ECONOMIC CONNECTIONS

Cost of road trauma in Australia 2015

Full report - 2017

Version 1.1 26 July 2021

TRANSPORT ECONOMICS AND POLICY ANALYSIS – CONNECTING PEOPLE, GOODS & PLACES

Economic Connections Pty Ltd has prepared this report for the Australian Automobile Association. We are grateful for the support of industry and government organisations in providing additional data to support the analysis, particularly, the Bureau of Transport, Infrastructure and Regional Economics (Department of Infrastructure and Regional Development), Insurance Statistics Australia, state and territory road safety agencies and the Transport Accident Commission (Victoria). The authors of the report are Phil Potterton, Anthony Ockwell and Jamie Cross. The report was independently reviewed by Cameron Gordon.

Executive summary

In December 2016, the Australian Automobile Association commissioned Economic Connections Pty Ltd to undertake an update of *Cost of road crashes in Australia 2006*, published by the Bureau of Infrastructure, Transport and Regional Economics (BITRE 2009). The commission is in the context that a BITRE update study is not planned until completion of research currently under way to improve estimates of key components of the cost of road trauma. The scope also includes an estimate of the cost to government budgets of road trauma in the year selected for analysis.

The **BITRE study** estimated an economic cost of road crashes in the calendar year 2006 of $17.85 billion ($23.87 billion in 2015 prices).[1] The study used a 'hybrid human capital' methodology, which centres on valuing loss of life, health and wellbeing on the basis of the cost of labour forgone in the economy and in the household (imputed cost). The study also included a sensitivity analysis, based on estimated willingness to pay, according to various studies, for reduction in statistical risk of loss of life. On the basis of a study by the Institute of Transport and Logistics Studies (University of Sydney),[2] the economic cost of road crashes was instead $27.12 billion ($36.96 billion in 2015 prices).

This study's **methodology** has involved:

- Consultation with academic and industry specialists on key changes over the past decade that may have influenced road trauma outcomes and associated costs
- Accessing available 2015 'population' data of all types (e.g. the number of insurance claims, or the number of fire and rescue service crash attendances), while using data estimation methods where, largely as in the BITRE study, data were unavailable
- Accessing available 2015 unit cost data and, where this was unavailable, adjusting BITRE's 2006 cost data to 2015 prices, applying the appropriate Australian Bureau of Statistics price indices
- Use of a 'disability-adjusted life year' framework to quantify the loss of life, health and wellbeing from fatality and the loss of health and wellbeing from disability caused by road injury [3]
- Valuing loss of life, health and wellbeing from fatality and disability using the willingness to pay based measure recommended by the Australian Government Office of Best Practice Regulation (OBPR), indexed to 2015 prices
- As in BITRE 2009, estimating costs, where applicable, on a 'whole of lifetime' (present value) basis, using a real three per cent discount rate
- Undertaking sensitivity analyses to reflect both the BITRE 'human capital hybrid' valuation of statistical life and the Australian willingness to pay for road safety-based valuation included in the BITRE report

---

[1] 2015 is the year of focus for this report, as indicated below. Prices are expressed in 2015 values, except where indicated.

[2] Hensher, D, Rose, J, de Dios Ortuzar, J and Rizzi, L 2009, *Estimating the willingness-to-pay and value of risk reduction for car occupants in the road environment*, February, Institute of Transport and Logistics Studies, University of Sydney http://sydney.edu.au/business/__data/assets/pdf_file/0007/25675/itls_wp_09_03.pdf

[3] The disability-adjusted life year framework involves assignment of weightings where a weighting of zero captures perfect health and a weighting of one represents death.

- Ensuring consistency between the 'whole of society' perspective of the economic cost of road crashes analysis and the contrasting 'government budget' perspective of the cost to government financial analysis.

With regard to trends and changes since 2006, **road fatalities have fallen** by 19 per cent, to 1,300 fatalities in 2016, notwithstanding increases in each of the last two calendar years. **Hospitalised injuries increased** by 21 per cent (to 37,646) over the eight years to 2014. Unprotected road users (i.e. motorcyclists, cyclists and pedestrians) comprised 36 per cent of fatalities in 2013, compared with 31 per cent five years earlier. These road users account for half of the fatality increase over the past two years and also make up 50 per cent of the growing number of hospitalised injuries.

The **average age of the fatality cohort increased** from 38.6 years in 2006 to 45.6 years in 2015, while the average age of those hospitalised increased from 36.6 years to 40.0 years between 2008 and 2013.

While measures to improve both road user behaviour and the safety of road infrastructure are long standing contributors to reduction in road trauma, with **improved vehicle safety technology**, the average crashworthiness of the Australian light vehicle fleet improved by an estimated 27 per cent over the decade to 2010, saving around 2000 lives.[4]

With regard to post-crash intervention, **improved road trauma management** over the past decade, notably in Victoria, has resulted in a documented reduction in fatality and disability following injury outcomes. Complementing this, **no-fault compensation**, long in place in Victoria, Tasmania and the Northern Territory, has been extended in respect of the catastrophically injured[5] in New South Wales (2007) and Queensland (2016).

At the level of research and analysis, **willingness to pay-based values of statistical life and statistical life year,** as recommended by OBPR for use in regulatory cost-benefit analysis in any sector ($3.5 million and $151,000 respectively in 2008), have now been applied in two (non-government) studies that address economic impacts of road trauma. In addition, an Austroads scoping study is under way for a new survey that will investigate willingness to pay for reduction in fatality risk on Australian roads. Whereas the previously referenced Institute of Transport and Logistics Studies study based its findings on two roads in New South Wales, a future study is seeking national applicability.

This study selected **calendar 2015 as the year for analysis.** The year offers a trade-off between, on the one hand, currency, in the context of recent trends and, on the other, adequacy of data, given the time lag associated with hospitalised injury data, in particular, becoming available.

Focussing on the year of analysis, **in 2015 there were**:

- 1,205 road crash fatalities, compared with 1,598 in 2006 (25 per cent reduction)
- An estimated 37,964 hospitalised injuries, compared with 31,204 in 2006

---

[4] Budd, L, Keall, M and Newstead, S 2015, *Retrospective and Prospective Changes in Secondary Safety of the Australian and New Zealand Vehicle Fleets and the Potential Influence of New Vehicle Safety Technologies*, Report No. 329, May https://www.monash.edu/__data/assets/pdf_file/0008/633554/VSRG-Prospective-and-Retrospective-Vehicle-Safety-Effects-Report-329.pdf

[5] Defined as a severe injury to the brain, spine, or spinal cord.

- 4,436 persons, from the hospitalised injury cohort, who became mildly, moderately, severely or profoundly disabled, compared with 4,619 in 2006 (both estimates)
- 227,572 non-hospitalised injuries, compared with 216,500 in 2006 (estimates)
- 679,359 road crashes compared with 653,853 in 2006 (estimates) and
- 1,246,083 vehicles involved in road crashes, compared with 1,160,794 in 2006 (both estimates).

Table ES.1 summarises the economic costs of road trauma in 2015. The largest cost item is **loss of life, health and wellbeing** valued at $9,276.8 million (m). For fatalities, this totalled 47,692 life years, valued at $4,926.8m at 2015 values of statistical life (life year) of $4.41m ($185,073). Loss of health and wellbeing for persons who became disabled due to road injury totalled 43,735 years with disability. The estimate was based on an average level of disability for the cohort of 4,436 persons of 0.182, in a context where a weighting of zero is equivalent to perfect health and a weighting of one represents death. This value was calculated based on the findings of a recent study of six large Australian and international injury cohorts.[6] These functional wellbeing losses were valued at $4,350.0m.

At $4,827.0m, **vehicle damage** is the second largest cost category. The average damage cost per passenger vehicle, estimated on Insurance Statistics Australia information, was $3,001. This value was within one per cent of the nominal (actual) average repair cost in 2006.

The cost of **disability care** comprises carer costs and the cost of aids, equipment, rehabilitation and therapy and customised housing and vehicles. Hours of care for persons with disabilities were valued at average weekly earnings for the profoundly disabled, who may depend on 'round the clock' institutional or home-based attendant care and on an 'opportunity cost of leisure forgone' basis for the mildly disabled. Estimated caring costs totalled $1,684.3m, while aids and related costs totalled $334.4m.

Health system costs (paramedical, medical, hospital stay) costs for fatalities, hospitalised injuries and non-hospitalised injuries were estimated at $1,631.0m. Whereas the all groups consumer price index increased by 25 per cent between 2006 and 2015, the hospital and medical cost index grew by 75 per cent over the period.

Road **network travel delay** costs relating to fatality or injury crashes on major roads were estimated at $1,130.6m.

Based on available insurance claim cost data and Australian Prudential Regulatory Authority information on insurer underwriting expenses, the cost of **administering insurance claims** was estimated at $1,124.9m.

The **efficiency cost of raising government revenue** relates to the adverse effect on economy-wide incentives, to earn income and to save and invest, resulting from the taxation that is required to meet the cost to government budgets of Australian road trauma. The estimate of $802.3m represents 21.5 per cent of the 2015 cost to government, which is outlined below.

---

[6] See Gabbé, B, Lyons, R, Simpson, P, Rivara, F, Ameratunga, S, Polinder, S, Derrett, S and Harrison, J 2016, "Disability weights based on patient-reported data from a multinational injury cohort", *Bulletin of the World Health Organisation* 94, pp. 806-816C http://www.who.int/bulletin/volumes/94/11/16-172155/en/

Table ES.1 Economic cost of road trauma 2015, $m

Cost category	Fatalities	Hospitalised injuries	Non-hospitalised injuries	Property damage	Total	*% total*
Life, health and wellbeing	4,926.8	4,350.0	na	na	9,276.8	*41.7%*
Vehicle damage	6.4	208.3	1,248.9	3,363.4	4,827.0	*21.7%*
Disability care	na	2,018.7	na	na	2,018.7	*9.1%*
Hospital, medical, paramedical	6.5	983.2	641.3	na	1,631.0	*7.3%*
Travel delay	18.2	177.6	399.8	535.0	1,130.6	*5.1%*
Insurance administration	5.4	340.4	289.7	489.4	1,124.9	*5.1%*
Efficiency cost of raising revenue	184.5	320.7	103.3	193.8	802.3	*3.6%*
Vehicle unavailability	0.2	19.3	115.6	311.6	446.7	*2.0%*
Emergency services	10.2	191.9	na	134.4	336.5	*1.5%*
Legal	3.7	325.4	na	na	329.1	*1.5%*
Workplace disruption	20.6	126.1	na	na	146.7	*0.7%*
Health cost of crash-induced pollution	0.3	8.6	19.4	43.4	71.8	*0.3%*
Street furniture damage	0.1	2.1	12.6	33.9	48.7	*0.2%*
Correctional services	37.3	na	na	na	37.3	*0.2%*
Funeral	5.6	na	na	na	5.6	*0.0%*
Coronial	3.0	na	na	na	3.0	*0.0%*
TOTAL	5,228.9	9,072.5	2,830.6	5,104.9	22,236.9	*100.0%*

na Not applicable

Totals may not sum precisely, due to rounding.

Source: Various and ECON analysis.

Vehicle unavailability costs, involving vehicle hire while damaged vehicles are off the road for assessment, repair and/or replacement, or alternative arrangements, totalled an estimated $446.7m.

Emergency services costs for crash attendance by ambulance, police and fire and rescue services totalled an estimated $336.5m. **Legal** costs, relating to the settlement of compensation claims and not including insurers' in-house counsel costs, were estimated at $329.1m.

Workplace disruption costs following fatalities and injuries were estimated primarily with reference to average gross earnings of employees, with the duration of absences following injury linked to injury and severity disability. Costs were estimated at $146.7m.

Other costs, comprising the health impact of crash delay-induced local pollution, street furniture damage, criminal legal expense, correctional services, recruitment and retraining and coronial totalled $166.4m.

The **total economic cost of road trauma** is estimated at $22,236.9m, equivalent to 1.3 per cent of gross domestic product. The cost per fatality was $4.34m, while the cost per hospitalised injury, including disabled persons, was $239,000. Separated out, the cost per person disabled following road crash injury was $694,000. The cost per non-hospitalised injury was $12,000.

The cost of road trauma in 2015 is 6.8 per cent lower than the 2006 cost, when expressed in 2015 prices ($23,869.4m). **Numerous factors have reduced the estimated cost compared to 2006, while others have increased it** (Table ES.2), with the former slightly more significant overall. Factors tending to reduce total cost include: reduced fatalities; reduced number of persons disabled following injury; casualty ageing, which reduces the average number of life years lost or disabled; and a revised approach to estimation of insurance administration and carer costs. On the other side of the ledger are: a high health service cost increase; inclusion of a new cost category, the efficiency cost of government revenue-raising; and use of a willingness to pay-based approach, in preference to a human capital-based approach, to valuing loss of life, health and wellbeing.

Table ES.2 Drivers of the cost of road trauma 2015: comparison with 2006

Cost driver type	Reducing total cost visavis 2006	Increasing total cost visavis 2006
Population numbers, characteristics	Fatalities	Hospitalised injuries
	Persons disabled	Non-hospitalised injuries
	Casualty ageing	Road crashes
Unit costs	Vehicle cost growth below CPI	Health (hospital and medical) cost growth above CPI
Cost categories		New cost category - Efficiency cost of government revenue-raising
Valuation methodology	Disability care - carers	
	Insurance administration	Life, health and wellbeing - Disability-adjusted life year and willingness to pay approaches

Sensitivity tests (Table ES.3) show that, if the BITRE 2009 hybrid human capital approach were used instead of the study approach, but with no other changes to the study methodology, the estimated economic cost of road trauma would be $2.0 billion lower ($20,196.6m). Conversely, under the willingness to pay for road safety in Australia approach, which was included as a sensitivity test in BITRE 2009, the total cost of road trauma would be $7.4 billion higher ($29,675.6m).

Table ES.3 Economic cost of road trauma 2015 (and 2006) sensitivity tests

Measure	BITRE 2009 Hybrid human capital approach (ECON proxy estimate)	ECON Willingness to pay approach (OBPR)	BITRE 2009 Willingness to pay for road safety in Australia sensitivity test
Value of statistical life 2015 (VSL, 40 years), 2015 $m	3.44	4.41	7.94
Value of statistical life year (VSLY), 2015 $m	144,370	185,073	333,473
Economic cost of road trauma 2015, 2015 $m	20,196.6	22,236.9	29,675.6
Economic cost of road trauma 2006 (BITRE 2009) estimates for reference			
Value of statistical life 2006 (40 years), 2006 $m	2.41		6.34 (1)
Value of statistical life year 2006 $m (1)	101,050		266,350
Economic cost of road trauma 2006, (2006 $m) 2015 $m	(17,849.3) 23,869.4		(27,120.0) 36,962.0

(1) ECON estimates based on BITRE 2009 and Hensher et al 2009

Source: BITRE 2009, Hensher et al 2009 and ECON analysis

Based on a range of published sources regarding funding shares, the **cost to government** of road trauma in 2015 was estimated at $3,731.6m (Table ES.4). More than three quarters of this cost (76.9 per cent) comprises the present value of many future years of forgone taxation revenue and additional income support payments, arising directly from road crash fatalities and disabilities and including the cost of disability carer income support. The health services area is also a significant contributor (11.8 per cent).

A **first year all-governments cost to budget** of $943.8m (25.3 per cent of the total of $3,731.6m) was estimated (Table ES.5). The 'first year' encompasses 2014-15 (second half), 2015-16 and 2016-17 (first half), allowing for a period of up to 12 months following all road crashes that occurred during 2015. First year costs primarily comprise the immediate systemic responses to road trauma in health, emergency services and other areas.

The balance and greater part of the cost to budget is incurred after the first year, over a period of up to approximately 70 years, by which time the youngest person killed or disabled in 2015, would otherwise, on actuarial assumptions, have ceased either paid work or reliance on disability-related income support. Total forgone taxation revenue and additional income support payments comprise 98.3 per cent of the **subsequent year average annual cost**, with disability care costs making up the remainder. This average cost is estimated at $141.2m per year, higher than this amount initially and lower in later years.

Table ES.4 Cost to government budgets from road trauma 2015, $m

Cost category	Economic cost	Cost to government					
		Commonwealth	State & territory	Local	Cost to all governments' budgets	*% total cost*	First year budget cost
Taxation and income support							
Taxation loss	na	1,050.3	216.4	46.4	1,313.1		62.4
Income support net increase	na	1,557.0			1,557.0		76.4
SUB-TOTAL		2,607.3	216.4	46.4	2,870.1	*76.9%*	138.8
Disability care (1)							
Aids, appliances and equipment	334.4	58.9			58.9		2.4
SUB-TOTAL	334.4	58.9			58.9	*1.6%*	2.4
Health services							
Paramedical	286.3	11.7	2.6		14.3		14.3
Medical - hospitalised	471.8	19.3	4.3		23.6		23.6
Medical - non-hospitalised	641.3	320.7	71.4		392.1		392.1
Hospital stay	231.7	9.5	2.1		11.6		11.6
SUB-TOTAL	1,631.0	361.2	80.4		441.6	*11.8%*	441.6
Emergency services							
Ambulance	112.4	76.5			76.5		76.5
Fire	124.4	40.4			40.4		40.4
Police	99.8	99.8			99.8		99.8
SUB-TOTAL	336.5	216.8			216.8		216.8
Vehicle-related							
Vehicle damage	4,827.0	4.8	29.8	3.7	38.3		38.3
Vehicle unavailability	446.8	0.4	2.8	0.3	3.5		3.5
Travel delays including additional pollution	1,202.4	1.2	7.4	0.9	9.5		9.5
Street furniture damage	48.7		32.3	16.4	48.7		48.7
SUB-TOTAL	6,524.9	6.5	72.3	21.3	100.1	*2.8%*	100.1
Legal and other							
Criminal legal	3.7		3.7		3.7		3.7
Correctional services	37.3		37.3		37.3		37.3
Coronial	3.0		3.0		3.0		3.0
SUB-TOTAL	44.1		44.1		44.1	*1.2%*	44.1
TOTAL (2)	8,871.0	3,250.7	413.2	67.7	3,731.6	*100.0%*	943.8

(1) Income support for carers of eligible disabled persons is included under 'Taxation and income support' above.
(2) Totals may not sum precisely, due to rounding.

Source: ECON analysis

Table ES.5 Annual cost of 2015 road trauma to government budgets, $m

Annual cost to government budgets	Commonwealth	State & territory	Local	Total
First year - immediate post-crash costs (1)	713.2	207.1	23.5	943.8
Subsequent years - long term average annual cost (2)	128.8	10.3	2.2	141.2

(1) The ‘first year’ encompasses 2014-15 (second half), 2015-16 and 2016-17 (first half), allowing for up to 12 months following each road crash that occurred during calendar 2015. First year costs capture the immediate systemic responses to road trauma in health, emergency services and other areas.
(2) ‘Subsequent year’ costs comprise forgone taxation, additional income support and disability care costs. Annual budget costs will be above this level initially, before declining and coming close to zero at around 70 years (2084-85).

Source: ECON analysis

Future studies of the economic and financial costs of road trauma would benefit from: improved data on non-hospitalised injuries, complementing a current National Road Safety Strategy initiative to link police-reported crash data and hospital admissions data on a nationally consistent basis; research into the longer term outcomes and costs for the full spectrum of persons disabled following road crash injury; improved understanding of the opportunity costs for carers, in areas including work, study and recreation; research into the impact of road crashes on road network congestion and efficiency; and authoritative, research-backed guidance on the use of willingness to pay-based valuations of statistical life and statistical life year in Australian road safety project and policy analysis.

Table of contents

Table index

Figure index

Abbreviations

AAA	Australian Automobile Association
ABS	Australian Bureau of Statistics
APRA	Australian Prudential Regulatory Authority
b	Billion (dollars)
BITRE	Bureau of Infrastructure, Transport and Regional Economics
BTE	Bureau of Transport Economics
CPI	Consumer price index
CTP	Compulsory third party (insurance)
DALY	Disability-adjusted life year
DSS	Department of Social Services
IRTAD	International Traffic Safety Data and Analytics Group
LCV	Light commercial vehicle
LTCSA	(New South Wales) Lifetime Care and Support Authority
m	Million (dollars)
MACC	(Northern Territory) Motor Accidents Compensation Commission
MAIB	(Tasmania) Motor Accidents Insurance Board
MAIC	(Queensland) Motor Accidents Insurance Commission
na	Not applicable
NRSS	National Road Safety Strategy
OBPR	Office of Best Practice Regulation
PAYG	'Pay as you go' (income tax payment arrangements)
PPI	Producer price index
SDAC	(Australian Bureau of Statistics) Survey of Disability, Ageing and Carers
TAC	Transport Accident Commission (Victoria)
TIC	Transport and Infrastructure Council
VSL	Value of statistical life
VSLY	Value of statistical life year
YLD	Year of life disabled
YLL	Year of life lost

1. Introduction

1.1 Research study objective and context

Economic Connections Pty Ltd (ECON) was commissioned in December 2016 to undertake research into the economic cost of road trauma. The study is the first stage in a two-stage research program that supports the Australian Automobile Association's goals in ensuring that Australian motoring is safe and affordable and that Australia's transport infrastructure delivers for the community and the economy. This study seeks to demonstrate the importance of the Federal Government prioritising road safety at a time of falling revenues and a focus on budget repair.

The context for the study is that an update of the widely referenced research by the Bureau of Infrastructure, Transport and Regional Economics (BITRE), *Cost of road crashes in Australia 2006* [7] is not planned until completion of long term research to improve estimates of key components of the cost of road trauma. Firstly, a project, aimed at producing nationally applicable estimates of the willingness to pay for safety on Australian roads, is currently being scoped through Austroads, the peak organisation of Australasian road transport and traffic agencies (National Road Safety Strategy 2016, p. 23). A report with recommendations on the design of an appropriate willingness to pay survey, is in finalisation.[8] Secondly, Austroads is conducting research to seek a national approach to collection and reporting of serious injury crash data, involving linking of hospital and police-sourced data. A pilot data linkage project is in progress (NRSS 2016, p. 34).

1.2 Study scope

This study is intended, firstly, to provide an 'interim' update of the BITRE 2009 estimates of the cost of road trauma in 2006, taking account of recent trends and developments and pending a future bureau study.

The study measures the cost of road trauma relative to a notional alternative world in which there are no road crashes and no road trauma. While policy interventions are referred to, the effectiveness of any intervention in reducing or eliminating road trauma is beyond the study's scope.

Secondly, the study involves assessment of how the costs of road trauma impact on government budgets. This involves a financial analysis perspective, rather than an economic analysis one.

In both areas, the study is a national one and, while making use of jurisdiction-specific data, it does not provide results at individual jurisdiction level, or on a regional basis (e.g. urban and non-urban).

---

[7] This report is referred to throughout as 'BITRE 2009'.

[8] BITRE personal communication 24 April 2017.

1.3 The BITRE study

BITRE 2009 is the third in a series of reports, which commenced in the 1980s (Bureau of Transport Economics 1988), providing an exhaustive examination of the human and other costs of crashes on Australian roads. Like its predecessors, the study focuses on the direct costs of crashes and does not include ‘second round’ impacts, or the impacts of road trauma on other sectors in the economy.

All three reports have used a human capital approach to the valuation of human life that forms a central part of studies of this type. Measurement centres on the loss of output from labour in the economy and includes an imputed value for the loss of labour in the household. With recognition that the approach stands at odds with a basic tenet of welfare economics that valuation of losses due to a premature death should reflect the preferences of individuals, BITRE 2009 included an amount for the loss of quality of life.[9] The report also included, as sensitivity tests, alternative valuations based on the willingness to pay for reduction in the risk of death on the roads. The willingness to pay approach, while providing for valuation based on individuals’ choices, is characterised by some empirical variability in the valuation of statistical human life (Abelson 2008).

