single Vehicle Crashes:	\$18678 M	937 K	2412 K
Struck Human	4236 M	251 K	346 K
Struck Animal	641 M	4 K	321 K
Struck Object	10261 M	523 K	1221 K
Rollover	2348 M	131 K	155 K
Struck Parked Car	1192 M	28 K	369 K



Costs by Crash Typology

	Direct Costs	Life Years	Nb of Crashes
Multiple Vehicle Crashes	41553 M	973 K	10483 K
<i>Cross Paths</i>	14523 M	341 K	3398 K
At Signal			
Both Vehicles Straight	2948 M	72 K	544 K
One Vehicle Turn Right	213 M	3 K	74 K
One Vehicle Turn Left	723 M	12 K	179 K
At Sign			
Both Vehicles Straight	4414 M	138 K	830 K
One Vehicle Turn Right	312 M	5 K	114 K
One Vehicle Turn Left	1854 M	62 K	429 K
No Signage			
Both Vehicles Straight	1033 M	16 K	253 K
One Vehicle Turn Right	403 M	4 K	142 K
One Vehicle Turn Left	1417 M	19 K	392 K
Unspecified	1206 M	10 K	441 K



Costs by Crash Typology

	Direct Costs	Life Years	Nb of Crashes
<i>Rear-End</i>	13906 M	204 K	4028 K
Lead Vehicle Stopped	6824 M	78 K	2063 K
Lead Vehicle Turning	763 M	10 K	254 K
Lead Vehicle Straight	3015 M	47 K	938 K
3+ Vehicles Straight	3101 M	67 K	670 K
Unspecified	203 M	2 K	103 K
<i>Sideswipe</i>	2794 M	36 K	1089 K
Lane Change	1712 M	20 K	733 K
Vehicles Straight	395 M	8 K	167 K
Unspecified	687 M	8 K	189 K



Costs by Crash Typology

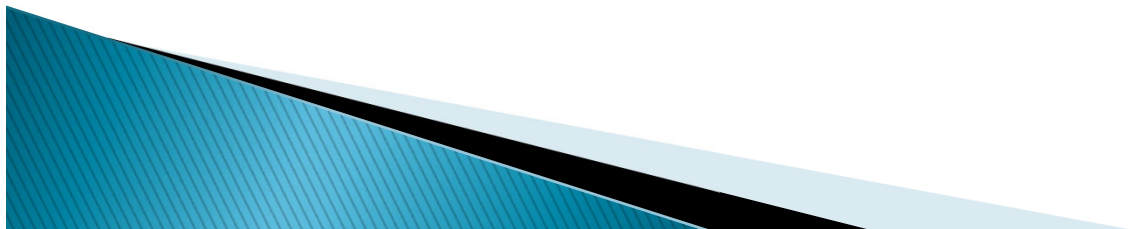
	Direct Costs	Life Years	Nb of Crashes
<i>Opposite Direction</i>	9517 M	387 K	1589 K
<i>Non-intersection</i>			
Both Vehicles Straight	3261 M	220 K	361 K
One Vehicle Turn Left	968 M	27 K	188 K
<i>Intersection</i>			
Both Vehicles Straight	545 M	20 K	106 K
One Vehicle Turn Left	4743 M	120 K	934 K



Costs by Truck Related Crashes

Table 2
Costs per crash, by type of truck involved (in 2000 dollars)

Truck crash type	Medical costs	Emergency services	Property damage	Lost productivity from delays	Total lost productivity	Monetized QALYs based on VSL from DOT	Total
Straight truck, no trailer	2286	177	4341	4887	15514	18690	41008
Straight truck with trailer	4569	204	6793	5116	24018	39220	74804
Straight truck, unknown if with trailer	2775	142	4548	4279	7685	6047	21196
Bobtail	1976	168	5961	5988	16554	18508	43167
Truck-tractor, 1 trailer	3854	186	6872	4677	23039	38509	72459
Truck-tractor, 2 or 3 trailers	3816	184	18132	4447	24302	42048	88483
Truck-tractor, with unknown # of trailers	1901	130	7296	4232	10778	11399	31505
Medium/heavy truck, unknown if with trailer	2051	157	5873	4184	8624	8835	25540
All large trucks	3195	182	6035	4800	19794	29945	59153



Costs by Truck Related Crashes

Table 3

Average annual crash costs, by type of truck involved: 1997–1999 (in millions of 2000 dollars)

Truck crash type	Medical costs	Emergency services	Property damage	Lost productivity from delays	Total lost productivity	Monetized QALYs based on VSL from DOT	Total
Straight truck, no trailer	300	24	608	692	1946	2089	4966
Straight truck with trailer	92	3	107	78	397	659	1259
Straight truck, unknown if with trailer	0	0	0	0	0	0	0
Bobtail	13	1	49	51	91	47	201
Truck–tractor, 1 trailer	697	35	1289	884	4015	6529	12564
Truck–tractor, 2 or 3 trailers	24	1	109	26	155	268	557
Truck–tractor, with unknown # of trailers	2	0	6	3	6	3	16
Medium/heavy truck, unknown if with trailer	5	1	23	17	26	12	66
All large trucks	1133	65	2190	1752	6636	9606	19630



See Zaloshnja et al. (2004) Crash Costs by Body Part Injured, fracture Involvement and Threat-to-Life Severity, United States, 2000. *Accident Analysis & Prevention*, Vol. 36(1), pp. 415-427

See Zaloshnja et al. (2006) Crash costs in the United States by crash geometry. *Accident Analysis & Prevention*, Vol. 38(4), pp. 644-651.

Latest costs:

The Economic and Societal Impact Of Motor Vehicle Crashes, 2010 (Revised May 2015)

<http://www-nrd.nhtsa.dot.gov/pubs/812013.pdf>



Application #1

- ▶ Economic effects of Red-Light Camera Programs
- ▶ Council et al. (2005) TRB
- ▶ Right-angle and rear-end collisions
- ▶ Modest economic benefits (\$28,000 to \$50,000 per site)
- ▶ Higher economic effects with higher entering flows



Economic Effects of Red-Light Running Programs

Table 2: Original comprehensive crash cost estimates by severity level, and combined estimates used in the economic effects analysis.

Crash Severity Level	Angle Crash Cost (\$)	Rear-end Crash Cost (\$)
K	\$4,090,042	\$3,781,989
A	\$120,810	\$84,820
B	\$103,468	\$27,043
C	\$34,690	\$49,746
O	\$8,673	\$11,463
(standard deviation)	(1,285)	(3,338)
K+A+B+C	\$64,468	\$53,659
(standard deviation)	(11,919)	(9,276)



Economic Effects of Red-Light Running Programs

Table 3: Economic effects including and excluding PDOs
 (Using a combined unit cost for K+A+B+C)

	All severities combined			PDO's excluded		
	Right-angle	Rear-end	All crashes	Right-angle	Rear-End	All crashes
EB estimate of crash costs without RLC	\$66,814,067	\$69,347,624	\$161,843,021	\$61,687,367	\$52,681,148	\$134,407,104
Cost of crashes recorded after RLC (370 site years)	\$48,319,090	\$75,222,780	\$147,470,550	\$43,868,392	\$53,944,539	\$115,901,685
% decrease in crash cost (s.e.) [negative is increase]	27.7 (0.6)	- 8.5 (0.7)	8.9 (0.4)	28.9 (0.6)	- 2.4 (0.8)	13.8 (0.5)
Crash cost decrease (per site year)			\$14,372,471 (\$38,845)			\$18,505,419 (\$50,015)