BITRE 2009 estimated an economic cost of road crashes in the calendar year 2006[10] of $17,849.3m ($23,869.4m in 2015 prices[11]), as shown in Figure 1. Losses from each of the 1,602 fatalities[12] were estimated at $2.40m ($3.26m in 2015 prices), while those from the 31,204 hospitalised injuries were valued at $214,000 per injury ($292,000 in 2015 prices). On the basis of an Institute of Transport and Logistics Studies (University of Sydney) study into willingness to pay for improved safety on Australian roads (Hensher et al 2009), the economic cost of road crashes was instead $27.12 billion ($36.96 billion in 2015 prices).

1.4 Study approach

One year’s road safety outcomes is often a fair guide to the next year’s, as the key determinants of the outcomes, road user behaviour, the vehicle fleet and the road infrastructure environment themselves change only gradually. Yet change over a period of a decade can be significant. This study has laid emphasis on seeking to understand the changes that have occurred since the mid 2000s, in use of the roads, the policy environment and other respects. Insights gained, through trend analysis and consultation with specialists, have assisted in many ways, including in choice of valuation approaches for particular cost categories and in the interpretation of available cost-related data. Some key changes since 2006 are outlined in Section 2.

---

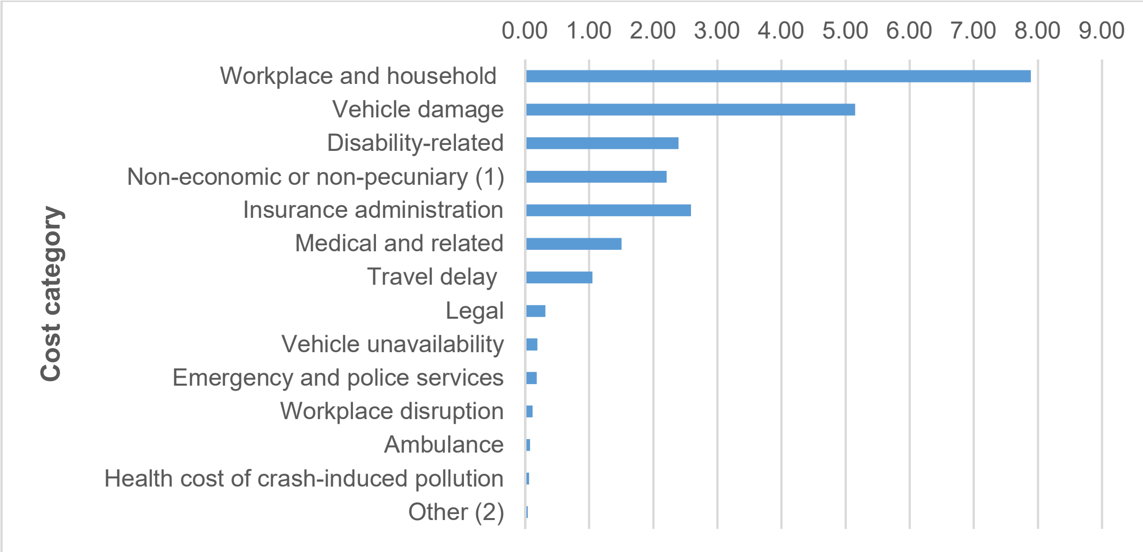
[9] The amount, $387,900 (2006 prices) per fatality, was based on a statutory value placed on total disability for a non-fatal road crash casualty (BITRE 2009, p. 28).

[10] All ‘year’ data in this report refer to calendar years, consistent with road safety policy and reporting norms, except where indicated, for reasons of data availability.

[11] 2015 is the year of focus for this report (see Section 3.1). For convenience, as with BITRE’s report in respect of the year 2006, 2015 prices proxy current prices. 2015 values are estimated by applying a range of prices indices, as described in Section 3.3.

[12] The 2006 fatalities total of 1,602 has been revised to 1,598 (BITRE 2016, p.48). The latter figure is used in this report for calculation purposes.

Figure 1 Economic cost of road crashes 2006 (2015 $b)



(1) Estimate of lost quality of life from fatality and disability
(2) Comprises correctional services, recruitment and retraining, premature funeral and coronial costs

Source: BITRE 2009 and ECON analysis

Secondly and notwithstanding the emphasis on what is new, the study is closely guided by the BITRE study, in terms of areas of focus and methods. This is apparent in the study methodology (Section 3). For example, where new cost information was not able to be accessed, BITRE's 2006 cost estimates have been indexed forward

Thirdly, in some contrast to BITRE 2009, the study involves differentiation between the 'economic', or 'whole of society' focus of the economic cost analysis and the 'financial' perspective of the cost to government analysis, which is undertaken from a specifically government perspective.

1.5 Terminology

As already indicated (Section 1.4), this study uses 'economic' to refer to the 'whole of society' cost perspective that is relevant to the task of updating BITRE 2009. An alternative widely used term for the whole of society perspective is 'social' (e.g. Austroads 2015). Under a whole of society approach, economic costs, involving use of actual 'physical' resources or alternatively opportunities forgone, are distinguished from 'financial' costs that involve flows of funds between individuals or groups in the society', whether or not these transactions also involve resource costs. The distinction is discussed further in the methodology section (Section 3.8). The study's cost to government analysis measures financial costs.

Secondly, unless otherwise indicated, 'year' refers to calendar year in the economic analysis and financial year in the cost to government analysis. The study follows both road safety convention and BITRE 2009 in adopting a calendar year approach for the economic analysis. However, a financial year approach is appropriate in considering costs to government budgets.

Finally, 'road crash' refers to a crash that occurs on a public road and excludes off road crashes, for example in car parks or on private property. Nearly 30 per cent of hospitalisations for road injury relate to off-road occurrences (Berry and Harrison 2012, p. 9).

Other definitions important to the analysis are addressed in context in later sections.

1.6 Report outline

The remainder of this report is set out as follows:

Section 2: Changes since 2006

Section 3: Methodology

Section 4: Key 2015 data

Section 5: Economic cost of road trauma 2015

Section 6: Cost to government of road trauma 2015

Section 7: Areas benefitting from future research.

1.7 Author disclosure

The lead authors of this report, Phil Potterton and Anthony Ockwell, are former officers of predecessor agencies to the Australian Government Department of Infrastructure and Regional Development, which includes the Bureau of Infrastructure, Transport and Regional Economics. Phil Potterton was head of the bureau during much of the preparation period for BITRE 2009.

1.8 Acknowledgements

Economic Connections is grateful for the co-operation of numerous organisations and individuals who provided insights, information and additional data to contribute to this study. Data was provided by the Bureau of Infrastructure, Transport and Regional Economics, Insurance Statistics Australia, the Northern Territory Department of Infrastructure, Planning and Logistics, the Queensland Department of Transport and Main Roads, the South Australian Department of Planning, Transport and Infrastructure, the Transport Accident Commission (Victoria) and the Western Australian Road Safety Commission. See Appendix A for further information.

2. Changes since 2006

This section provides contextual information for the study. It outlines some key changes since the mid 2000s that impact its estimates of the cost of road trauma and that are relevant in interpreting the estimates.

The section considers changes and developments in: key road safety trends; post crash interventions including trauma management and insurance arrangements; and road safety-related economic research and advice for practitioners.

2.1 Road trauma trends

2.1.1 Road crash fatalities

The challenge to reduce road trauma involves constant engagement with rising levels of road user 'exposure', with a growing Australian population and increase in the total number of vehicle kilometres travelled on Australian roads. Between 2006 and 2016, the Australian population grew by 20.7 per cent, from 20.1 million to 24.1 million (Australian Bureau of Statistics 2017a). Distance travelled on the nation's roads increased comparably, by 19.4 per cent, from 209.4 billion to 249.5 billion vehicle kilometres (ABS 2015c, 2017d).

Road fatalities continued a decades-long decline after 2006 until 2014 (Figure 2). Fatalities have increased in the last two calendar years, including as a rate per 100,000 population (4.9 per 100,000 population in 2014, rising to 5.1 in 2015 and increasing further in 2016).

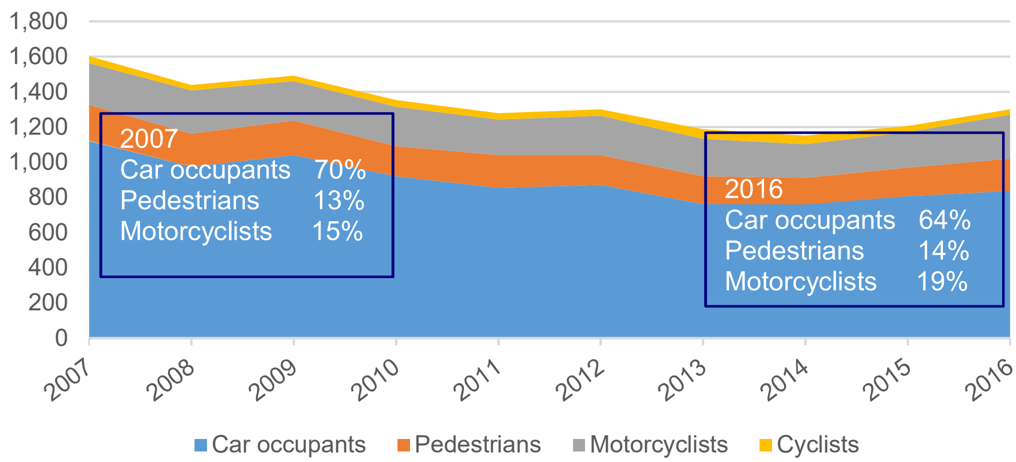
Unprotected road users (motorcyclists, pedestrians and cyclists) comprised 36 per cent of fatalities in 2016, compared with 31 per cent in 2007.[13] The motorcyclist share increased from 15 per cent to 19 per cent. Motorcyclist fatalities also rose slightly in absolute terms (237 to 248). At six per cent per year, motorcycles have increased faster than any other registered vehicle type over the past decade (ABS 2016g).

A second important trend relates to the increasing fatality share of older age groups (Figure 3), consistent with a broader ageing of the Australian population. While the fatality share of those aged 40 and below declined slightly, there were increases of three percentage points and five percentage points in the 40 to 64 and 65 and older age groups respectively.

Gender distribution was essentially unchanged over the decade, with males continuing to account for three quarters of all road crash fatalities.

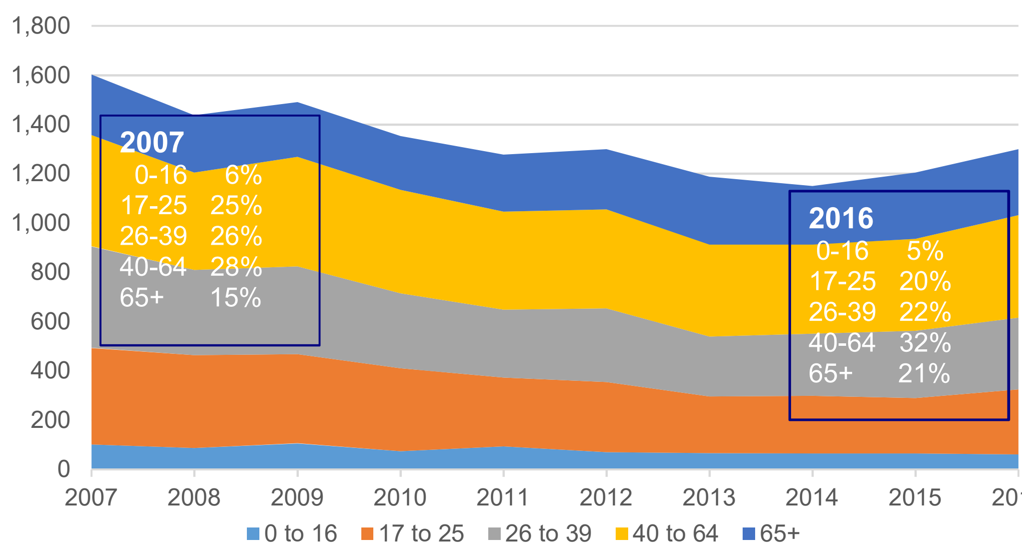
[13] Data available for the trends analysis commenced in 2007 (fatalities) and 2008 (hospitalised injuries). Due to lags in data availability, the hospitalised injury trend analysis is confined to 2008 to 2014. See also Section 3.1.

Figure 2 Road fatality trends by road user, 2007 to 2016



Source: BITRE 2017a and ECON analysis

Figure 3 Road fatalities by age group, Australia 2007 to 2016



Source: BITRE 2017a and ECON analysis

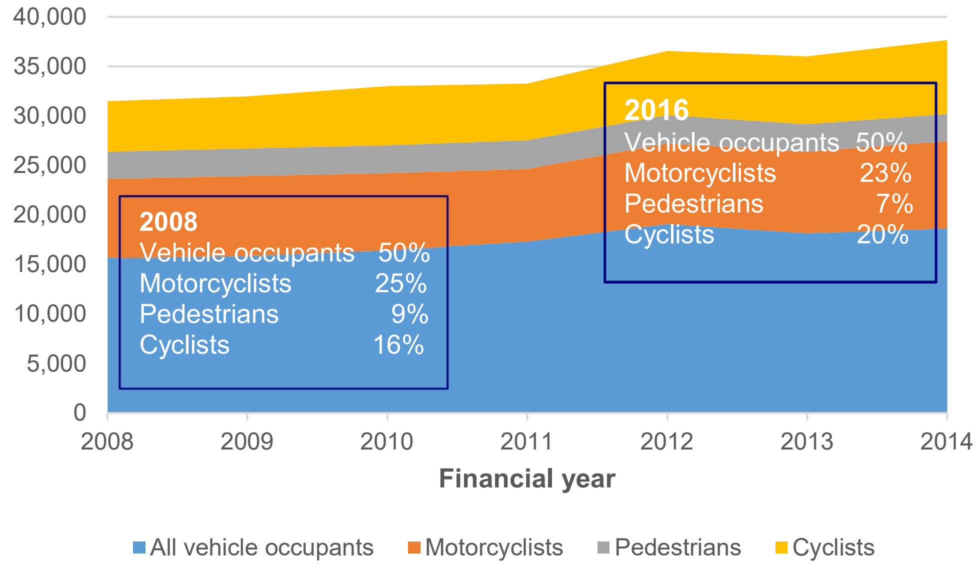
2.1.2 Road crash injuries

Hospitalised injuries increased at an average rate of growth of three per cent a year between 2008 and 2014 (Figure 4).[14] Notably, the cyclist share increased from 16.2 per cent to 19.8 per cent over that time. While there are no national exposure data for cycling, cycling as a journey to work mode increased by 15 per cent between 2006 and 2011, as measured by the census in those years (Bicycle Council of Australia 2016).

---

[14] As the most up to date data available, this is a financial year data series.

Figure 4 Hospitalised injuries by road user, Australia 2008 to 2014



Note: In 2012, there was a series break involving removal of 2,000 cases cared for solely in hospital emergency departments of one jurisdiction (BITRE 2017c). This chart 'adds back' these cases, assigned to different road user categories on a pro rata basis.

Source: BITRE 2017c and ECON analysis.

As with fatalities, there is a trend in hospitalised injuries towards older age groups. It is most noticeable in the 40 to 64 age cohort, which increased from 27.8 per cent of the total to 32.4 per cent over the five years to 2013. Males continue to account for around two thirds of hospitalised injuries.

2.1.3 Factors contributing to reduction in road trauma

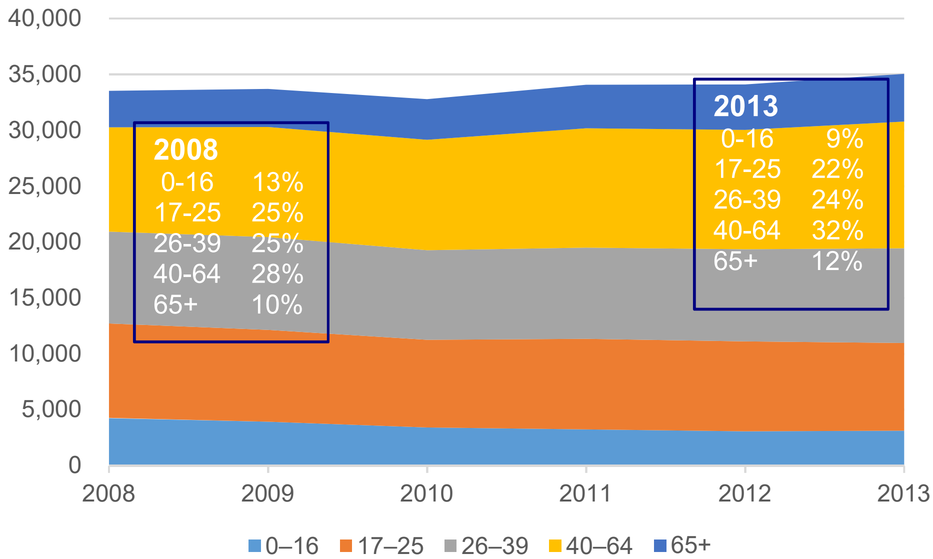
Over the decade of the 2000s, the average crashworthiness of the Australian light vehicle fleet improved by an estimated 27 per cent, representing a saving of around 2,000 deaths over the period (Budd et al 2015). The estimated reduction in fatalities reflects the penetration into the vehicle fleet of successive generations of safety improvements; initially associated with Australian Design Rules for passenger vehicle standards covering seatbelt fitment, energy-absorbing steering columns, head restraints and improved cabin strength; and more recently with improvements including seat belt pre-tensioners, anti-whiplash seats, active head restraints and front, side and knee airbags (D'Elia and Newstead 2015).[15]

Infrastructure improvements aimed at reducing deaths and serious injuries have also become more prominent. The Victorian Government introduced a program focusing on run-off-road and intersection crashes in 2004, with run-off-road treatments including shoulder sealing, safety barriers and tactile lanes. Intersection treatments included fully controlled right turns, new traffic signals and roundabouts. Program evaluation indicates reduction in deaths and serious injuries in Victoria due to the program (D'Elia and Newstead 2015).

[15] Further reductions in fatalities and serious injuries in the current decade, resulting from increased fitment of emerging new technologies (Electronic Stability Control, Autonomous Emergency Braking Systems, Fatigue Warning Systems, Lane Departure Warning Systems and Lane Change Warning Systems) have also been projected (Budd et al 2015).

Many other measures, including more targeted driver behaviour programs such as the introduction of 0.05 Blood Alcohol Concentration maximum limits and progress in introducing 40 kilometre per hour speed limits around schools and shopping areas, will also have contributed to an overall reduction in the level of road trauma.

Figure 5 Hospitalised injuries by age group, Australia 2008 to 2013



Source: BITRE 2017c and ECON analysis

2.2 Changes in post crash intervention

2.2.1 Integrated trauma management

In Victoria, the system for delivering trauma care has moved in recent years from ‘ad hoc’ to one that is ‘regionalised, integrated and … inclusive’ (Gabbé, Richardson et al 2015). Three hospitals in the state are now designated as major trauma services and a single ambulance service provides road and air transport of patients. Direct transport from the scene of injury to a major trauma service increased from 55 per cent of cases in 2001-02 to 77 per cent of cases in 2011-12, while the proportion admitted to intensive care units declined from 63 per cent to 39 per cent. As a result of the changes, there was a 43 per cent reduction in years of life lost and a 32 per cent increase in years of life with disability. Estimated net benefits totalled $15.4 billion at the value of statistical life year recommended by the Department of Finance and Deregulation for 2007 ($154,000). While Victoria is regarded as a leader in road safety both nationally and internationally, the extent to which Victoria’s approach is being replicated in other jurisdictions lies outside the scope of this study.

2.2.2 Client-centred care

The National Disability Insurance Scheme commenced, following a three year trial, in July 2016. The scheme’s goal is to achieve ‘an ordinary life’ for people with disabilities. This is defined in the National Disability Insurance Scheme Act as that which ‘enable(s) people with a disability to exercise choice and control in the pursuit of their goals, and the planning and delivery of their supports’ (NDIA 2016). At a minimum, client-centred planning and delivery of care is a more widely enunciated policy goal than formerly.

Since 2006, no-fault accident compensation, long in place in Victoria, Tasmania and the Northern Territory, has been extended in respect of the catastrophically injured[16] in New South Wales (2007) and Queensland (2016). Whereas it had been estimated that compulsory third party insurance arrangements covered two thirds of motor vehicle crashes resulting in a catastrophic injury, it is likely that 80 per cent or more of such injuries are covered now, with no requirement for a person to prove fault by another party or lack of personal fault, in order to trigger compensation for care.[17]

2.2.3 Road crash reporting

Today, only one jurisdiction (Australian Capital Territory) retains a requirement for all vehicle collisions to be reported to police. In other jurisdictions, there is no requirement to report crashes below certain damage value thresholds (e.g. $3,000 in Western Australia). Police crash attendance obligations have also reduced somewhat. For example, in New South Wales there is no longer a requirement for all tow-away crashes to be attended by police. Such changes have had some adverse impact on the level of crash reporting by the community. This adds to the challenge of estimating accurately the total number of crashes that occur across Australia in any year (see Section 4.1 and Appendix B).

Improved reporting of non-fatal and disabling injury crashes is under consideration, through development of matched police-sourced crash and hospital database systems. A national working group, under Austroads auspices, is currently investigating best practice options (National Road Safety Strategy 2016).

2.2.4 Developments in economic analysis, research and guidance

Two studies in the road trauma field over the past decade (Access Economics 2009, Gabbé, Richardson et al 2015) have applied the approach to the valuation of statistical life that is recommended by the Australian Government Office of Best Practice Regulation, for use in regulatory cost-benefit analysis in any sector (OBPR 2008, 2014). The office recommends valuation based on a willingness to pay to reduce the possibility of early death, rather than valuation based on the human capital or cost of illness method, the latter involving ‘the ex-post sum of various identifiable costs, such as loss of work income and medical expenses’ (Abelson 2008). Abelson was critical of the use of the human capital approach for, on the one hand, not addressing the circumstance that “If individuals are risk averse, they may be prepared to pay a premium to reduce risk” and, on the other, for introducing apparently arbitrary add-ons to compensate for what may be an otherwise implausibly low level of valuations.[18]

Consistent with Abelson’s work (2003, 2008), the OBPR guidance also flags the potential, with the willingness to pay approach, for consistency between valuation of the benefit of reducing the risk of death and valuation of the benefit of reducing the risk of injury or disability. This draws on the ‘disability adjusted life year’ or ‘DALY’ quantification concept, as developed by the World

---

[16] Defined as a severe injury to the brain, spine, or spinal cord.

[17] Productivity Commission 2011, p. 821. The two-thirds estimate is attributed to Walsh et al 2005, while the commission stated that the establishment of a non-fault lifetime care scheme in New South Wales meant that “closer to 80 per cent would now be covered”. A similar scheme in Queensland is likely to have added to this percentage.

[18] Abelson notes that a value of life, recommended at that time by the New South Wales Roads and Traffic Authority of $1.57m included “an estimated present value loss of income and a rather arbitrary amount (a little over $0.4 million) for non-economic costs and loss of quality of life” (p. 18).

Health Organisation and the World Bank and their partners, where a DALY of zero represents a year of perfect health and a DALY of one represents death. Suites of disability weightings are now available for use in application of the DALY approach, based on empirical study of large road injury and other cohorts, in Australia and internationally (Gabbé et al 2016).

The OBPR recommendation took account of Abelson (2008), which favoured paying greater attention to the lower valuations of statistical life found in European studies than to the higher values generally found in United States studies. Abelson suggested a value of statistical life (VSL) of $3.5m and a value of statistical life year (VSLY) of $151,000, discounted at three per cent real and so providing consistency and inter-changeability between the two measures.[19] In 2014 prices, these two measures were, respectively, $4.2m and $182,000 (OBPR 2014).

As shown in Table 1, current Transport and Infrastructure Council advice for practitioners undertaking transport project evaluations and related activities proposes alternative values that, in effect, straddle the OBPR recommendation (TIC 2016a, pp. 23-25) and thus do not offer clear advice. Firstly, at the low end, a 'fatal crash cost per person' of $2.2 million (2013 prices) is proposed. Based on Bureau of Transport Economics (BTE) 2000, a predecessor study to BITRE 2009 and as presented in Austroads 2012, it reflects a human capital approach and includes valuation of lost income, lost labour in the household, lost quality of life and other smaller costs.[20] Secondly, at the high end, willingness to pay values of statistical life are proposed of $7.4m for urban areas and $7.3m for non-urban ones (both 2013 prices). The latter two are based on values estimated for the NSW Roads and Traffic Authority in 2008 and are for use as an interim measure, pending the outcome of a future national willingness to pay study.[21]

Table 1 Current guidance on the value of statistical life for evaluation purposes

Sector coverage	Approach	Value of statistical life $m	Value of statistical life year $	Reference year	Source
Road transport	Hybrid human capital	2.5	na	2013	Transport and Infrastructure Council 2016a, pp. 22-23
Road transport	Willingness to pay	7.5-7.6 (1)	na	2013	Transport and Infrastructure Council 2016a, pp. 24-25
All	Willingness to pay	4.2	182,000	2014	Office of Best Practice Regulation 2014

(1) Non-urban and urban values

[19] A corollary is that, at any alternative discount rate, VSL, VSLY and/or duration of expected future life, will also differ. This point is overlooked in OBPR 2014, where, in an example, a seven per cent discount rate is applied to a $4.2m VSL. This implies a VSLY of 294,500, rather than $182,000.

[20] The $2.2m valuation is less than the valuation in BITRE 2009 (p. v): $2.4m in 2006 prices and $3.4m in 2015 prices, with indexation based on movement in total earnings (persons). See Section 0.

[21] These values are based on the study documented in Hensher et al 2009, which is also the source for the Australian willingness to pay value referenced in BITRE 2009. The values are based on stated preference surveys of two roads in New South Wales in 2008, whereas a new study will seek national applicability (Austroads 2016).

3. Methodology

This section sets out key steps in the study methodology on which the economic analysis results and cost to government analysis results in the next two sections are based.

3.1 Choose the year of analysis

Choice of the year for detailed analysis takes account of two main considerations: the adequacy of the data base for analysis, having regard to the lead times that may apply before data are available and the level of interest in the currency or of the results of the analysis.

The most important data sets are those for fatalities and hospitalised road traffic crash injuries, each by age group and gender, together with data for fatal crashes. The Australian Road Deaths Database, managed by BITRE, is routinely up to date, while there are extended lags in availability of hospitalised injury data. Currently, hospitalised road traffic crash injury data are available to calendar year 2013 and financial year 2013-14 (BITRE 2017c).[22]

Interest in more recent rather than less recent analysis is high at the present time, particularly in the context of 'against trend' road fatality outcomes in 2015 and 2016 (see Figure 2).

The calendar year 2015 has been selected for analysis. With hospitalised injury data for this year not yet available, hospitalised injuries for this year have been estimated based on trend, with the confidence intervals of the estimates noted. See Appendix B for further information on the data estimation involved.

3.2 Access 2015 'population' data, using an estimation approach as needed

2015 road crash and other 'population' data have been sought (e.g. on the number of insurance claims, or the number of fire and rescue crash attendances) through published sources and via approaches to industry and government stakeholders. State and territory governments were contacted for up to date road crash data (see also Appendix B), while BITRE provided the study with Excel files of road fatalities by age group and gender (BITRE 2017a) and of fatal crashes by number and type of vehicle (BITRE 2017b).

As with BITRE 2009 and earlier cost of road crashes studies (BTE 1988, BTE 2000), due to lack of coverage through any suitable national data base, data estimation is essential to answer the question of how many non-fatal road crashes occurred in total in the year of interest. Similarly, the question of how many non-hospitalised or minor injuries occurred as a result of road crashes also requires an estimation approach. See Appendix B for detail of approaches taken.

Numbers in data estimation tables, in ensuing chapters of the report, may not sum to the total, due to rounding.

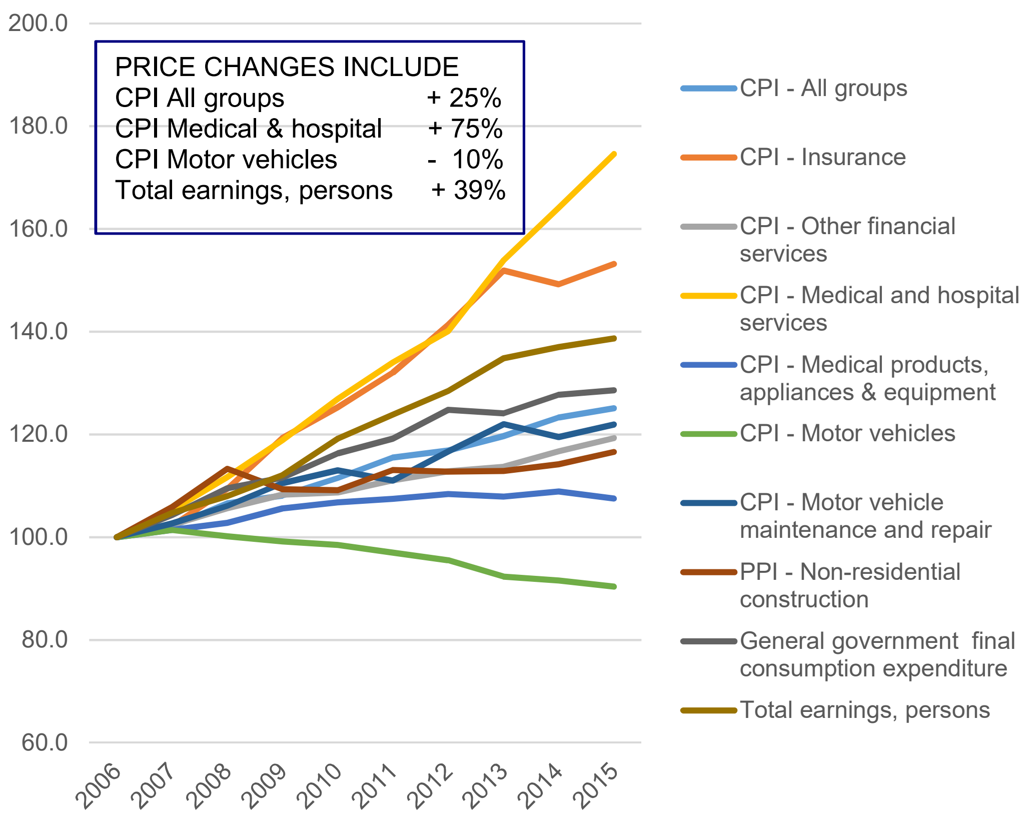
---

[22] 2014-15 financial year data are included in Productivity Commission 2017b (Table 6A.37). However, whether due to definitional differences or other reasons, the series does not align with the data series prepared by the National Injury Surveillance Unit under agreement with the Australian Institute of Health and Welfare (BITRE 2017c), which has been used in this analysis. See also Appendix B.2.

3.3 Access 2015 unit cost data, indexing 2006 unit costs as needed

The project has accessed 2015 cost data through published sources and approaches to stakeholders. In many instances, it has not proved possible to obtain new cost data. Indexing of 2006 (BITRE 2009) unit cost data has therefore been undertaken, using an appropriate indexing factor (Figure 6), to 2015 values. All values in this report are 2015 ones, unless otherwise stated. Numbers in costing tables may not sum to totals, due to rounding.

Figure 6 Price indices used in the study, 2006 to 2015 (June of each year)



Source: ABS 2016e, ABS 2017c and ECON analysis

3.4 Quantify loss of life and functional wellbeing using DALYs

The study analysis has adopted the disability-adjusted life year (DALY) approach (see Section 2.2.4) to the quantification of statistical life and disability following injury. This offers consistent and transparent treatment of both loss of life and loss of functional wellbeing. Years of life lost, in cases of fatality and involving a DALY value of one can be summed with years of life disabled, in cases of disability and involving a DALY value between zero and one.

Table 2 illustrates the arithmetic of the method. Firstly, 10 fatalities, each occurring at age 40, with an expected remaining life of 42 years, equates to 420 years of life lost. Secondly, the situation of 100 disabled persons, with similar life pre-crash life expectancy (and post-crash life expectancy of 40 years, due to the impact of the crash) and where the average level of disability, continuing through life, is assessed at 0.2 or 20 per cent (i.e. implying retention of 80 per cent of functional wellbeing), is equivalent to 800 years of life disabled. The life foreshortening effect is calculated as 200 years of life lost. There is a combined loss of life and functional wellbeing of 1.420 DALYs.

Table 2 Disability-adjusted life years (DALYs) following road crashes, example

Casualty	No persons	Remaining life expectancy (years)	Years of life lost (YLL)	Years of life disabled (YLD)	Disability adjusted life years (DALYs)
Fatalities	10	42	420		420
Persons disabled	100	40	200	800	1,000
TOTAL	110		620	800	1,420

Source: ECON analysis

3.5 Value loss of life and functional wellbeing using OBPR willingness to pay guidance

The value of statistical life and value of statistical life year recommended by the Office of Best Practice Regulation have also been adopted to place a value on the DALY totals. In 2015 prices, these values are $4.41m (on the basis of a loss of 40 years of life expectancy) and $185,073 respectively. They compare with a human capital-based value of statistical life, also in 2015 prices, of $3.44m and a willingness to pay value, as referenced in Section 1.3, of $7.94m.

As a more holistic valuation approach than the hybrid human capital approach (see Section 2.2.4), the value of lost life, health and wellbeing is taken as subsuming forgone output in the workplace and in the household and forgone quality of life ('non-pecuniary or non-economic costs') as measured in BITRE 2009. This is a common, although not universal, approach.[23] No other cost categories in the analysis are impacted (Table 3).

3.6 Estimate costs on a 'lifetime' basis, where appropriate

Many of the costs arising from road trauma in 2015, for example, emergency services, hospital, or vehicle damage costs are costs that occur in the days, weeks and months immediately following the road crash. In contrast, other costs, for example those involved in caring for persons disabled following road crash injury, may continue for the remainder of the person's life (Table 4).

The average age of those killed and injured on Australian roads is around 45, so, based on actuarial life tables (ABS 2016f), significant further costs are expected for some 40 years (i.e. towards 2060). For a child of eight, killed or severely disabled in a road crash in 2015, costs would be expected to accrue for close to 80 years (i.e. 2095).

For the purpose of the analysis, costs that are incurred between 1 January 2015 and 31 December 2015 and for up to 12 months thereafter for each individual case, i.e. up to December 2016, are deemed 'immediate' or 'first year' and no discounting is applied.

---

[23] In relation to the quality-adjusted life year (QALY) measure, which has close similarities to the DALY, Hendrie and Miller (2012) write that "The QALY measure includes health-related work loss also, but some analysts choose to value the wage-related loss separately and explicitly" (p. 13).

In contrast, longer term costs are discounted, at a real discount rate of three per cent per year, consistent with BITRE 2009, for the relevant life time period and are then summed to provide a present value estimate. As with the approach taken for the 'immediate' costs, the first year of costs in a longer term series, where costs occur over many years, are deemed 'undiscounted', so that the discounting 'year one' is, in effect, 2016, rather than 2015.

Table 3 Cost categories in this study and in the 2006 (BITRE 2009) study

2006 (BITRE 2009)	2015 (ECON)
Workplace and household losses	Loss of life, health and wellbeing
Vehicle damage	Vehicle damage
Disability care	Disability care
Non-economic or non-pecuniary costs	Loss of life, health and wellbeing
Insurance administration	Insurance administration
Hospital and medical	Hospital and medical
Travel delay and vehicle operating costs	Travel delay and vehicle operating costs
Legal	Legal
Vehicle unavailability	Vehicle unavailability
Emergency, police and ambulance services	Emergency, police and ambulance services
Workplace disruption	Workplace disruption
Health cost of crash-induced pollution	Health cost of crash-induced pollution
Street furniture damage	Street furniture damage
Correctional services	Correctional services
Recruitment and retraining	Workplace disruption
Premature funeral	Premature funeral
Coronial	Coronial
Not included	Efficiency cost of government revenue-raising

Source: BITRE 2009 and ECON analysis

Table 4 Timing of the economic costs of road trauma 2015

<table>
<tr><th>Year</th><th>First year economic costs</th><th>Subsequent year economic costs</th></tr>
<tr><td>2015, 2016</td><td colspan="2">All cost categories (see Table 3)</td></tr>
<tr><td rowspan="3">Continuing to 2095 (approx)</td><td rowspan="3"></td><td>Life, health and wellbeing</td></tr>
<tr><td>Disability care</td></tr>
<tr><td>Efficiency cost of government revenue raising</td></tr>
</table>

Source: ECON analysis

3.7 Acknowledge 'value of life' precedents, uncertainties through sensitivity analysis

The study includes a sensitivity analysis which proxies the 'hybrid human capital' approach of BITRE 2009 and provides a benchmark against which to compare the study's willingness to pay-based approach. Similarly, a second sensitivity analysis reflects the higher Hensher et al 2009 willingness to pay valuation that also featured in BITRE 2009.

The two sensitivity analyses also assist in addressing any concern about what is the appropriate willingness to pay valuation for this particular study. Use of any willingness to pay base valuation involves, in effect, placing a value on the notional 'abolition' of road trauma and road crashes, albeit in just one year.[24] This is a 'non-marginal' or 'volume' impact and differs from the context for which willingness to pay valuations are developed: namely, the trading off of a marginal or incremental increase in safety against a marginal or incremental loss of income. On the basis of the theory of diminishing marginal utility of income, it could be inferred that, as large numbers of lives are saved and injuries prevented, the community's willingness to pay for further safety improvement could wane and that therefore a lower average value is appropriate in this study. Against this, it can be argued that, as the fatality and injury burden reduces, community valuation of the benefit of reducing the burden to zero would increase, due to an increased capacity to pay and a higher 'per fatality' and 'per injured person' budget constraint.

This issue is ultimately an empirical one and no published research guidance has been sighted to help resolve it. However, acknowledging the element of uncertainty is appropriate through use of sensitivity analysis.

3.8 Ensure consistency between the economic and financial analyses

The financial analysis of the cost to government of 2015 road trauma complements the economic analysis. While the former involves an 'agent' perspective, i.e. that of government and the latter a whole of society one, consistency and transparency between the two analyses are important.

In the economic analysis, 'costs' comprise either resource costs that are incurred in addressing road trauma (e.g. hospital, medical and emergency services costs) or opportunity costs, in the sense of forgone opportunities to live, maintain health and wellbeing and to participate normally in society. These costs may or may not have a financial counterpart, wholly or in part. In contrast, in the financial or cost to government analysis, 'costs' are calculated as the net sum of all financial flows, i.e. the negative flows less any positive flows or savings that are known to affect government budgets.

Consistent with these characterisations, the economic analysis excludes the impacts for taxation revenue and government income support payments of 2015 road trauma, while the financial analysis includes them. The exclusion, as in BITRE 2009, is on the basis that these financial flows represent transfers between agents in the economy, i.e. from taxpayers as a whole to eligible individuals, rather than resource costs (Department of Finance 2006, p. 27, TIC 2016b, p. 17).[25] However, these financial flows are appropriately and prominently part of the financial analysis.

In addition to providing lifetime (present value) cost estimates, as in the economic analysis, annual cost to government budget estimates are provided for the Commonwealth government,

[24] BITRE personal communication 7 March 2017. Somewhat similarly, Abelson (2008, p. 17) asks whether making large-scale public policy decisions on the basis of estimated willingness to pay for marginal changes in health and safety would be consistent with aggregate community budget constraints and notes that the issue has not been studied. See also Section 7.6.

[25] The economic analysis does include, in contrast to BITRE 2009, an estimate of the effect of the additional taxation required to fund the financial costs of 2015 road trauma, in reducing incentives for individuals to work and earn income and to save and invest. See Table 3.

state and territory governments (aggregated) and local governments (also aggregated). A first year cost is presented, together with an average subsequent year cost. The time period for the latter is similar to that for the economic analysis (Section 3.6), while taking account of such matters as the impact of age-based eligibility conditions for government income support, as explained further in Section 6.3.

4. Key 2015 data

This section sets out the foundation 2015 data for the economic and financial analyses. It addresses the numbers of: fatal and other road crashes; fatalities; hospitalised injuries; non-hospitalised injuries; persons disabled following injury; and vehicles involved in road crashes.

Due to data coverage and availability limitations, all of these data items involve some estimation. For information on estimation methods, see Appendix B.

4.1 Road crashes

A road crash is defined as a crash involving a road vehicle on a public road and excluding off-road crashes.[26] Crashes are defined according to casualty severity: thus fatal crashes may include hospitalised and non-hospitalised injuries, as well as fatalities and hospitalised injury crashes may also include non-hospitalised injuries.[27]

There were an estimated 679,359 road crashes in 2015, 3.9 per cent more than in 2006. Fatal crashes, i.e. involving one or more fatalities, were 24.3 per cent below the 2006 level, while hospitalised injury crashes were 24.1 per cent higher. Property damage crashes dominate numerically (67.3 per cent), followed by non-hospitalised or minor injury crashes (27.9 per cent), with hospitalised injury crashes comprising 4.7 percent and fatal crashes 0.2 per cent of the total. Details are shown in Table 5.

Table 5 Road crashes by type, 2006 and 2015

Crash type	**2006**	**2015**	***% all 2015 crashes***	***% change from 2006***
Fatal crashes	1,455	1,101	*0.2%*	*-24.3%*
Hospitalised injury crashes	25,498	31,637	*4.7%*	*24.1%*
Non-hospitalised injury crashes	188,200	189,643	*27.9%*	*0.8%*
Property damage crashes	438,700	456,978	*67.3%*	*4.2%*
TOTAL	653,853	679,359	*100.0%*	*3.9%*

Source: BITRE 2009, BITRE 2016, Jurisdiction road crash statistics and ECON analysis

4.2 Fatalities

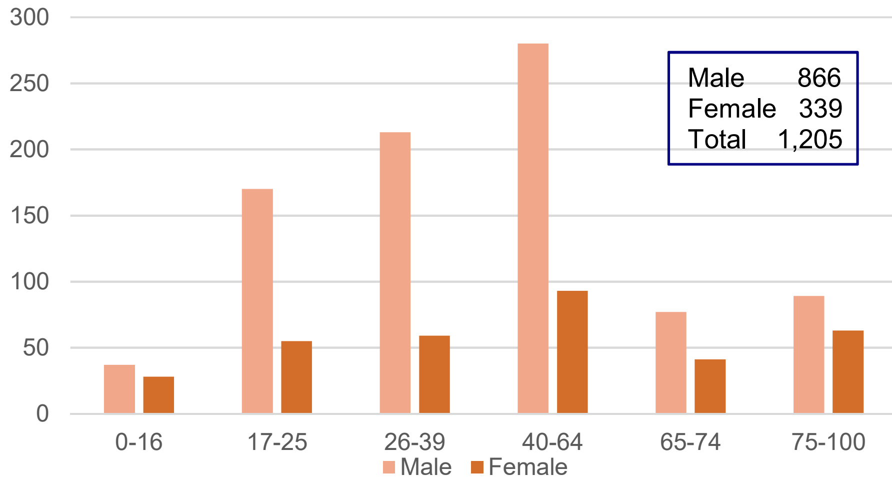
There were 1,205 road crash fatalities[28] in 2015, compared with 1,598 in 2006, a 25 per cent fall. Males comprised 72 per cent of the 2015 total. The age group profile was fairly similar for men and women, with the 40 to 64 age group the largest for both (32 per cent of men, 27 per cent of women, see Figure 7). The average age was 44.4 for men and 48.7 for women, compared with 37.6 for males and 41.3 for females in 2006.

[26] For example, crashes in car parks, or on private property. See BITRE 2009 (p.1) for a more extended discussion.

[27] See Appendix B (Section B.1.1) for casualty rates by road crash type.

[28] Fatality counts exclude suicides and homicides (BITRE 2009, p. 1).

Figure 7 Fatalities by age group and gender, Australia 2015



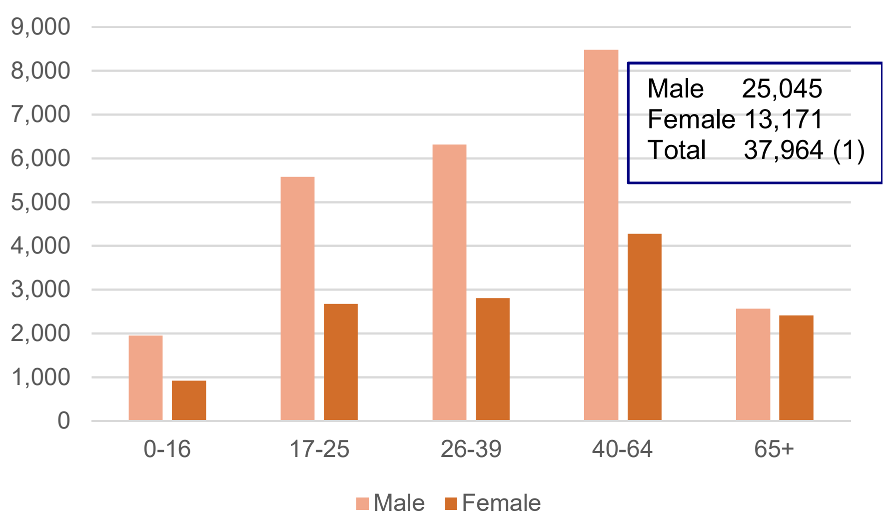
Source: BITRE 2017a and ECON analysis

4.3 Hospitalised injuries

Excluding persons who died of fatal injuries while in hospital, there were an estimated 37,964 hospitalised injury cases in 2015, compared with 31,204 in 2006. The total excludes an estimated 252 persons who died of fatal injuries while in hospital.

Hospitalised injuries peaked similarly in the 40 to 64 age group for both men and women in 2015. Average ages were 39.7 years and 43.9 years for men and women respectively. Men comprised 66 per cent of the hospitalised injury cohort. In the 65 and over age group, male over-representation was only small (52 per cent male, 48 per cent female).

Figure 8 Hospitalised injuries by age group and gender, Australia 2015 (estimate)



(1) The total excludes an estimated 252 persons who died in hospital from fatal injuries.

Source: BITRE 2017c and ECON analysis. This is an ECON estimate based on preceding time series data. See Appendix B for further information.

4.4 Non-hospitalised injuries

With limited capture of Emergency Department presentations that do not result in admission to hospital across jurisdictions – and which are accordingly recorded, with the source of injury included – and with no capture of general practitioner presentations, data on non-hospitalised injuries resulting from road crashes are limited. However, data on the total number of no-fault compensation claims, cover both hospitalised and non-hospitalised injury claims, provided by the Transport Accident Commission (Victoria), indicated growth of 0.4 per cent a year between 2006 and 2015, while Queensland insurance claims data indicated an annual growth rate of 0.7 per cent (Motor Accidents Insurance Commission 2016).

The 2015 estimate of 227,572 non-hospitalised injuries is based on an average annual growth rate of 0.5 per cent from the 2006 estimate of 216,500.

4.5 Disability following road crash injury

Most people injured in road crashes recover fully, or almost fully, while a minority do not. Of 37,964 people hospitalised as a result of a road crash in 2015, an estimated 4,436 (11.7 per cent, Table 6) will have become lastingly disabled, in the sense of facing a limitation in undertaking the core activities of communication, mobility and/or self-care. This estimate is based on analysis of change in the number of people disabled from road injury identified in the two most recent Australian Bureau of Statistics surveys of disability, ageing and carers (2012 and 2015) and taking account of cohort attrition, due to deaths and other factors.[29]

Table 6 Estimated persons disabled from road crash injury, 2006 and 2015

Disability level	2006	2015			
		Males	Females	Total	*Total as % hospitalised injuries (N=37,964)*
Mild	1,540	888	922	1,811	*4.8%*
Moderate	1,809	565	516	1,081	*2.8%*
Severe	584	626	431	1,057	*2.8%*
Profound	686	253	235	488	*1.3%*
TOTAL	4,619	2,332	2,104	4,436	*11.7%*

Source: BITRE 2009, ABS 2016h and ECON analysis

The total of 4,436 persons disabled compares with an estimate of 4,619 in BITRE 2009, a reduction of four per cent. The estimate is consistent with information provided by the New South Wales Lifetime Care and Support Authority and the Transport Accident Commission (Victoria), in respect of the minority of cases of largely profound disability [30] involving traumatic

---

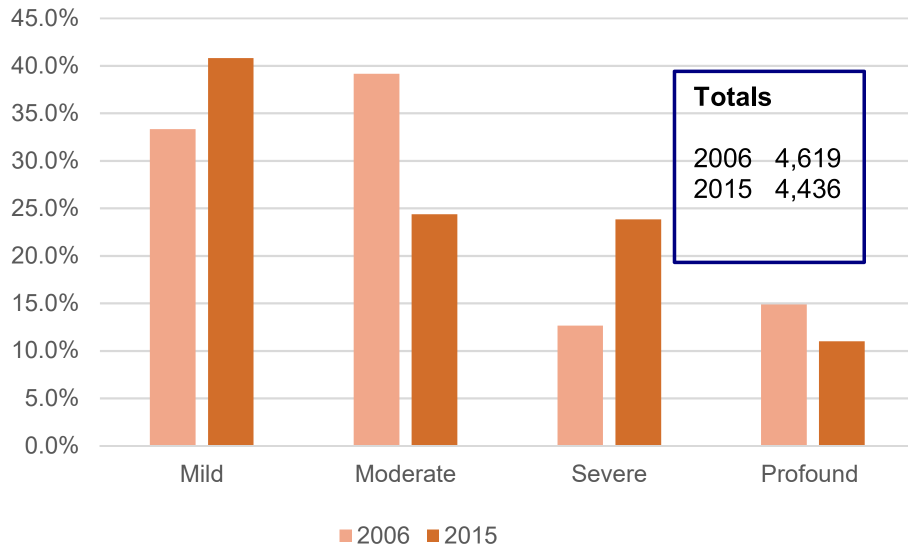
[29] The relatively even gender profile in Table 6 (54 per cent male, 46 per cent female) differs from that of the hospitalised injury cohort (66 per cent male, 34 per cent female, see Section 4.3). The ABS Survey of Disability, Ageing and Carers, used in this analysis, involves a more targeted group, i.e. persons living in households who have been identified as having a long term health condition that has been caused (in any year) by a road traffic accident. Other factors that may contribute to the gender difference include: differences in age (48 for males and 53 for females); and any sampling error. ABS personal communication (16 May 2017) has assisted in this note.

[30] Disability in the ABS Survey of Disability, Ageing and Carers aligns with the World Health Organisation's International Classification of Functioning, Disability and Health. The survey provides information on four

brain injury and spinal cord injury. The annual number of new cases has remained stable in New South Wales and has declined in Victoria. Improved vehicle safety technology, notably air bags, together with investment in road infrastructure safety (in Victoria), are cited as major factors in stabilising and reducing the number and severity of head injuries in particular. See also Section 2.1.3.

Some positive change is observable in the profile of people disabled from road crash injury in 2015, compared with 2006: reductions of 4.9 percentage points and 14.8 per cent in profound disability and moderate disability respectively (Figure 9). However, less positively, the increase in severe disability (11.2 percentage points) exceeded the reduction in profound disability.

Figure 9 Profile of people disabled from road crash injury, 2006 and 2015



Source: ABS 2016h and ECON analysis

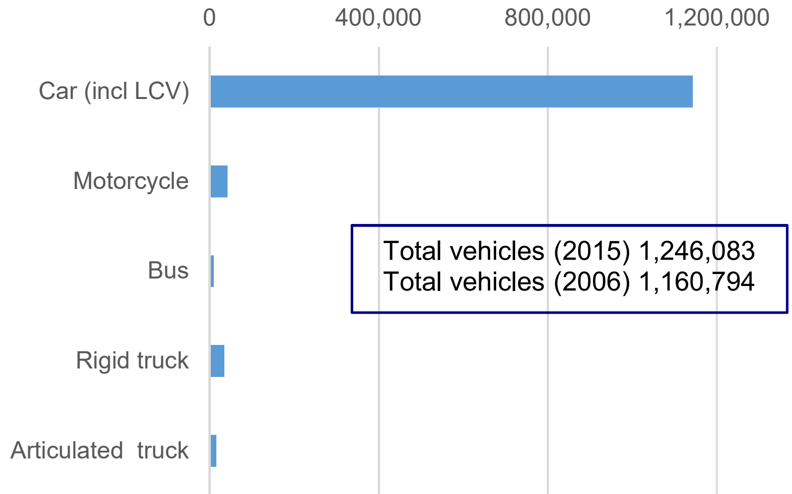
4.6 Vehicles involved in crashes

There were an estimated 1,246,083 vehicles involved in road crashes in 2015. The profile of vehicles comprises 91.8 per cent cars including light commercial vehicles (LCVs),3.4 per cent motorcycles, 4.1 per cent heavy vehicles and 0.8 per cent buses (Figure 10).[31]

levels of severity: profound limitation, defined as the people with the greatest need for help or who are unable to do an activity; severe, comprising people who sometimes need help and/or have difficulty; moderate, people who need no help but have difficulty and mild, those who need no help and have no difficulty, but use aids or have limitations. (ABS 2016h).

[31] The number of bicycles involved in road crashes, other than fatal road crashes, cannot be reliably estimated, due to incomplete data.

Figure 10 Vehicles involved in road crashes, Australia 2015



Note: Bicycles are not included due to insufficient road crash data on which to base an estimate.

Source: BITRE 2009, BITRE 2017b, Jurisdiction road crash statistics and ECON analysis

The estimate reflects an average number of 1.83 vehicles per crash, as indicated in Table 7.

Table 7 Average vehicles per crash and total estimated vehicles 2015

Crash type	**Average no vehicles per crash**	**Total no vehicles**	***% total no vehicles***
Fatal	1.53	1,649	*0.1%*
Injury	1.70	376,175	*30.2%*
Property damage only	1.90	868,258	*69.7%*
TOTAL	1.83	1,246,083	*100.0%*

Note: Total number of vehicles does not sum precisely, due to rounding.

Source: BITRE 2017b, Jurisdiction road crash statistics and ECON analysis

5. Economic cost of road trauma 2015

This section sets out the economic costs of road trauma that occurred in 2015. Cost categories are discussed in size order.

As applicable, costs are 'lifetime' costs (Section 3.6), expressed as 2015 present values.

A summary of costs is also provided, together with sensitivity testing based on alternative values of statistical life and statistical life year and a comparison with 2006 (BITRE 2009) costs.

5.2 Loss of life, health and wellbeing

Loss of life and/or health and wellbeing, through both fatalities and injuries that result in disability, is measured through the disability-adjusted life year (DALY) metric, as used in literature on the health impacts of road injury (Access Economics 2009, Gabbé, Richardson et al 2015) and as endorsed by the Office of Best Practice Regulation (OBPR 2014).

5.2.1 Fatalities

Years of life lost through road crash fatalities in 2015 total 47,692 (34,445 male and 13,247 female) and are shown, by age group, in Table 8. Life expectancy values were obtained from Australian Bureau of Statistics standard life tables (ABS 2016f).

Table 8 Years of life lost from road crash fatalities 2015, Australia

Age group	Male fatalities	Male years of life lost	Female fatalities	Female years of life lost	Disability adjusted life years lost (DALYs)	Discounted DALY cost $m
0-16	37	2,598	28	2,094	4,692	364.8
17-25	170	10,233	55	3,549	13,782	1,201.7
26-39	213	10,564	59	3,228	13,791	1,350.4
40-64	280	9,073	93	3,171	12,244	1,483.3
65+	166	1,978	104	1,205	3,183	526.7
Total	866	34,445	339	13,247	47,692	4,926.8

Note: Totals may not sum precisely, due to rounding.

Source: ABS 2016f, BITRE 2016 and ECON analysis

At a 2015 value of statistical life year of $185,073, the present value of the fatality DALY total, at a three per cent real discount rate, is $4,926.9m.

5.2.2 Injuries

Years of life disabled as a result of road crash injuries are estimated with the aid of annualised (i.e. level through time) disability weightings for the 4,436 persons estimated to have become disabled as a consequence of road crashes in 2015.

In the absence of information on the injury category profile of people disabled from road crashes, the average extent of disability is aligned with disability weightings developed for a total of 47 injury diagnoses and based on a survey of six injury cohorts (two Victorian, four international), with 9,676 participants (Gabbé et al 2016). This gives a weighted average level of disability per person of 0.182.[32] The measure implies that, on average, persons disabled retain 81.8 per cent of their pre-crash functional wellbeing. Years of life disabled total 17,778 male and 14,714 female.

Table 9 Years of life disabled and lost from road crash injuries 2015

Age group	Males			Females			Disability adjusted life years (DALYs)	Discounted DALY cost $m
	No disabled	Years of life disabled	Years of life lost	No disabled	Years of life disabled	Years of life lost		
0-16	183	2,417	442	147	1,906	375	5,141	361.4
17-25	523	5,661	1,270	430	4,602	1,096	12,630	1,017.6
26-39	592	5,227	1,454	451	3,976	1,151	11,818	1,082.1
40-64	795	4,219	1,972	687	3,758	1,767	11,723	1,405.7
65+	240	254	643	388	471	1,001	2,424	483.2
Total	2,332	17,778	5,781	2,104	14,714	5,391	43,735	4,350.0

Note: Totals may not sum precisely, due to rounding.

Source: ABS 2016e, Gabbé et al 2016 and ECON analysis

Years of life lost are also calculated. These reflect the effect of disabling road injury in reducing life expectancy. A three per cent (approximately 2.5 year) effect is adopted as an average across all disabled persons,[33] with a total discounted value of loss estimated at $4,350.0m.

5.2.3 Total disability-adjusted life year loss

Summing tables Table 8 and Table 9, total disability-adjusted life years (DALYs) lost are 91,428 (Table 10). This total is valued, in discounted present value terms, at $9,276.8m.

Table 10 Total disability adjusted life year loss 2015

Age group	Male DALYs lost	Female DALYs lost	Total DALYs lost	Discounted DALY cost $m
0-16	5,458	4,001	9,833	726.2
17-25	17,164	8,151	26,412	2,219.3
26-39	17,245	7,203	25,609	2,432.5
40-64	15,263	6,930	23,967	2,889.0
65+	2,875	1,676	5,607	1,009.8
TOTAL	58,005	27,961	91,428	9,276.8

Source: ABS 2016e, Gabbé et al 2016 and ECON analysis

[32] This weighting is consistent with indicative average weightings of less than 10 per cent for the mildly disabled, between 10 and 20 per cent for the moderately disabled, around 30 per cent for the severely disabled and between 45 and 50 per cent for the profoundly disabled.

[33] In the absence of more specific information, this is intended as a relatively conservative assumption. See BITRE 2009 (p. 46).

5.3 Vehicle damage

Costs of vehicle repair and replacement in 2015 in fatal, hospitalised injury, non-hospitalised injury and property damage only crashes are shown in Table 11. A current value for the average repair cost per vehicle was obtained from Insurance Statistics Australia for passenger vehicles (i.e. cars including LCVs). With the cost of motor vehicles having declined in recent years (Figure 6), this value was only slightly higher than the corresponding 2006 value ($2,989). For other vehicle types (motorcycles, buses and trucks), the ABS consumer price index for maintenance and repair of motor vehicles was used (increase of 22 per cent over nine years).

Towing costs ($3.1m) have been included in the repair cost estimates for buses and trucks, using BITRE's estimated costs indexed to 2015 values. As in BITRE 2009, towing costs for light vehicles and motorcycles are assumed to be included in insurance claim costs.

Total vehicle damage costs are estimated at $4,827.0m.

Table 11 Damage costs for vehicles in road crashes, Australia 2015

Vehicle type	Est no of vehicles	Damage cost per vehicle $	Cost $m
Car including LCV	1,143,432	3,001	3,431.4
Motorcycle	42,045	3,941	165.7
Bus	10,071	11,656	117.4
Rigid truck	34,922	14,731	514.4
Articulated truck	15,613	38,305	598.0
TOTAL	1,246,083		4,827.0

Note: Totals may not sum precisely, due to rounding.

Source: ABS 2016d, BITRE 2009, Insurance Statistics Australia 2017 and ECON analysis

5.4 Disability care

Disability care, comprising carer support to undertake daily activities and aids and appliances, including housing modifications, are typically essential for people with moderate, severe and profound disabilities.

5.4.1 Carer costs

Primary carers for people mildly, moderately or severely disabled from road crashes are typically unpaid family members and relatives (ABS 2015b). Those profoundly disabled are frequently, though not always, cared for in specialised care facilities.

Hours spent caring were estimated, as per BITRE 2009: an average of nine hours per week for moderately disabled individuals, 28.5 hours per week for severely disabled and 105 hours per week for profoundly disabled persons. Carers adapt to the caring need by modifying either their working life, their non-working life, or both. While information on hours worked differentials is not available, labour force participation of carers is around four per cent lower than the population average for men and some six per cent lower for women (Productivity Commission 2017b, Table 15A.81). The carer workforce is approximately two-thirds female and one-third male (ABS 2015b).

Carer costs for the moderately disabled were calculated on the basis that carers give up non-working or leisure time rather than paid work.[34] Costs were valued using a standard parameter for the value of travel time to and from work, i.e. 40 per cent of average weekly earnings (TIC 2016, p. 16).[35] Carer costs for the severely disabled were valued using a mix of the 40 per cent AWE valuation (9 hours) and 100 per cent of AWE (the balance of 19.5 hours). The profoundly disabled were assumed, for simplicity, to be fully cared for through (paid) attendant care, whether in an institutional setting or at home. The reported cost experience of the NSW Lifetime Care and Support Authority (LTCSA 2015, p. 18, 63), which reflects at home care,[36] was used to provide the estimate.

Estimated carer costs total $1,684.3m (Table 12).

Table 12 Cost of caring for people disabled from road crash injury 2015

Disability group	No	Average hours of care	Costs $m
Moderate	1,081	9.0	318.4
Severe	1,057	28.5	910.5
Profound	488	105.0	455.3
TOTAL	2,626		1,684.3

Note: Totals may not sum precisely, due to rounding.

Source: ABS 2015b, ABS 2016b, BITRE 2009 and ECON analysis

5.4.2 Aids, appliances and home and vehicle modifications

The costs of aids, appliances and equipment including housing and vehicle modifications for the profoundly disabled (488 persons) are estimated at $28,498 per person per year, based on reported NSW Lifetime Care and Support Authority information in respect of persons in its care who are catastrophically injured in road crashes (LTCSA 2015, p. 63).

In relation to mildly, moderately and severely disabled persons, this study assumes an average level of lifetime support at five per cent of the profoundly disabled level. While available data are limited, this estimate takes account of claims expenditure in this area by the Transport Accident Commission (Victoria) for all mildly, moderately and severely disabled persons.

Estimated total costs are $334.4m.

5.4.3 Total disability care costs

Estimated lifetime disability care costs for carers and aids and appliances totalled $2,018.7m.

[34] This differs from the approach in BITRE 2009, where all carer labour is valued at average weekly earnings.

[35] Average weekly earnings values used in this analysis were $1,370 for males and $908 for females (May 2015 total earnings, ABS 2016b).

[36] Personal communication, New South Wales Lifetime Care and Support Authority, 11 April 2017

5.5 Health services

Within minutes, hours or days of a road crash, casualties may engage with one or more different arms of the health system: typically, first with paramedical services,[37] particularly through ambulances (see Section 5.9.1); then with hospitals, either as an admitted patient or as a non-admitted presentation at an Emergency Department; or with a general practitioner or specialist (e.g. physiotherapist).

Total post crash health services costs are estimated at $1,631.0m, an increase of 88.7 per cent on 2006 costs. A fall in the number of fatalities is offset by increase in the number of injured, both hospitalised and non-hospitalised. However, the main factor in the cost increase is the estimated price increase for hospital and medical services of 75 per cent over the nine years. This was applied to the 2006 unit cost values for paramedical and medical costs.[38] This increase compared with a 25 per cent rise for the all groups consumer price index (see Section 3.3).

Table 13 Post crash health system costs 2015, $m

Health services sub-category	Fatalities	Hospitalised injuries	Non-hospitalised injuries	Total
Paramedical	1.9	284.4		286.3
Medical	3.1	468.7	641.3	1,113.1
Hospital stay	1.5	230.2		231.7
TOTAL	6.5	983.2	641.3	1,631.0

Note: Totals may not sum precisely, due to rounding.

Source: ABS 2016d, AIHW 2016a, BITRE 2009 and ECON analysis

5.6 Insurance administration

Insurance administration costs arise in respect of claims under compulsory third party (CTP) insurance schemes by close relatives in relation to fatalities and by persons injured in road crashes. Road vehicle insurers also incur costs regarding claims under comprehensive and third party property insurance policies.

Cost-related information is available in the published accounts of certain individual insurers, such as the Transport Accident Commission (Victoria), the Motor Accidents Insurance Board (Tasmania) and the Royal Automobile Club (Queensland). In addition, the Australian Prudential Regulatory Authority (APRA) publishes quarterly statistics on underwriting expenses, which include claims administration, for both CTP and motor vehicle insurance. Both APRA and individual insurer sources, including further data provided by the Transport Accident Commission, were used in estimating insurance administration costs.

---

[37] In addition to emergency treatment, paramedical costs include a wide range of therapy and rehabilitation services.

[38] Hospital stay costs were estimated by reference to the average cost per public hospital separation and a cost weight for motor vehicle accident third party personal separations (AIHW 2016, pp. 200-204).

5.6.1 Injury insurance

Based on data accessed for four jurisdictions extrapolated to the whole of Australia,[39] there were an estimated 56,873 new personal injury insurance claims in 2015. At an estimated cost per claim of $3,500, a maximum figure that allows for some limited variability between jurisdictions, total first year insurance administration costs were $199.1m.

Future year insurance administration costs should also be considered, both in relation to persons with long term disabilities and other injured persons whose claim may need to be reopened in subsequent years. Based on available information, there will be an estimated 2,070 future claims per year sourced from the 2015 injury cohort. This yields an estimated cost of $169.6m.

Total injury insurance claims administration cost is estimated at $368.6m.

5.6.2 Vehicle insurance

Motor vehicle underwriting expenses totalled $1,962m in the year to September 2015 (APRA 2016). 90 per cent of this ($1,765.8m) is estimated to relate to road crash insurance, i.e. excluding other causes such as theft, fire etc., following Insurance Statistics Australia data, as reported in BITRE 2009 (p. 81). Underwriting expenses include business acquisition and other costs and can be viewed as an upper bound of claims administration costs. Instead, the administration share of CTP insurance underwriting costs (43 per cent, TAC 2015, p.28) is employed here and applied to the vehicle insurance context.

Applying this percentage to the adjusted motor vehicle underwriting expenses above yields a total cost of $1,124.9m and an average cost per claim of $706. The latter was calculated on the basis of an estimated 1,070,783 vehicle damage insurance claims. This estimate took account of data provided by Insurance Statistics Australia and includes an estimate of the number of vehicles damaged in road crashes in 2015, for which there was no associated insurance claim. See Appendix B (Section B.5.1) for further discussion.

5.6.3 Total insurance administration costs

Total estimated insurance administration costs are $1,124.9m.

Table 14 Insurance administration costs, 2015 road trauma

Insurance claim type	Est no of claims	Est cost per claim $	Claim type cost $m
Fatality and injury - first year	56,873	3,500	199.1
Injury - all subsequent years, claims per year (present value)	2,557		169.6
Vehicle	1,070,783	706	756.3
TOTAL			1,124.9

Note: Total does not sum precisely, due to rounding.

Source: ABS 2016d, APRA 2016, BITRE 2009, injury insurer industry sources (refer Footnote 39), Insurance Statistics Australia and ECON analysis

[39] Victoria, Tasmania and the Northern Territory have public monopoly no-fault insurers and each reports on total claims for the year. Queensland's Motor Accident Insurance Commission reports similarly. See MACC 2015, MAIB 2015, MAIC 2016 and TAC 2015. Additional information was provided by the TAC. A four jurisdiction claims estimate was extrapolated to the remaining four jurisdictions on a population basis.

5.7 Travel delay, vehicle operating costs and additional pollution

Traffic incidents, including crashes and signal failures, are recognised as a major cause of so-called 'non-recurrent' congestion. Together with the other major causes, planned events (i.e. closures for maintenance, road works or other reasons) and weather, non-recurrent congestion explains between two per cent and 12 per cent of congestion in Australian and New Zealand cities (Austroads 2016, p. 83ff).

BITRE 2009 estimated crash-related travel delays based on a database of 122,179 major urban arterial crashes and rural freeway crashes, comprising 24 per cent of all estimated crashes in 2006 (Table 15). Road closure durations were estimated based on ambulance response times and the time that police and/or emergency services spend at the crash scene. Based on McDermott et al (2005), these times were 25.2 minutes in metropolitan areas and 35.6 minutes in non-metropolitan areas. Required crash scene time is understood to have lengthened in recent years, in response to more stringent work, health and safety regulations and other factors. However, no adjustment was made to response times, due to insufficient data. Traffic volumes were modelled taking account of the time of day of each crash.

BITRE's estimate of travel delay costs was adjusted to take account of differences in the distribution and volume of crashes, i.e. reduced fatal crashes and increases in injury and property damage crashes. No adjustment was made for any change in average delay times, whether due to possible lengthening of road closure times, changes in the level of congestion or other factors, due to lack of any readily available performance information in this area.[40]

2006 costs were indexed by the all groups CPI. The estimated total cost of travel delay in 2015 is $1,130.6m. This includes additional vehicle operating costs, as a result of additional time spent queuing ($61.8m).

In addition, the adverse health impact of crash-related urban pollutant emissions was estimated at $71.8m. [41]

Table 15 Crashes in scope for travel delay estimation, 2006 and 2015

Crash type	2006	2015
Fatal	792	599
Injury	45,141	51,430
Property damage only	76,246	79,423
TOTAL	122,179	131,452

Source: BITRE 2009 and ECON analysis

5.8 Efficiency cost of raising government revenue

In the absence of annual road trauma, government budget funding costs would be reduced. This could allow either a reduction in taxation, or in government borrowing, that would also

[40] As confirmed by contacting, with the assistance of Austroads, jurisdiction network operation managers.

[41] The combined total of $1,266.6m computes as 7.7 per cent of BITRE's estimate of the cost of congestion in Australian capital cities, at $16.45b (BITRE 2015, p. 26). This is consistent with the Austroads 2016 finding noted above regarding the magnitude of non-recurrent causes of congestion in Australian and New Zealand cities.

reduce longer term tax liabilities. Alternatively, expenditure proposals that currently cannot be pursued due to government budget constraints might be implemented.

Drawing on the study's cost to government analysis (Section 6), it is estimated that the all-government fiscal balance would be improved by $943.8m in the first year and by an average of $141.2m per annum in subsequent years in the absence of 2015 road trauma. This amount totals $3,734.5m as a present value.

The efficiency cost of raising the required amount of taxation revenue over time, having regard to the effects on incentives to earn income and to save and invest, is estimated at $802.3m, at a marginal cost of taxation estimate of 21.5 per cent.[42]

5.9 Emergency services – ambulance, police and fire and rescue

5.9.1 Ambulance costs

Ambulance services include: attending to crash victims at the crash site; transporting casualties from crash site to hospital; providing medical and respite care to injured persons before they reach the hospital; and transferring injured people between hospitals.

Based on information provided by ambulance authorities, BITRE assumed that in 2006 ambulance services attended all fatal crashes and 83.8 per cent of hospitalised injury crashes. An average of 1.2 ambulances were required at each crash and the average ambulance costs per crash were $2,372 (2006 prices). This is increased to $3,051 in 2015.

For the 2015 analysis, a patient transfer rate of 15 per cent was used, as assumed in BITRE 2009 (p. 53).[43] Total estimated costs were $112.4m, $3.8m of which were for fatalities.

5.9.2 Police costs

Police costs were estimated on the basis of the same fatal and injury crash attendance as for ambulances. Police attendance cost was $1,384 (2006) per hospitalised injury crash, increased to $1,767 for 2015.

BITRE also assumed that police attended 22 per cent of reported property damage only costs, equivalent to 6.3 per cent of all estimated property damage only crashes. While noting reduced reporting obligations for those involved in crashes in many jurisdictions and reduced police attendance requirements (see Section 2.2.3), this attendance rate was retained for the 2015 analysis, in the absence of specific data.

Estimated police costs across the range of crash types totalled $99.8m.

5.9.3 Fire and rescue costs

In urban areas, fire and rescue services attend road crashes only as and when requested by those first present at the crash scene. Fire and rescue services across Australia reported

[42] This draws on the Campbell and Bond (1987) estimate of a marginal cost of taxation in Australia between 19 per cent and 24 per cent, as cited in Robson 2005.

[43] BITRE's assumption was based on an earlier source that indicated 15 to 20 per cent of road trauma patients required transfer between hospitals. Use of the lower bound estimate may overestimate cost slightly, given evidence of a more integrated trauma management system now in place, particularly in Victoria (Gabbé, Richardson et al 2015). However, no specific data could be accessed for this study.

attending 30,541 road crash rescue incidents including extrications in 2014-15 (Productivity Commission 2016a). This compares with 31,136 in 2006.[44]

On the basis of a 2006 average cost per attendance of $3,167, indexed to 2015, the total cost in 2015 prices is $124.4m.

5.9.4 Total emergency services costs

Estimated 2015 emergency services for ambulance, police and fire and rescue totalled $336.5m.[45]

5.10 Legal

5.10.1 Criminal matters

Criminal legal costs relate to the court processes that involve individuals charged with the offence of culpable driving causing death and others such as negligently causing serious injury and conduct endangering life.

An estimated 68 persons were prosecuted for criminal offences arising from 2015 road trauma. This estimate is calculated with reference to the number of people sentenced for offences related to culpable driving in Victoria in 2009-10, a total of 15 (Victorian Sentencing Advisory Council 2011, p. 1). This number is then adjusted to account, firstly, for the whole of Australia and, secondly, for the post-2010 reduction in road fatalities. An acquittal rate of eight per cent, as used by BITRE and based on Victorian Sentencing Advisory Council information, is also applied.

The cost of a court case lasting one week was estimated at $55,431. This estimate is based on BITRE 2009 (from Victorian Bar 2008), with indexation to 2015 prices.

The total cost of criminal court cases was estimated at $3.7m.

5.10.2 Civil matters

Legal costs are influenced by the extent to which insurance claims settlements involve litigation. Access to common law settlement, in respect of compensation for future economic losses and pain and suffering, remains available in all jurisdictions, including those with (universal or targeted) ‘no fault’ arrangements, other than the Northern Territory, i.e. in New South Wales, Victoria, Queensland and Tasmania.

Motor injury legal costs were estimated at $409.1m in an ABS survey of legal expenses in 2007-08 (ABS 2009).[46] Recent overall trends are unclear, with, for example, some increase in common law resolutions in Victoria, on the one hand and declining rates of litigation in Queensland on the other, albeit amid continuing high rates of legal representation.[47]

---

[44] ECON estimate, based on BITRE 2009.

[45] This total does not include the cost of time and services provided by volunteer State Emergency Services and rural fire service personnel who attend road crashes in regional areas.

[46] The survey encompassed businesses and organisations mainly engaged in providing legal services. As such, ‘in house’ legal advice, that would form part of insurance administration costs (Section 5.6), is excluded.

[47] Victorian common law resolutions increased from 945 in 2011-12, 4.8 per cent of claim lodgements, to 1,112 in 2014-15, 5.0 per cent of claim lodgements (TAC 2016). In Queensland, claims litigated declined

The ABS's 2007-08 costs are adjusted firstly to remove the likely off-road proportion (30 per cent) and secondly for indexation to 2015 prices. Estimated 2015 civil legal costs total $329.1m.

5.11 Vehicle unavailability

Vehicle time off the road following a crash, while damage is assessed and the vehicle is repaired or replaced, imposes costs on owners and other vehicle occupants of inconvenience and/or temporary vehicle replacement. Average vehicle repair time, as estimated in a recent industry research report, is seven days (Street 2016).[48]

Financial costs of alternative transport options differ markedly, with some vehicle owners accessing temporary vehicle replacement, either through their comprehensive insurance policy arrangements or otherwise, while others may use public transport or forego at least some travel. In the absence of available research on vehicle owner behaviour, this study follows BTE 2000 in estimating maximum and minimum costs of overcoming temporary vehicle unavailability. The methodology differs slightly in excluding from the calculations vehicles involved in fatal crashes. It also differs in not including bus and truck unavailability, due to lack of data. Larger bus and truck operators may be able to minimise costs by rearranging servicing and other schedules. Motorcycle unavailability was also excluded, in this case similarly to BTE 2000, which assumed that most motorcycles are not their user's main form of transport.

Vehicle rental for seven days represents a notional maximum cost. An estimated rental cost of $102 per day ($714 per week) is based on the cost of renting a medium size car through a major national car rental chain for one week with 'excess reduction' included, in order to proxy normal driving insurance cover circumstances and also weighted for: the proportion of drivers under the age of 25 years for whom a higher charge applies; and capital city and non-capital city location.[49] With passenger cars including LCVs comprising 92 per cent of vehicles involved in road crashes (Table 11), total 'maximum' vehicle unavailability costs were estimated at $809.8m.

The cost of owning the vehicle for one week, i.e. the 'standing cost' involving the cost of funds, depreciation, registration and compulsory third party insurance and excluding the running costs of fuel, tyres and servicing, represents a minimum cost, on the basis that this is the minimum that owners are paying to possess the vehicle for use when required. The estimated standing cost per day of owning for ten years a vehicle valued at $30,000, with 90 per cent 'straight line' depreciation over that time and a private real cost of funds (discount rate) of five per cent, is $10.46 ($73.23 per week). This yields a total 'minimum' unavailability cost of $83.7m.

---

from 8.5 per cent in 2007-08 to 1.5 per cent in 2014-15 while legal representation increased from 72.8 per cent to 80.5 per cent (MAIC 2016).

[48] BITRE 2009 assumed in contrast that vehicles towed from the crash scene were unavailable for seven days, while untowed vehicles required only two days.

[49] 29 per cent of persons injured in road crashes in 2015 were aged 25 years or less. Based on analysis of vehicle distance travelled in the 2016 Survey of Motor Vehicle Use (ABS 2017d). 56.2 per cent of rental hires were assumed to occur in capital cities, where rental costs are generally lower than in regional locations (43.8 per cent of vehicle hires).

Taking the midpoint of the estimated minimum and maximum costs, the estimated cost of vehicle unavailability is $359 per vehicle involved in a crash and a total of $446.8m.[50]

5.12 Workplace disruption

Following a fatality, employers face costs of lost output, or temporary replacement and permanent replacement of the employee. Following BITRE 2009, these costs were estimated by using average employee earnings as a proxy measure for a period of 9.6 weeks, as estimated by the Australian Safety and Compensation Council (predecessor to Safe Work Australia). To this was added a recruitment and/or retraining cost of $8,907 per employee replacement. Costs totalled $20.6m.

Employers similarly face costs pending an employee's return to work following injury and following an employee's work-preventing disability. Using the same approach, 'duration of the earnings forgone due to an affected person', as per BITRE 2009, is shown, for different disability work categories, in Table 16. Replacement and/or retraining costs are calculated (not shown), using the 'return to work' proportions adopted by BITRE 2009: zero for the profoundly disabled, three percent for severely disabled, 50.6 per cent for the moderately disabled and 99 per cent for mildly disabled persons. This means that, for example, recruitment and retraining costs are included in respect of all of the profoundly disabled, deemed not to return to work and in relation to one per cent of mildly disabled persons, nearly all of whom return to work. Total costs are estimated at $126.1m.

Table 16 Short term workplace disruption costs due to road crash injury 2015

Work category	Disability grouping	Duration of earnings forgone (weeks)	Total cost $m
Permanent incapacity: no return to work	Profound	37.1	25.7
Temporary incapacity: reduced return	Severe	44.1	62.4
Temporary incapacity: return to full duties	Moderate	4.6	14.2
Temporarily off work	Mild	0.7	1.5
	Not disabled	0.7	22.3
TOTAL			126.1

Source: BITRE 2009 and ECON analysis

Total workplace disruption costs from both fatality and injury are estimated at $146.7m.

5.13 Street furniture damage

Non-vehicle objects including light or telephone poles, buildings, kerbs and guard rails were involved in three per cent of reported crashes in 2006 (BITRE 2009, p. 81).

BITRE's total cost estimate was adjusted for the increase in the total number of road crashes in 2015 compared with 2006 (Table 5) and for price inflation, giving an estimate of $48.7m.

50 While noting that there is no basis for choosing any particular value, BTE 2000 opted for the 25th percentile value.

5.14 Correctional services

Correctional services costs comprise the costs relating to those convicted of a criminal offence arising from a road crash and who are sentenced.

In Victoria in the five years to 2009-10, 80 per cent of those convicted were imprisoned and 12 per cent received a youth justice centre order (Sentencing Advisory Council 2011). The balance received a wholly suspended sentence (with or without a fine), a partially suspended sentence, or a non-custodial supervision order.

Costs were calculated for an estimated 63 persons across Australia convicted, sentenced and detained, either in prison or in a youth justice centre. The daily cost of detention was $301 for imprisonment and $1,391 for a youth justice centre order (Productivity Commission 2016d). Average detention durations were 5.5 years (imprisonment) and assumed at two years (youth justice centre order), where three years is the permitted maximum.

Total correctional services costs were estimated at $37.3m.

5.15 Funeral

To estimate the premature funeral costs for the 2015 road fatalities, the BITRE 2009 cost estimate was adjusted for the reduced number of fatalities, increase in the average age of the fatality cohort and price inflation.

Total costs of premature funerals were estimated at $5.6m.

5.16 Coronial

Road fatalities are in the category of 'reportable deaths' that must be reported to and investigated by a coroner. The investigation may include a post mortem examination (autopsy) and a hearing in open court (inquest).

BITRE 2009 estimated that the cost of a coronial investigation amounted to an average of $1,965 per fatality. At an indexed 2015 value of $2,527, total estimated coronial costs amounted to $3.0m.

5.17 Summary of economic costs

The estimated economic cost of road crashes in 2015 was $22,236.9m, equivalent to 1.3 per cent of gross domestic product in that year. See Table 17 for details.

Based on the information in Table 17, the estimated total cost per fatality was $4.34m,[51] while the total cost per hospitalised injury, including disabled persons, was $239,000. Separated out from the hospitalised injury group, the total cost per person disabled following road crash injury was $694,000. The total cost per non-hospitalised injury was $12,000 (Table 18).

---

[51] This cost is to be distinguished from the 40-year value of statistical life ($4.41m) used in the study (Section 3.5). The latter is a measure of willingness to pay to avoid risk of losing a life with 40 future years of life expectancy. The estimate here of a total cost per fatality includes average values of the many other costs that result from a fatality, as shown in Table 17. See also Section 5.19. In addition, years of life lost are calculated based on the actual age profile of the fatalities and average less than 40 years per fatality.

Table 17 Economic cost of road trauma 2015, $m

No	Cost category	Fatalities	Hospitalised injuries	Non-hospitalised injuries	Property damage	Total	*% total*
1	Life, health and wellbeing	4,926.8	4,350.0	na	na	9,276.8	*41.7%*
2	Vehicle damage	6.4	208.3	1,248.9	3,363.4	4,827.0	*21.7%*
3	Disability care	na	2,018.7	na	na	2,018.7	*9.1%*
4	Hospital, medical, paramedical	6.5	983.2	641.3	na	1,631.0	*7.3%*
5	Travel delay	18.2	177.6	399.8	535.0	1,130.6	*5.1%*
6	Insurance administration	5.4	340.4	289.7	489.4	1,124.9	*5.1%*
7	Efficiency cost of raising revenue	184.5	320.7	103.3	193.8	802.3	*3.6%*
8	Vehicle unavailability	0.2	19.3	115.6	311.6	446.7	*2.0%*
9	Emergency services	10.2	191.9	na	134.4	336.5	*1.5%*
10	Legal	3.7	325.4	na	na	329.1	*1.5%*
11	Workplace disruption	20.6	126.1	na	na	146.7	*0.7%*
12	Health cost of crash-induced pollution	0.3	8.6	19.4	43.4	71.8	*0.3%*
13	Street furniture damage	0.1	2.1	12.6	33.9	48.7	*0.2%*
14	Correctional services	37.3	na	na	na	37.3	*0.2%*
15	Funeral	5.6	na	na	na	5.6	*0.0%*
16	Coronial	3.0	na	na	na	3.0	*0.0%*
	TOTAL	5,228.9	9,072.5	2,830.6	5,104.9	22,236.9	*100.0%*

Note: Totals may not sum precisely, due to rounding.

Source: ECON estimates

Table 18 Cost of road trauma 2015 per casualty, $m

Casualty type	No	Total cost $m	Cost per person $m
Fatalities	1,205	5,228.9	4.339
Hospitalised injuries	37,964	9,072.5	0.239
Disabled persons (1)	4,436	3,078.9	0.694
Non-hospitalised injuries	227,572	2,830.6	0.012
TOTAL	266,741	17,132.0	

(1) Disabled persons are included in the hospitalised injuries total.

Source: ECON analysis

Similarly, the total cost per fatal crash, which involves on average 1.1 fatalities. 0.45 hospitalised injuries and 0.3 non-hospitalised injuries (see Appendix B, Section B.1.1) is estimated at $4.7m. The corresponding costs per hospitalised injury crash, non-hospitalised injury crash and property damage crash are $287,000, $15,000 and $11,000 respectively (Table 19).

Table 19 Cost of road trauma 2015 per road crash, $m

Crash type	No	Total cost $m	Cost per crash $m
Fatal crashes	1,101	5,228.9	4.749
Hospitalised injury crashes	31,637	9,072.5	0.287
Non-hospitalised injury crashes	189,643	2,830.6	0.015
Property damage crashes	456,978	5,104.9	0.011
TOTAL	679,359	22,236.9	0.033

Source: ECON analysis

5.18 Sensitivity analysis

Table 20 sets out two sensitivity test cases, each varying the value of statistical life and value of statistical life year assumptions. The table also includes the BITRE 2009 estimates for reference, in both 2006 prices and 2015 prices. See Section 5.19 for further discussion.

One sensitivity test proxies a human capital approach and is based on the BITRE 2009 hybrid human capital value of statistical life indexed to 2015 prices, on the basis of the increase in all persons' average weekly earnings ($3.44m). The second case uses a value of statistical life that is based on the willingness to pay for road safety in Australia, as per Hensher et al (2009) and as also included in BITRE 2009, similarly indexed ($7.94m). With no other changes made to the study methodology, the first approach indicates a total economic cost of 2015 road trauma of $20,196.6m (9.2 per cent lower), while the second results in a total economic cost of $29,675.6m (33.5 per cent higher).

Table 20 Economic cost of road trauma 2015 (and 2006) sensitivity tests

Measure	BITRE 2009 Hybrid human capital approach (ECON proxy estimate)	ECON Willingness to pay approach (OBPR)	BITRE 2009 Willingness to pay for road safety in Australia sensitivity test
Value of statistical life 2015 (VSL, 40 years), 2015 $m	3.44	4.41	7.94
Value of statistical life year (VSLY), 2015 $m	144,370	185,073	333,473
Economic cost of road trauma 2015, 2015 $m	20,196.6	22,236.9	29,675.6
Economic cost of road trauma 2006 (BITRE 2009) estimates for reference			
Value of statistical life 2006 (40 years), 2006 $m	2.41		6.34 (1)
Value of statistical life year 2006 $m (1)	101,050		266,350
Economic cost of road trauma 2006, (2006 $m) 2015 $m	(17,849.3) 23,869.4		(27,120.0) 36,962.0

(1) ECON estimates based on BITRE 2009 and Hensher et al 2009

Source: BITRE 2009, Hensher et al 2009 and ECON analysis

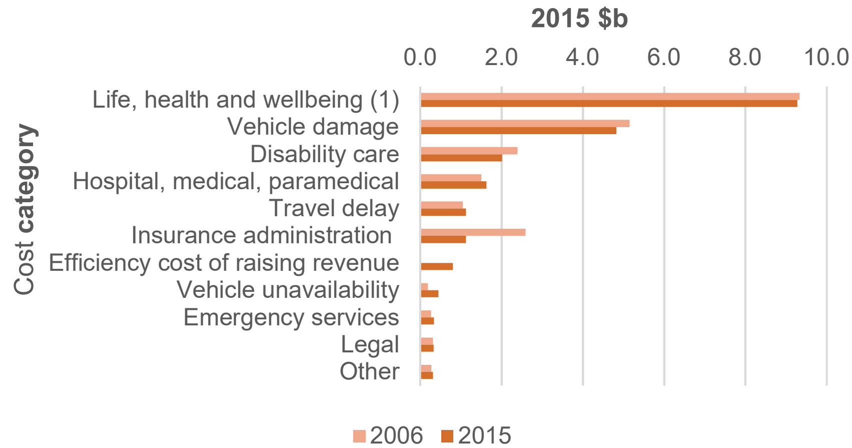
5.19 Cost comparison with 2006

The 2015 economic cost of road trauma ($22,236.9m) compares with a 2006 economic cost of $23,869.4m in 2015 prices, 6.8 per cent more than the 2015 estimates. Indexation of the original cost estimate in 2006 prices, $17,849.5m, uses the range of prices indices listed in Figure 6.

The 2015 willingness to pay sensitivity estimate ($29,675.6m) compares with a 2006 counterpart at $36,962.0m, indexed to 2015 prices. The original 2006 estimate in 2006 prices was $27,120.0m.

A comparison on a cost category basis is shown in Figure 11. Cost categories shown are those of the present study rather than those of BITRE 2009. 'Life, health and wellbeing' takes the place of and compares with the combination of 'workplace and household losses' and 'non-pecuniary or non-economic costs' in BITRE 2009.

Figure 11 Economic cost of road crashes, 2006 and 2015



(1) The 2006 counterpart for loss of life, health and wellbeing was workplace and household losses and non-pecuniary or non-economic costs.

Source: BITRE 2009 and ECON analysis

Numerous factors have reduced the estimated cost compared to 2006, while others have increased it, with the former slightly more significant overall. Factors tending to reduce total cost include: reduced fatalities; reduced number of persons disabled following injury; casualty ageing, which reduces the average number of life years lost or disabled; and a revised approach to estimation of insurance administration and carer costs (a component of disability care costs). On the other side of the ledger are: a high health service cost increase; inclusion of a new cost category, the efficiency cost of government revenue-raising; and use of a willingness to pay-based approach to valuing loss of life, health and wellbeing, involving a higher value of statistical life than in the hybrid human capital approach. See Table 21.

Table 21 Drivers of the cost of road trauma 2015: comparison with 2006

Cost driver type	Reducing total cost visavis 2006	Increasing total cost visavis 2006
Population numbers, characteristics	Fatalities	Hospitalised injuries
	Persons disabled	Non-hospitalised injuries
	Casualty ageing	Road crashes
Unit costs	Vehicle cost growth below CPI	Health (hospital and medical) cost growth above CPI
Cost categories		New cost category - Efficiency cost of government revenue-raising
Valuation methodology	Disability care - carers	
	Insurance administration	Life, health and wellbeing - Disability-adjusted life year and willingness to pay approaches

Source: ECON analysis

Cost per person comparisons between the two studies are shown in Table 22. The change in valuation approach, from human capital to willingness to pay, is the key factor in the 33.1 per cent increase in the cost per fatality between the two studies, from $3.26m to $4.34m (both in 2015 prices). Conversely, the assignment of what may appear to be a low average disability weighting (0.182) to persons disabled following road crash injury (Section 5.2.2), limits the 'cost increasing' impact of the change to a willingness to pay approach in respect of hospitalised injuries (18 per cent fall in cost, from $292,000 to $239,000). A change in valuation approach to disability carer labour also reduces hospitalised injury cost per person, as does increasing average age, with regard to both fatalities and hospitalised injuries.

In respect of non-hospitalised injuries, a change in approach in this study, whereby vehicle damage and other 'non-human' costs are assigned to the different casualty streams, rather than to a residual 'property damage and general costs' stream (thereby better reflecting cost causality), has a marked impact (254 per cent increase). The effect of this change is muted in the other two casualty streams, due to the dominance of the loss of life, health and wellbeing and disability care cost categories, neither of which contribute to the cost of non-hospitalised injuries.

Table 22 Comparison of cost of road trauma per casualty, 2015 $m

Casualty type	2006 (BITRE 2009) cost per person	2015 (ECON 2017) cost per person	*% change*
Fatalities	3.260	4.339	*33.1%*
Hospitalised injuries	0.292	0.239	*-18.0%*
Non-hospitalised injuries	0.004	0.012	*253.7%*

Source: BITRE 2009 and ECON analysis

6. Cost to government of road trauma 2015

The insurance system is central to enabling individuals and families to fund the financial costs that can result from road crashes, in areas including health and disability care and support, earnings losses, compensation for pain and suffering and vehicle repair and replacement. In addition, individuals may fund costs for which they do not carry insurance cover. Government budgets also are affected by road trauma, particularly through the lasting effects it has on workforce participation and earnings and, in consequence, on government taxation revenues and income support expenditure outlays. Other areas of government activity are impacted as well.

This section examines the financial impact for government of the incidence of road trauma in 2015. 'Lifetime' estimates of the cost to government are developed, in the same manner as for the economic cost estimates, covering prospective lifetime losses in relation to both fatalities and injuries (Section 3.6). The discount rate used is three per cent real per year, as in the preceding analysis.

In addition, annual cost to budget estimates are provided for the Commonwealth, government, state and territory governments (aggregated) and local governments (also aggregated).

6.2 Government funding shares

Based on a range of published sources, estimated government and non-government funding shares of the various financial cost categories for the road trauma burden are shown in Table 23.

6.1.1 Exclusions and inclusions

With the cost to government analysis measuring financial flows to and from government rather than necessarily resource costs, as in the economic analysis (Section 3.8), there are some differences in the cost categories that are in scope.

Firstly, Table 23 excludes the 'life, health and wellbeing' cost category, the largest contributor to the economic cost of road trauma (Table 17). As an economic measure of the value of losses resulting from road trauma to the individuals themselves and those around them, unlike other cost categories, it has no direct financial or funding analogue.

Secondly, the table excludes insurance administration and funeral costs, on the basis that these are wholly ultimately borne by the private or non-government sector.

Thirdly, the table omits the efficiency costs of additional government revenue-raising. While some impact on government budgets is to be expected, as a consequence of the effect of taxation on work and saving incentives, the modelling complexity of what is an indirect rather than a direct impact precludes its consideration.

Turning to inclusions, the table features taxation forgone and the net increase in income support payments that flow from the consequences of road trauma for earned income and labour market participation. As resource transfers between agents in the economy, rather than resource costs per se, taxation and income support effects do not form part of the economic cost of road trauma (Section 3.8).

6.1.2 Government funding shares by cost category

Government funding shares by cost category are outlined in cost to government size order, as detailed in Section 6.3.

Taxation and income support

Taxation shares by government, with the Commonwealth's (80 per cent) the dominant one, are based on ABS taxation revenue statistics (ABS 2016i). Income support is treated as a wholly Commonwealth Government function. Concessions provided to eligible income support recipients by state and territory governments, for example for public transport travel, are not included.

Disability care

Disability care is primarily funded privately through insurance compensation arrangements and unpaid carer labour by family members. The government share of aids and appliances costs in the health system is estimated at 17.5 per cent (AIHW 2016b). This proportion is applied here to disability care aids and appliances funding. The Commonwealth also provides some income support for carers of severely disabled persons in private homes. Based on analysis which supports the economic cost estimates (Section 5.4.1), this share is estimated at 17.7 per cent of the total carer cost, with private sources (insurance and individuals) supplying the balance.

Health services

In principle, governments face only limited ultimate (non-capital) health-related costs for road trauma, due to cost recovery through the motor vehicle third party insurance system. In all jurisdictions, compulsory third party (CTP) insurance is in place to fund treatment and other health-related costs arising from road crashes, while, in non no-fault jurisdictions, individuals, rather than their insurers, may face costs if at fault in the crash, through application of the contributory negligence principle. In cases where vehicles are unregistered (estimated at around three per cent of all vehicles)[52] and the driver is accordingly uninsured, it is likely that the costs largely remain with the public hospital system. With allowance also for a possibly above average injury rate for drivers of older, less crashworthy, uninsured vehicles and other factors,[53] five per cent of 'medical-hospitalised' costs, 'hospital stay' costs and 'paramedical' costs are assigned to government. The balance, 95 per cent, is assigned to non-government (i.e. insurance and private individual) sources.

Whereas injury compensation insurers (motor vehicle third party and workers' compensation) are the largest non-government source of funds for the hospital system as a whole, individuals are the main non-government funding source for primary health care.[54] Particularly where the costs involved are relatively small, individuals may self-fund, and/or access services funded

---

[52] ECON estimate based on the reported number of drivers caught by police driving unregistered vehicles each month over the period 2011-12 to 2014-15 in South Australia, averaging some 3.400 per month (Nankervis 2015) and on Motor Vehicle Census data (ABS 2016g).

[53] For example, any recovery 'leakage' associated with the medical costs of insured at fault drivers and their vehicle occupants in non no-fault jurisdictions.

[54] In 2014-15, government provided 77.5 per cent of recurrent cost funding for hospital services (i.e. public and private hospitals combined). Of this, the Commonwealth share was 35.6 per cent and the state and territory share was 41.9 per cent. Health insurance funds, predominantly motor vehicle third party accident insurers and workers' compensation funds, provided 12.8 per cent of system-wide hospital recurrent funding in that year (ECON analysis based on AIHW 2016b, pp. 59-63).

through Medicare, rather than seek reimbursement through insurance, avoiding any associated administrative complexity. Accordingly, the Australian Institute of Health and Welfare's system-wide cost proportions are adopted in respect of 'medical – non-hospitalised costs', implying a significantly larger share of costs for government than in the case of hospital and related services. These proportions are 61.1 per cent government and 39.9 per cent non-government (AIHW 2016b, p. 63).

Emergency services

Ambulance services are around two thirds reliant on government funding, with fees and charges imposed on service users providing most of the difference (Productivity Commission 2016a). In contrast, fire and rescue services are only one third reliant on government, with fire levies on property owners providing the bulk of the difference. Police services are assumed to be fully reliant on government funding.

Vehicle-related

An estimated 0.8 per cent of the national vehicle fleet (142,992 vehicles) comprises vehicles owned or managed by Commonwealth, state and territory and local governments for business purposes.[55]

Government fleet ownership shares were estimated on the basis of each level of government's share of public sector employment, i.e.12.6 per cent Commonwealth, 77.7 per cent state and territory and 9.7 per cent local government (ABS 2016e).

Funding shares for the government-related costs of both vehicle unavailability following a road crash and network travel delay resulting from road crashes were estimated similarly.

Repair of street furniture damage is a traditional responsibility of the road manager. Funding shares are estimated on the basis of road expenditure funding shares (BITRE 2011) and excluding Commonwealth grant funding, which are primarily allocated to specified infrastructure projects: 66.4 per cent attributable to state and territory governments and 33.4 per cent to local governments.

Legal and other

Criminal legal costs are assigned fully to state and territory governments, as with correctional services and coronial costs.

[55] There are no consolidated data on government vehicle fleets and this is an ECON estimate. A 2009 report on the Victorian Government fleet with information on both state and local government fleets was accessed (Victorian Auditor-General 2009). The non-executive (i.e. business purposes only) share of this fleet was applied to the balance of seven states and territories, on a population basis. It was also applied to the Commonwealth Government vehicle fleet (Department of Finance 2013) and to Australia's 566 local governments.

Table 23 Cost of road trauma 2015: Government and non-government funding shares

Cost category	*Government*				*Non-government*
	Commonwealth	*State & territory*	*Local*	*Total*	
Taxation and income support (fatalities and injuries)					
Taxation loss	*80.0%*	*16.5%*	*3.5%*	*100.0%*	*0.0%*
Income support net increase	*100.0%*			*100.0%*	*0.0%*
Disability care					
Carers	*20.7%*			*20.7%*	*79.3%*
Aids, appliances and equipment	*17.6%*			*17.6%*	*82.4%*
Health services					
Paramedical	*4.1%*	*0.9%*		*5.0%*	*95.0%*
Medical - hospitalised	*4.1%*	*0.9%*		*5.0%*	*95.0%*
Medical - non-hospitalised	*50.0%*	*11.1%*		*61.1%*	*38.9%*
Hospital stay	*4.1%*	*0.9%*		*5.0%*	*95.0%*
Emergency services					
Ambulance		*68.1%*		*68.1%*	*31.9%*
Fire		*32.5%*		*32.5%*	*67.5%*
Police		*100.0%*		*100.0%*	*0.0%*
Vehicle-related					
Vehicle damage	*0.1%*	*0.6%*	*0.1%*	*0.8%*	*99.2%*
Vehicle unavailability	*0.1%*	*0.6%*	*0.1%*	*0.8%*	*99.2%*
Travel delays including additional pollution	*0.1%*	*0.6%*	*0.1%*	*0.8%*	*99.2%*
Street furniture damage		*66.4%*	*33.6%*	*100.0%*	*0.0%*
Legal and other					
Criminal legal		*100.0%*		*100.0%*	*0.0%*
Correctional services		*100.0%*		*100.0%*	*0.0%*
Coronial		*100.0%*		*100.0%*	*0.0%*

Source: ABS 2016g, AIHW 2016b, Productivity Commission 2016a and ECON analysis

6.3 Total cost to government

The total cost to government of 2015 road trauma is estimated at $3,731.6m (Table 24). Of this, 76.9 per cent comprises costs to taxation revenue and additional income support costs, arising from road crash fatalities and disabilities and including disability carer income support costs. Health services (11.8 per cent) is the other area contributing significantly to total cost.

Calculation of the taxation and income support payment consequences of road trauma is detailed in Appendix C.

Table 24 Cost to government of road trauma 2015, $m

Cost category	Economic cost	Cost to government					
		Commonwealth	State & territory	Local	Cost to all governments' budgets	*% total cost*	First year budget cost
Taxation and income support							
Taxation loss	na	1,050.3	216.4	46.4	1,313.1		62.4
Income support net increase	na	1,557.0			1,557.0		76.4
SUB-TOTAL		2,607.3	216.4	46.4	2,870.1	*76.9%*	138.8
Disability care (1)							
Aids, appliances and equipment	334.4	58.9			58.9		2.4
SUB-TOTAL	334.4	58.9			58.9	*1.6%*	2.4
Health services							
Paramedical	286.3	11.7	2.6		14.3		14.3
Medical - hospitalised	471.8	19.3	4.3		23.6		23.6
Medical - non-hospitalised	641.3	320.7	71.4		392.1		392.1
Hospital stay	231.7	9.5	2.1		11.6		11.6
SUB-TOTAL	1,631.0	361.2	80.4		441.6	*11.8%*	441.6
Emergency services							
Ambulance	112.4	76.5			76.5		76.5
Fire	124.4	40.4			40.4		40.4
Police	99.8	99.8			99.8		99.8
SUB-TOTAL	336.5	216.8			216.8		216.8
Vehicle-related							
Vehicle damage	4,827.0	4.8	29.8	3.7	38.3		38.3
Vehicle unavailability	446.8	0.4	2.8	0.3	3.5		3.5
Travel delays including additional pollution	1,202.4	1.2	7.4	0.9	9.5		9.5
Street furniture damage	48.7		32.3	16.4	48.7		48.7
SUB-TOTAL	6,524.9	6.5	72.3	21.3	100.1	*2.8%*	100.1
Legal and other							
Criminal legal	3.7		3.7		3.7		3.7
Correctional services	37.3		37.3		37.3		37.3
Coronial	3.0		3.0		3.0		3.0
SUB-TOTAL	44.1		44.1		44.1	*1.2%*	44.1
TOTAL (2)	8,871.0	3,250.7	413.2	67.7	3,731.6	*100.0%*	943.8

(1) Income support for carers of eligible disabled persons is included under 'Taxation and income support' above.
(2) Totals may not sum precisely, due to rounding.
Source: ECON analysis

6.4 Annual cost to government budgets

6.4.1 Approach

In estimating the annual cost to government budgets, two generic budget years are presented. One is the 'first year' cost and the other is the 'subsequent year' cost (Table 25). The 'first year' may be understood as encompassing the financial years 2014-15 (second half), 2015-16 and 2016-17 (first half), depending on when in 2015 the crash occurred and the length of time required, potentially up to 12 months, for treatment, rehabilitation and return to work of injured persons.

The ‘subsequent year’ cost captures the lasting impact of road crash fatalities and injuries as they affect government budgets: forgone taxation, due to partial or complete loss of earnings; additional income support payments, for the same reasons and long term disability care and support costs. The time duration of the first two of these cost types extends until members of the youngest age group will have reached the age of retirement from the workforce (i.e. age 70 from the mid 2030s onwards, under existing government policy), at which time both forgone taxation and disability-related income support payments are no longer applicable. This is because, at age 70, individuals who have been in receipt of the Commonwealth Disability Support Pension, due to road crash injury, would, just as other members of the community and subject to relevant means tests, become eligible for the Age Pension. This time horizon is estimated to be approximately 2084-2085. It should be noted that income support costs for carers of persons disabled through road crash injury and any government-funded support services for disabled persons would continue after this cut-off, potentially until death.

Table 25 Timing of annual budget costs of road trauma

Annual budget year	First year financial costs	Subsequent year financial costs
2014-15 (2nd half), 2015-16, 2016-17 (1st half)	All cost categories (see Table 24)	
Continuing to 2084-2085 (approx)		Taxation revenue and income support expenditure
Continuing to 2094-2095 (approx)		Disability care (including carer income support

Source: ECON analysis

6.4.2 Results

The estimated cost of 2015 road trauma to government budgets in the first year is $943.8m (Table 26). This is equivalent to 25.3 per cent of the total cost to government of $3,731.6m (Section 6.3). The greater part (74.7 per cent) of the cost occurs in subsequent years, with up to an 80 year time horizon (Section 6.4.1).

Total forgone taxation revenue and additional income support payments, including payments to carers, comprise 98.3 per cent of the subsequent year average cost, with disability care costs making up the balance. This cost averages $141.2m per year (Table 26), higher in the early years and lower later. This is consistent with the age profile of road fatalities and injured persons, where those aged between 40 and 64 (with, absent road trauma, high levels of labour force involvement) comprise the largest group (Figure 7 and Figure 8).

Table 26 Annual cost of road trauma 2015 to government budgets, $m

Annual cost to government budgets	Commonwealth	State & territory	Local	Total
First year - immediate post-crash costs (1)	713.2	207.1	23.5	943.8
Subsequent years - long term average annual cost (2)	128.8	10.3	2.2	141.2

(1) First year costs capture the immediate systemic responses to road trauma in health, emergency services and other areas.

(2) Subsequent year budget costs are higher initially and are expected to decline to minimal levels by around 70 years (2084-85). By this time, the youngest persons killed or injured in 2015 would have reached retirement age, had they lived, or had they not become disabled. On average at this age these persons would no longer be working and paying tax and they would also have become eligible for age-based income support (Age Pension). Disability care payments could continue, on actuarial assumptions, for around a further 10 years.

Source: ECON analysis

7 Areas benefitting from future research

In assembling and accessing information for this study, some areas where new or additional research and/or assembly of data would be beneficial for future similar studies have become evident. These are briefly outlined in this section.

7.1 Improving data on the number of road crash injuries

The number of hospitalised injuries due to road crashes by year is available through the National Injury Surveillance Unit at Flinders University under agreement with the Australian Institute of Health and Welfare. BITRE has recently published a time series used in this study (BITRE 2017c). Further improvement is in train through a pilot project involving linking of police-reported crash data and hospital admissions data on a nationally consistent basis (NRSS 2016, p. 34). In addition, New South Wales has recently introduced a categorisation of police-sourced road crash injury data into ‘seriously injured’, ‘moderately injured’ and ‘minor/other injured’ (Transport for NSW 2016).

With regard to non-hospitalised injuries, New South Wales is also currently analysing data on Emergency Department presentations (i.e. those that do not result in a subsequent admission to hospital) in the state. These relate to situations where the person indicates a road injury cause, but the data cannot be matched with a police-sourced road crash.[56] Availability of data on Emergency Department presentations due to a road crash cause, in individual jurisdictions, would assist estimation of the number of non-hospitalised injuries, both for particular years and for the longer term trend. Research into the number of presentations to general practitioners, i.e. with no hospital involvement, would also be beneficial.

7.2 Longer term injury outcomes and costs

There is a level of information available regarding the longer term outcomes for persons experiencing catastrophic injury (i.e. traumatic brain injury and spinal cord injury) as a result of a road crash or other causes and the associated care and support costs. Many in this group become profoundly disabled for the remainder of their lives. However, less information is available regarding the larger numbers of mildly, moderately and severely disabled persons. For studies of the economic and financial costs of road trauma, outcomes with regard to functional wellbeing, workforce participation, earnings and other income over time and care and support costs (including rehabilitation, aids and equipment, home and vehicle modifications and hours and type of in-person care provided) are important for the full spectrum of persons disabled following road crash injury.

Improved information on longer term injury outcomes would complement improved reporting of injury crashes (NRSS 2016) and would be consistent with international road safety directions (IRTAD 2013).

Relatedly, confirmation of the extent to which the wellbeing and workforce experience of persons who are considered to have recovered fully from road crashes mirrors that of the broader population would also be beneficial.

---

[56] NSW Centre for Road Safety personal communication, 8 March 2017

7.3 Information on carers

There is relatively little available information on carers in private homes of persons disabled following road crash injury. Deficits include the impact of care provision on carers' labour force involvement and earnings and the impact of care provision on leisure, study and other activities. Specific information on the attendant care sector, which provides 'full time' care and support for disabled persons, either in private homes or residential facilities, would also be beneficial.

7.4 Road network travel delay

Many factors influence the severity of road network travel delays due to road crashes, including the extent and duration of any resulting lane closure, location, time of day and overall network resilience and efficiency. Whether as part of consideration of all of the major causes of congestion or on its own, a research focus on this issue would be beneficial, as would performance reporting attention by road network managers.

7.5 Response to vehicle unavailability

The behaviour of vehicle owners and their passengers in responding to temporary vehicle unavailability, due to vehicle damage following a road crash, is relatively unknown. The issue is a complex one, as the extent of damage experienced, the type of vehicle insurance cover held, alternative travel options available, the opportunity costs of foregoing travel while the vehicle is unavailable and the income level of the person or persons involved will all influence behavior. Research into this issue may also spin-off benefits for the accuracy of the much larger vehicle repair and replacement costs, enabling a sharper focus on both the number of vehicles repaired and replaced and the distribution of repair costs.

7.6 Willingness to pay for road safety

Authoritative national guidance on willingness to pay-based valuation of improved road safety is important in the context of consistent evaluation of individual road-related projects with due prioritisation of road safety and the reduction of road trauma (Hendrie and Miller 2012, p. 43). Integrated guidance on the valuation of savings of 'life years' as well as 'lives' in the road transport context is also needed, as part of a focus on the impacts of injuries and disabilities resulting from road crashes.

Commencement of a process, under National Road Safety Strategy auspices, to design and implement a national survey that could inform guidance on the willingness to pay for road safety is noted and its timely completion is supported (Section 1.1).

With regard to the application of willingness to pay valuations to future studies which, like this one, estimate aggregated costs of road trauma, research into practice in other countries, many of which have adopted a willingness to pay framework over the past 30 years (Hendrie and Miller, p. 17ff), would be beneficial. This could include research into use of such studies in the public policy process and consideration of how they have dealt with what Abelson describes as "the aggregate budget implications and feasibility of basing all public policy for safety and health on individual marginal valuations" (2008, p. 17), as are provided by the willingness to pay approach. With the recognised superiority of the willingness to pay valuation approach over the human capital one (Abelson 2003, 2008 and Section 2.2.4), consideration of this issue would be beneficial.

8 References

Abelson, P 2003, “The Value of Life and Health for Public Policy”, *Economic Record*, Vol 79 Special Issue

Abelson, P 2008, *Establishing a Monetary Value for Lives Saved: Issues and Controversies*, Office of Best Practice Regulation, Department of Finance and Deregulation WP 2008-02 https://www.dpmc.gov.au/sites/default/files/publications/Working_paper_2_Peter_Abelson.pdf

Access Economics 2008, *The Health of Nations: The Value of a Statistical Life*, July, for the Australian Safety and Compensation Council, http://www.safeworkaustralia.gov.au/sites/SWA/about/Publications/Documents/330/TheHealthOfNations_Value_StatisticalLife_2008_PDF.pdf

Access Economics 2009, *The economic cost of spinal cord injury and traumatic brain injury in Australia*, Report for the Victorian Neurotrauma Initiative https://www.tac.vic.gov.au/about-the-tac/our-organisation/research/tac-neurotrauma-research/vni/the20economic20cost20of20spinal20cord20injury20and20traumatic20brain20injury20in20australia.pdf

Australian Bureau of Statistics (ABS) 2009, *Legal Services. Australia*, 8667.0 file:///C:/Users/philp/Desktop/Road%20safety/ABS/Legal%20Services%2086670_2007-08.pdf

Australian Bureau of Statistics (ABS) 2010, *Australian Labour Market Statistics*, 6105.0, October http://www.ausstats.abs.gov.au/ausstats/subscriber.nsf/0/B9BE5F9EA40AA538CA2577B5000CB666/$File/61050_oct%202010.pdf

ABS 2015a, *Australian Demographic Statistics September Quarter 2014*, 3101.0, http://www.abs.gov.au/AUSSTATS/abs@.nsf/allprimarymainfeatures/1B9F5B9134A29AFACA257E6E00119B3D?opendocument

ABS 2015b, *Gender Indicators, Australia, Feb 15* 4125.0 http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/4125.0Feb%202015?OpenDocument

ABS 2015c, *Survey of Motor Vehicle Use, Australia, Year ended 31 October 2014*, 9208.0

ABS 2016a, *Australian National Accounts: National Income, Expenditure and Product, Dec. 2016*, 5206.0, http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/5206.0Dec%202016?OpenDocument

ABS 2016b, *Average Weekly Earnings, Australia, Nov 2016*, 6302.0 http://www.abs.gov.au/ausstats/abs@.nsf/mf/6302.0

ABS 2016c, *Characteristics of Employment, Australia, August 2015,* 6333.0 http://www.abs.gov.au/ausstats/abs@.nsf/mf/6333.0

ABS 2016d, *Consumer Price Index, Australia, Dec. 2016,* 6401.0, http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/6401.0Dec%202016?OpenDocument

ABS 2016e, *Employment and Earnings, Public Sector, Australia,* 6248.0.55.002 http://www.abs.gov.au/ausstats/abs@.nsf/mf/6248.0.55.002

ABS 2016f, *Life Tables, States, Territories and Australia, 2013-2015* http://www.abs.gov.au/ausstats/abs@.nsf/mf/3302.0.55.001

ABS 2016g, *Motor Vehicle Census, Australia, 31 Jan 2016*, 9309.0 http://www.abs.gov.au/ausstats/abs@.nsf/mf/9309.0

ABS 2016h, *Survey of Disability, Ageing and Carers 2015*, 4430.0, customised tables and Summary of Findings http://www.abs.gov.au/ausstats/abs@.nsf/mf/4430.0

ABS 2016i *Taxation Revenue, Australia, 2014-15*, 5506.0 http://www.abs.gov.au/ausstats/abs@.nsf/mf/5506.0

ABS 2017a, *Australian Demographic Statistics*, *Sep 2016*, 3101.0 http://www.abs.gov.au/ausstats/abs@.nsf/0/BCDDE4F49C8A3D1ECA257B8F00126F77?Opendocument

ABS 2017b, *Labour Force, Australia, Jan 2017*, 6202.0 http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/6202.0Jan%202017?OpenDocument

ABS 2017c, *Producer Price Indexes*, *Australia, Mar 2017*, 6427.0 http://www.abs.gov.au/ausstats/abs@.nsf/mf/6427.0

ABS 2017d*, Survey of Motor Vehicle Use, Australia, 12 months ended 30 June 2016*, 9208.0 http://www.abs.gov.au/ausstats/abs@.nsf/mf/9208.0

Australian Capital Territory (ACT) Government 2016, *2015 ACT Road Crash Report*, August, http://www.pedalpower.org.au/wp-content/uploads/2016/09/Crash-report.pdf

Australian Institute of Criminology, *Thefts of vehicles* http://www.aic.gov.au/publications/current%20series/rpp/121-140/rpp129/13-thefts-of-vehicles.html (website accessed 28 April 2017)

Australian Institute of Health and Welfare 2016a, *Admitted patient care 2014-15: Australian hospital statistics*, March, http://www.aihw.gov.au/WorkArea/DownloadAsset.aspx?id=60129554729

AIHW 2016b, *Health expenditure Australia 2014-15*, http://www.aihw.gov.au/WorkArea/DownloadAsset.aspx?id=60129557188

Australian Prudential Regulatory Authority (APRA) 2016, *Quarterly General Insurance Performance Statistics*, September, http://www.apra.gov.au/GI/Publications/Pages/quarterly-general-insurance-statistics.aspx

Austroads 2012, *Guide to project evaluation: part 4: project evaluation data*, AGPE04-12

Austroads 2015, *Social Costs of Road Crashes in Australia: The Case for Willingness-to-pay Values for Road Safety*, Research Report AP-R438-15, February https://www.onlinepublications.austroads.com.au/items/AP-R438-15

Austroads 2016, *Congestion and Reliability Report: Full Report*, Research Report AP-R534-16, December https://www.onlinepublications.austroads.com.au/items/AP-R534-16

Austroads 2016. Work brief for provision of survey design and testing: willingness to pay survey for travel times, reliability and road safety, unpublished

Berry J and Harrison J 2008, *Serious injury due to land transport accidents 2005-06*, Australian Institute of Health and Welfare, July http://www.aihw.gov.au/publication-detail/?id=6442468109

Berry J and Harrison J 2012, *Serious injury due to land transport accidents 2008-09*, Australian Institute of Health and Welfare, http://www.aihw.gov.au/WorkArea/DownloadAsset.aspx?id=10737421994

Bicycle Council of Australia 2016 (BCA) 2016, http://bicyclecouncil.com.au/publication/national-cycling-strategy-implementation-report-2015

Budd, L, Keall, M and Newstead, S 2015, *Retrospective and Prospective Changes in Secondary Safety of the Australian and New Zealand Vehicle Fleets and the Potential Influence of New Vehicle Safety Technologies*, Report No. 329, May https://www.monash.edu/__data/assets/pdf_file/0008/633554/VSRG-Prospective-and-Retrospective-Vehicle-Safety-Effects-Report-329.pdf

Bureau of Infrastructure, Transport and Regional Economics (BITRE) 2009, *Cost of road crashes in Australia 2006*, Report 118 https://bitre.gov.au/publications/2010/report_118.aspx

BITRE 2011, *Public road-related expenditure and revenue in Australia*, Information Sheet 40, https://bitre.gov.au/publications/2011/files/is_040.pdf

BITRE 2015, *Traffic and congestion cost trends for Australian capital cities* https://bitre.gov.au/publications/2015/files/is_074.pdf

BITRE 2016, *Road trauma Australia 2015 statistical summary*, https://bitre.gov.au/publications/ongoing/files/Road_trauma_Australia_2015.pdf

BITRE 2017a, Fatalities file by road user, age group and gender, 2007 to 2016

BITRE 2017b, National Crash Database file, (data provided to 2015)

BITRE 2017c, *Hospitalised injury statistics*, Series produced by the National Injury Surveillance Unit, Flinders University under agreement with AIHW, February, https://bitre.gov.au/publications/ongoing/hospitalised-injury.aspx

Bureau of Transport Economics (BTE) 1988, *Cost of Road Accidents in Australia*, Occasional Paper, https://bitre.gov.au/publications/1988/files/op_091.pdf

BTE 2000, *Road Crash Costs in Australia*, Report 102, https://bitre.gov.au/publications/2000/files/report_102.pdf

Campbell, H and Bond K (1987) "The Cost of Public Funds in Australia", *Economic Record* 73, pp. 22-34.

D'Elia, A and Newstead, S 2015, "Contribution of vehicle safety improvements and infrastructure investment on reducing road trauma in Victoria and projected future benefits", Monash University Accident Research Centre, *Proceedings of the 2015 Australasian Road Safety Conference,* 14-16 October, Gold Coast

Department of Finance 2006, *Handbook of Cost-Benefit Analysis*, https://www.finance.gov.au/sites/default/files/Handbook_of_CB_analysis.pdf

Department of Finance 2013 *Fleet Statistics* https://www.finance.gov.au/archive/vehicle-leasing-and-fleet-management/FleetStatistics.html

Department of Prime Minister and Cabinet 2014, *Best Practice Regulation Guidance Note Value of statistical life*, December https://www.dpmc.gov.au/sites/default/files/publications/Value_of_Statistical_Life_guidance_note.pdf

Department of Social Services 2015, DSS Payments Demographic Data https://data.gov.au/dataset/dss-payment-demographic-data

Gabbé, B, Lyons, R, Fitzgerald, M, Judson, R, Richardson, J and Cameron, P (2015) "Reduced Population Burden of Road Transport-related Major Trauma After Introduction of an Inclusive Trauma System", *Annals of Surgery*, March, pp. 565-572 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4337622/

Gabbé, B, Lyons, R, Simpson, P, Rivara, F, Ameratunga, S, Polinder, S, Derrett, S and Harrison, J 2016, "Disability weights based on patient-reported data from a multinational injury cohort", *Bulletin of the World Health Organisation* 94, pp. 806-816C http://www.who.int/bulletin/volumes/94/11/16-172155/en/

Hendrie, D and Miller, T 2012, *Measuring the costs of road trauma and its longer term consequences*, Curtin-Monash Accident Research Centre, School of Public Health, Curtin University, August http://c-marc.curtin.edu.au/local/docs/MCRTLTC_FINAL.pdf

Hensher, D, Rose, J, de Dios Ortuzar, J and Rizzi, L 2009, *Estimating the willingness-to-pay and value of risk reduction for car occupants in the road environment*, February, Institute of Transport and Logistics Studies, University of Sydney http://sydney.edu.au/business/__data/assets/pdf_file/0007/25675/itls_wp_09_03.pdf

Insurance Statistics Australia 2017, Motor Syndicate http://www.insurancestats.com.au/coverage/motor-syndicate/

Klapdor, M 2014, *Changed indexation of pensions and tightened eligibility for all benefits*, http://www.aph.gov.au/about_parliament/parliamentary_departments/parliamentary_library/pubs/rp/budgetreview201415/indexation

International Traffic Safety Data and Analysis Group (IRTAD) *Road Safety Annual Report 2013* https://www.itf-oecd.org/sites/default/files/docs/13irtadreport.pdf

Lifetime Care and Support Authority (LTCSA) *Annual Report 2014-15*, NSW Government, file:///C:/Users/philp/Downloads/LTCSA_annual_report_2014_15_1546%20(1).pdf

McDermott, F, Cooper, G, Hogan, P, Cordner, S, Tremayne, A 2005, "Evaluation of the pre-hospital management of road traffic fatalities in Victoria, Australia, *Pre-hospital Disaster Medicine*, 20(4), pp. 219-227

Motor Accidents Compensation Commission (MACC) 2015, *Annual Report 2015*, Norther Territory Motor Accidents (Compensation Commission) http://www.ntmacc.com.au/MACC_Annual_Report_2015.pdf

Motor Accidents Insurance Board (MAIB) 2015, *2014-15 Annual Report*, Tasmania, http://www.maib.tas.gov.au/wp-content/uploads/2016/10/AnnualReport2015.pdf

Motor Accidents Insurance Commission (MAIC) 2015, *Annual Report 2014-15*, Queensland Government https://maic.qld.gov.au/publications/annual-report-2014-15/

MAIC 2016, *Statistical Information I January to 30 June 2016*, https://maic.qld.gov.au/wp-content/uploads/2016/09/Statistical-Information-1-Jan-to-30-Jun-2016.pdf

Nankervis, D 2015, "SA government making millions from rego fines", *Carsguide*, 20 April https://www.carsguide.com.au/car-news/sa-government-making-millions-from-rego-fines-31948

National Disability Insurance Agency (NDIA) 2016, *Annual Report 2016*, https://www.ndis.gov.au/medias/documents/ha5/h04/8798853726238/NDI7040-AnnualReport2016-vFaccessible.pdf

National Road Safety Strategy 2016 (NRSS), *Implementation Status Report*, http://roadsafety.gov.au/performance/files/NRSS_Implementation_report_Nov2016.pdf

Productivity Commission 2011, *Disability Care and Support Inquiry Report*, http://www.pc.gov.au/inquiries/completed/disability-support/report

Productivity Commission 2015, *Report on Government Services 2015 Volume F: Community Services* http://www.pc.gov.au/research/ongoing/report-on-government-services/2015/community-services/services-for-people-with-disability/rogs-2015-volumef-chapter14.pdf

Productivity Commission 2016a, *Report on Government Services 2016 Volume D: Emergency* Management http://www.pc.gov.au/research/ongoing/report-on-government-services/2016/emergency-management/rogs-2016-volumed-emergency-management.pdf

Productivity Commission 2016b. *Report on Government Services 2016 Volume C: Justice* http://www.pc.gov.au/research/ongoing/report-on-government-services/2016/justice/corrective-services/rogs-2016-volumec-chapter8.pdf

Productivity Commission 2016c, *Report on Government Services 2016 Volume E: Health* http://www.pc.gov.au/research/ongoing/report-on-government-services/2016/health/rogs-2016-volumee-health.pdf

Productivity Commission 2016d, *Report on Government Services 2016 Volume F: Youth Services* http://www.pc.gov.au/research/ongoing/report-on-government-services/2016/community-services/youth-justice/rogs-2016-volumef-chapter16.pdf

Productivity Commission 2017a, *Report on Government Services 2017 Volume C: Justice* http://www.pc.gov.au/research/ongoing/report-on-government-services/2017/justice

Productivity Commission 2017b, *Report on Government Services 2017 Volume F: Community Services* http://www.pc.gov.au/research/ongoing/report-on-government-services/2017/community-services

RACQ, *Private vehicle expenses 2016*, https://www.racq.com.au/cars-and-driving/cars/owning-and-maintaining-a-car/car-running-costs

Read, D 2015, "Open speeds on Northern Territory roads: Not so fast", *Medical Journal of Australia*, 203 (1), pp. 14-15 https://www.mja.com.au/journal/2015/203/1/open-speeds-northern-territory-roads-not-so-fast

Robson, A 2005, *The Costs of Taxation: Perspectives on Tax Reform (8)* Centre for Independent Studies file:///C:/Users/philp/Desktop/Road%20safety/CIS%20Robson%20Costs_of_taxation%202005.pdf

Ruseckaite, R, Gabbé, B, Vogel, A and Collie, A 2012 "Health care utilisation following hospitalisation for transport-related injury", *International Journal of the Care of the Injured,* 43, pp. 1600-1605

Sentencing Advisory Council 2011, *Sentencing Snapshot: Culpable driving causing death*, May https://www.sentencingcouncil.vic.gov.au/sites/default/files/publication-documents/Snapshot%20111%20Sentencing%20Trends%20for%20Culpable%20Driving%20Causing%20Death%20in%20the%20Higher%20Courts%20of%20Victoria%20May%202011.pdf

Street, S 2016, "IBIS 2016 Global Focus Repair Report Australia", *Australasian Paint and Panel*, 31 May, http://www.paintandpanel.com.au/news/news/ibis-2016-global-focus-repair-report-australia

Transport Accident Commission (TAC) 2015, *Annual Report 2014-15*, https://www.tac.vic.gov.au/__data/assets/pdf_file/0008/169838/TAC_Annual_Report_2015_WEB.pdf

Transport Accident Commission 2016, *Annual Report 2015-16*, http://www.tac.vic.gov.au/__data/assets/pdf_file/0006/206169/TAC_Annual_Report_2016_web-FINAL.pdf

Transport and Infrastructure Council (TIC) 2016a, *Australian Transport Assessment and Planning Guidelines PV2 Road Parameter Values*, https://atap.gov.au/parameter-values/road-transport/index.aspx

Transport and Infrastructure Council (TIC) 2016b, *Australian Transport Assessment and Planning Guidelines T2 Cost Benefit Analysis*, https://atap.gov.au/tools-techniques/cost-benefit-analysis/files/t2_cost_benefit_analysis.pdf

Transport for NSW 2016, *Road Traffic Casualty Crashes in New South Wales*, Statistical Statement for the year ended 31 December 2015, Centre for Road Safety http://roadsafety.transport.nsw.gov.au/downloads/crashstats2015.pdf

Treasury 2015a, *Budget 2015, Statement 5: Expenses and Net Capital Investment* http://www.budget.gov.au/2015-16/content/bp1/download/bp1_bs5.pdf

Treasury 2015b, *2015 Intergenerational Report: Australia at 2055*, http://www.treasury.gov.au/PublicationsAndMedia/Publications/2015/2015-Intergenerational-Report

Victorian Auditor-General 2009, *Vehicle Fleet Management*, November PP No 255, http://www.audit.vic.gov.au/publications/2009-10/20091125-VFM-Full-Report.pdf

Appendices

Appendix A - Consultation

State and territory road safety agencies were contacted for additional, unpublished data in relation to recent year road crashes. Additional data were provided by:

- Northern Territory Department of Infrastructure, Planning and Logistics
- Queensland Department of Main Roads
- South Australian Department of Planning, Transport and Infrastructure,
- Tasmanian Department of State Growth
- Western Australian Road Safety Commission.

In addition, Insurance Statistics Australia and the Transport Accident Commission (Victoria) provided data on insurance claims and costs.

The Queensland Department of Transport and Main Roads provided data on travel delay costs resulting from road crashes in Southeast Queensland. This was facilitated by Austroads, the peak organisation of Australasian road transport and traffic agencies.

The following individuals and organisations were consulted, in person or by phone, in the context of investigating changes over the past decade in the drivers of the economic costs of road trauma industry and, as applicable, in relation to project methodology and data matters.

- Gary Brennan, Senior Policy Officer, Bicycle Network Victoria
- Professor Alex Collie, Head of Insurance, Work and Health Group, Faculty of Medicine, Nursing and Health Sciences, Monash University
- Gary Dolman, Head, Bureau of Infrastructure Transport and Regional Economics
- Associate Professor Michael Fitzharris, Monash University Accident Research Centre
- Professor Belinda Gabbé, Head, Pre-Hospital, Emergency and Trauma Research Unit, Monash University
- David Gifford, Chief Strategy Officer, Office of the CEO, Transport Accident Commission, Victoria
- Mark Harvey, Research Leader, Bureau of Infrastructure Transport and Regional Economics
- Professor James Harrison, Research Centre for Injury Studies, Flinders University
- Anne Kirwan, Chief Executive Officer, CatholicCare, Red Hill, ACT
- Julie McRoy, Manager, Dorothy Sales Cottages, CatholicCare, ACT
- Neil Mackinnon, NSW Lifetime Care and Support Authority
- David Minty, Insurance Statistics Australia (through the Australian Automobile Association)
- Brian Negus, General Manager, Public Policy, Royal Automobile Club of Victoria
- Associate Professor Stuart Newstead, Monash University Accident Research Centre
- Tim Risbey, Research Leader, Bureau of Infrastructure Transport and Regional Economics
- Stella Samoborec, Doctoral student, Department of Epidemiology and Preventive Medicine, School of Public Health and Preventive Medicine, Monash University

Appendix B – Data estimation

This appendix details the estimation approach for the numbers of:

- Road crashes
- Hospitalised injuries
- Persons disabled following road crash injury
- Non-hospitalised injuries
- Vehicles involved in road crashes

in 2015 that are used in the study.

B.1 Number of road crashes in 2015

While all jurisdictions report fatal road crash data annually, injury crash data are not consistently reported and only the Australian Capital Territory (ACT) publicly reports property damage crash statistics publicly. Accordingly, all jurisdictions were contacted for additional data to assist in complementing the publicly available information. Additional summary data, for 2015 and other years, were received from Queensland (QLD), Western Australia (WA), South Australia (SA), Tasmania (TAS) and Northern Territory (NT) that was invaluable in completing the estimation task.

The number of road crashes was estimated separately for hospitalised injury crashes, non-hospitalised injury crashes and property damage crashes (see Table B.1). Fatal crash data are available through the National Crash Database (BITRE 2016). In addition, data on the number of vehicle insurance claims in the year provide a partial 'top down' check on the total estimate. This is discussed further in Section B.3.1.

Table B.1 Road crashes by type, 2006 and 2015

Crash type	2006	2015	*% all 2015 crashes*	*% change from 2006*
Fatal crashes	1,455	1,101	*0.2%*	*-24.3%*
Hospitalised injury crashes	25,498	31,637	*4.7%*	*24.1%*
Non-hospitalised injury crashes	188,200	189,643	*27.9%*	*0.8%*
Property damage crashes	438,700	456,978	*67.3%*	*4.2%*
TOTAL	653,853	679,359	*100.0%*	*3.9%*

B.1.1 Hospitalised injury crashes

The number of 'serious injury' crashes in 2015 for six jurisdictions was accessed. The ratio of serious to fatal crashes in these jurisdictions (16.1 to one) was used to estimate hospitalised injury crashes in the remaining two jurisdictions, NT and ACT. The resulting serious injury crash estimates for all jurisdictions were then factored up by the ratio between the national total of hospitalised injury crashes, as estimated through the Australian Institute of Health and Welfare hospitalised injury dataset (as projected for 2015, see Section B.2) and the national estimated total of police-reported serious injury crashes (1.8 to one). The former estimate involves 'working backwards' from the number of persons admitted to hospital following crashes to the number of hospitalised injury crashes, using an estimate of the average number of hospitalised casualties per crash (1.2, see also Table B.2). See Section B.2 regarding the number of hospitalised injuries in 2015.

Table B.2 Casualty rates by road crash type 2015

<table>
<tr><th>Crash type</th><th>Fatalities per crash</th><th>Hospitalised injuries per crash</th><th>Non-hospitalised injuries per crash</th></tr>
<tr><td>Fatal</td><td>1.09</td><td>0.45</td><td>0.27</td></tr>
<tr><td>Hospitalised injury</td><td rowspan="2">N/A</td><td>1.20</td><td>0.19</td></tr>
<tr><td>Non-hospitalised injury</td><td>N/A</td><td>1.20</td></tr>
</table>

Source: BITRE 2009, BITRE 2016 and ECON analysis

B.1.2 Non-hospitalised injury crashes

Non-hospitalised injury crash data for 2015 were accessed for three jurisdictions, NSW, QLD and WA. NSW, which reports separately serious, moderate and minor injury crashes (Transport for NSW 2016), was used as the benchmark for the national estimate, with its moderate and minor injury crashes together comprising NSW's total 'non-hospitalised' injury crashes. Estimates for VIC, SA and TAS were calculated, taking account of each jurisdiction's population and exposure (kilometres travelled per person), relative to those of NSW.[57] ACT reports injury crashes but, unlike, NSW, does not differentiate between serious and other injury crashes. Therefore, the ACT total was calculated as the difference between this number and the estimate for ACT hospitalised injury crashes (see Section B.1.1). As NT's crash rate is systematically higher than that of other jurisdictions,[58] the ratio of NSW non-hospitalised injury crashes to fatal crashes (66.6 to one) was applied to NT's fatal crash number, on the basis that this would produce a more accurate estimate.

This approach generated a national estimate (70,833 crashes) that aims to simulate consistent national reporting of non-hospitalised injury crashes and with the NSW reporting rate as the benchmark. However, this estimate does not take account of other non-hospitalised injury road crashes, i.e. road crash injury presentations at Emergency Departments where there is no hospital admission, or of presentations to general practitioners, again with no subsequent hospital admission. BITRE 2009 estimated a total number of non-hospitalised crashes for 2006 having regard to its estimate of the total number of non-hospitalised injuries (i.e. again 'working backwards') and this study follows a similar approach. BITRE's estimate of 216,500 non-hospitalised injuries comprised 110,200 people who attended hospital but were not admitted and 106,300 who were treated by general practitioners.

This study estimates an increase in non-hospitalised injury crashes based on the limited trend growth in insurance claims in the two jurisdictions for which data are available, VIC and QLD. Claims growth averaged 0.4 per cent a year between 2006 and 2016 in VIC and 0.7 per cent over this period in QLD. A rate of growth of 0.5 per cent per year was adopted, giving an increase in non-hospitalised injuries from 216,500 (2006) to 227,572.

---

[57] Sources were ABS 2015a and ABS 2015c for population data and travel exposure data respectively.

[58] "Annual road deaths in Australia have decreased from 7.9 to 5.2 per 100 000 population in the period from 2004 to 2013 … In contrast to the national figures, the Northern Territory has recorded a mean of 21.8 deaths per 100 000 over the same period." (Read 2015)

This translates to a total of 189,643 non-hospitalised injury crashes, again using a casualty rate per crash in respect of the incremental casualties.

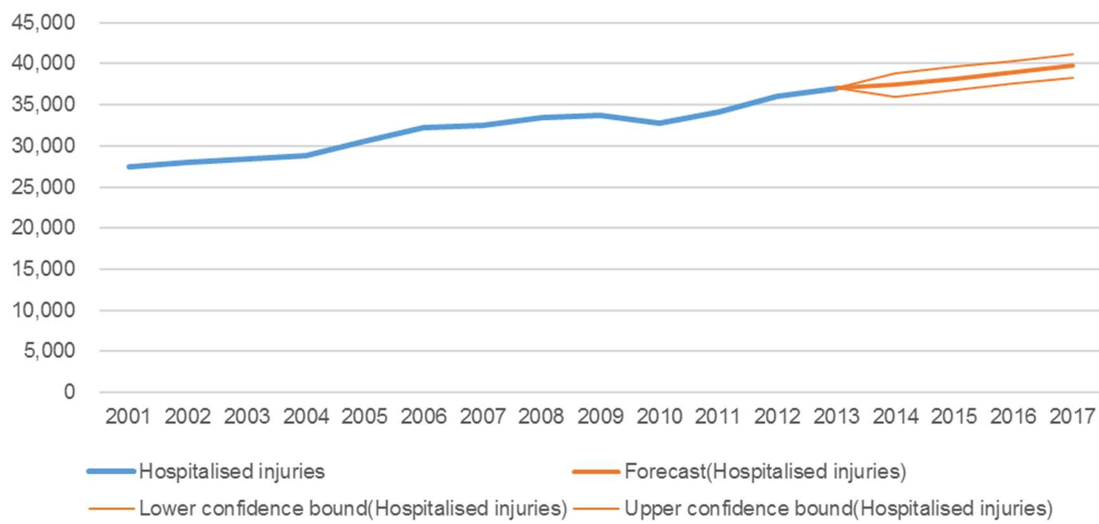
B.1.3 Property damage only crashes

Data for property damage only crashes were accessed for WA, TAS and ACT.[59] The ACT ratio of reported crashes to fatal crashes (514 to one) exceeded BITRE's national estimate of (reported and unreported) property damage crashes to fatal crashes (302 to one) for 2006. When applied nationally,[60] in similar manner to the approach to non-hospitalised injury crashes (Section B.1.2), the ACT benchmark generates national property damage only crash estimates four per cent above the 2006 total.

B.2 Number of hospitalised injuries

With national 2015 hospitalised injury data not yet available, the number of hospitalised injuries is estimated, based on trend data from 2001 to 2013 (Figure B.1). Confidence intervals for the 2015 estimates are shown in Table B.3.

Figure B.1 Hospitalised injury estimates, 2014 to 2017



Source: BITRE and NISU 2017 and ECON analysis

[59] ACT data are publicly available (ACT 2016).

[60] This excludes NT, where the approach outlined in Section B.1.2 is used, allowing for NT's systematically higher crash rate.

Table B.3 Hospitalised injury estimates, with confidence bounds,2014 and 2015

Calendar year	Central estimate (1)	*Central estimate year on year growth %*	Lower confidence bound (95%)	Upper confidence bound (95%)
2012	36,091		36,091	36,091
2013	37,059	*2.7%*	37,059	37,059
2014	37,450	*1.1%*	36,036	38,865
2015	38,216	*2.0%*	36,802	39,631

(1) Actuals to 2013 and estimates thereafter,with 2,000 Emergency Department cases of a major jurisdiction that were removed in 2011 added back to the series.

Source: BITRE 2017c and ECON analysis

Forecasts based on the alternative financial year data series provide additional validation for the 2015 central estimate of 38,216 hospitalisations (Table B.4).[61] The calendar 2015 estimate is less than 600 cases higher than the 2014-15 estimate (37,860) and in turn is less than 500 cases lower than the 2015-16 estimate (38,658, not shown in the table). Financial year central estimates for both years are within the confidence bound range for the central calendar year estimate.

Table B.4 Hospitalised injury estimates, 2014-15 and 2015-16

Financial year	Central estimate (1)	*Central estimate year on year growth %*	Productivity Commission Report on Government Services 2017	*Productivity Commission year on year growth %*
2011-12	36,550		40,665	
2012-13	36,011	*-1.5%*	40,171	*-1.2%*
2013-14	37,646	*4.5%*	41,223	*2.6%*
2014-15	37,860	*0.6%*	42,169	*2.3%*

(1) Actuals to 2013-14, but with 2,000 Emergency Department cases of a major jurisdiction that were removed in 2011-12 added back to the series

Source: BITRE 2017c, Productivity Commission 2017a and ECON analysis

In addition, the central financial year estimate for 2014-15, with a 0.6 per cent growth rate over 2013-14, is comfortably within the year on year growth rate of the data reported by the Productivity Commission for the year (2.3 per cent). As noted in Section 3.1 and is apparent from the table, the commission 'traffic accident hospitalisation' series does not align with the Australian Institute of Health and Welfare public road crash hospitalisation series used in this study (BITRE 2017c).

B.3 Number of persons disabled

The number of persons disabled from 2015 road crashes is calculated with reference to the change in numbers, as measured by the ABS Survey of Disability, Ageing and Carers, between the survey years of 2012 and 2015.

[61] This figure includes an estimated 252 persons who died in hospital from fatal injuries.

ABS estimates that there were 130,100 persons disabled from road crashes in 2015, 3,500 more than in 2012 (126,600 persons) and equivalent to three per cent of all persons with a disability in that year. In the absence of data on the annual inflow into the total group of disabled persons, the number of persons disabled from road crash injury in 2015 was estimated taking account of both the change in the size of the cohort over the three years and assumed cohort attrition over that time, due to death or other reasons.

The cohort attrition factors used were 2.5 per cent per year (male) and 2.6 per cent per year (female), taking account of estimated life expectancy.

Table B.5 Calculation of the number of persons disabled from 2015 road crash injury

	Mild	Moderate	Severe & profound	Total
2012	48,800	31,200	46,600	126,600
2015	53,100	31,700	45,300	130,100
Change (3 years)	4,300	500	-1,300	3,500
Attrition (3 years)	3,894	2,403	3,512	9,809
New cases (3 years)	8,194	2,903	2,212	13,309
Annual new cases	2,731	968	737	4,436

Note: Severe and profound disability severity groups are combined, as the method generated a negative number of new profound disability cases, which is not consistent with evidence provided by care and support agencies (see Section 4.5). The lower three rows in this table are ECON estimates.

Source: ABS 2016h and ECON analysis

The estimated 4,436 persons disabled (Table B.5) were assigned to the four disability severity levels in accordance with the ABS survey data. See Table 6 and Figure 9 (Section 4.5).

B.4 Number of non-hospitalised injuries

The estimate of the number of non-hospitalised injuries is an input into the estimate of non-hospitalised crashes. See Section B.1.2.

B.5 Number of vehicles in road crashes

The total number of vehicles involved in crashes was estimated with the aid of: data on vehicles involved in reported crashes; standardised parameters based on these data; and data on the aggregate number of vehicle damage insurance claims. The vehicle profile, in terms of five vehicle types (car including LCV, motorcycle, bus, rigid truck and articulated truck) was then developed.

B.5.1 Total number of vehicles involved in road crashes

The total number of vehicles involved in fatal crashes in 2015 was 1,649, an average of 1.53 per crash (BITRE 2017b). Vehicle estimates for other crash types involve estimation. While based on recent data, average vehicle numbers per crash parameters are similar to those in BITRE 2009, which had an average number of vehicles for all crash types of 1.77 compared with 1.83 in this study (Table B.5).

Parameter values are 1.7 vehicles per crash for injury crashes (both hospitalised and non-hospitalised) and 1.9 vehicles per crash for property damage only crashes.

Table B.5 Average vehicles per crash and total vehicles, 2015

Crash type	Average no vehicles per crash	Total no vehicles	*% total no vehicles*
Fatal	1.53	1,649	*0.1%*
Injury	1.70	376,175	*30.2%*
Property damage only	1.90	868,258	*69.7%*
TOTAL	1.83	1,246,083	*100.0%*

Source: BITRE 2017b and ECON analysis

Insurance claim data provided by Insurance Statistics Australia was used as a 'top down' check on both the total number of vehicles estimate and the total number of road crashes estimates (see Section B.1.1). Based on these data, with adjustments to the raw data to allow for 100 per cent of market coverage and to omit off road claims (28.9 per cent of the total, following Berry and Harrison 2008), there were an estimated 1,070,783 vehicle-related insurance claims in 2015. This implies an additional number of 175,299 vehicles (14.1 per cent of the total of 1,246,083) that were damaged in road crashes and repaired, or scrapped, outside the insurance framework (e.g. vehicles with no insurance other than Compulsory Third Party insurance, vehicles where damage claims are less than the insurance excess). It appears, from analysis of the BITRE estimate of the number of vehicles involved in road crashes in 2006 in the context of vehicle insurance claims data from the 2000s provided by Insurance Statistics Australia, that this is a lower percentage of 'additional' vehicles than at that time.

B.5.2 Vehicle profile

The 2015 profile of vehicles involved in crashes is shown in Table B.6. It makes use particularly of 2014 NSW, SA and ACT road crash statistics (injury crashes) and 2014 NSW and ACT data (property damage crashes). NSW statistics showed an incidence of rigid truck involvement in crashes in excess of 10 per cent for both injury crashes and property damage crashes in the state. This contrasted with BITRE's national estimate for 2006 of under four per cent. A possible explanation for the discrepancy is that this is a reporting effect, i.e. that crashes involving heavy vehicles in NSW may be more likely to be reported to police than other crashes, regardless of whether or not road user injuries are involved. This study has adopted a weighting of four per cent (i.e. a rigid truck vehicle share of 2.8 per cent and an articulated truck share of 1.3 per cent), close to that of BITRE 2009 (see also Figure B.2).

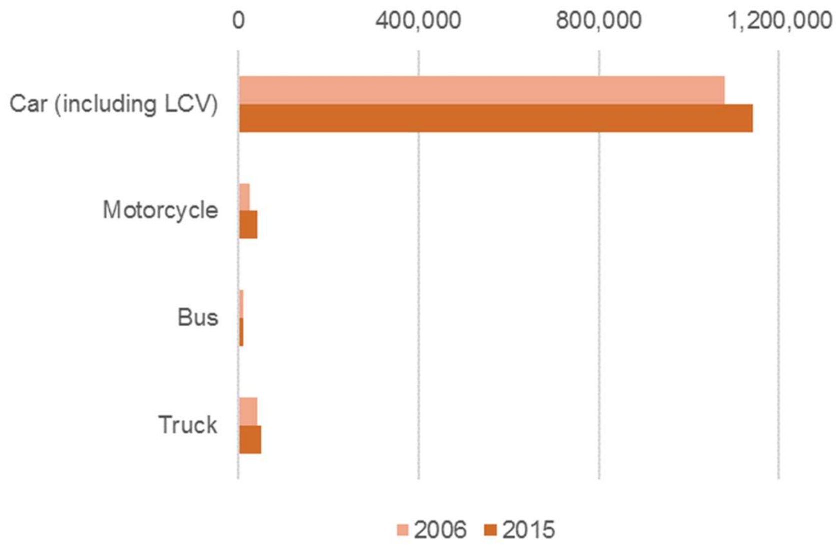
Table B.6 Vehicles involved in road crashes in 2015, by crash type

Vehicle type	Fatal crashes	Injury crashes	Property damage crashes	Total crashes	% total vehicles
Car (including LCV)	1,221	323,678	818,532	1,143,432	*91.8%*
Motorcycle	223	34,008	7,814	42,045	*3.4%*
Bus	18	2,996	7,057	10,071	*0.8%*
Rigid truck	78	10,533	24,311	34,922	*2.8%*
Articulated truck	109	4,960	10,544	15,613	*1.3%*
TOTAL VEHICLES	1,649	376,175	868,258	1,246,083	*100.0%*

Note: Totals may not sum precisely, due to rounding.

Source: BITRE 2009, Jurisdiction road crash statistics 2014 and 2015 and ECON analysis

Figure B.2 Profile of vehicles involved in road crashes, 2006 and 2015



Source: BITRE 2009, BITRE 2017b, Jurisdiction road crash statistics and ECON analysis

Appendix C – Cost to government: taxation and income support impacts

Taxation losses and additional income support payments resulting from road fatality and injury are calculated by estimating what the outcome for government finances, on the basis of population averages, would have been, in the absence of the road trauma. This appendix:

- Profiles the numbers of people impacted, by age group and gender
- Describes the methodology to estimate forgone lifetime taxation revenue
- Describes the methodology to estimate additional net income support payments, comprising a saving in payments in the case of fatalities and an increase in respect of disabling injuries that result in reduced workforce participation
- Outlines net costs to government by gender and age group for fatalities, injuries and in total.

C.1 Fatalities and disabled persons profile

Table C.1 sets out 2015 fatalities by age group and gender.

Table C.1 Fatalities by gender and age 2015

Age group	Male	Female	Total	*% total*
0-16	37	28	65	*5.4%*
17-25	170	55	225	*18.7%*
26-39	213	59	272	*22.6%*
40-64	280	93	373	*31.0%*
65-74	77	41	118	*9.8%*
75-100	89	63	152	*12.6%*
TOTAL	866	339	1,205	*100.0%*

Source: BITRE 2016 and ECON analysis

Of an estimated 37,964 persons injured in road crashes in 2015,[62] an estimated 4,436 (11.7 per cent) became lastingly disabled. This group's gender and age profile is shown in Table C.2. The gender profile is as per the ABS Survey of Disability, Ageing and Carers (SDAC, ABS 2016g), while the age profile replicates that of the hospitalised injury cohort.

[62] This larger group is not profiled as no taxation losses and income support impacts are calculated in relation to it. Employed injured persons may either return to work quickly, or may continue to receive income and pay usual levels of tax for at least some part of the recovery period before returning to work. However, to the extent that they lose income, there is an associated cost to government that is not reflected in these calculations. Insurance compensation that they may receive for lost income is not subject to income tax. From available data sighted, the cost to government from loss of earnings pending return to work (excluding longer term disabled) is considered unlikely to exceed $40m (present value).

Table C.2 Persons disabled from 2015 road trauma, by gender and age

Age group	Male	Female	Total	*% total*
0-16	183	147	330	*7.4%*
17-25	523	430	953	*21.5%*
26-39	592	451	1,043	*23.5%*
40-64	795	687	1,482	*33.4%*
65+	240	388	628	*14.2%*
TOTAL	2,332	2,104	4,436	*100.0%*

Note: Totals may not sum precisely, due to rounding.

The disability profile by severity level and gender of this group is shown in Table C.3.

Table C.3 Disability profile by severity and gender

Disability level	Males	Females	Total	*Total as % hospitalised injuries (N=37,964)*
Mild	888	922	1,811	*4.8%*
Moderate	565	516	1,081	*2.8%*
Severe	626	431	1,057	*2.8%*
Profound	253	235	488	*1.3%*
TOTAL	2,332	2,104	4,436	*11.7%*

Note: Totals may not sum precisely, due to rounding.

C.1 Estimation methodology: introduction

Estimation of costs to government necessarily involve a net impact calculation that compares estimates of actual impacts with estimates of what the outcome could otherwise have been in the absence of the road crash in an individual case, or of road crashes in the aggregate. In regard to both fatalities and disabilities, the 'counterfactual' scenario for taxation is calculated similarly: it reflects population averages for earnings and taxation that take account of labour force participation, employment status, age group and gender. The same applies to income support, where population averages for receipt of payments such as Newstart Allowance (unemployment), Family Tax Benefit and the Age Pension can be identified.

In the fatalities case, the 'actual' scenario is straightforward: all future earnings cease and with them, so do all future tax payments to government. Almost all future income support receipts also cease,[63] whether in place at the time of death, or as age-contingent or otherwise contingent (e.g. disability-related) future government liabilities. In contrast, in regard to disabilities, the actual scenario involves continued labour force participation, to the extent compatible with the disability and with income support receipt also to be taken into account. Behavioural assumptions are therefore involved in developing both the actual and the counterfactual scenarios.

[63] Income support payments in relation to others, notably carer payments and parenting payments, are likely to continue. See also Section C.3.1.

In view of this additional complexity, taxation, earnings and income support are discussed together, under the income support heading below (Section C.3.2), rather than separately, as with fatalities.

C.3 Taxation estimation methodology

Forgone taxation in relation to both fatalities and disabled persons was calculated with reference to 2015 data on: labour force participation rates; unemployment rates; and average weekly earnings, in each case by gender and age group.

The duration of loss encompassed the years of working life. A commencement age of 16 was selected rather than 15 (as per the ABS definition), for convenience in aligning with commencement of income support payment eligibility. The average male retirement age was deemed to be 65. This involved rounding up from a current actual average retirement age of 63. The average female retirement age adopted was the current average age of 60 (ABS 2016).

Direct (i.e. income) tax revenue loss was calculated with the aid of the 'Pay as you go' tax calculator.[64] This was applied to trend average weekly earnings for males ($1,376.90, November 2016) and females ($915.70). Indirect tax was calculated at the rate of 13.1 per cent of disposable income (Access Economics 2009).

Taxation revenue was grown at 1.5 per cent per year, consistent with Treasury 2015b (p. xi).

C.3 Income support estimation methodology

C.3.1 Estimating impacts from fatalities

Based on population averages, the expected incidence of income support receipt among the members of the fatality cohort was estimated (tables C.4 and C.5). In size order, the most significant payment types are: Age Pension; Family Tax Benefit; Disability Support Pension; Newstart Allowance; and Parenting Payment.

Table C.4 Expected incidence of income support receipt (males, by age group)

Income support payment	0-15	16-24	25-34	35-44	45-54	55-64	65+
Age Pension	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*67.0%*
Carer Allowance & Payment	*0.0%*	*0.0%*	*1.0%*	*3.0%*	*3.0%*	*4.0%*	*3.0%*
Disability Support Pension	*0.0%*	*2.0%*	*2.0%*	*4.0%*	*7.0%*	*12.0%*	*1.0%*
Family Tax Benefit	*0.0%*	*6.0%*	*23.0%*	*33.0%*	*19.0%*	*3.0%*	*1.0%*
Newstart Allowance	*0.0%*	*2.0%*	*5.0%*	*6.0%*	*6.0%*	*6.0%*	*0.0%*
Parenting Payment	*0.0%*	*0.0%*	*1.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*
Austudy & Youth Allowance	*0.0%*	*10.0%*	*1.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*

Source: DSS 2015 and ECON analysis

64 See http://www.paycalculator.com.au/.

Table C.5 Expected incidence of income support receipt (females, by age group)

Income support payment	0-15	16-24	25-34	35-44	45-54	55-64	65+
Age Pension	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*71.0%*
Carer Allowance & Payment	*0.0%*	*1.0%*	*3.0%*	*8.0%*	*10.0%*	*10.0%*	*8.0%*
Disability Support Pension	*0.0%*	*2.0%*	*2.0%*	*4.0%*	*7.0%*	*10.0%*	*1.0%*
Family Tax Benefit	*0.0%*	*6.0%*	*23.0%*	*33.0%*	*21.0%*	*3.0%*	*0.0%*
Newstart Allowance	*0.0%*	*2.0%*	*4.0%*	*5.0%*	*6.0%*	*5.0%*	*0.0%*
Parenting Payment	*0.0%*	*5.0%*	*9.0%*	*6.0%*	*1.0%*	*0.0%*	*0.0%*
Austudy & Youth Allowance	*0.0%*	*11.0%*	*1.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*

Source: DSS 2015 and ECON analysis

The estimated numbers of members of the fatality cohort that would have been in receipt of payments at the time of death is shown in Tables C.6 and C.7.

Table C.6 Estimated 2015 fatality cohort members in receipt of income support (males)

Income support payment	0-15	16-24	25-34	35-44	45-54	55-64	65 and over	Total
Age Pension	0.0	0.0	0.0	0.0	0.0	0.0	107.0	107.0
Carer Allowance and Payment	0.0	0.0	0.0	1.0	1.0	1.0	5.0	8.0
Disability Support Pension	0.0	1.0	1.0	1.0	2.0	3.0	2.0	10.0
Family Tax Benefit	0.0	4.0	6.0	6.0	4.0	1.0	1.0	22.0
Newstart Allowance	0.0	2.0	1.0	1.0	1.0	1.0	0.0	6.0
Parenting Payment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Youth Allowance and Austudy	0.0	7.0	0.0	0.0	0.0	0.0	0.0	7.0

Source: ABS 2017b, DSS 2015 and ECON analysis

Table C.7 Estimated 2015 fatality cohort members in receipt of income support (females)

Income support payment	0-15	16-24	25-34	35-44	45-54	55-64	65 and over	Total
Age Pension	0.0	0.0	0.0	0.0	0.0	0.0	73.0	73.0
Carer Allowance and Payment	0.0	1.0	2.0	1.0	1.0	2.0	8.0	15.0
Disability Support Pension	0.0	1.0	1.0	0.0	1.0	2.0	1.0	6.0
Family Tax Benefit	0.0	3.0	12.0	3.0	2.0	0.0	0.0	20.0
Newstart Allowance	0.0	1.0	2.0	0.0	1.0	1.0	0.0	5.0
Parenting Payment	0.0	2.0	5.0	0.0	0.0	0.0	0.0	7.0
Youth Allowance and Austudy	0.0	6.0	0.0	0.0	0.0	0.0	0.0	6.0

Source: ABS 2017b, DSS 2015 and ECON analysis

Carer Allowance, Caring Payment and Parenting Payment receipts could be expected to continue in most instances following a fatality, with the payment made to another family member, relative or guardian. This would be the case except where the person cared for, or the child involved, also died. However, for simplicity and noting the small share of these payments (less than two per cent of the total), no adjustment was made to the estimates.

Average payment duration data was combined with data on average payment levels to generate total payments received for each age group (DSS 2015). Average payment levels were estimated with regard to total annual payments and the number of recipients (Treasury 2015a).

Income support payments are indexed by government twice yearly to maintain their value.[65] In contrast to taxation revenue losses, payments in relation to both fatalities and disabilities (Section C.3.2) were estimated as constant in real terms over time.

C.3.2 Estimating impacts from disability

Available evidence suggests that around 80 per cent of injured road crash casualties receive compensation for loss of income and/or for non-economic loss, i.e. pain and suffering (Section 2.2.2). Thus 3,458 persons (80 per cent of the estimated 4,436 persons disabled as a result of injury) were assumed to receive compensation following the road crash, while the remaining 20 per cent (887 persons) were assumed to receive Commonwealth income support (Disability Support Pension), subject to age-related eligibility conditions.[66]

'Lump sum preclusion periods' limit early year access to income support for those in receipt of compensation, although there is discretion in application (Productivity Commission 2011, p. 812). The estimated 3,548 persons who received compensation were assumed to become eligible for government income support six years following the crash (i.e. in 2021). While the six year waiting period assumption may be conservative and imply some underestimation of cost, other simplifying assumptions may have a counterbalancing effect. These are: universal eligibility for Commonwealth income support, with no one excluded on grounds of their income or assets exceeding the relevant eligibility levels; and non-exclusion of those in receipt of ongoing income-related compensation payments. [67]

To calculate income support payments, the disability cohort was divided into three sub-groups:

- Sub-group 1: those who are unable to work at all and receive full pension:

---

[65] At the time of writing, all pension payments and pension equivalent payments are to be indexed by the CPI from September 2017, subject to passage of legislation (see https://www.humanservices.gov.au/corporate/budget/budget-2014-15/budget-measures/older-australians/index-pension-and-pension-equivalent-payments-consumer-price-index, accessed 8 May 2017). Currently, a benchmarking adjustment against a percentage of male total average weekly earnings can result in higher rates of payment for most pensions, but not for other income support payments such as Newstart Allowance (Klapdor 2014).

[66] Those outside working age (15 to 64 years) are excluded as general community arrangements, rather than the impact of road trauma, will govern eligibility and ineligibility for receipt of income support at these ages. This reduces the relevant number of persons from 4,436 to 3,807.

[67] Under no-fault compensation arrangements in Victoria, income support compensation payments are limited to three years, except in cases where a person is assessed as more than 50 per cent impaired, in which case payment continues for as long as the impairment remains and potentially for life. TAC personal communication, 28 April 2017.

- Sub-group 2: persons who work limited part-time hours and remain eligible for full pension
- Sub-group 3: those who work more hours and receive a part pension.

Sub-group 1 comprises 49 per cent of the total group (1,865 persons). This is calculated consistent with ABS SDAC estimates, to the effect that 46 per cent of road injury disabled persons are not in the labour force and a further five per cent are unemployed. This group encompasses all profoundly and severely disabled persons, a total of 1,545 persons, together with some moderately disabled ones (Table C.3).

Sub-group 2 comprises 35 per cent of the total group (1,332 persons) and sub-group 3 comprises 610 persons. While there is little guiding information here, the latter two percentages yield an average payment rate per person ($784 per fortnight) across the entire group that is broadly consistent with publicly reported payment levels for the Disability Support Pension (i.e. $746 per fortnight in 2013-14, Productivity Commission 2015, p. 14.9).

Payment duration continued up to retirement age at 65.[68] Post-retirement income support costs were not included, as these relate to a general community entitlement under Age Pension eligibility and not to a road crash cause.

C.3.3 Carer Payment and Carer Allowance

Persons eligible for the Carer Payment “give constant daily care to someone who has a severe disability or severe illness or is frail aged … in a private home … and spend no more than 25 hours a week away from caring for work, study or training”.[69]

Carer Payment receipts were calculated in respect of the severely disabled (1,057 persons) and 50 per cent of the profoundly disabled (244 persons). Profoundly disabled persons are cared for both at home and in residential facilities: the carers of those in residential facilities would be ineligible for Carer Payment.

70 per cent of carers are in non-caring work for 25 hours or less and are thereby eligible for the Carer Payment. The remainder, who work more than 25 hours, receive the (non-means tested) Carer Allowance, involving a lesser amount of up to about 20 per cent of the Carer Payment,

Because carers provide lifetime care for disabled persons, where required, these expenditures are estimated to continue beyond the retirement age for working persons until death. Year of death is brought forward by three per cent of normal actuarial life expectancy, due to the disability (sections 3.4 and 5.2.2).

C.4 Results

Results are presented here, firstly in relation to fatalities, secondly for disabilities and finally in terms of total cost to government.

[68] For simplicity, the analysis was not adjusted to reflect the planned staged introduction of a 67 year eligibility age for the Age Pension from 2023-24 and a 70 year eligibility age from 2035-36. This results in some underestimation of income support costs, as average duration in receipt of disability-related income support for eligible persons is likely to increase.

[69] Department of Human Services website, Eligibility Rules for Carer Payment, https://www.humanservices.gov.au/customer/enablers/eligibility-carer-payment#a2, accessed 20 March 2017

C.4.1 Fatalities

Tax revenue (PAYG and indirect taxes) lost as a result of road fatalities were estimated to total $378.0m in 2015 prices representing the present value of foregone tax over the lifetime of the fatalities group (Table C.8).

Table C.8 Tax revenue cost from 2015 road trauma – fatalities

Age group	Foregone tax tevenue (male)	Foregone tax revenue (female)	Total foregone tax tevenue
0-15	15.2	6.6	21.8
16-24	77.9	17.2	95.1
25-34	106.0	18.6	124.6
35-44	59.5	7.6	67.1
45-54	43.1	6.5	49.6
55-64	11.2	2.9	14.1
65+	3.5	2.2	5.7
TOTAL	316.5	61.5	378.0

Note: Totals may not sum precisely, due to rounding.

Estimated lifetime net income support savings, resulting from reduced Age Pension and other payment type expenditure, total $112.2m (Table C.9).

Table C.9 Income support saving from 2015 road trauma – fatalities

Age group	Income support expenditure (male)	Income support expenditure (female)	Total income support expenditure
0-15	0.8	0.9	1.7
16-24	7.1	3.9	10.9
25-34	9.7	4.9	14.6
35-44	9.3	3.3	12.6
45-54	14.0	5.6	19.6
55-64	12.2	7.8	20.0
65+	19.9	13	32.8
TOTAL	72.9	39.2	112.2

Note: Totals may not sum precisely, due to rounding.

C.4.2 Disabilities

The tax revenue and income support expenditure cost to government, as a result of the disability impact of 2015 road trauma, was calculated as the difference between the financial outcome for government in the absence of the trauma and the financial outcome consequential on the trauma. Tables showing the estimated actual cost to government ('gross' cost, Table C.10), counterfactual cost (Table C.11) and net effect (Table C.12), follow.

Table C.10 Tax and income support gross cost to government from 2015 road trauma – disabilities, $m

Age group	Tax revenue cost	Income support expenditure	Cost to government
0-16	-41.4	179.8	138.4
17-25	-112.4	476.2	363.8
26-39	-102.9	399.6	296.7
40-64	-83.3	194.5	111.2
TOTAL	-340.0	1,250.1	910.1

Table C.11 Tax and income support cost to government in the absence of 2015 road trauma – disabilities, $m

Age group	Tax revenue cost	Income support expenditure	Cost to government
0-16	-131.7	0	-131.7
17-25	-458.7	3.4	-455.3
26-39	-420.1	6.5	-413.6
40-64	-264.7	12.1	-252.6
TOTAL	-1,275.1	21.9	-1,253.2

Note: Totals may not sum precisely, due to rounding.

Table C.12 Tax revenue and income support cost from 2015 road trauma - disabilities, $m

Age group	Tax revenue cost	Income support expenditure	Cost to government
0-16	-90.3	179.8	270.0
17-25	-346.3	472.9	819.1
26-39	-317.2	393.1	710.3
40-64	-181.3	182.5	363.8
TOTAL	-935.1	1,228.2	2,163.3

Note: Totals may not sum precisely, due to rounding.

C.4.3 Total cost

The total tax revenue cost and income support from road trauma 2015 is estimated at $2,870.1m (Table C.13). The total cost to government from fatalities was $265.9m, with an income support saving partly offsetting forgone tax revenue.

The total cost in relation to disabled persons was $2,163.3m and the total cost of carer income support is estimated at $441.0m.

Table C.13 Total tax revenue and income support cost from 2015 road trauma, $m

Road trauma group	Forgone tax revenue	Income support expenditure	Net budget cost	*% total*
Fatalities	378.0	-112.2	265.9	*9.3%*
Disabled persons	935.1	1,228.2	2,163.3	*75.4%*
Carers of disabled persons (1)		441.0	441.0	*15.4%*
TOTAL	1,313.1	1,557.0	2,870.1	*100.0%*

Note: Totals may not sum precisely, due to rounding.

Source: ECON analysis

Economic Connections Pty Ltd

PO Box 470. Hall ACT 2618

M:0430 204 370 E: pjpotterton@bigpond.com